BRITISH STANDARD

BS EN 201:2009

Plastics and rubber machines — Injection moulding machines — Safety requirements

ICS 83.200

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 201:2009. It supersedes BS EN 201:1997 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/3/2, Rubber and plastics machine - Safety.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 January 2010

ISBN 978 0 580 60020 3

Amendments/corrigenda issued since publication

Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 201

October 2009

ICS 25.120.20; 83.200

Supersedes EN 201:1997

English Version

Plastics and rubber machines - Injection moulding machines - Safety requirements

Machines pour les matières plastiques et le caoutchouc - Machines de moulage par injection - Prescriptions de sécurité

Kunststoff- und Gummimaschinen - Spritzgießmaschinen - Sicherheitsanforderungen

This European Standard was approved by CEN on 12 September 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 201:2009: E

Contents

Page

Foreword

This document (EN 201:2009) has been prepared by Technical Committee CEN/TC 145 “Plastics and rubber machines”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2010, and conflicting national standards shall be withdrawn at the latest by April 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 201:1997.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document.

A transition period of one year is permitted following the publication of this document during which the manufacturer may choose to apply either version of the standard.

In addition to EN 201:1997, requirements for machines with electrical axes, machines with L-type configuration, cellular foam injection moulding machines, machines with fluid injectors, and machines safeguarded by light curtains or two-hand control devices are included.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

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

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

When provisions of this type C standard are different from those which are stated in type A and B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built in accordance with the provisions of this type C standard.

1 Scope

This European Standard specifies the essential safety requirements for injection moulding machines for the processing of plastics and/or rubber.

All hazards listed in Clause 4 are covered by this standard.

The following machines are not covered:

— machines on which the clamping unit can only be operated by the physical force of the operator;

— injection moulding machines with pneumatic drives for the platen movement;

— injection moulding machines with vertical platen movements driven by an electrical axis;

— blow moulding machines associated with an injection process (EN 422);

— machines for reaction injection moulding (RIM) (EN 1612-1);

— presses (EN 289);

— footwear moulding machines covered by EN 1845.

The safety requirements for the interaction between injection moulding machines and ancillary equipment are specified.

This standard covers magnetic clamping systems only if:

— machines have horizontal clamping units; and

— the mould area is protected by guards; and

— such systems are delivered at the same time as the injection moulding machine by the machine manufacturer.

This standard does not cover requirements for the design of an exhaust system.

This standard is not applicable to injection moulding machines which are manufactured before the date of its publication as an EN.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendment) applies.

EN 349:1993+A1:2008, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

EN 574:1996+A1:2008, *Safety of machinery — Two-hand control devices — Functional aspects — Principles for design*

EN 953, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

EN 982:1996+A1:2008, *Safety of machinery — Safety requirements for fluid power systems and their components — Hydraulics*

EN 983:1996+A1:2008, *Safety of machinery — Safety requirements for fluid power systems and their components — Pneumatics*

EN 999:1998+A1:2008, *Safety of machinery — The positioning of protective equipment in respect of approach speeds of parts of the human body*

EN 1088:1995+A2:2008, *Safety of machinery — Interlocking devices associated with guards – Principles for design and selection*

EN 1760-1:1997+A1:2009, *Safety of machinery — Pressure sensitive protective devices — Part 1: General principles for the design and testing of pressure sensitive mats and pressure sensitive floors*

EN 1760-2:2001+A1:2009, *Safety of machinery — Pressure sensitive protective devices — Part 2: General principles for the design and testing of pressure sensitive edges and pressure sensitive bars*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60529:1991, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 61000-6-2:2005, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments (IEC 61000-6-2:2005)*

EN 61000-6-4:2007, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments (IEC 61000-6-4:2006)*

EN 61496-1:2004, *Safety of machinery — Electro-sensitive protective equipment — Part 1: General requirements and tests (IEC 61496-1:2004, modified)*

CLC/TS 61496-2:2006, *Safety of machinery — Electrosensitive protective equipment — Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs) (IEC 61496- 2:2006)*

CLC/TS 61496-3:2008, *Safety of machinery — Electro-sensitive protective equipment — Part 3: Particular requirements for Active opto-electronic protective devices responsive to diffuse reflection (AOPDDR) (IEC 61496-3:2008)*

EN ISO 3744:2009, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free-field over a reflecting plane (ISO 3744:1994)*

EN ISO 3746:2009, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method employing an enveloping measurement surface over a reflecting plane (ISO 3746:1995, including Cor 1:1995)*

EN ISO 3747:2009, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Comparison method for use in situ (ISO 3747:2000)*

EN ISO 4871:2009, *Acoustics — Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)*

EN ISO 11201:2009, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Engineering method in an essentially free field over a reflecting plane (ISO 11201:1995, including Cor 1:1997)*

EN ISO 11202:2009, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Survey method in situ (ISO 11202:1995)*

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

EN ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles (ISO 12100-2:2003)*

EN ISO 13732-1:2008, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces (ISO 13732-1:2006)*

EN ISO 13849-1:2008, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2006)*

EN ISO 13850:2008, *Safety of machinery — Emergency stop — Principles for design (ISO 13850:2006)*

EN ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)*

EN ISO 14122-2:2001, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways (ISO 14122-2:2001)*

EN ISO 14122-3:2001, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails (ISO 14122-3:2001)*

EN ISO 14122-4:2004, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders (ISO 14122-4:2004)*

EN ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

3.1
injection moulding machine
machine for the discontinuous production of moulded parts from plastics and/or rubber. The plasticised material is injected through a nozzle into a mould containing one or more cavities in which the article is formed.

NOTE If the plasticised material is not injected through a nozzle into the mould then EN 289 refers.

An injection moulding machine essentially consists of one or more clamping units, one or more plasticising and/or injection units, drive and control systems.

3.2
mould area
area between the platens

3.3
clamping mechanism area
area which comprises mechanisms for the movement of the mobile platen and/or the application of the clamping force

3.4
plasticising and/or injection unit
unit for plasticising and subsequently injecting material through a nozzle

NOTE On some machines the plasticising unit(s) may be separate from the injection unit(s).

3.5
rubber
for the purpose of this document: any material which generates no splashing hazards during processing

3.6
carousel machine
machine consisting of two or more clamping units mounted on a carousel in either a vertical or horizontal configuration to index to one or more fixed plasticising and/or injection units (see Figure 1)

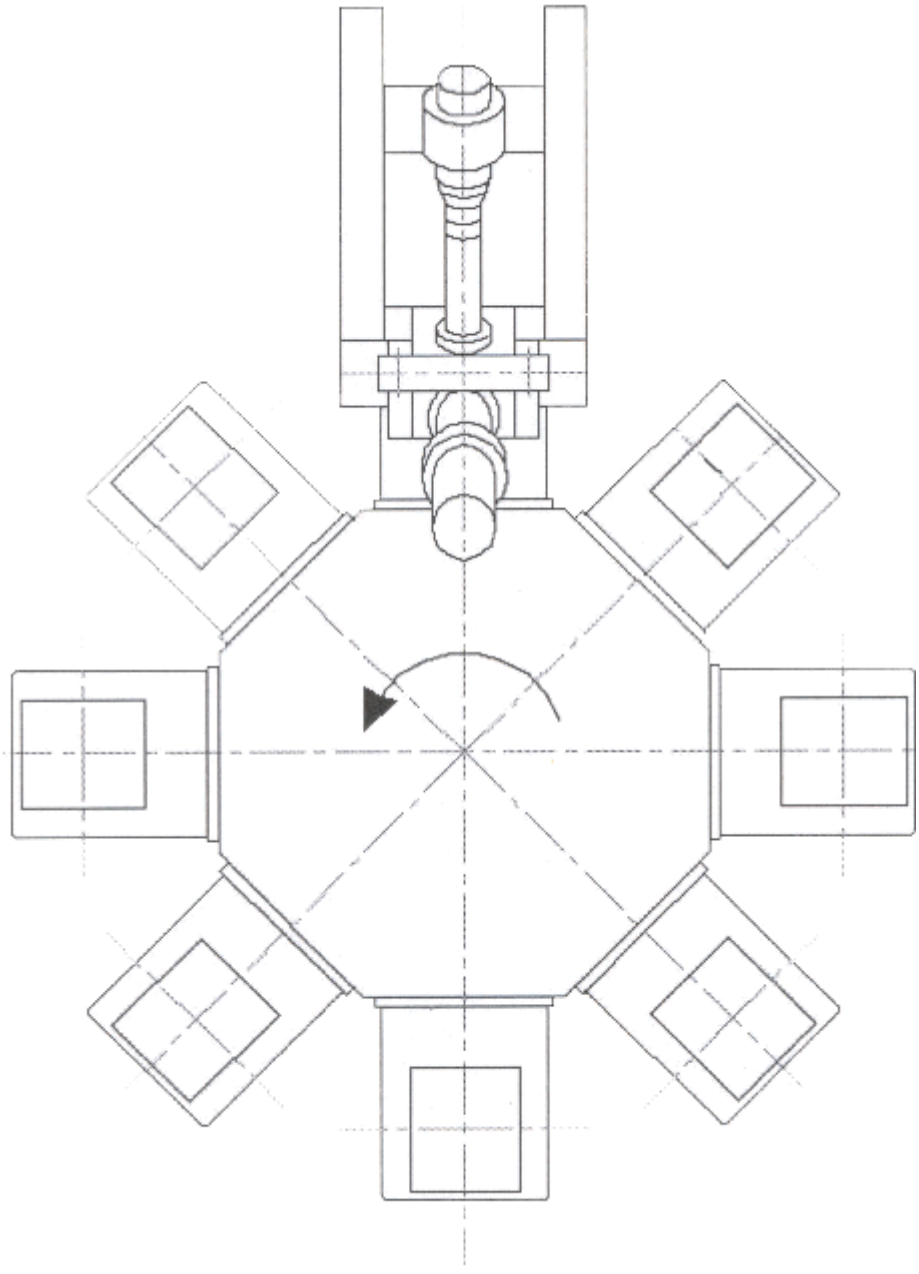


Figure 1 — Example of a carousel machine

3.7
shuttle-table machine/machine with a sliding lower platen and turn-table machine
machines designed to contain one or more lower parts of moulds attached to a table/sliding lower platen. The table indexes the lower parts of the mould by a sliding or rotary motion between the loading/unloading station and the injection position (see Figures 2 and 3).

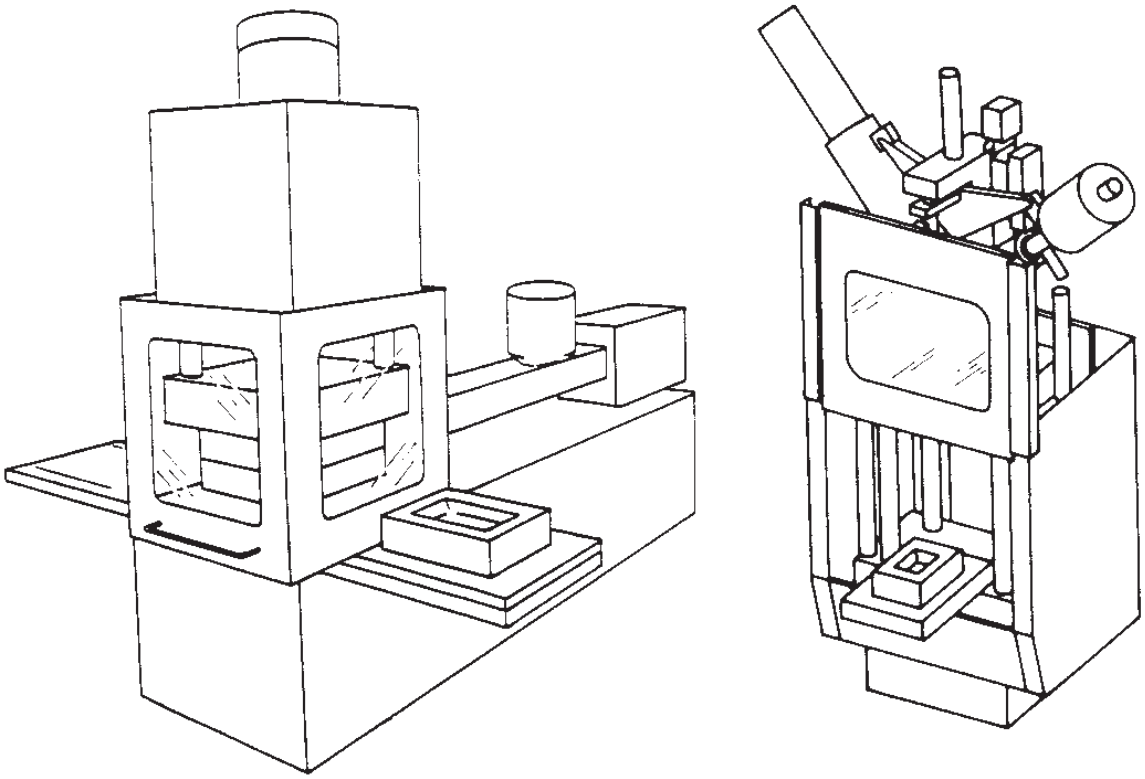


Figure 2 — Examples of shuttle-table machines (two stations left; single station right), shown without guards for the movements of the table

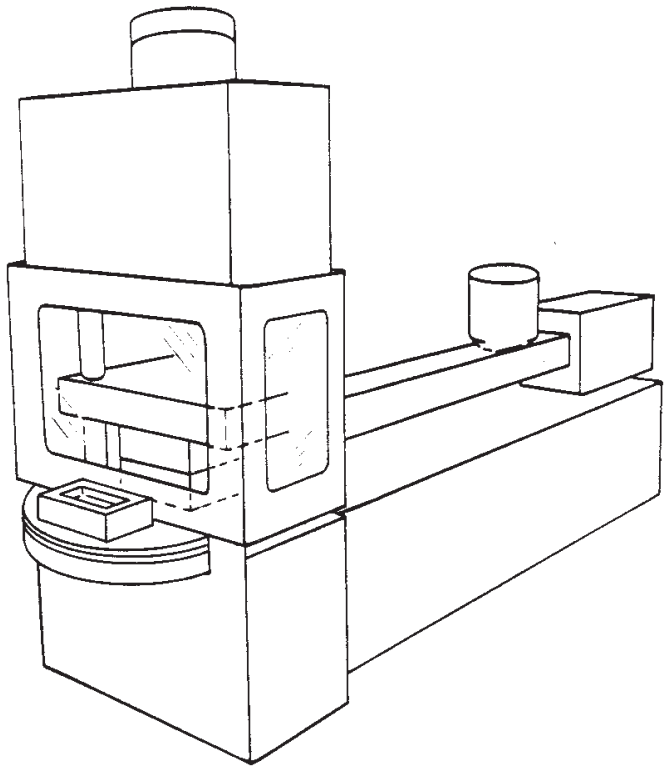


Figure 3 — Example of a turn-table machine, shown without guards for the movements of the table

3.8
multi-station machine with mobile injection unit
machine consisting of a mobile plasticising and/or injection unit which indexes between two or more stationary clamping units (see Figures 4 and 5)

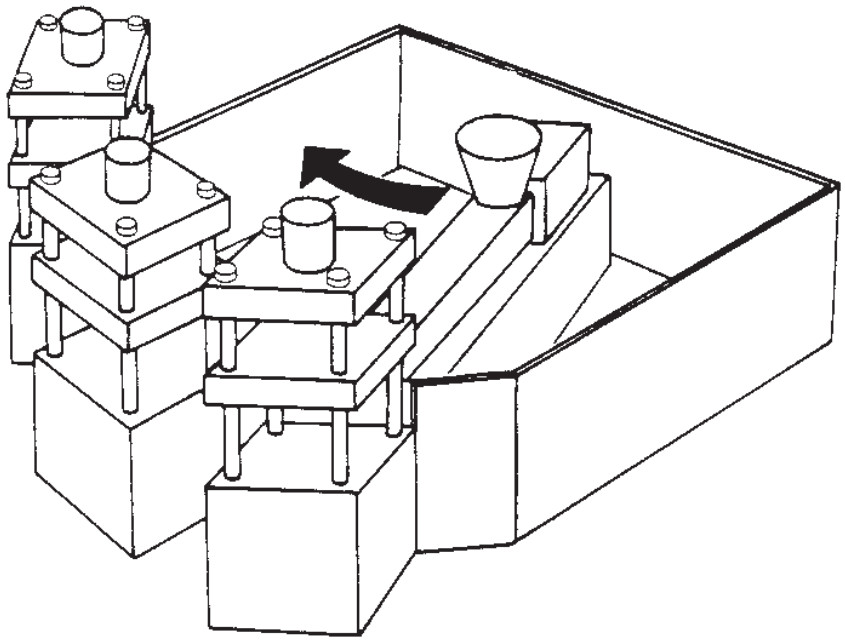


Figure 4 — Example of multi-station machine with mobile plasticising and injection unit, shown without guards for the clamping units

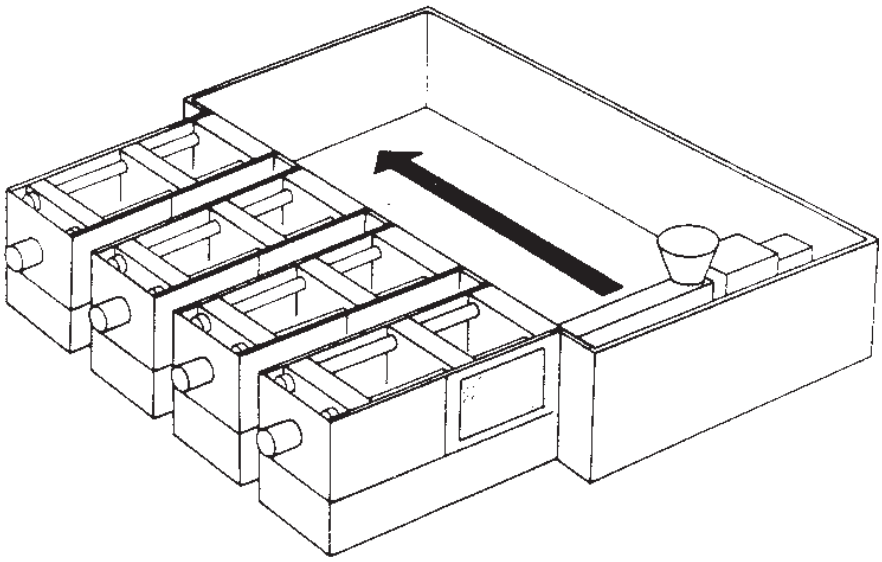


Figure 5 — Example of multi-station machine with mobile plasticising and injection unit, shown with guards for the clamping units

3.9
injection assembling machine
machine with a C-shaped frame and a vertical closing movement used for assembling long or bulky parts by the injection of rubber (see Figure 6)

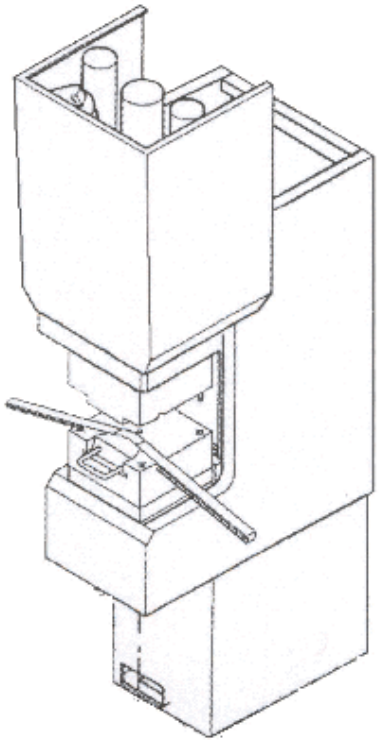


Figure 6 — Example of an injection assembling machine, shown without protective devices for the mould area

3.10
L-type machine
injection moulding machine with injection directed towards the usual operating position (see 3.24) on an axis of approximately a 90° angle to the axis of the closing movement

3.11
ancillary equipment
equipment which interacts with the injection moulding machine, e.g. pick and place device, robot, mould changing equipment, mould clamping device or a conveyor

3.12
magnetic clamping system
clamping system utilising magnetic force to attach the mould to the platens

3.13
fluid-assisted injection moulding
injection moulding where a fluid (gas or liquid) is injected separately into the mould to create a cavity in the moulded part

3.14
cellular foam injection moulding
injection moulding which involves either a gas mixed into the melt or a granulate containing a foaming agent to achieve a cellular-structured product

3.15
electrical motor
any type of motor using electrical energy, e.g. servo or linear motor

3.16
motor control unit
unit to control the movement, stopping process and standstill of an electrical motor, with or without an integrated electronic device, e.g. frequency converter, contactor

3.17
electrical axis
system consisting of an electrical motor, a motor control unit and any additional contactors

3.18
standstill
condition under which there is no movement of a machine part with an electrical axis

3.19
safe standstill
standstill (see 3.18), during which additional measures are taken to prevent unexpected start-up

3.20
safety related input
input to a motor control unit used to interrupt the energy supply to the electrical motor

3.21
stopping
deceleration of a movement of a machine part with an electrical axis until standstill (see 3.18) is achieved

3.22
safe stopping
stopping (see 3.21), during which additional measures are taken to prevent a dangerous run-down

3.23
run-down time
time from initiation of stopping (see 3.21) until standstill (see 3.18) is achieved

3.24
usual operating position
position in front of the mould area where the operator usually stands

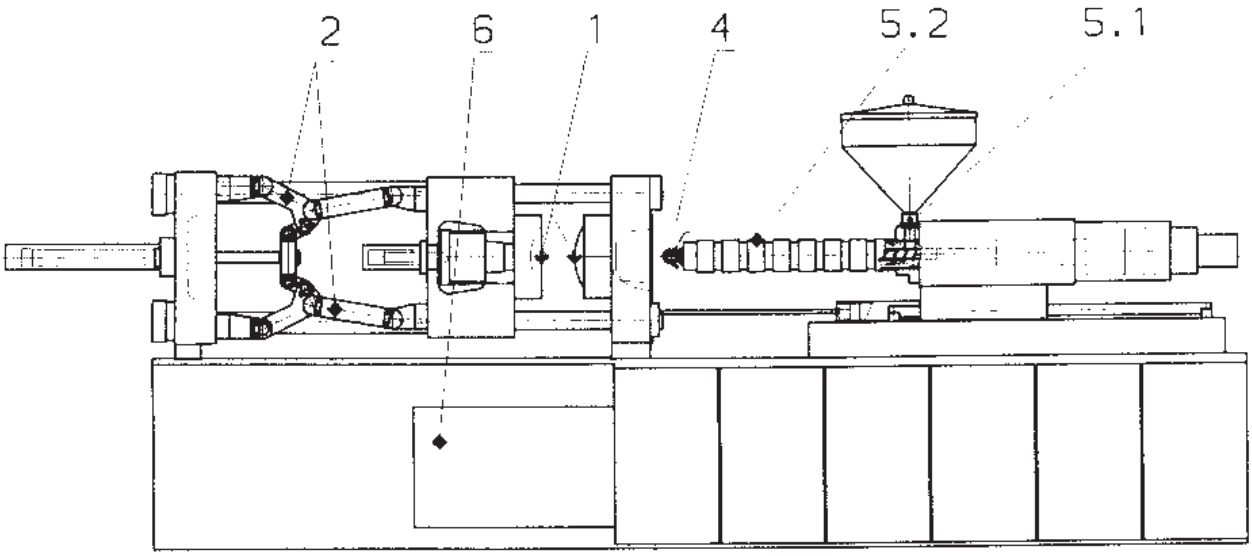
4 List of significant hazards

4.1 General

Clause 4 lists the significant hazards associated with injection moulding machines.

NOTE The numbering system of the safety requirements and protective measures in Clause 5 corresponds with the numbering system of the significant hazards in Clause 4.

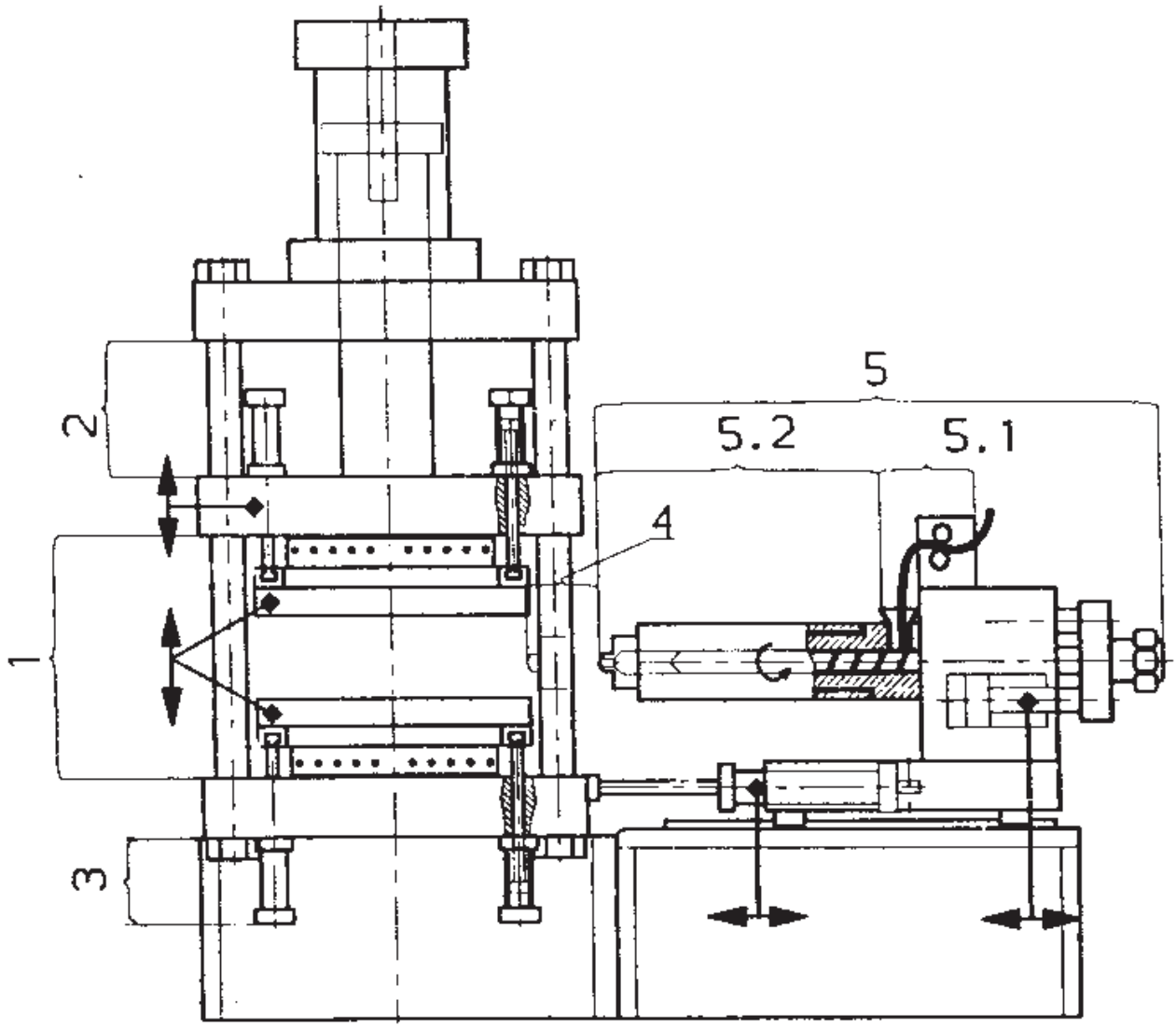
The principal danger areas are shown in Figures 7 to 9:



Key

1 mould area
2 clamping mechanism area
4 nozzle area
5 plasticising and injection unit area
5.1 feed aperture area
5.2 area of the heater bands on the plasticising and injection cylinders
6 discharge area

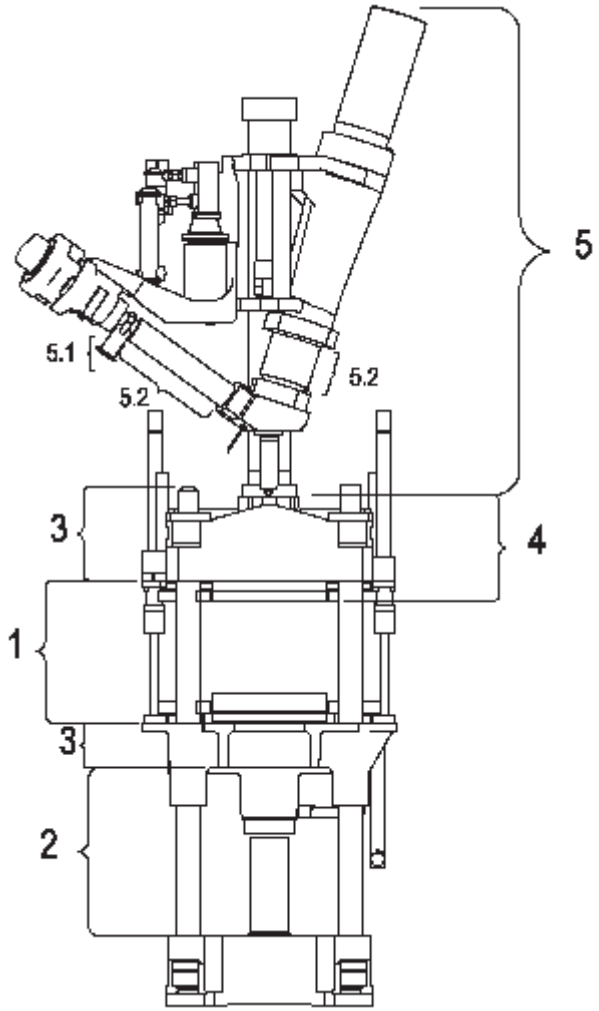
Figure 7 — Injection moulding machine with horizontal clamping unit and horizontal plasticising and injection unit, shown without guards



Key

1 mould area
2 clamping mechanism area
3 area of movement of core and ejector drive mechanisms outside areas 1 and 2
4 nozzle area
5 plasticising and injection unit area
5.1 feed aperture area
5.2 area of the heater bands on the plasticising and injection cylinders

Figure 8 — Injection moulding machine with vertical clamping unit and horizontal plasticising and injection unit, shown without guards



Key

1 mould area
2 clamping mechanism area
3 area of movement of core and ejector drive mechanisms outside areas 1 and 2
4 nozzle area
5 plasticising and injection unit area
5.1 feed aperture area
5.2 area of the heater bands on the plasticising and injection cylinders

Figure 9 — Injection moulding machine with vertical clamping unit, shown without guards

4.2 Mould area

Crushing, shearing, and/or impact hazards caused by the:

— closing movement of the platen, including movement due to gravity on downstroking machines;

— closing movement of the platen for mould height adjustment;

— closing movement of the mobile platen with a mould attached to it during mould setting when the mould area is accessible through the opening for the nozzle in the fixed platen;

— movement of the nozzle tip of the injection unit through the opening for the nozzle in the fixed platen;

— movement of the nozzle tip of any additional injection unit when it comes into contact with the mould;

— movement of cores and ejectors and their drive mechanisms.

Splashing of material from the mould and/or the nozzle (this does not apply to rubber, see 3.5).

Burns or scalds due to operating temperatures of:

— the moulds;

— heating elements of the moulds and plasticising and/or injection cylinders;

— material released from the closed moulds or plasticising and/or injection cylinders.

Mechanical and thermal hazards on machines with an L-type configuration caused by the ejection of material directly to the usual operator's position (see 3.24), as a result of the forward movement of the screw or piston, or degradation of the material.

4.3 Clamping mechanism area or area behind the mobile platen

Crushing, shearing and/or impact hazards caused by:

— movements of the drive and clamping mechanisms of the platen;

— opening movement of the platen;

— movements of core and ejector drive mechanisms;

— opening movement of the platen due to gravity on upstroking machines;

— opening movement of power operated guards for the mould area.

4.4 Area of movement of core and ejector drive mechanisms outside both the mould area and the clamping mechanism area

(See Figures 8 and 9, item 3.)

Crushing and/or shearing hazards caused by the movements of core and ejector drive mechanisms.

4.5 Nozzle area

Crushing and/or shearing hazards caused by:

— the forward movement of the plasticising and/or injection unit(s);

— movements of parts of the power operated shut-off nozzle and its drive.

Impact and/or entanglement due to movement of the exposed screw during changing of the screw.

Splashing of material from the nozzle(s), except for rubber processing machines.

Hazards due to ejection of the nozzle or its parts caused by:

— incorrect mounting of the nozzle;

— use of an incorrect type of nozzle.

Burns or scalds due to operating temperatures of:

— the nozzle(s);

— plasticised material released from the nozzle(s).

4.6 Plasticising and/or injection unit area

Crushing, shearing and/or drawing-in hazards caused by:

— unintentional movement due to gravity of vertical or inclined plasticising and/or injection units;

— movement of the screw and/or the injection piston in the plasticising and/or injection cylinder, accessible through the feed opening;

— movement of the hopper attached to the plasticising and/or injection unit towards the fixed platen (especially in the case of small machines);

— movement of the injection mechanism;

— movement of the plasticising mechanism.

Burns or scalds due to operating temperatures of:

— the plasticising and/or injection unit;

— the heating elements e.g. heater bands, heat exchangers;

— the plasticised material released from the vent opening;

— hot gas or material ejected through the feed opening following a degradation of the material due to the material being overheated or heated for too long a time.

Hazards due to the reduction in mechanical strength of the plasticising and/or injection cylinders due to overheating.

4.7 Discharge area

Crushing, shearing and/or impact hazards due to moving parts in the mould area accessible through the discharge aperture.

4.8 Hazards not associated with a particular area of the machine

4.8.1 Whiplash of flexible hoses

Crushing, shearing and/or impact hazards caused by whiplash after tearing or detachment of flexible hoses with pressures higher than 5 MPa from their connection points.

4.8.2 Release of fluids under pressure

Injury to the eyes or skin due to unintended release of fluids under pressure from hydraulic, pneumatic, or heat conditioning systems, in particular from flexible hoses and their connections with pressures higher than 5 MPa.

4.8.3 Hazards during adjustment and servicing

Injury due to the use of unsuitable tools or equipment.

4.8.4 Electrical hazards and hazards due to electromagnetic interference

Electric shock or burns due to direct or indirect contact with live conductive parts.

Malfunction of the control circuits due to electromagnetic interference with the electrical equipment.

4.8.5 Thermal hazards

Burns or scalds due to operating temperatures of:

— heat conditioning system hoses and fittings;

— fluids released from the heat conditioning system.

4.8.6 Hazards generated by noise

Noise emitted by injection moulding machines may be created by:

— the hydraulic system, especially during injection;

— moving mechanical parts.

Hazards may result from noise peaks interfering with verbal communication or with the perception of acoustic signals.

4.8.7 Hazards generated by gases, fumes and dusts

Hazards resulting from contact with or inhalation of gases, fumes and dusts harmful to health:

— during plasticising of the material and subsequent injection into the mould or purging;

— during curing or vulcanising of the part in the mould;

— when the mould is not closed.

Hazards resulting from the lack of oxygen when nitrogen is used.

4.8.8 Slip, trip and fall hazards

Injury caused by slips, trips and falls from designated access or designated working positions on or around the machine.

4.8.9 Hydraulic and pneumatic systems

Hazards due to malfunctions of the hydraulic and pneumatic systems.

4.8.10 Power operated guards

Crushing, shearing and/or impact hazards caused by the movement of power operated guards.

4.9 Additional hazards associated with specific machine design

4.9.1 Carousel machines

Impact by movement of the carousel, crushing, shearing and/or drawing-in hazards between the moving carousel and fixed parts.

4.9.2 Shuttle-table machines/machines with sliding lower platen and turn-table machines

Crushing, shearing, impact, and/or drawing-in hazards caused by horizontal movement of the table or sliding lower platen.

Crushing, shearing and/or impact hazards caused by unintentional gravity descent of the shuttle-table.

4.9.3 Multi-station machines with mobile injection unit

Crushing, shearing and/or impact hazards due to movement of the mobile injection unit between the clamping units.

4.9.4 Cellular foam injection moulding machines

Mechanical and/or thermal hazards due to uncontrolled escape of the melt from the nozzle or the mould.

4.10 Additional hazards when using ancillary equipment

4.10.1 Power operated mould changing equipment

Crushing and/or shearing hazards between the moving mould and/or transfer unit and fixed parts of the machine.

Impact hazards caused by the moving mould and/or transfer unit within the immediate vicinity of the mould area.

4.10.2 Power operated mould clamping devices

Crushing, shearing and/or impact hazards caused by:

— movement of the mould clamping device;

— falling of the mould or parts of the mould due to failure of the power supply, the unintentional declamping or unsuccessful clamping, and, in the case of magnetic clamping, an insufficient magnetic force;

— movement of the mould or other magnetic objects (e.g. tool-box tool) during the magnetisation in the case of magnetic clamping.

Electrical or electromagnetic disturbances generated by the magnetic clamping system or external radiation which are liable to create failures in the control system of the magnetic clamping system.

In the case of magnetic clamping interference with the operation of, for example, pacemakers and hearing aids.

4.10.3 Fluid injectors

Impact and/or injection hazards from the unexpected escape of fluid or moulded part when opening the mould if the internal pressure in the moulded part is not sufficiently reduced.

Bursting of moulded parts after de-moulding.

4.10.4 Other ancillary equipment

Hazards are dependent on the type of ancillary equipment. In particular, the additional hazards listed below shall be taken into account:

— overturning of the machine (mainly on machines with vertical clamping unit) where ancillary equipment not supported by the floor is fitted to the machine;

— access to moving parts of the machine if the safeguards are modified or ancillary equipment is removed;

— access to moving parts of the ancillary equipment;

— impairment of the visibility and accessibility of the machine by failing to take account of ergonomic principles.

5 Safety requirements and protective measures

5.1 General

Machinery shall comply with the safety requirements and protective measures of this clause. In addition, the machine shall be designed in accordance with the principles of EN ISO 12100 for relevant but not significant hazards, which are not dealt with by this document (e.g. sharp edges).

Protective devices in accordance with Type I, II and III as specified in Annexes A, B, C, D, E or F shall be used. Alternatively, the safety related parts of the control systems shall be in accordance with the required performance levels PL_r, as specified in the relevant sub-clauses.

NOTE The safety level achieved when applying the PL_r as specified in the relevant sub-clauses is at least equivalent to the safety level achieved when applying the annexes.

If the principles of interlocking according to Annexes A, B, C, D, E or F are applied, the calculation of the PL achieved is not required.

5.1.1 Emergency stop

The emergency stop shall function as a category 0 or 1 stop of EN 60204-1:2006, 9.2.2. In the case of machines with electrical axis a category 1 stop shall be used.

Emergency stop devices shall be in accordance with EN ISO 13850:2008 and EN 60204-1:2006, 10.7.

Actuation of emergency stop actuators shall stop any movement and shall discharge the hydraulic accumulators.

In addition, the actuation of emergency stop devices shall stop the supply of the following if their continued supply creates further hazards:

— power to the cooling/heating elements;

— gas/water;

— power to mould clamping systems.

See also 7.1.1.

5.1.2 Guards

5.1.2.1 Common requirements

Guards shall be designed in accordance with EN 953. They shall be mounted on or close to the injection moulding machine.

Safety distances for guards shall be in accordance with EN ISO 13857:2008, Table 1 and/or Table 4 unless otherwise specified.

Access to dangerous areas shall be prevented by movable interlocking guards (see 5.2 to 5.10) complemented by fixed guards where necessary.

5.1.2.2 Machines with electrical axis and interlocking guards without guard locking

For machines with electrical axis, the following additional requirements for movable interlocking guards without guard locking for this axis shall be fulfilled (see Annexes D, E and F, F.4):

— Movable interlocking guards without guard locking shall be positioned so that when the guard is opened, the stopping time is shorter than the access time.

— The access time (t) shall be calculated as follows:

$$t = \frac{d}{v} + \Delta t$$

where

t is the access time;

d is the distance between guard and dangerous point;

v is 1,6 m/s, approach speed as defined in EN 999:1998+A1:2008;

Δt is 100 ms, to take into account the time necessary to open the guard sufficiently to gain access to the protected area.

— When calculating or measuring the overall system stopping performance, as defined in EN 999:1998+A1:2008, 3.2, the worst case shall be taken into account related to speed, mass, temperature. See 7.1.2. If a safe stopping function in accordance with EN ISO 13849-1:2008, PL_r = d, category 3 is used, the calculation can be carried out without considering any failures.

When t (access time) < T (overall system stopping performance), dangerous run-down of the movement will occur and the guards for that movement shall be interlocking guards with guard locking.

NOTE For the rotation of the plasticizing screw and for the linear movement of the injection screw or piston, there is no dangerous run-down.

5.1.2.3 Machines with electrical axis and interlocking guards with guard locking

For machines with electrical axis, the following additional requirements for movable interlocking guards with guard locking for this axis shall be fulfilled (see Annexes D, E and F, F.1, F.2, F.3):

— For the guard locking device, well tried components in accordance with EN ISO 13849-1:2008, PL_r = c shall be used. The components shall be designed to withstand a minimum force of 1000 N**,** applied for example when trying to open the guard with guard locking still effective.

— Guard locking shall remain effective until standstill has been detected.

— If Annex E for the clamping mechanism area or Annex F, F.1, F.2, F.3 for the mould area are applied, the detection of standstill shall be safe against single fault. This shall be done by:

  — automatic monitoring of two independent standstill signals; or

  — standstill detection in accordance with EN ISO 13849-1:2008, PL_r = d; or

  — permanent automatic monitoring of the change of position of the platen by means of a motor encoder.

— If Annex D is applied for the movement of the plasticizing and/or injection unit, and if Annex D or E are applied for movements of cores and ejectors, the detection of standstill shall be in accordance with EN ISO 13849-1:2008, PL_r = b.

5.1.3 Electro-sensitive protective equipment (ESPE) in the form of light curtains

Light curtains shall be designed in accordance with EN 61496-1:2004 and CLC/TS 61496-2:2006.

Light curtains shall become effective as soon as the injection moulding machine is switched on.

Light curtains shall be positioned in accordance with the formulae given in EN 999:1998+A1:2008.

It shall not be possible to reach the danger area around, above or beneath the light curtains.

The end of an interruption of a light curtain shall not automatically initiate any further movement. A new start command shall be required.

An acknowledgement switch in accordance with the single acknowledgement system as described in Annex J shall be fitted on each side of the machine where a light curtain is installed.

It shall be necessary to actuate the acknowledgement switch after interruption of the corresponding light curtain before it is possible to give a start command for a cycle or movement, except if:

— the light curtain that has been interrupted is located on the side of the machine where a cycle can be initiated; and

— the light curtain has been interrupted at the end of a production cycle.

NOTE For machines where whole body access is possible between the light curtain for the mould area and the mould area itself, or where whole body access is possible to the mould area, the above mentioned acknowledgement switch fulfills the requirements given in 5.2.7 and 5.2.8 for a single acknowledgement system. Where a double acknowledgement system is required (see 5.2.8), the above mentioned acknowledgement switch may be the push button (2) as specified in Annex J, J.2.

See also 7.1.3, 7.1.4 and 7.2.

5.1.4 Two-hand control devices

The two-hand control device shall be designed in accordance with EN 574:1996+A1:2008.

The actuators of the two-hand control devices shall be positioned in accordance with the formulae given in EN 999:1998+A1:2008 and allow a clear view of the danger area.

At the sides of the machine where no actuators of two-hand control devices are installed, additional safeguarding shall be provided to prevent access to the danger area.

See also 7.1.3 and 7.2.

5.1.5 Hold-to run control devices associated with reduced speed of the dangerous movement

For a hold-to-run control device associated with speed reduction of the dangerous movement, the maximum value of the reduced speed shall be a fixed value. The speed may be adjustable below this maximum value.

5.1.6 Pressure sensitive mats, floors and edges

Pressure sensitive mats or floors shall be designed in accordance with EN 1760-1:1997+A1:2009, and pressure sensitive edges shall be designed in accordance with EN 1760-2:2001+A1:2009.

Pressure sensitive mats, floors and edges shall be active when the injection moulding machine is switched on.

5.1.7 Common requirements for automatic monitoring

The basic requirements for automatic monitoring are as follows:

— if there is a single fault in one of the safety related components of a control system, it shall not be possible to initiate the next movement or the next cycle. Automatic monitoring shall be carried out at least once during each operation cycle of the corresponding safeguard;

— the monitoring circuit shall not produce a direct control signal for starting a movement or initiating a cycle;

— monitoring may be performed via the programmable controller. If so, the monitoring programme shall be in permanent memory with protection against electrical interference, and the monitoring system shall be equipped with a start-up test;

  In addition, for position detectors, contactors and/or motor control unit to control the same safety function:

  — each one of those components shall be connected to its own input module; or

  — if a common input module is used, either the inverse signals from each one of those components shall be input as well, or any fault in the input circuits shall be automatically recognised; or

  — if an input unit (input card) consists of several input modules, the signals from each one of those components to be monitored for anti-valence, shall be separated by at least the input module bit distance (e.g. 4 bits, 8 bits or 16 bits). In addition, signals from each one of those components which are not anti-valent and are connected to the same input module, shall not occupy adjacent bits;

— the enable signal for the control circuit of the machine shall be produced by the monitoring circuit;

— if relays are used, e.g. for the purpose of contact multiplying, automatic monitoring of these relays is necessary. This monitoring may be carried out by a programmable electronic system. Any fault in a relay shall be automatically recognised and the start of any further dangerous movement shall then be prevented;

— where Annexes B to H are not applied, the monitoring system shall be designed so that the PL_r of EN ISO 13849-1:2008 is achieved as specified in 5.2 to 5.10.

5.1.8 Movements caused by gravity during production

Where a movement is achieved by a non-electrical axis, dangerous movement caused by gravity during production shall be prevented by mechanical, hydraulic or pneumatic restraint devices. Hydraulic and pneumatic restraint devices shall be fitted as close as possible to the cylinder, using flanged (flared or welded) pipework or flared unions only.

Where a movement is achieved by an electrical axis, dangerous movement caused by gravity during production shall be prevented by mechanical restraint devices, or by a spring loaded parking brake applied to the electrical motor. See 7.1.5.

Restraint devices or parking brakes shall activate automatically over the complete stroke of the movement.

5.2 Mould area

5.2.1 Hazards due to the closing movement of the platen during production

Where the movement of the platen is hydraulically operated, the interlocking guards shall be in accordance with Annex C or EN ISO 13849-1:2008, PL_r = e.

Where the movement of the platen is achieved by an electrical axis:

— Interlocking guards with guard locking shall be in accordance with:

  — Annex F, F.1, F.2, F.3; or

  — EN ISO 13849-1:2008, PL_r = e.

— Interlocking guards without guard locking shall be in accordance with:

  — Annex F, F.4; or

  — EN ISO 13849-1:2008, PL_r = e for safe standstill, and EN ISO 13849-1:2008, PL_r = d, category 3 for safe stopping. This can be achieved for example by using an external electro-mechanical circuit.

— When an interlocking guard (with or without guard locking) for the mould area is open, safe standstill shall be achieved by interrupting the energy supply to the movement of the platen in accordance with Annex F or EN ISO 13849-1:2008, PL_r = e. This interruption shall be independent from the programmable controller and be achieved using:

  — contactor(s) in the power supply to the electrical motor or the motor control unit; and/or

  — safety related input(s) to the motor control unit.

For hydraulically operated machines designed to only process rubber (see 3.5), light curtains in accordance with Annex G may be used and complemented by guards where necessary.

Access via the top side of machines with a horizontal closing movement of the platen, shall be prevented by interlocking top guards in accordance with Annex B or E or EN ISO 13849-1:2008, PL_r = d. This is not required where safety distances from designated access or designated working positions in accordance with EN ISO 13857:2008, Table 1 are achieved, by design or by fixed guards. If the top guard is connected to the movable front or rear guard in such a way that the top guard cannot be moved independently, it does not require additional interlocking.

For larger machines the additional requirements in 5.2.7 and/or 5.2.8 shall also apply.

Two-hand control devices in accordance with Annex H may only be used where:

— it is not possible to safeguard the mould area by the use of guards or light curtains, for example on injection assembling machines, as defined in 3.9, where parts of the mould or inserts are protruding from the mould area; and

— whole body access to the mould area is not possible (see 5.2.8).

On these machines, the actuators of a two-hand control device may be released without interrupting the movement of the platen, if the mould is sufficiently closed (gap ≤ 6 mm). For this purpose two position sensors shall be provided which shall be monitored automatically at least once per production cycle. The system for detecting the mould gap, at which the actuators of the two-hand control device can be released shall have at least the same level of integrity as the two-hand control device. The two-hand control device shall be reactivated automatically before the start of the next production cycle.

On machines fitted with two-hand control devices, which may be used for processing materials other than rubber, the splashing hazard shall be prevented by design of the machine and/or the control circuit, see also 7.1.28.

On rubber processing machines, the mobile platen may move during de-gassing. The gap between the two mould faces shall not exceed 6 mm. This maximum opening shall be monitored automatically by a circuit in accordance with EN ISO 13849-1:2008, PL_r = d. The device inhibiting the safeguard shall conform with EN ISO 13849-1:2008, PL_r = e.

Where proportional valves are used for the control of the platen movement Annex M shall apply.

See also 7.1.6.

5.2.2 Sides of the machine where a cycle cannot be initiated

For hydraulic machines, interlocking guards in accordance with Annex C or EN ISO 13849-1:2008, PL_r = e may be replaced by interlocking guards in accordance with Annex B or EN ISO 13849-1:2008, PL_r = d.

Opening these guards shall automatically:

— switch off the energy supply to the main drive for any dangerous movement; and

— shut-off and discharge the hydraulic accumulator for the closing movement of the platen.

On machines with an electrical axis for the platen closing movement, the interlocking of the guards shall be in accordance with Annex E, Figure E.3 or EN ISO 13849-1:2008, PL_r = d. In the case of dangerous run-down, guard locking is required according to 5.1.2.3 and 5.2.1.

When the guard is returned to its closed position, manual resetting of the controls shall be necessary at the side of the machine where a cycle can be initiated.

For larger machines the requirements of 5.2.7 and/or 5.2.8 shall also be met.

5.2.3 Hazards due to movements other than the closing movement of the platen during production

The guards or protective devices, as specified in 5.2.1 and 5.2.2, shall also protect against these other movements.

For these movements, interlocking guards shall be in accordance with Annex B or E or EN ISO 13849-1:2008, PL_r = d and two-hand control devices or light curtains shall be in accordance with EN ISO 13849-1:2008, PL_r = d.

If the movements of cores and ejectors, or the forward movement of the injection unit are driven by electrical axes, the calculation of the run-down time may be carried out without considering any failures.

When a guard is opened, a light curtain is interrupted or an actuator of a two-hand control device is released, it shall:

— arrest and prevent rotation of the plasticising screw; this does not apply to machines designed to process only rubber or to machines where escape of the plasticised material is not possible (e.g. fitted with a mechanically operated shut-off nozzle, or when the rotational speed is sufficiently reduced);

— arrest and prevent forward movement of the screw or piston;

— arrest and prevent forward movement of the injection unit;

— arrest and prevent movements of cores and ejectors, and their drive mechanisms;

— arrest and prevent the closing movement of the platen during mould height adjustment;

— arrest and prevent the movement of parts of the power operated nozzle shut-off or flap (see 5.2.9) and their drives;

— discharge the pressure in the injection unit to a safe value or prevent the escape of plasticised material (e.g. via the shut-off nozzle).

To allow movements of cores and/or ejectors with the guard of the mould area open or the light curtain interrupted, there are two possible alternatives:

a) the machine shall be equipped with a two-position lockable or coded selector switch.

The design shall ensure that, for each position not in use, circuits are completely isolated by positively operated contacts, or by redundant and monitored hardware.

In position 1 of the selector switch, movements of cores and/or ejectors shall only be possible with guard of the mould area closed or the light curtain not interrupted.

In position 2, with guard of the mould area open or the light curtain interrupted, movements of cores and/or ejectors are permitted by means of:

— a two-hand control device type II of EN 574:1996+A1:2008; or

— a hold-to-run control device in accordance with EN ISO 13849-1:2008, PL_r = c with reduced speed equal or less than 10 mm/s; the speed control shall be in accordance with at least EN ISO 13849-1:2008, PL_r = b.

If the actuator of the hold-to-run control device is positioned on a portable control unit, it shall have the following positions: 1 for stop, 2 for run, 3 for stop again. After the actuator has passed the pressure point to position 3, a restart shall only be possible after returning the actuator to position 1.

Where the hold to run control device is a foot pedal, the range of force required to reach the 3rd position shall be between 200 and 350 Newton.

See 7.1.7 a).

or

b) the machine shall be equipped with a three-position lockable or coded selector switch.

In positions 1 and 2, the movements of cores and/or ejectors shall be controlled as described in a).

In position 3, with guard of the mould area open or the light curtain interrupted, movements of cores and/or ejectors are permitted by means of a hold-to-run control device in accordance with EN ISO 13849-1:2008, PL_r = c and the requirements specified in a), however without speed reduction. When position 3 is selected, a warning shall appear on the control panel and movements of cores and/or ejectors shall only be possible after a confirmation by the operator. The warning shall remain on the control panel as long as position 3 is selected.

In alternative b) the selector may also be a 2-position selector with only position 1 and position 3.

See 7.1.7 b).

When the machine is in setting mode and the mould area is accessible through the registers of the fixed platen, opening an interlocking guard for the nozzle area shall stop the closing movement of the mobile platen, in accordance with EN ISO 13849-1:2008, PL_r = b.

5.2.4 Use of control guards

As an alternative to interlocking guards, control guards in accordance with EN ISO 12100-1:2003, 3.25.6 may be used providing:

— the requirements of EN ISO 12100-2:2003, 5.3.2.5 except the 2nd and 3rd indents are met; and

— the requirements of 5.2.1 and 5.2.3 are met, and

— it is not possible to gain whole body access between the mould area and the guard (see 5.2.7); and

— for horizontal machines:

  — the dimension (a) in Figure 11 is ≥ 750 mm, and

  — the distances e_1, e_2 between tie-bars (see Figure 10) or the corresponding distances e_1, e_2 for a machine without tie-bars (see Figure 11) are ≤ 630 mm;

— for vertical machines:

  — the height of the lower platen clamping surface above the operator's standing level is ≥ 750 mm, and

  — the maximum distance between the platens is ≤ 630mm and the greater dimension of the platen is ≤ 1000 mm.

In addition, for power operated control guards:

— the position of the manual controls shall allow a clear view of the mould area; and

— the release of the manual control shall be detected before each new machine cycle or after a stop of the guard. For machines where the operator's action on the manual control is not maintained, but the command is stored in the memory until the guard is closed, the memory shall be erased on every occasion when the guard stops. This applies whether the guard is fully or partly closed and whenever the time set for guard closing is exceeded.

5.2.5 Thermal hazards

The warning sign for thermal hazard given in Annex L, Figure L.2 shall be fitted to draw attention to the hazards caused by hot moulds and heating elements. See 7.2.

Fixed and movable guards shall be designed to contain any ejected plasticised material. This requirement does not to apply to machines that are designed for processing rubber only (see 3.5).

The release of material from the plasticising and/or injection cylinders is prevented by the provisions of 5.2.3.

See 7.1.8.

5.2.6 Additional safety requirements for machines with a downstroking platen

Hydraulic downstroking injection moulding machines shall be equipped with two independent mechanical and/or hydraulic restraint devices. Such restraint devices shall automatically become effective over the

complete stroke of the platen when the movable guards of the mould area are opened or when the light curtain is interrupted or when a manual actuator of a two-hand control device is released.

Where the platen is greater than 800 mm in one of its dimensions, and the maximum distance between platens can exceed 500 mm, at least one of the restraint devices shall be mechanical.

Where two hydraulic restraint devices are installed, one of these devices may be one of the shut-off devices according to Annexes C, G or H.

Where mechanical restraint devices are installed, and if it is not possible to open the movable guard of the mould area until the platen has reached its maximum opening stroke, mechanical restraint devices that only become effective in that position are permitted.

In the event of a failure of one of the restraint devices the other device shall stop the gravity descent of the platen.

The restraint devices shall be automatically monitored so that in the case of a failure of one of these devices,

— this failure is automatically recognized; and

— the initiation of any further downward movement of the platen is prevented.

For maintenance operations on machines where a mechanical restraint device is not installed, the machine shall be designed so that the mobile platen can be blocked by a mechanical device or that it shall be possible to move the platen to a position where further unintentional movement by gravity is impossible. See also 7.1.9.

5.2.7 Additional requirements for machines where whole body access is possible between the interlocking guard or light curtain for the mould area and the mould area itself

Protective devices additional to those specified in 5.2.1 and, where relevant, to those specified in 5.2.8 shall be provided for the following machines:

(a) machines with a horizontal distance of more than 100 mm between the guard and the machine frame (see Figures 10 and 11), or with a horizontal distance of more than 150 mm between the light curtain and the machine frame; or

(b) machines where there are designated access positions between the guard or light curtain and the mould area and where there is no good view to these access positions from the usual operating position.

For these machines, one of the following protective devices shall be provided:

— a single or double acknowledgement system in accordance with Annex J for interlocking guards or light curtains; or

— a mechanical latch; this device shall become effective with each opening movement of the guard. It shall be necessary to separately reset this safety device before another machine cycle can be initiated. The position from which the latch is reset shall afford a clear view of the mould area, if necessary with the use of aids to vision. The correct functioning of the latch shall be monitored at least once during each movement cycle of the guard, so that a fault in the latch will be automatically recognized and commencement of all further platen closing movement shall be prevented. For all power operated guards fitted with a mechanical latch, the closing movement of the guard shall be operated by a hold-to-run control device which is positioned to give a clear view of the mould area; or

— for power operated guards with horizontal closing movement, a hold-to-run control device meeting the following requirements:

  — the hold-to-run control device and the circuit shall be in accordance with EN ISO 13849-1:2008, PL_r = c; and

— the position of the hold to run control device actuator shall provide a clear view of the mould area; and

— the hold to run control device shall not be easily defeated (this may be achieved e.g. by automatically monitoring that the manual actuator is released after each closing movement of the guard); or

— a component of the guard which prevents the closing of the guard when an operator is standing in the safeguarded area; such a component shall be so designed that the operator cannot easily get around it when the guard is open; for power operated guards, the requirements of 5.1.2 shall also apply to that component; or

— a sensitive protective equipment to detect the presence of persons between the movable guard or light curtain for the mould area and the mould area itself, e.g.:

— electro-sensitive protective equipment in accordance with EN 61496-1:2004, type 2*;* or

— pressure sensing mats or floors in accordance with EN 1760-1:1997+A1:2009 and EN ISO 13849-1:2008, PL_r = c. If the mats and floors are not designed in accordance with EN 1760-1:1997+A1:2009, the control system of the injection moulding machine shall be so designed that it is only possible to start a production cycle after a test of the correct functioning of the mat or floor. This test shall be performed when the machine is switched on. See 7.1.10; or

— scanner in accordance with CLC/TS 61496-3:2008 and EN ISO 13849-1:2008, PL_r = d.

Such sensitive protective equipment shall become effective when the machine is switched on and, when persons are standing in this area, shall:

— prevent the closing and opening movement of the platen according to EN ISO 13849-1:2008, PL_r = c; and

— in the case of a power operated guard, prevent the closing movement of the guard in accordance with EN ISO 13849-1:2008, PL_r = c; and

— prevent any dangerous movement of the cores and ejectors (however see 5.2.3), in accordance with EN ISO 13849-1:2008, PL_r = c; and

— prevent injection in accordance with EN ISO 13849-1:2008, PL_r = c.

Dimensions in mm

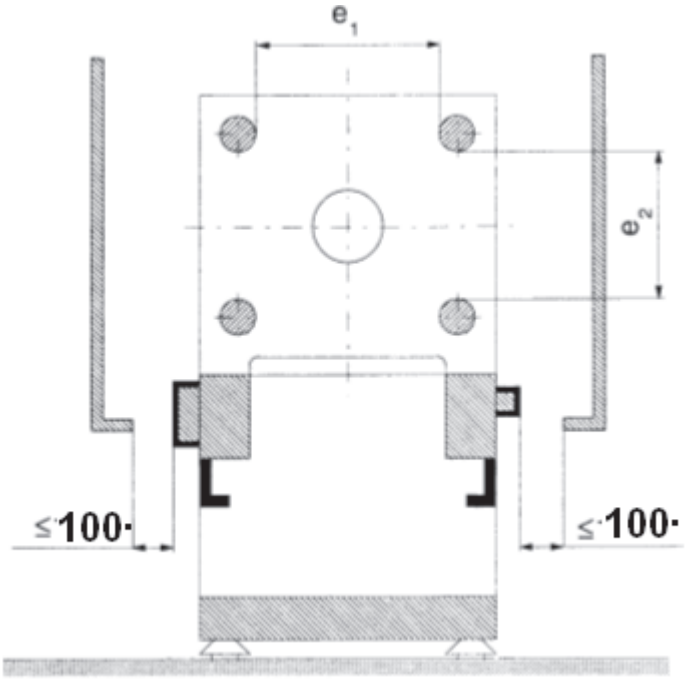


Figure 10 — Examples of the positioning of movable guards and dimensions e_1, e_2 for machines with tie-bars

Dimensions in mm

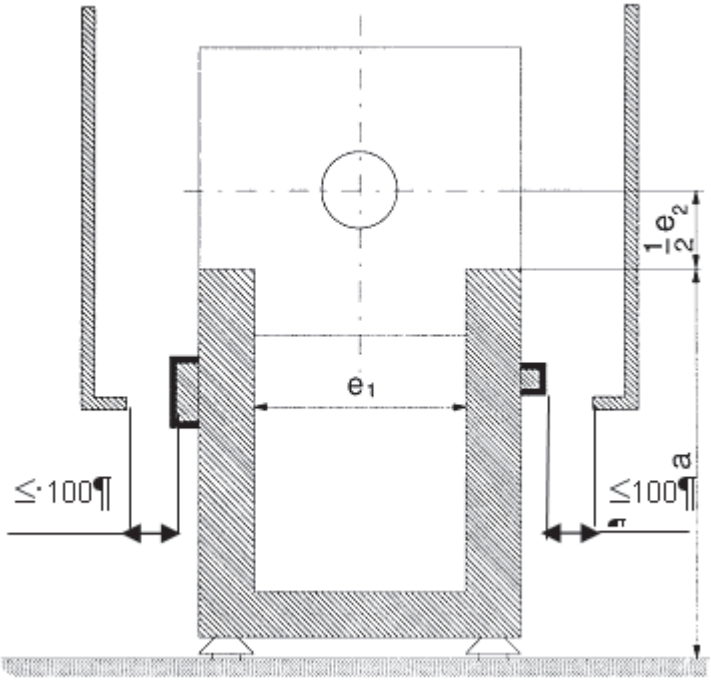


Figure 11 — Examples of the positioning of movable guards and dimensions a, e_1, e_2 for machines without tie-bars

5.2.8 Additional requirements for machines where whole body access is possible to the mould area

Protective devices additional to those specified in 5.2.1 and, where relevant, to those specified in 5.2.7 shall be provided on the following machines:

a) machines with horizontal clamping unit and tie-bars (see Figure 10) where e_1 or e_2 > 1200 mm. For machines with two tie-bars the relevant dimension is e_1. For machines with three tie-bars the relevant dimension is the maximum clearance between two tie-bars;

b) machines with horizontal clamping unit without tie-bars (see Figure 11), where:

— e_1 or e_2 > 1200 mm; or,

— if a < 850 mm, then e_2 > 400 mm;

c) machines with vertical clamping unit and tie-bars where:

— e_1 or e_2 > 1200 mm; and

— maximum opening between the platens > 1200 mm;

d) machines with vertical clamping unit without tie-bars where:

— one of the platen dimensions > 1200 mm; and

— maximum opening between the platens > 1200 mm.

These additional protective devices shall be:

a) for machines where the mould area is safeguarded by guards, devices which prevent the unintentional closing of interlocking guards such as:

— a mechanical latch as specified in 5.2.7; or

— for power operated guards with horizontal closing movement, a hold-to-run control device as specified in 5.2.7;

b) for machines where the mould area is safeguarded by light curtains,at any side where there is a light curtain a single acknowledgement switch as described in Annex J; after interruption of one or more light curtain(s), an acknowledgement shall be carried out at all sides of the injection moulding machine where a light curtain was interrupted.

Additionally to a) or b):

— for machines with horizontal clamping unit, sensitive protective equipment to detect the presence of persons in the mould area; this equipment shall be in accordance with 5.2.7. To prevent unintentional stopping of production, e.g. due to falling parts, the device which detects the presence of persons in the mould area may be deactivated after closing the guards or resetting the light curtains for the mould area if no presence is detected. The detection device shall be automatically reactivated when a guard is opened or a light curtain is interrupted. This "muting" of the detection device shall be in accordance with EN ISO 13849-1:2008, PL_r = c. For machines which are designed for special production purposes, e.g. machines with rotary table in the middle of the mould area, the mechanical latch and additional presence detecting devices may be replaced by a double acknowledgement system in accordance with Annex J;

— for machines with vertical clamping unit, either a light curtain or a scanner as specified in 5.2.7 (see 7.1.11). As an alternative, a single acknowledgement system in accordance with Annex J may be used. However, if the lowest position of the clamping surface of the lower platen is less than 750 mm above the

operator's standing surface, the single acknowledgement system shall be replaced by a double acknowledgement system in accordance with Annex J.

NOTE Only one acknowledgement switch is necessary on each side of the mould area where whole body access is possible.

For unloading operations, inside the mould area designated access and designated working positions in accordance with 5.8.8 are required.

5.2.9 Additional requirements for machines with L-Type configuration during production

Safeguarding for the mould area on the operator's side of an L-type machine shall only be by guards and the design of any window in that guard shall take into account the maximum injection pressure and the maximum injection speed.

Ejection of material due to the forward movement of the screw or piston, when the guards of the mould area are open, shall be prevented in accordance with:

— Annex C or F or EN ISO 13849-1:2008, PL_r = e; or

— Annex B or E or EN ISO 13849-1:2008, PL_r = d with additional automatic monitoring of the movement of the screw or piston, so that if there is a forward movement of the screw or piston when the guard is open, the drive of the injection movement shall stop in accordance with stop category 0 or 1 of EN 60204-1:2006.

Ejection of material due to degradation shall be prevented:

— by design of the machine and the control system so that the material can be injected only in the part of the mould attached to the fixed platen and the injection can be possible only if the contact force actuated by the nozzle on the mould is detected in accordance with EN ISO 13849-1:2008, PL_r = c. The presence of that part of the mould on the fixed platen shall be detected; if its presence is not detected, the forward movement of the screw/piston shall be stopped as specified in the 2nd paragraph of this sub-clause and the heating shall be stopped in accordance with stop-category 0 of EN 60204-1:2006; or

— by a mechanically (e.g. spring) or power operated flap which automatically moves in front of the nozzle when the nozzle is moved off the mould prior to mould opening. The design of the flap shall take into account the maximum injection pressure and the maximum injection speed. The closed position of the flap shall be interlocked with the opening movement of the mould in accordance with Annex A or D or EN ISO 13849-1:2008, PL_r = c. In all cases, automatic monitoring of the closed position of the flap is required in each movement-cycle of the flap. If there is a failure, initiation of the next machine cycle shall be prevented and an alarm shall be given. If there is no mould or the mould is not closed, the opening of the guard of the mould area shall prevent the opening of power operated flap according to Annex A or D or EN ISO 13849-1:2008, PL_r = c; or

— by a mechanically (e.g. spring) or power operated shut-off nozzle which automatically closes when the nozzle is moved off the mould prior to mould opening. The closed position of the shut-off nozzle shall be interlocked with the opening movement of the mould in accordance with Annex A or D or EN ISO 13849-1:2008, PL_r = c. In all cases, automatic monitoring of the closed position of the shut-off nozzle is required in each movement-cycle of the shut-off nozzle. If there is a failure, initiation of the next machine cycle shall be prevented and an alarm shall be given. If there is no mould or the mould is not closed the opening of the guard of the mould area shall prevent the opening of power operated shut-off nozzle according to Annex A or D or EN ISO 13849-1:2008, PL_r = c; or

— by interlocking guards with guard locking and by a mechanically (e.g. spring) or power operated flap or shut off nozzle. The unlocking of the guard of the mould area shall only be possible when the flap or shut off nozzle is in the closed position. In addition it shall only be possible to open the flap or shut off nozzle when the guard is locked. Both interlocking functions shall be in accordance with EN ISO 13849-1:2008, PL_r = c.

See 7.1.13.

5.3 Clamping mechanism area or area behind the mobile platen

5.3.1 Basic safety requirements

To prevent access to dangerous movements in the clamping mechanism area or to the area behind the mobile platen, guards in accordance with Annex B or E or EN ISO 13849-1:2008, PL_r = d shall be provided.

Opening the interlocking guards shall:

— interrupt the cycle;

— interrupt all movements of the platen and the clamping mechanism;

— interrupt the opening movement of the power operated guard for the mould area if there is a danger for a person accessing from the guard for the clamping mechanism area.

Where access is required only for machine repair or maintenance, fixed guards are permitted.

Access to the area of dangerous movements of the core and ejector drive mechanisms is already prevented by the guards for the clamping mechanism area described above. For these movements, the guards, if movable, shall be interlocked in accordance with Annex A or D or EN ISO 13849-1:2008, PL_r = c. Alternatively, additional fixed guards may be used.

For machines where the mould area is safeguarded by light curtains, access to dangerous movements in the clamping mechanism area may be prevented by the light curtains for the mould area, appropriately extended in a way to cover the clamping mechanism area. For these movements, the light curtains shall act in accordance with EN ISO 13849-1:2008, PL_r = d.

An opening movement of the platen when the guards for the mould area are open, or the light curtains are interrupted, or the manual actuators of any two hands control device are released shall only be possible if access to crushing and/or shearing points behind the mobile platen is prevented.

5.3.2 Additional safety requirements for machines with an upstroking platen

On hydraulic upstroking machines, shearing or crushing hazards below the mobile platen due to unintentional gravity descent of that platen during setting the strokes for the cores and ejectors, shall be prevented by a restraint device that shall be effective over the complete dangerous stroke of the platen when the guards for the clamping mechanism area have been opened or the light curtains have been interrupted or the manual actuators of any two-hand control devices have been released.

When it is possible to gain access under the movable platen during production the same restraint device shall be effective over the complete dangerous stroke of the platen when the guards for the mould area have been opened or the light curtains have been interrupted or the manual actuators of any two-hand control device have been released.

For repair or maintenance operations on machines where a mechanical restraint device is not installed, the machine shall be designed so that the mobile platen can be blocked by a mechanical device or that it shall be possible to move the platen to a position where further unintentional movement by gravity is impossible. See also 7.1.9.

5.4 Area of movement of core and ejector drive mechanisms outside the mould area and outside the clamping mechanism area

Access to this area (see Figures 8 and 9, item 3) shall be prevented by:

— interlocking guards in accordance with Annex A or D or EN ISO 13849-1:2008, PL_r = c; or

— the light curtains of the mould area extended to cover this area and acting in accordance with EN ISO 13849-1:2008, PL_r = d; or

— fixed guards.

5.5 Nozzle area

5.5.1 Mechanical hazards

Direct access to the nozzle area shall be prevented by interlocking guards or a combination of fixed and interlocking guards. Those guards shall be dimensioned so as to cover the whole area of operating movement of the nozzle during production, excluding maintenance positions. In case of horizontal injection moulding machines, an opening in the nozzle guard is permissible underneath the nozzle.

Interlocking guards shall act in accordance with Annex A or D or EN ISO 13849-1:2008, PL_r = c.

If the forward movement of injection unit is driven by an electrical axis the calculation of the run-down time may be carried out without considering any failures.

The design of the guards shall take into consideration the hazards of splashing from hot plasticised material. This requirement does not to apply to machines that are designed for processing rubber only (see 3.5).

When an interlocking guard is opened, the following shall be interrupted in all positions of the injection unit:

— the forward movement of the injection unit(s);

— shut-off the forward movement of the injection screw or plunger;

— the rotation of the plasticising screw; this does not apply to machines designed to only process rubber or to machines where release of the plasticised material is not possible (e.g. fitted with a mechanically operated shut-off nozzle or when the rotational speed is sufficiently reduced).

The guards mentioned above are not necessary where the dangerous moving parts are made inaccessible by distance in accordance with Table 1 of EN ISO 13857:2008 and where there is no splashing hazard (rubber processing machines).

On horizontal injection moulding machines with a vertical injection unit, additional guards shall be provided unless the guards surrounding the machine already prevent the splashing hazard.

If when changing the screw or the non return valve for the melt, the injection unit needs to be slid outside the nozzle guard, movement of the screw and the injection unit shall only be possible by means of a manual control in accordance with EN ISO 12100-2:2003, 4.11.8 and 4.11.9 and at reduced speed, i.e. max. 30 mm/s for linear movement and max. 10 % of the maximum speed for rotational movement.

See also 7.1.12.

5.5.2 Thermal hazards

Warning notices as shown in Annex L, Figure L.2 shall be displayed drawing attention to the hazards associated with the hot nozzle and unintentional ejection of material from the nozzle. See 7.2.

Hazards generated by hot plasticized material coming from the nozzle shall be prevented by the guards described in 5.5.1.

See also 7.1.12.

5.6 Plasticising and/or injection unit area

5.6.1 Mechanical hazards

See 5.1.8.

The feed opening shall be designed so that access to the crushing, shearing and/or drawing-in points is prevented, even when the automatic feeding system or the hopper are removed.

This objective can be met:

— by applying EN ISO 13857:2008 Table 4; or

— with the following dimensions: the diameter or side length of the feed opening shall be smaller than or equal to 50 mm and the length of the feed duct shall be at least 120 mm. If the opening diameter or side length is bigger than 50 mm, parallel bars shall be installed to reduce the dimensions of the opening, with a maximum distance of 25 mm between 2 adjacent bars, and a minimum distance of 120 mm between the bars and the screw.

Where the minimum gap defined in EN 349:1993+A1:2008 for the head cannot be met by design in relation to the minimum distance between the fixed platen and the hopper or any part of the plasticising and/or injection unit, at a height between 1300 mm to 1700 mm above the floor, a fixed guard or a protective device according to EN ISO 13849-1:2008, PL_r = c shall be installed. If a movable guard is used, it may be the same as the one specified in 5.5.1. Actuating the protective device shall stop the forward movement of the plasticising and/or injection unit.

Hazards due to movement of the drive mechanisms of parts of the plasticising and/or injection unit shall preferably be prevented by design or by safety distances in accordance with EN ISO 13857:2008 Table 1. If this is not reasonably practicable, fixed or movable guards according to Annex A or D or EN ISO 13849-1:2008, PL_r = c shall be installed.

For maintenance and exchange, the non-return valve shall be accessible.

See also 7.1.12.

5.6.2 Thermal hazards

The requirements in accordance with 5.5.2 shall be met.

Heat insulation of the plasticising and/or injection cylinders shall be provided so that, for a cylinder temperature of 240 °C, the temperature of the surface of the insulation does not exceed the limit values in accordance with EN ISO 13732-1:2008.

Insulation can be achieved by a direct insulation in the immediate vicinity of the heater bands or by distant guarding, covering the full length of the plasticizing and/or injection cylinders. If this guarding incorporates a movable guard an additional direct insulation of the heater bands is necessary. This additional insulation needs not to meet the requirements of EN ISO 13732-1:2008.

Additional direct insulation at the heater band next to the nozzle is not necessary if:

— the movable guard of the nozzle area prevents access to this heater band when the nozzle is in the operative position; or

— the distant guarding covering the plasticizing and/or injection cylinders is designed to prevent access to this heater band when its movable guard is closed.

Hazards due to the plasticised material being released from the vent opening shall be prevented by a guard able to contain this plasticised material.

Warning signs in accordance with Annex L, Figure L.1 shall be displayed drawing attention to the hazards associated with the unintentional ejection of hot gas or material through the feed opening.

See 7.1.12. and 7.2.

5.6.3 Mechanical and/or thermal hazards

The temperature of the plasticising and/or injection cylinders shall be automatically monitored to ensure that the temperature does not exceed the maximum permissible value set by the manufacturer with regard to the mechanical strength of the barrel (see 7.1.12).

The energy supply to all heating elements of the barrel shall be automatically interrupted:

— in case the maximum permissible limit value is reached; or

— in case of a fault in the temperature control.

These requirements do not apply to injection moulding machines designed exclusively for processing rubber or when the heating system is such that the maximum limit value allowed by the mechanical strength of the barrel cannot be exceeded.

5.7 Discharge area

The discharge aperture shall be designed or safeguards shall be provided to prevent access to any dangerous movement through this aperture.

Preferably the dimensions in Figure 12 should be met if necessary by using fixed guards.

Alternatively the following safeguards may be used:

— interlocking guards according to Annex A or D or EN ISO 13849-1:2008, PL_r = c; and/or

— electro-sensitive protective equipment in accordance with EN 61496-1:2004, type 2.

These safeguards shall not be used to re-initiate a cycle.

When conveyors are used, see 5.10.4.

Dimensions in mm

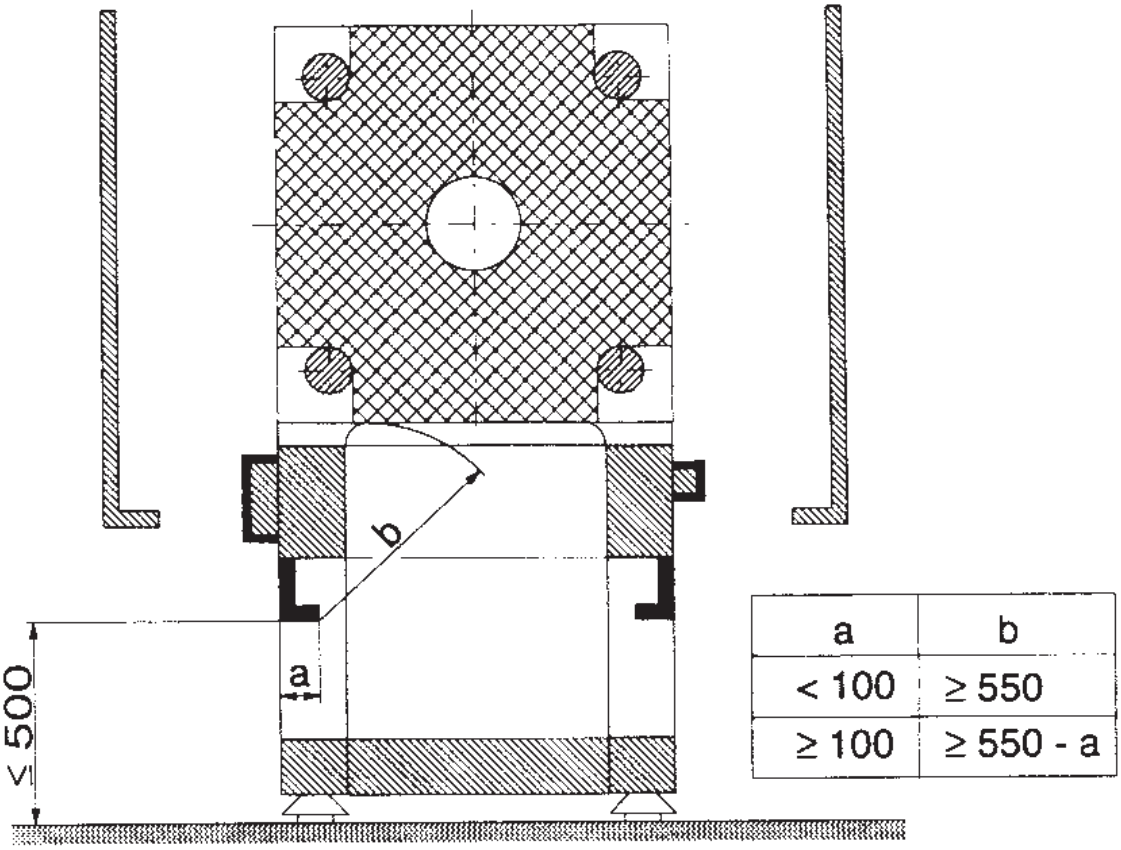


Figure 12 — Dimensions of the discharge area

5.8 Safety requirements and/or protective measures against hazards not associated with a particular area of the machine

5.8.1 Whiplash of flexible hoses

For flexible hoses with pressures higher than 5 MPa dangerous whiplash shall be prevented by fixed enclosing guards (see EN 953:1997, 3.2.1) and/or additional attachment of the hoses e.g. by a chains or cables or brackets.

Alternatively, to prevent whiplash, flexible hoses and their connections shall be designed to prevent tearing from the fittings and unintentional detachment from connection points.

Tearing shall be prevented by the use of tear-proof fittings. The hose assembly shall be tear-proof; this shall be proved by drawing and test report. The hoses shall have a minimum of two steel-cord layers in order to achieve the tear-proof connection mentioned.

To prevent unintentional detachment from connection points, cutting ring type connectors shall not be used. Appropriate connections are for example flanged joints, flared unions or conical nipple connections.

In addition, the ratio of the burst pressure of the hose and fitting to the maximum pressure in the circuit shall not be less than 3,5.

See also 7.1.14.

5.8.2 Release of fluids under pressure

To prevent the uncontrolled release of fluids under pressure hydraulic and pneumatic equipment shall be designed in accordance with EN ISO 12100-2:2003 4.10, EN 982:1996+A1:2008 and EN 983:1996+A1:2008.

To prevent release of pressurised fluids from hose assemblies, the requirements listed in 5.8.1 for flexible hoses and their connections shall be met.

5.8.3 Hazards during adjustment and servicing

Machines have to be supplied with special tools and equipment for adjustment and servicing e.g. for spanning the tie bar nuts, changing of the screw or barrel, if this cannot be done with tools and equipment usually available on the market.

See also 7.1.15

5.8.4 Electrical hazards and hazards due to electromagnetic interference

The electrical equipment shall be in accordance with EN 60204-1:2006.

Protection against direct contact shall be in accordance with 6.2 of EN 60204-1:2006, with minimum degrees of protection in accordance with EN 60529:1991.

Protection against indirect contact shall be in accordance with 6.3 of EN 60204-1:2006.

Electronic control systems shall be designed and installed so as to be protected from electromagnetic interference and stable when exposed to operation or a failure of the electrical system in accordance with EN 61000-6-2:2005.

Electrical/electronic design shall apply technical information and physical measures to limit electromagnetic emissions in accordance with EN 61000-6-4:2007.

During installation of electrical and electronic components, the machine manufacturer shall follow the information for use provided by the manufacturer of those components.

5.8.5 Thermal hazards

To prevent burns through unintentional contact with heat conditioning hoses and fittings, fixed guards or insulation shall be provided at accessible parts outside of the guarded area where the maximum operating temperature can exceed the limit values determined in accordance with EN ISO 13732-1:2008. In addition warning signs in accordance with Annex L, Figure L.2 shall be fitted (see 7.2).

Injury caused by escaping fluids from uncovered heat conditioning hoses and fittings shall be prevented by guards.

5.8.6 Hazards generated by noise

Injection moulding machines shall be designed and constructed so that risks resulting from the emission of airborne noise are reduced.

NOTE Useful guidance is given in EN ISO 11688-1 and EN ISO 11688-2.

For the hydraulic system noise reduction shall be achieved by selecting low noise emission components. Additional noise reduction can be achieved by partial or complete enclosure.

Noise reduction for the pneumatic system shall be achieved by the application of vent silencers.

See 7.1.27 and Annex K.

5.8.7 Hazards generated by gases, fumes and dusts

The machine shall be so designed that an exhaust system can be fitted or positioned, for the extraction of harmful substances.

See also 7.1.16.

5.8.8 Slip, trip and fall hazards

The machine shall be designed in accordance with 5.5.6 of EN ISO 12100-2:2003.

Designated access positions and designated working positions on the machine shall be:

— permanently marked (see also 7.1.17 and 7.2);

— safe against slipping and tripping because of granules and oil leakages;

— safe against falling for heights ≥ 1000 mm above floor level;

— either provided with permanent safe means of access in accordance with EN ISO 14122, parts 2, 3 and 4, or designed so that it is possible to use a non-permanent safe means of access, see 7.1.18. In this case, the manufacturer shall provide a quotation for non-permanent safe means of access.

For machines designed to have automatic feeding of material see 7.1.19.

For machines designed to have manual feeding, the following requirements shall be fulfilled:

— if the upper edge of the hopper is more than 1500 mm above floor level, the positions on the machine for manual feeding of the material shall be designated working positions;

— for rubber band machines, if the height of the feeding opening is more than 2000 mm above the floor level the positions on the machines for manual feeding shall be designated working positions.

See 7.1.20.

5.8.9 Hydraulic and pneumatic systems

The requirements in EN 982:1996+A1:2008 and EN 983:1996+A1:2008 shall be taken into consideration in designing hydraulic and pneumatic systems.

See 7.1.26.

5.8.10 Power operated guards

For power operated guards the following additional requirements shall apply:

— where there are contact forces more than 75 N and less or equal to 150 N, a pressure sensitive edge in accordance with EN 1760-2:2001+A1:2009 shall be supplied. Actuation of the sensitive edge shall stop the closing movement of the guard in accordance with EN ISO 13849-1:2008, PL_r = c;

— where there are contact forces more than 150 N, these shall not exceed 300 N and a pressure sensitive edge in accordance with EN 1760-2:2001+A1:2009 shall be supplied. Actuation of the sensitive edge shall stop the closing movement of the guard in accordance with EN ISO 13849-1:2008, PL_r = c, and

allow the reversing movement without creating any additional hazard. Closing of the guard shall be achieved by a hold-to-run control device in accordance with of EN ISO 13849-1:2008, PL_r = c;

— the actuator to close the guard shall be positioned so as to give the operator a clear view of the danger zone;

— if there is a failure in the power supply to the operation of the guard, any dangerous movement of the guard due to gravity shall be prevented.

5.9 Additional safety requirements and/or protective measures associated with specific machine design

5.9.1 Carousel machines

Access to dangerous movements of the carousel shall be prevented by fixed guards and/or interlocking guards according to Annex B or E or EN ISO 13849-1:2008, PL_r = d. However where interlocking guards allow access to the mould area then the requirements specified in 5.2.1 and where applicable 5.2.7 and 5.2.8 shall also apply.

5.9.2 Shuttle-table machines / machines with sliding lower platen and turn-table machines

Access to dangerous movements of the table/platen shall be prevented by one or more of the following:

— fixed guards;

— interlocking guards according to Annex B or E or EN ISO 13849-1:2008, PL_r = d;

— electro-sensitive protective equipment in accordance with EN 61496-1:2004, type 2;

— scanners in accordance with CLC/TS 61496-3:2008, EN ISO 13849-1:2008, PL_r = d;

— pressure sensitive mat or floor in accordance with EN 1760-1:1997+A1:2009, EN ISO 13849-1:2008, PL_r = d;

— two-hand control devices in accordance with EN 574:1996+A1:2008, type IIIA.

Opening the interlocking guard, interrupting the light curtain or scanner, or actuating the pressure sensitive mat or floor, or releasing a manual actuator of the two-hand control device shall stop the dangerous horizontal movement of the table / sliding lower platen.

Where safeguards are used which also allow access to the mould area then the requirements specified in 5.2.1 shall also apply.

Where vertical movement of the shuttle-table is possible, gravity descent of the shuttle-table shall be prevented as described in 5.1.8.

5.9.3 Multistation machines with mobile injection unit

Access to dangerous movement of the injection unit as it moves between the clamping units shall be prevented by fixed guards and/or interlocking guards according to Annex B or E or EN ISO 13849-1:2008, PL_r = d.

Where the interlocking guards also allow access to the mould area, then the requirements specified in 5.2.1 and where applicable 5.2.7 and 5.2.8 shall also apply.

5.9.4 Cellular foam injection moulding machines

Shut-off nozzles shall be used which automatically close when the interlocking guards are opened. The interlocking shall be in accordance with:

— Annex B or E or EN ISO 13849-1:2008, PL_r = d for the guards for the mould area; and

— Annex A or D or EN ISO 13849-1:2008, PL_r = c for the guard for the nozzle area.

In addition:

— the shut-off nozzle shall prevent leakage when the maximum back pressure is applied; or

— the pressure, when opening the guards, shall be reduced to such a level that release of the melt from the closed nozzle is prevented.

The closed position of the nozzle shall be automatically monitored at least once during each cycle of the guard. In case of a failure, initiation of the next machine cycle shall be prevented and an alarm shall be given.

See 7.1.25.

5.10 Additional safety requirements and/or protective measures when using ancillary equipment

5.10.1 Power operated mould changing equipment

Access to the mould change area shall be prevented by safeguards according to Annex A or D or EN ISO 13849-1:2008, PL_r = c for the movements of the mould changing equipment, in conjunction with fixed guards where necessary.

Where it is possible to gain whole body access into the mould change area, additional devices, e.g. electro-sensitive protective equipment in accordance with EN 61496-1:2004, type 2, or pressure sensing mats or floors, EN ISO 13849-1:2008, PL_r = c shall be fitted. These additional devices when actuated shall interrupt the control circuit for movements of the mould changing equipment.

Movements of the mould and/or mould transfer device may be initiated manually without the existence of guards or with guards open or with additional safety devices being ineffective using a selector switch lockable in all positions and by actuation of:

— a hold to run control device, provided the maximum speed cannot exceed 75 mm/s; or

— a limited movement control device.

The manual control device shall be positioned to give a clear view of the danger area.

5.10.2 Power operated mould clamping devices

5.10.2.1 Common requirements

The safeguards as specified in 5.2.1 or 5.2.2 shall also provide protection against the movements of the power operated mould clamping device. For these movements, the safeguards shall act in accordance with Annex B or E or EN ISO 13849-1:2008, PL_r = d.

The correct clamping of the mould shall be easily verifiable by the operator, either by direct vision or via indicators.

Falling of the mould or its parts shall be prevented even in case of failure of the energy supply e.g. by additional mechanical restraint devices or by self retaining clamping elements or by clamping elements such that unclamping can be effected only by applying energy.

Clamping and unclamping shall be possible only in a specific mode, accessible only via a key selector switch or an access code.

5.10.2.2 Additional requirements for magnetic clamping

Guards only shall be used to prevent access to the mould area.

Only permanent magnets shall be used.

The magnetic field shall create sufficient force to clamp the maximum expected weight of the mould of the injection moulding machines and withstand the different forces that can be applied to the mould (see 7.1.21).

The magnetic field shall be controlled by an electric current that is not required to sustain the magnetic field.

Magnetising/demagnetising shall be possible only if:

— the machine is in the specific mode for mould clamping/unclamping; and

— the guards for the mould area are closed. The interlock shall act on the power circuit of the magnetic clamping system:

  — in accordance with EN ISO 13849-1:2008, PL_r = c for magnetisation; and

  — in accordance with EN ISO 13849-1:2008, PL_r = d for demagnetisation.

For machines where whole body access is possible between the movable guard for the mould area and the mould area itself (see 5.2.7) and/or whole body access is possible to the mould area (see 5.2.8) the protective devices that detect the presence of persons shall prevent the magnetisation and the demagnetisation according to EN ISO 13849-1:2008, PL_r = d.

Movement of the mobile platen shall be possible only if both platens are correctly magnetised or demagnetised. If only one platen is magnetised/demagnetised it shall be possible to move the mobile platen in the mode for mould clamping/unclamping only.

Two separate actuators are required to avoid the unintentional magnetisation/demagnetisation. They shall be clearly marked to identify which platen they affect.

A visual indicator of the magnetisation or demagnetisation status shall be fitted.

The control circuit of the magnetic clamping system shall incorporate:

— a system in accordance with EN ISO 13849-1:2008, PL_r = b to detect:

  — the correct location and contact of the mould parts on the platens to allow magnetisation; and

  — the correct saturation of the magnets to allow production; and

  — the detachment of the mould from the platen, in this case the cycle shall be automatically interrupted;

— a temperature sensor that activates an alarm, interrupts the cycle and prevents the next cycle if the limit value for the temperature has been reached.

See also 7.1.21 and 7.2.

5.10.3 Fluid injectors

The signal to allow the fluid to be injected shall be interrupted with the opening of the guards, in accordance with Annex B or E or EN ISO 13849-1:2008, PL_r = d for the guard of the mould area and in accordance with Annex A or D or EN ISO 13849-1:2008, PL_r = c for the guard of the nozzle area.

It shall only be possible to open the mould if the fluid injector has sent a signal to the injection moulding machine to indicate that the pressure has been sufficiently reduced.

See 7.1.24.

5.10.4 Other ancillary equipment

The installation/connection of ancillary equipment shall not reduce the level of safety specified in this standard for injection moulding machines.

When the machine manufacturer also provides the ancillary equipment or if the injection moulding machine is intended to be used only together with an ancillary equipment, the machine shall be so designed that it can only be operated if this ancillary equipment is installed and connected in accordance with the following requirements:

— if de-activation of the safeguarding system (e.g. a light curtain) of the injection moulding machines gives access to a danger area of ancillary equipment, this safeguarding system shall meet the safety requirements applicable to that ancillary equipment;

— the connection of ancillary equipment and the resulting modifications of the safeguarding of the injection moulding machine shall not allow unprotected access to danger areas of the machine;

— if de-activation of the safeguarding system of the ancillary equipment gives access to a danger area of the injection moulding machine, this safeguarding system shall meet the safety requirements applicable to that particular danger area of the machine;

— in the case of whole body access to the machine (see 5.2.7 and 5.2.8), additional protective devices as specified in 5.2.7 and/or 5.2.8 shall be provided;

— ancillary equipment, the presence of which prevents access to a danger area of the injection moulding machine and which can be removed without the use of a tool, shall be interlocked with the machine control circuit in the same way as a movable guard for the danger area concerned.

For information for use and ergonomic principles see 7.1.22 and 7.1.23.

6 Verification of the safety requirements and/or protective measures

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

Table 1 — Verification methods

CLAUSE	Item	VERIFICATION METHODS				
		VISUAL INSPEC-TION	FUNC-TIONAL TEST	MEAS-UREMENT	CALCU-LATION	DOCU-MENTA-TION
5.1.1	General - Emergency stop	x	x			x
5.1.2	General - Guards	x	x	x	x	x
5.1.3	General - ESPE	x	x	x	x	x
5.1.4	General - Two hand control devices	x	x	x	x	x
5.1.5	General - Hold to run control devices	x	x			
5.1.6	General - Mats, floors, edges	x	x			
5.1.7	General - Automatic monitoring		x			
5.1.8	General - Gravity movements	x	x			x
5.2.1	Mould area - Platen movement - Operator sides	x	x	x	x	x
5.2.2	Mould area – Platen movement - Non operator sides	x	x	x	x	
5.2.3	Mould area - Other movements	x	x	x	x	x
5.2.4	Mould area - Control guards	x	x	x		
5.2.5	Mould area – Thermal hazards	x				x
5.2.6	Mould area - Downstroking platen	x	x	x		x
5.2.7	Mould area – Whole body access between guards/light curtains and mould area	x	x	x		x
5.2.8	Mould area – Whole body access to mould area	x	x	x		x
5.2.9	Mould area – L-type configuration	x	x			x

Table 1 *(continued)*

CLAUSE	Item	VERIFICATION METHODS				
		VISUAL INSPEC-TION	FUNC-TIONAL TEST	MEAS-UREMENT	CALCU-LATION	DOCU-MENTA-TION
5.3.1	Clamping mechanism area – Movements behind platen	x	x	x	x	
5.3.2	Clamping mechanism area – Upstroking platen	x	x			x
5.4	Area outside the mould/clamping areas - Core/ejector drive mechanisms	x	x			
5.5.1	Nozzle area – Mechanical hazards	x	x		x	x
5.5.2	Nozzle area – Thermal hazards	x				x
5.6.1	Injection unit – Mechanical hazards	x	x	x		x
5.6.2	Injection unit – Thermal hazards	x	x	x		x
5.6.3	Injection unit – Mechanical/thermal hazards		x	x		x
5.7	Discharge area	x	x	x		
5.8.1	Flexible hoses	x			x	x
5.8.2	Release of fluids under pressure	x			x	x
5.8.3	Adjustment and servicing	x				x
5.8.4	Electrical hazards and electromagnetic interference	x		x		
5.8.5	Thermal hazards	x		x		
5.8.6	Noise hazards	x		x	x	x
5.8.7	Gases, fumes and dusts	x				x
5.8.8	Slip, trip and fall	x		x		x
5.8.9	Hydraulic and pneumatic systems					x
5.8.10	Power operated guards	x	x	x		
5.9.1	Carousel machines	x	x	x	x	
5.9.2	Shuttle-table/sliding lower platen, turn-table	x	x	x	x	
5.9.3	Multistation machines	x	x	x	x	
5.9.4	Cellular foam injection moulding machines	x	x			x

Table 1 *(continued)*

CLAUSE	Item	VERIFICATION METHODS				
		VISUAL INSPEC-TION	FUNC-TIONAL TEST	MEAS-UREMENT	CALCU-LATION	DOCU-MENTA-TION
5.10.1	Ancillary – Power operated mould changing	x	x	x		
5.10.2	Ancillary – Power operated mould clamping	x	x			x
5.10.3	Ancillary – Fluids injectors	x	x			x
5.10.4	Ancillary – Others	x	x			x

Functional testing of safeguards in accordance with Annexes B to H or EN ISO 13849-1:2008, with PL_r = c, d or e shall also include the simulation of faults which are likely to occur.

7 Information for use

7.1 Instruction handbook

Each injection moulding machine shall be accompanied by a handbook giving general instructions for use (see 6.5 of EN ISO 12100-2:2003) and the following information.

7.1.1 Emergency stop

The manufacturer shall indicate the effects of the emergency stop.

7.1.2 Stopping performance

The manufacturer shall specify the maximum stopping time of the parts driven by electrical axes for which there is an interlocking guard without guard locking.

7.1.3 Stopping time

The manufacturer shall state that the user should ensure that the stopping time relating to the light curtains and two-hand control devices is verified at least once a year.

7.1.4 Light curtains

The manufacturer shall give adequate instructions on the verification of the stopping time and that on an injection moulding machine equipped with light curtains, moulds protruding from the mould area should not be used.

7.1.5 Parking brakes

The manufacturer shall specify the frequency (at least once per shift) and procedure for testing the parking brake system.

The manufacturer shall specify the maximum additional mass that can be added to the parts liable to move by gravity.

The manufacturer shall also specify which replacement belts should be used.

7.1.6 Moulds and extensions

The manufacturer shall inform the user that the moulds and extensions should not protrude from the mould area.

7.1.7 Movements of cores and ejectors

a) The manufacturer shall indicate to the user that the components in the kinematic line must be selected and arranged so that the maximum speed of cores and ejectors is ≤ 10 mm/s.

b) The manufacturer shall indicate that in the case that a position selector with a position 3 is installed, it is the responsibility of the user to ensure that if position 3 is selected, the design of the mould, cores and ejectors and their drive mechanisms prevent access to shearing or crushing area created by the movements of the cores and ejectors and their drive mechanisms.

7.1.8 Thermal hazards in the mould area

The manufacturer shall specify which items of personal protective equipment against thermal hazards should be provided by the user to operators working in this area.

7.1.9 Maintenance operations on vertical machines

For machines with downstroking or upstroking platen, the manufacturer shall describe the safe blocking of the platen for maintenance operations.

7.1.10 Machines where whole body access is possible

The manufacturer shall inform the user how the function of pressure sensitive mats and floors should be tested.

7.1.11 Presence detecting devices in the mould area

The manufacturer shall state that presence detecting devices in accordance with 5.2.7 or 5.2.8 may require readjustment after a mould change.

7.1.12 Plasticising and/or injection unit

The manufacturer shall give information for changing the screw and the non return valve for the melt.

The manufacturer shall give information for selecting and for assembly/disassembly of the nozzle.

The manufacturer shall state that only nozzles, plasticising and/or injection cylinders and their fastening bolts as specified by the manufacturer should be used.

The manufacturer shall state that due to insufficient pre-drying or degradation of certain plastic materials, unintentional ejection from the nozzle or the feed opening may occur and that in this case appropriate personal protective equipment should be worn.

The manufacturer shall declare the maximum permissible limit value of the temperature of the plasticising and/or injection cylinders.

The manufacturer shall state that for all work at the plasticising and/or injection unit at least a face shield and gloves should be used.

7.1.13 Machines with L-Type configuration

The manufacturer shall state that the user should set the heating parameters of the machine in accordance with the specifications of the material supplier.

The manufacturer shall inform the user about the risks due to degradation of the material due to too high a temperature and/or too long a residence time in the barrel.

The manufacturer shall state that at least a face-shield and gloves should be worn during setting, start-up and fault-finding etc.

The manufacturer shall indicate for which moulds and which materials the machine is designed and under which circumstances it should be used.

7.1.14 Flexible hose assemblies

The manufacturer shall give information on regular inspections of flexible hose assemblies and their replacement.

7.1.15 Adjustment and servicing

The manufacturer shall give information for adjustment and servicing (e.g. for spanning the tie bar nuts, changing of the screw or barrel) and how to use the special tools and equipment.

7.1.16 Exhaust system

The manufacturer shall indicate that some materials can emit harmful gases, vapours or dusts during processing and that an exhaust system is then needed. The manufacturer shall indicate that in that case an exhaust system should be positioned or fitted under the responsibility of the user. The manufacturer shall give information concerning the fitting or positioning of the exhaust system.

The manufacturer shall inform the user that where nitrogen is used in the process, the oxygen rate should be verified prior to any intervention in pits.

7.1.17 Designated access and working positions

The manufacturer shall indicate that all positions which are not marked in accordance with 5.8.8 are not to be used as access or working positions.

The manufacturer shall remind the user that it is the user’s responsibility to keep the floor and the designated access and working positions free from oil and granules.

7.1.18 Non-permanent safe means of access

The manufacturer shall indicate:

— the appropriate characteristics of the non-permanent safe means of access to the designated working positions on the machines;

— the space to be reserved in order to install and use the non-permanent means of access;

— the necessary precautions when installing and using the non-permanent means of access.

The manufacturer shall indicate that the user is responsible for providing non-permanent means of access that are safe against slipping, tripping and falling.

The manufacturer shall inform the user about the correct positioning of the non-permanent safe means of access so that danger areas of the machine cannot be reached from those means of access.

7.1.19 Automatic feeding of material

The manufacturer shall state that the machine is designed for automatic feeding only. They shall inform the user that all devices for automatic feeding of material should be in place before the machine is started.

7.1.20 Manual feeding of material

The manufacturer shall inform the user that all means of access necessary for manual feeding material should be in place before the machine is started.

7.1.21 Magnetic mould clamping

The machine manufacturer shall declare the following:

— the intended use;

— only trained and qualified personal should be allowed to operate the magnetic clamping system;

— the magnetic clamping force for smallest/largest mould under ideal conditions;

— a method to estimate the magnetic clamping force for a particular mould;

— mould and/or base plate material requirements;

— minimum base plate thickness;

— a formula to calculate allowable cantilever force from the mould (e.g. see Figure 1 of EUROMAP 72);

— required minimum contact area of mould, taking into account e.g. holes;

— required conditions of mating surfaces;

— limit temperature for the magnetic force specified;

— allowable ejector force and importance of properly adjusting the ejector stroke and alignment;

— allowable nozzle force and mould opening force;

— overpacking the mould will increase the force that is necessary to open the mould;

— mould change procedure(s);

— warn users that the magnetic field exerts a high force on ferrous objects placed close to the magnetic clamping system surface and could create pinch points;

— warn users not to magnetise the magnetic clamping system without the mould being in contact with the magnetic clamping system surface;

— optimum magnetic clamping force for each mould is achieved when the magnetic field is built with the surfaces already in contact;

— pacemakers, hearing aids or other medical devices can be damaged or affected by the use of the magnetic clamping system;

— the magnetic clamping system cannot be re-located, re-installed or switched from one horizontal injection moulding machine to another without first contacting the machine manufacturer;

— recommended maintenance schedule;

— the magnetic clamping system shall be switched off when the horizontal injection moulding machine is switched off;

— the function of the emergency stop, especially if:

  — it does not stop the magnetisation and demagnetisation; or

  — it stops the magnetisation and demagnetisation but the platens are in an undefined status; in this case, clear instructions shall be written about the operations to reach a safe status.

— the procedures after an alarm.

7.1.22 Ancillary equipment

The machine manufacturer shall give adequate information so that the safety level is not reduced when ancillary equipment which has not been supplied by them is installed by the user. The machine manufacturer shall specify the interfaces available on the machine to connect the ancillary devices (e.g. see EUROMAP 67 Recommendation for handling devices/robots).

The manufacturer shall state that they are only responsible for the interaction of the machine with ancillary equipment where they have designed the interface system.

The machine manufacturer shall state that if ancillary equipment is removed, the original guards or safety devices should be replaced.

The machine manufacturer shall state that a reassessment of the risk of overturning is necessary if ancillary equipment not supported by the floor is fitted to the machine and that their agreement is required before fitting ancillary equipment to the machine.

7.1.23 Applying ergonomic principles when using ancillary equipment

The manufacturer shall state that the installation of ancillary equipment should not reduce the necessary visibility of dangerous machine areas, nor prevent access to the working positions specified in the instruction handbook.

7.1.24 Bursting of moulded parts

The manufacturer shall describe suitable measures to reduce the hazard of bursting of the moulded parts after demoulding.

7.1.25 Cellular foam injection moulding

The manufacturer shall inform the user that in case of hotrunners, moulds with shut-off nozzles should be used.

The manufacturer shall inform the user that with the machine running in manual or semiautomatic mode, the operator should use personal protective equipment.

7.1.26 Hydraulic system cleaning

The manufacturer shall specify procedures and time intervals for the cleaning and changing of filters and refilling the hydraulic system.

The manufacturer shall advise the user that whilst working on the hydraulic system, appropriate measures should be taken to avoid contamination of the oil.

7.1.27 Noise emission

The instruction handbook shall:

— give noise emission values of the injection moulding machines in accordance with Annex K of this standard and A.2.2 of EN ISO 4871:2009, as dual-number emission values;

— refer to the noise test code specified in Annex K to this standard upon which the determination of the noise emission values of the injection moulding machine is based and state which basic noise measurement standards have been used.

7.1.28 Splashing hazards where two-hand control devices are used

If the machine is designed so that the design of the mould has to contribute to prevent the splashing hazard (see 5.2.1), the machine manufacturer has to inform the user that only moulds of an appropriate design should be used for processing materials other than rubber.

7.2 Marking

The minimum markings for all machines shall include:

— designation of the machinery;

— name and address of the manufacturer and supplier;

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

— CE mark;

— designation of series or type;

— serial number if any, or machine number;

— year of construction;

— designated access positions and designated working positions on the machine;

— warning notices about hot parts: heat conditioning hoses and fittings, moulds, heating elements and nozzles.

In addition, where a light curtain or two-hand control device is used, the following shall be included:

— the stopping time; and

— the distance between the light curtain and the mould area; or

— the distance between the two-hand control and the mould area.

In addition where a magnetic clamping system is delivered by the machine manufacturer at the same time as the machine, safety signs shall be displayed to indicate that:

— ferromagnetic objects close to the platen may be subjected to a magnetic force; and

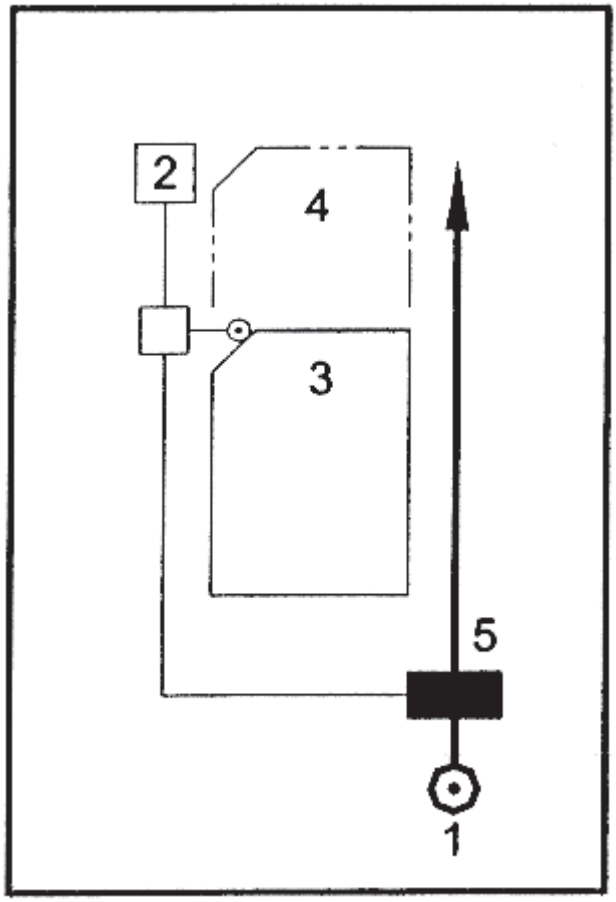
— pacemakers, hearing aids or other medical devices can be damaged or affected by the use of the magnetic clamping system.

NOTE A reference for safety signs could be EUROMAP 64, EUROMAP 68 and EUROMAP 69.

Annex A
(normative)

Movable interlocking guards type I (non-electrical axis)

Movable interlocking guard with one position switch (see 6.2 of EN 1088:1995+A2:2008) acting on the main shut-off device of the power circuit via the control circuit (see Figure A.1).



Key

1 power circuit
2 control circuit
3 movable guard (closed)
4 movable guard (open)
5 main shut-off device

Figure A.1 — Movable interlocking guard type I

A.1 Interlocking function

When the guard is in the closed position, the position switch:

— shall not be operated;

— shall have closed contacts or function in an equivalent mode;

— shall enable the control signal initiating the dangerous movement.

When the guard is not in the closed position, the position switch shall be positively and directly operated by the guard and shall positively interrupt the control signal for the dangerous movement.

A.2 Quality of the components

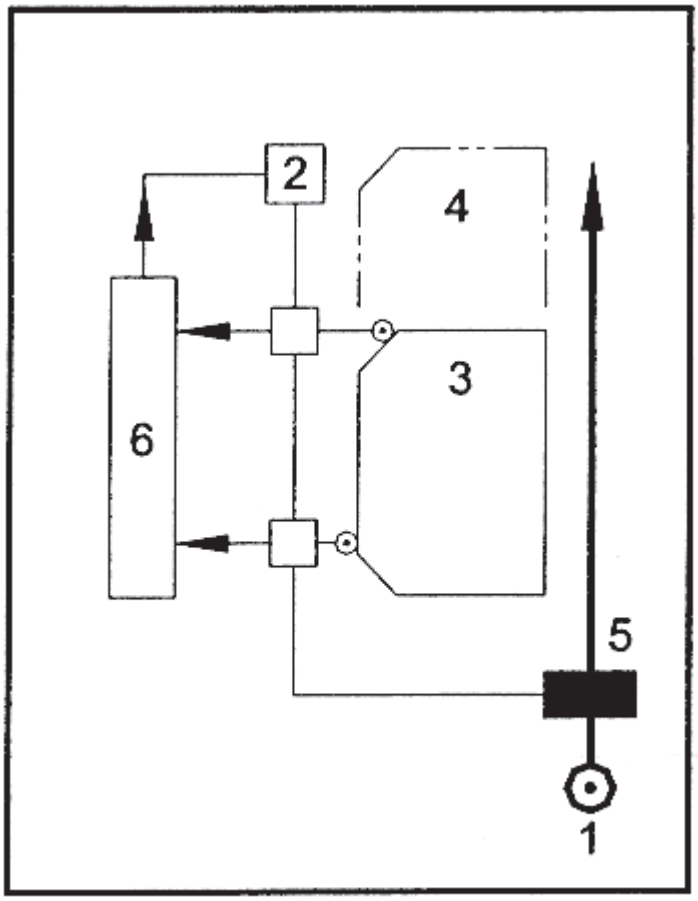
The main shut-off device as well as position switches shall be well tried components according to EN ISO 13849-1:2008, PL_r = c.

See 5.8.9 and 7.1.26.

Annex B
(normative)

Movable interlocking guards type II (non-electrical axis)

Movable interlocking guard with two position switches both acting on the main shut-off device of the power circuit via the control circuit (see Figure B.1).



Key

1 power circuit
2 control circuit
3 movable guard (closed)
4 movable guard (open)
5 main shut-off device
6 monitoring circuit

Figure B.1 — Movable interlocking guard type II

B.1 Interlocking function

When the guard is in the closed position, the first position switch:

— shall not be operated;

— shall have closed contacts or function in an equivalent mode;

— shall enable the control signal initiating the dangerous movement.

When the guard is not in the closed position, the first position switch shall be positively and directly operated by the guard and shall positively interrupt the control signal for the dangerous movement.

When the guard is in the closed position, the second position switch:

— shall be operated by the guard;

— shall have closed contacts or functions in an equivalent mode;

— shall enable the control signal initiating the dangerous movement.

When the guard is not in the closed position, the second position switch shall no longer be operated and shall interrupt the control signal for the dangerous movement.

B.2 Quality of the components

The main shut-off device as well as the first position switch shall be well tried components according to EN ISO 13849-1:2008, PL_r = c.

See 5.8.9 and 7.1.26.

B.3 Automatic monitoring requirements

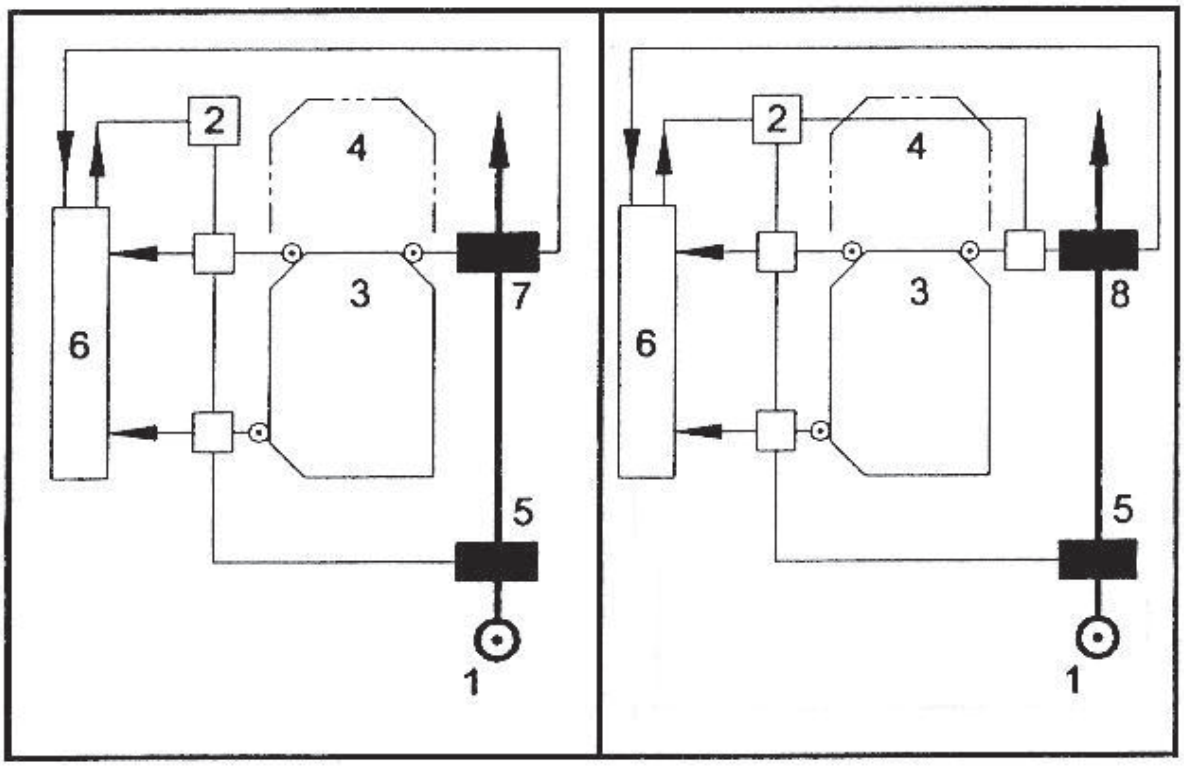
See 5.1.7.

Annex C
(normative)

Movable interlocking guards type III (non-electrical axis)

C.1 Movable interlocking guard with three position detectors

Movable interlocking guard with two interlocking devices independent of one another (see Figure C.1).



Key

1 power circuit
2 control circuit
3 movable guard (closed)
4 movable guard (open)
5 main shut-off device
6 monitoring circuit
7 second shut-off device (direct actuation, see C.1.3.1)
8 second shut-off device (indirect actuation, see C.1.3.2, C.1.3.3, C.1.3.4)

Figure C.1 — Movable interlocking guard type III with three position detectors

C.1.1 Interlocking function

One interlocking device shall act via the control circuit as follows:

When the guard is in the closed position, the first position switch:

— shall not be operated;

— shall have closed contacts or function in an equivalent mode;

— shall enable the control signal initiating the dangerous movement.

When the guard is not in the closed position, the first position switch shall be positively and directly operated by the guard and shall positively interrupt the control signal for the dangerous movement.

When the guard is in the closed position, the second position switch:

— shall be operated by the guard;

— shall have closed contacts or functions in an equivalent mode;

— shall enable the control signal initiating the dangerous movement.

When the guard is not in the closed position, the second position switch shall no longer be operated and shall interrupt the control signal for the dangerous movement.

The other interlocking device shall act directly or indirectly on the power circuit using a position detector (see 5.1 and 5.2 of EN 1088:1995+A2:2008).

When the guard is in the closed position, the position detector:

— shall not be operated;

— shall have closed contacts or function in an equivalent mode;

— shall enable the power circuit.

When the guard is not in the closed position, the position detector shall be positively and directly operated by the guard and shall interrupt the power circuit for the dangerous movement via the second shut-off device.

C.1.2 Quality of the components

See 5.8.9 and 7.1.26.

C.1.3 Additional requirements for the second shut-off device in Figure C.1

The second shut-off device which interrupts the flow to the cylinder for the dangerous movement shall be an additional valve which shall be:

C.1.3.1 positively and directly actuated by the movable guard when the guard is opened; or

C.1.3.2 controlled by an additional position switch being positively and directly actuated by the movable guard when the guard is opened; or

C.1.3.3 controlled by a pilot valve being positively and directly actuated by the movable guard when the guard is opened; or

C.1.3.4 controlled by a pilot valve which is controlled by an additional position switch being positively and directly actuated by the movable guard when the guard is opened.

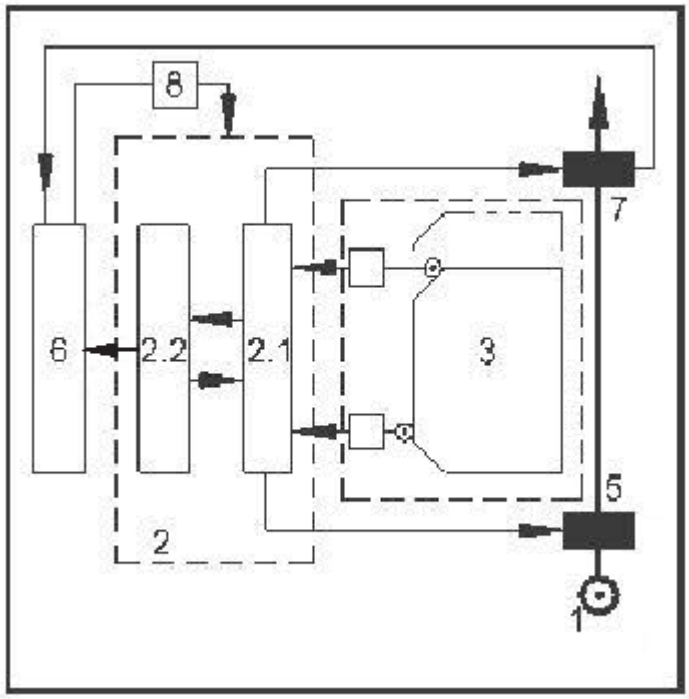
Where the additional valve is controlled by a position switch according to C.1.3.2 or C.1.3.4:

— the position switch shall have positive opening contacts;

— the connection between the position switch and the additional valve shall be via a hardwired circuit and shall be independent from the programmable controller.

C.2 Movable interlocking guard with two position detectors

Movable interlocking guard with two position detectors independent of one another (see Figure C.2).



Key

1 power circuit
2 control and monitoring unit according to EN ISO 13849-1:2008, PL_r = e
2.1 control circuit of shut-off devices
2.2 monitoring circuit of position detectors
3 movable guard (closed)
5 main shut-off device
6 monitoring circuit of injection moulding machine
7 second shut-off device
8 control circuit of the injection moulding machine

Figure C.2 — Movable interlocking guard type III with two position detectors

C.2.1 Interlocking function

Both position detectors shall act directly on a control and monitoring unit according to EN ISO 13849-1:2008, PL_r = e to interrupt the power circuit for the dangerous movement via the two shut-off devices when the guard is opened.

When the guard is in the closed position, the first position switch:

— shall not be operated;

— shall have closed contacts or function in an equivalent mode;

— shall enable the control signal initiating the dangerous movement.

When the guard is not in the closed position, the first position switch shall be positively and directly operated by the guard and shall positively interrupt the control signal for the dangerous movement.

When the guard is in the closed position, the second position switch:

— shall be operated by the guard;

— shall have closed contacts or functions in an equivalent mode;

— shall enable the control signal initiating the dangerous movement.

When the guard is not in the closed position, the second position switch shall no longer be operated and shall interrupt the control signal for the dangerous movement.

C.2.2 Quality of the components

See 5.8.9 and 7.1.26.

C.2.3 Additional requirements for the second shut-off device in Figure C.2

The second shut-off device which interrupts the flow to the cylinder for the dangerous movement shall be an additional valve which shall be:

C.2.3.1 controlled directly by the control unit; or

C.2.3.2 actuated by a pilot valve controlled by the control unit.

C.3 Automatic monitoring requirements

C.3.1 Common requirements (see also 5.1.7)

The shut-off position of the second shut-off device shall be monitored during each movement cycle of the guard so that a fault in the second shut-off device shall be automatically recognised and commencement of any further dangerous movement shall then be prevented.

In the case of the second shut-off device being pilot operated, the correct functioning of the pilot valve shall be monitored. Where this is automatically monitored by the position switching of the second shut-off device, additional automatic monitoring of the pilot valve is not required.

C.3.2 Additional automatic monitoring requirements (Figure C.1)

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if an automatic monitoring of the following has been performed without detecting a fault:

— the switching of the position switches acting on the control circuit;

— the switching of the position of the additional valve according to C.1.3;

— the switching of the position of the additional position detector (according to C.1.3.2 or C.1.3.4) and/or the pilot valve (according to C.1.3.3 or C.1.3.4). Where this is automatically monitored by the position switching of the additional valve, additional automatic monitoring of the additional position detector and/or pilot valve is not required.

C.3.3 Additional automatic monitoring requirements (Figure C.2)

A control and monitoring unit according to EN ISO 13849-1:2008, PL_r = e shall:

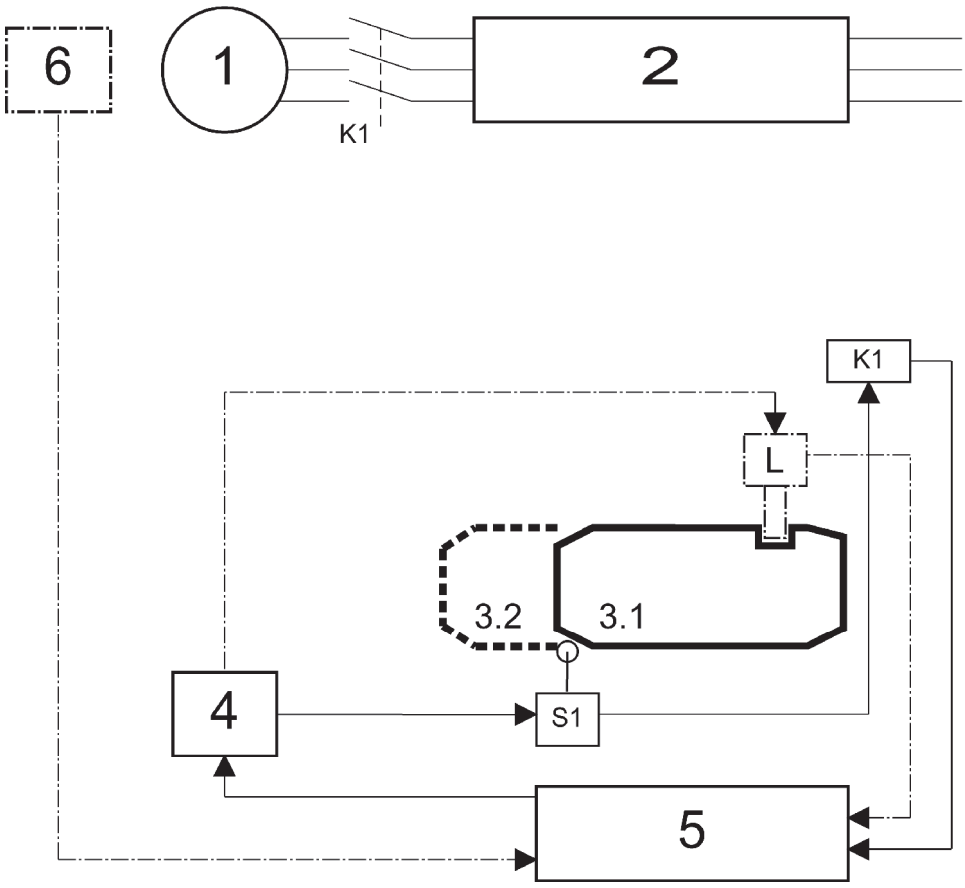
— monitor the two position detectors; and

— control the two shut-off devices as shown in Figure C.2.

Annex D
(normative)

Movable interlocking guards type I (electrical axis)

D.1 Principle of interlocking corresponding to type I, using one electromechanical component



Key

K1	contactor with linked or mirror control contacts
S1	position detector
L	guard locking device (if dangerous run-down can occur)
1	electrical motor
2	motor control unit according to EN ISO 13849-1:2008, PL_r = b
3.1	guard closed
3.2	guard open
4	control circuit of the machine
5	monitoring circuit of the machine
6	standstill detection (see 5.1.2.3)

Figure D.1 — Principle of interlocking corresponding to type I, using one electromechanical component

The position detector may be used to achieve guard locking.

K1 shall be positioned between the motor and the motor control unit, if there is the possibility of hazardous movements due to stored energy in the motor control unit. In other cases, K1 may be positioned on the other side of the motor control unit.

If there is no guard locking, the broken lines are deleted.

The following shall be automatically monitored at least once during each cycle of the movable guard:

— position of the contactor;

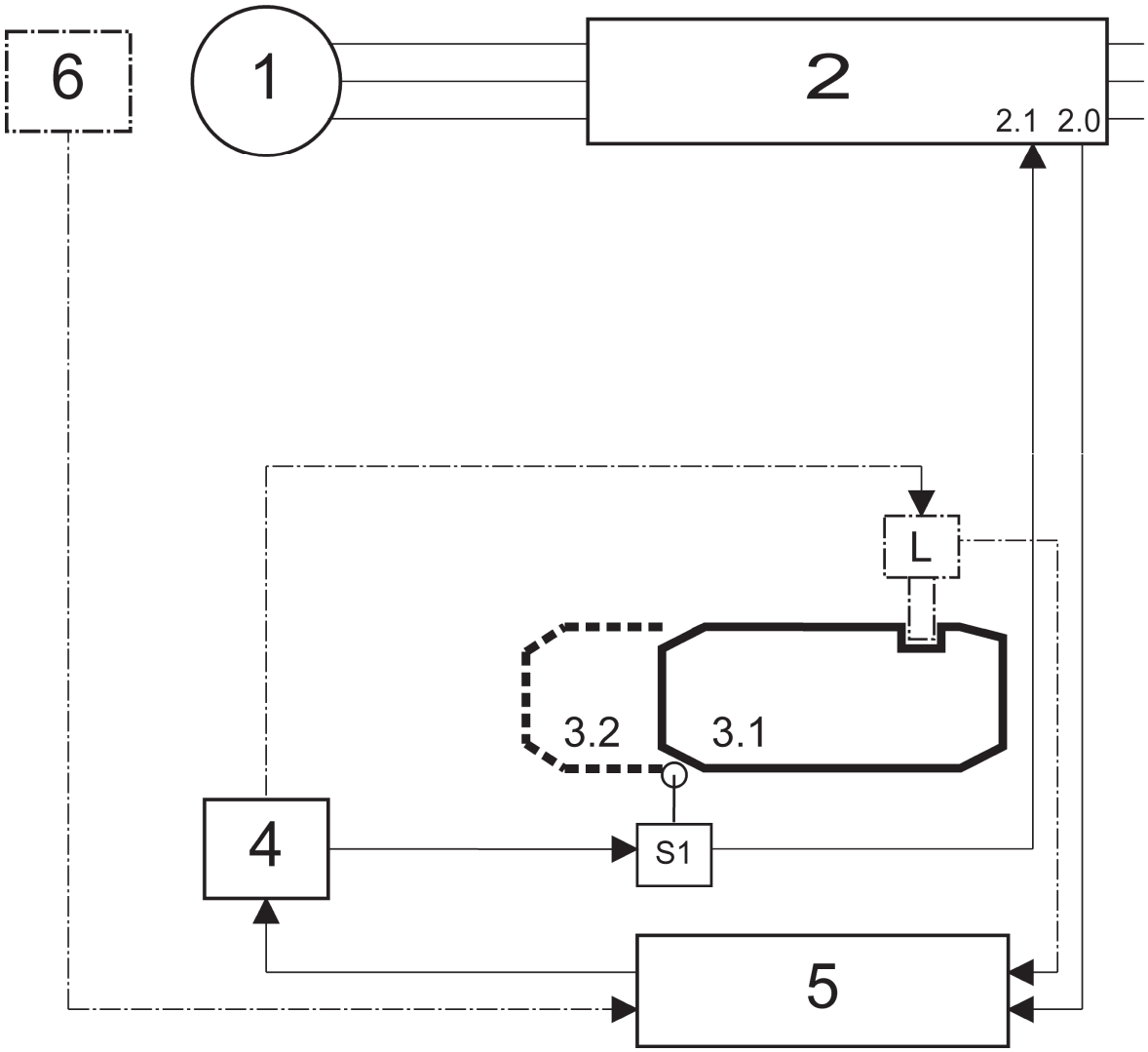
— position of the lock, if applicable;

— information given by the standstill detection, if applicable.

S1 shall be a well tried component.

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if no faults have been detected.

D.2 Principle of interlocking corresponding to type I, using the motor control unit



Key

S1	position detector
L	guard locking device (if dangerous run-down can occur)
1	electrical motor
2	motor control unit according to EN ISO 13849-1:2008, PL_r other than a and b for safe standstill and for safe stopping where there is no guard locking device, certified by an independent third party according to EN ISO/IEC 17025
2.0	confirmation of switch off condition from 2.1
2.1	safety related input
3.1	guard closed
3.2	guard open
4	control circuit of the machine
5	monitoring circuit of the machine
6	standstill detection (see 5.1.2.3)

Figure D.2 — Principle of interlocking corresponding to type I, using the motor control unit

The position detector may be used to achieve guard locking.

If there is no guard locking, the broken lines are deleted.

The following shall be automatically monitored at least once during each cycle of the movable guard:

— the information given by the motor control unit;

— position of the lock, if applicable;

— information given by the standstill detection, if applicable.

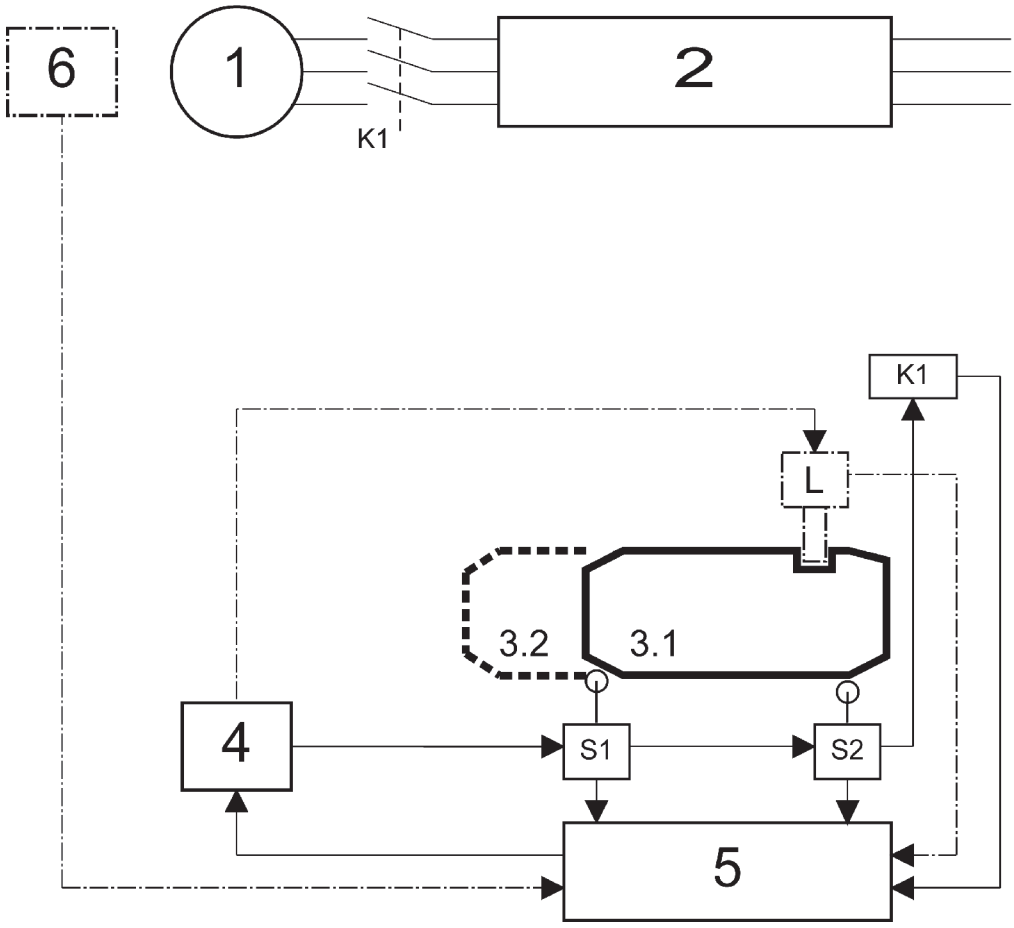
S1 shall be a well tried component.

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if no faults have been detected.

Annex E
(normative)

Movable interlocking guards type II (electrical axis)

E.1 Principle of interlocking corresponding to type II, using one electromechanical component



Key

K1	contactor with linked or mirror control contacts
S1, S2	position detectors
L	guard locking device (if dangerous run-down can occur)
1	electrical motor
2	motor control unit according to EN ISO 13849-1:2008, PL_r = b
3.1	guard closed
3.2	guard open
4	control circuit of the machine
5	monitoring circuit of the machine
6	standstill detection (see 5.1.2.3)

Figure E.1 — Principle of interlocking corresponding to type II, using one electromechanical component

One of the position detectors may be used to achieve guard locking.

K1 shall be positioned between the motor and the motor control unit, if there is the possibility of hazardous movements due to stored energy in the motor control unit. In other cases, K1 may be positioned on the other side of the motor control unit.

If there is no guard locking, the broken lines are deleted.

The following shall be automatically monitored at least once during each cycle of the movable guard:

— change of state of the position detectors of the guard;

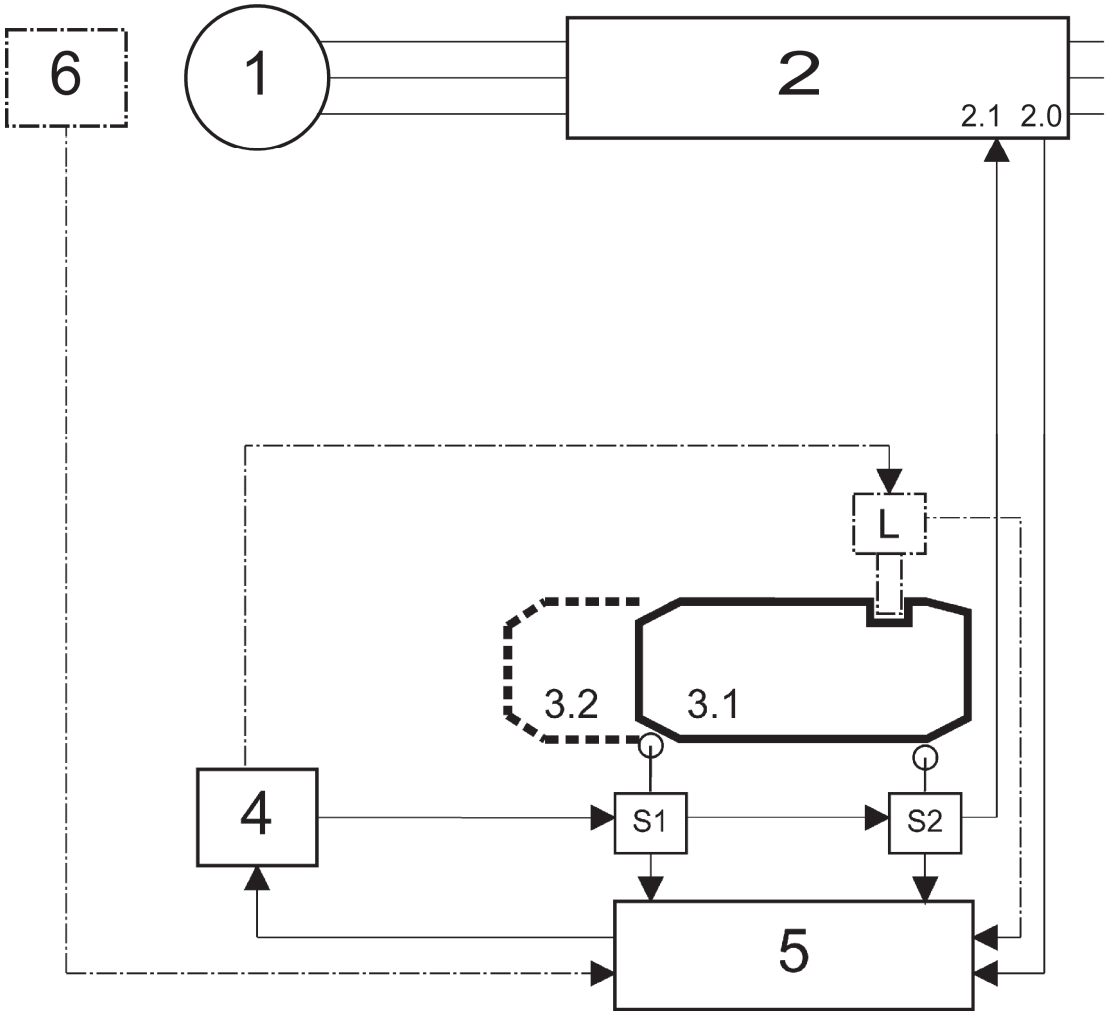
— position of the contactor;

— position of the lock, if applicable;

— information given by the standstill detection, if applicable.

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if no faults have been detected.

E.2 Principle of interlocking corresponding to type II, using the motor control unit (version A)



Key

S1, S2	position detectors
L	guard locking device (if dangerous run-down can occur)
1	electrical motor
2	motor control unit according to EN ISO 13849-1:2008, PL_r other than a and b for safe standstill and for safe stopping where there is no guard locking device, certified by an independent third party according to EN ISO/IEC 17025
2.0	confirmation of switch off condition from 2.1
2.1	safety related input
3.1	guard closed
3.2	guard open
4	control circuit of the machine
5	monitoring circuit of the machine
6	standstill detection (see 5.1.2.3)

Figure E.2 — Principle of interlocking corresponding to type II, using the motor control unit (version A)

One of the position detectors may be used to achieve guard locking.

If there is no guard locking the broken lines are deleted.

The following shall be automatically monitored at least once during each cycle of the movable guard:

— change of state of the position detectors of the guard;

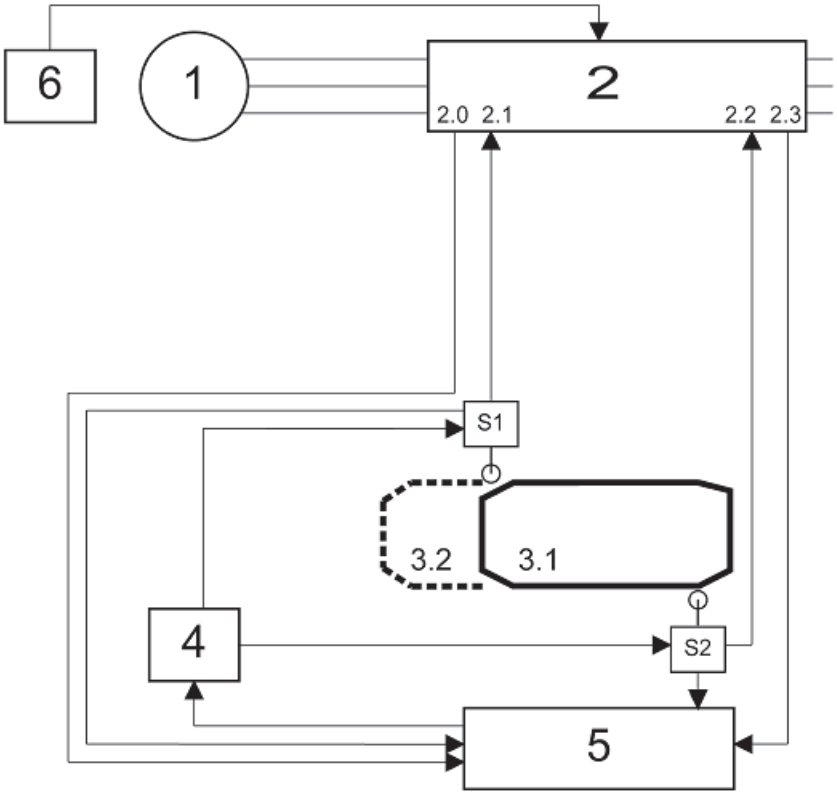
— the information given by the motor control unit;

— position of the lock, if applicable;

— information given by the standstill detection, if applicable.

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if no faults have been detected.

E.3 Principle of interlocking corresponding to type II, using the motor control unit (version B)



Key

S1, S2	position detectors
1	electrical motor
2	motor control unit according to EN ISO 13849-1:2008, PL_r = d, category 3 for safe standstill and for safe stopping, certified by an independent third party according to EN ISO/IEC 17025
2.0	confirmation of switch off condition and of safe stopping initiated by 2.1
2.1, 2.2	safety related inputs
2.3	confirmation of switch off condition and of safe stopping initiated by 2.2
3.1	guard closed
3.2	guard open
4	control circuit of the machine
5	monitoring circuit of the machine
6	stopping and standstill detection (see 5.1.2.3)

Figure E.3 — Principle of interlocking corresponding to type II, using the motor control unit (version B)

If automatic monitoring of the safety related inputs is achieved within the motor control unit, one return line to the monitoring circuit of the machine is sufficient.

The following shall be automatically monitored at least once during each cycle of the movable guard:

— change of state of the position detectors of the guard;

— the information given by the motor control unit;

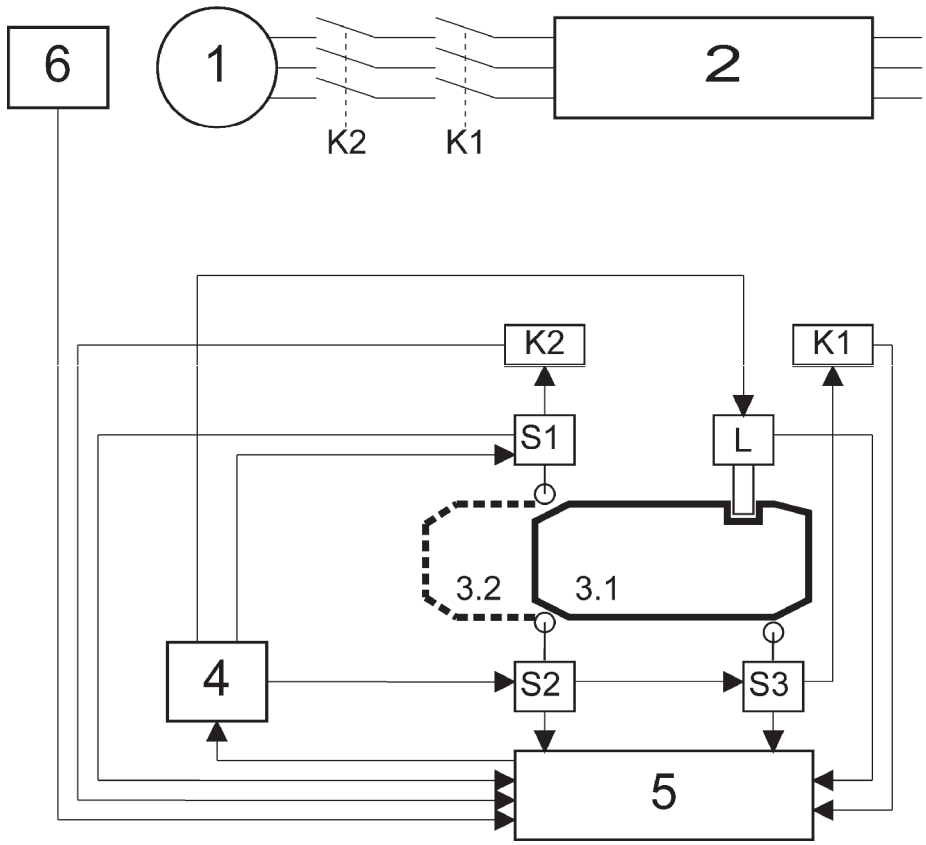
— information given by the safe stopping detection.

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if no faults have been detected.

Annex F
(normative)

Movable interlocking guards type III (electrical axis)

F.1 Principle of interlocking corresponding to type III, using electromechanical components



Key

K1, K2	contactors with linked or mirror control contacts
S1, S2, S3	position detectors
L	guard locking device
1	electrical motor
2	motor control unit according to EN ISO 13849-1:2008, PL_r = b
3.1	guard closed
3.2	guard open
4	control circuit of the machine
5	monitoring circuit of the machine
6	standstill detection (see 5.1.2.3)

Figure F.1 — Principle of interlocking corresponding to type III, using electromechanical components

One of the position detectors may be used to achieve guard locking.

K1 and K2 shall be positioned between the motor and the motor control unit if there is the possibility of hazardous movements due to stored energy in the motor control unit. In other cases, K1 and K2 shall be positioned on opposite sides of the motor control unit to prevent common mode failure.

Automatic monitoring of the position detector S1 is not required if its change of state is automatically monitored by the position switching of contactor K2.

The following shall be automatically monitored at least once during each cycle of the movable guard:

— change of state of the position detectors of the guard;

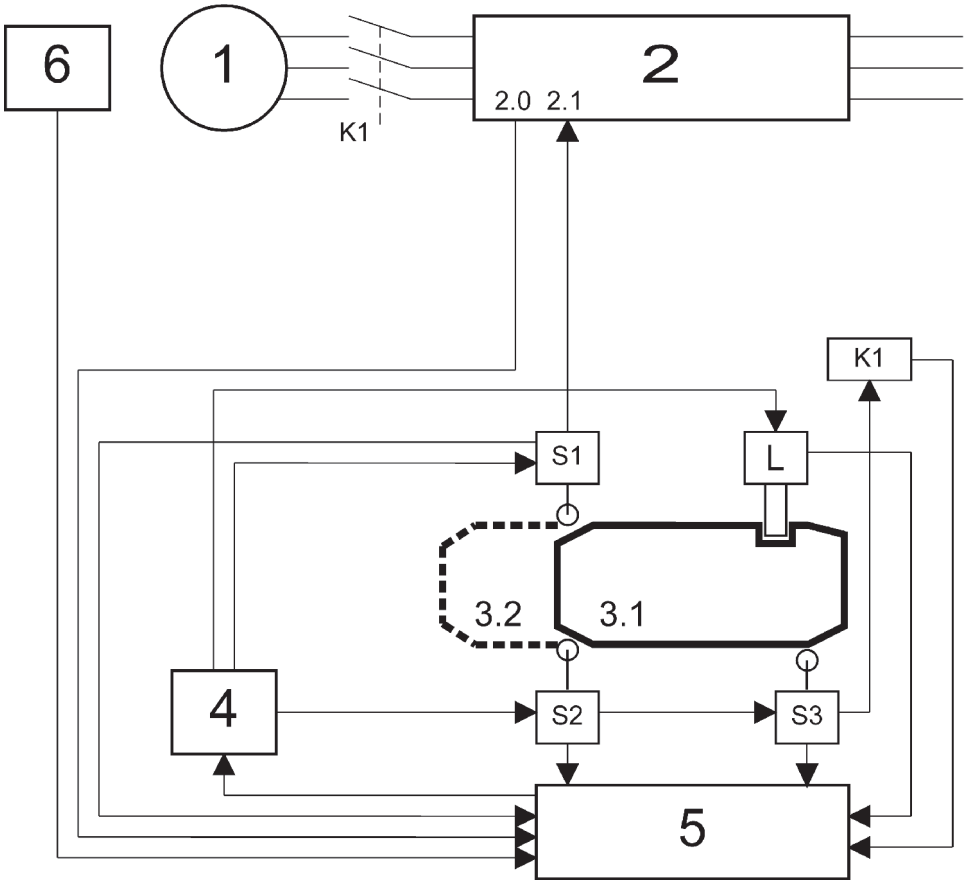
— position of the contactors;

— position of the lock;

— information given by the standstill detection.

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if no faults have been detected.

F.2 Principle of interlocking corresponding to type III, using one electromechanical component and the motor control unit



Key

K1	contactor with linked or mirror control contacts
S1, S2, S3	position detectors
L	guard locking device
1	electrical motor
2	motor control unit according to EN ISO 13849-1:2008, PL_r other than a or b for safe standstill, certified by an independent third party according to EN ISO/IEC 17025
2.0	confirmation of the switch off condition from 2.1
2.1	safety related input
3.1	guard closed
3.2	guard open
4	control circuit of the machine
5	monitoring circuit of the machine
6	standstill detection (see 5.1.2.3)

Figure F.2 — Principle of interlocking corresponding to type III, using one electromechanical component and the motor control unit

One of the position detectors may be used to achieve guard locking.

K1 shall be positioned between the motor and the motor control unit, if there is the possibility of hazardous movements due to stored energy in the motor control unit. In other cases, K1 may be positioned on the other side of the motor control unit.

The following shall be automatically monitored at least once during each cycle of the movable guard:

— change of state of the position detectors of the guard;

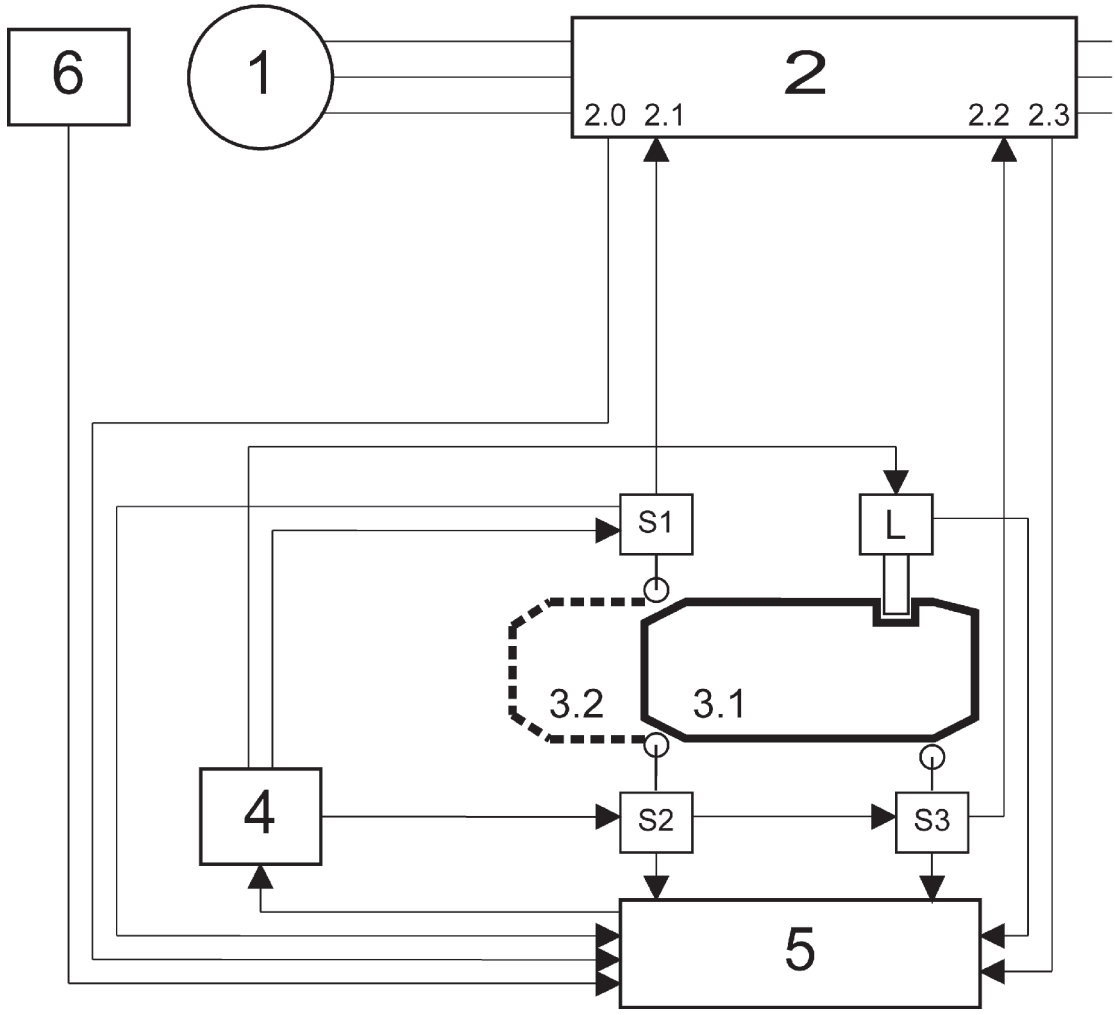
— position of the contactor and the information given by the motor control unit;

— position of the lock;

— information given by the standstill detection.

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if no faults have been detected.

F.3 Principle of interlocking corresponding to type III, using the motor control unit (version A)



Key

S1, S2, S3	position detectors
L	guard locking device
1	electrical motor
2	motor control unit according to EN ISO 13849-1:2008, PL_r = d, category 3 for safe standstill, certified by an independent third party according to EN ISO/IEC 17025
2.0	confirmation of switch off condition from 2.1
2.1, 2.2	safety related inputs
2.3	confirmation of switch off condition from 2.2
3.1	guard closed
3.2	guard open
4	control circuit of the machine
5	monitoring circuit of the machine
6	standstill detection (see 5.1.2.3)

Figure F.3 — Principle of interlocking corresponding to type III, using the motor control unit (version A)

One of the position detectors may be used to achieve guard locking.

If automatic monitoring of the safety related inputs is achieved within the motor control unit, one return line to the monitoring circuit of the machine is sufficient.

The following shall be automatically monitored at least once during each cycle of the movable guard:

— change of state of the position detectors of the guard;

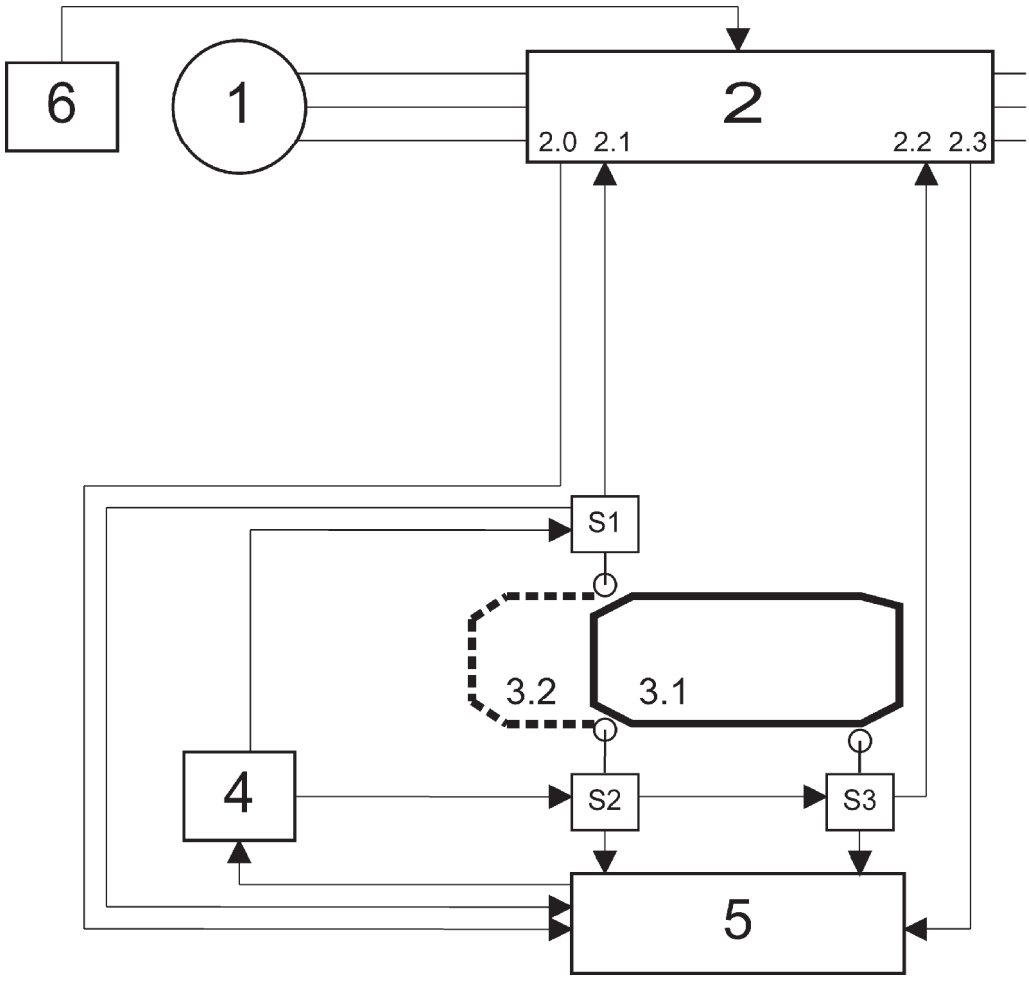
— the information given by the motor control unit;

— position of the lock;

— information given by the standstill detection,.

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if no faults have been detected.

F.4 Principle of interlocking corresponding to type III, using the motor control unit (version B)



Key

S1, S2, S3	position detectors
1	electrical motor
2	motor control unit according to EN ISO 13849-1:2008, PL_r = d, category 3 for safe standstill and for safe stopping, certified by an independent third party according to EN ISO/IEC 17025
2.0	confirmation of switch off condition and safe stopping initiated by 2.1
2.1, 2.2	safety related inputs
2.3	confirmation of switch off condition and safe stopping initiated by 2.2
3.1	guard closed
3.2	guard open
4	control circuit of the machine
5	monitoring circuit of the machine
6	stopping and standstill detection (see 5.1.2.3)

Figure F.4 — Principle of interlocking corresponding to type III, using the motor control unit (version B)

If automatic monitoring of the safety related inputs is achieved within the motor control unit, one return line to the monitoring circuit of the machine is sufficient.

The following shall be automatically monitored at least once during each cycle of the movable guard:

— change of state of the position detectors of the guard;

— the information given by the motor control unit;

— information given by the safe stopping detection.

Commencement of any further injection moulding machine cycle after closing of the movable guard shall be possible only if no faults have been detected.

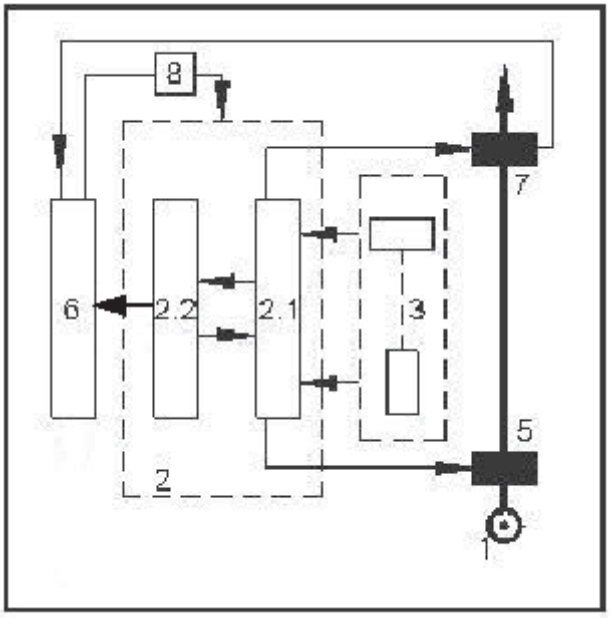
Automatic monitoring shall prevent the initiation of any further movement if the time between the switching of S1, S2, S3 and the confirmation signal on 2.0 and 2.3 exceeds twice the access time.

As an alternative to the safety integrated circuit in the motor control unit in Figure F4 an external electromechanical circuit for the drive of the platen movement with EN ISO 13849-1:2008, PL_r = e for safe standstill and EN ISO 13849-1:2008, PL_r = d, category 3 for safe stopping may be used.

Annex G
(normative)

Electro-sensitive protective equipment in the form of a light curtain

Light curtain according to type 4 of EN 61496-1:2004 (see Figure G.1).



Key

1	power circuit
2	control and monitoring unit of the light curtain according to EN ISO 13849-1:2008, PL_r = e
2.1	control circuit of the shut-off devices
2.2	monitoring circuit of the light curtain
3	light curtain
5	main shut-off device
6	monitoring circuit of the injection moulding machine
7	second shut-off device
8	control circuit of the injection moulding machine

Figure G.1 — Electro-sensitive protective equipment in the form of a light curtain

G.1 Mode of operation of the light curtain

An interruption of the light curtain shall directly interrupt the power circuit for the dangerous movement via the two shut-off devices.

The second shut-off device which interrupts the flow to the cylinder for the dangerous movement shall be an additional valve which shall be controlled directly by the control unit or actuated by a pilot valve controlled by the control unit.

G.2 Automatic monitoring requirements

A control and monitoring unit according to EN ISO 13849-1:2008, PL_r = e shall:

— monitor the light curtain; and

— control the two shut-off devices as shown in Figure G.1.

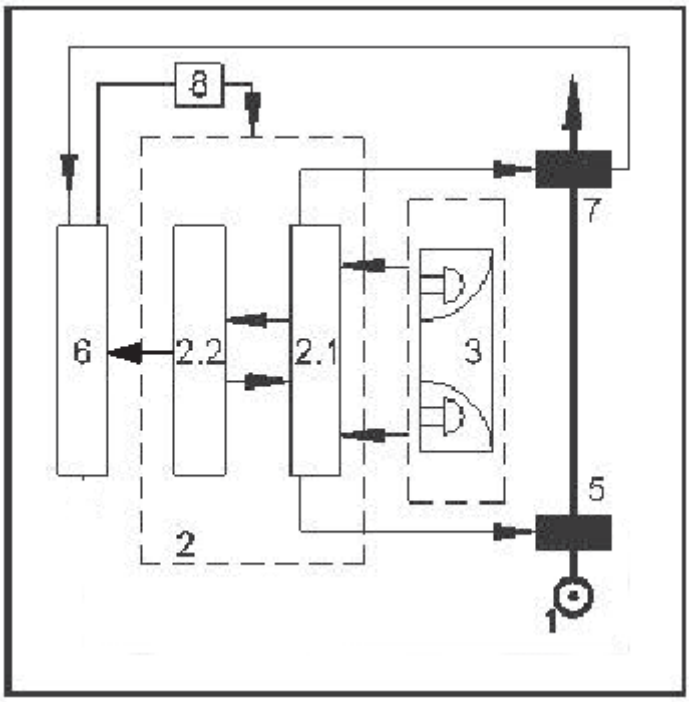
The monitoring circuit of the injection moulding machine shall monitor the shut-off position of the second shut-off device at, or after, each interruption of the light curtain so that a fault in the second shut-off device shall be automatically recognised and commencement of any further dangerous movement shall then be prevented.

In the case of the second shut-off device being pilot operated, the correct functioning of the pilot valve shall be monitored. Where this is automatically monitored by the position switching of the second shut-off device, additional automatic monitoring of the pilot valve is not required.

Annex H
(normative)

Two-hand control device

Two-hand control device according to type III C of EN 574:1996+A1:2008 (see Figure H.1).



Key

1 power circuit
2 control and monitoring unit of the two-hand control device according to EN ISO 13849-1:2008, PL_r = e
2.1 control circuit of the shut-off devices
2.2 monitoring circuit of two-hand control device
3 two-hand control device
5 main shut-off device
6 monitoring circuit of the injection moulding machine
7 second shut-off device
8 control circuit of the injection moulding machine

Figure H.1 — Two-hand control device

H.1 Mode of operation of the two hand control

Releasing either of the actuators of the two hand control device shall directly interrupt the power circuit for the dangerous movement via the two shut-off devices.

The second shut-off device which interrupts the flow to the cylinder for the dangerous movement shall be an additional valve which shall be controlled directly by the control unit or actuated by a pilot valve controlled by the control unit.

H.2 Automatic monitoring requirements

A control and monitoring unit according to EN ISO 13849-1:2008, PL_r = e shall

— monitor the two-hand control device; and

— control the two shut-off devices as shown in Figure H.1.

The monitoring circuit of the injection moulding machine shall monitor the shut-off position of the second shut-off device after each release of the two-hand control device so that a fault in the second shut-off device shall be automatically recognised and commencement of any further dangerous movement shall then be prevented.

In the case of the second shut-off device being pilot operated, the correct functioning of the pilot valve shall be monitored. Where this is automatically monitored by the position switching of the second shut-off device, additional automatic monitoring of the pilot valve is not required.

Annex J
(normative)

Acknowledgement systems

J.1 Single acknowledgement system

A single acknowledgement system shall consist of an acknowledgement switch located outside of the danger area which cannot be actuated from inside the danger area when the movable guards are closed or without interrupting the light curtain.

The acknowledgement switch shall be positioned to afford a clear view of the danger area.

Restart of the dangerous movements shall only be possible after:

— actuation of the acknowledgement switch following interruption of the light curtain, or

— closing the relevant movable guard, followed by actuating the acknowledgement switch.

Actuating the acknowledgement switch shall not initiate a dangerous movement.

The correct functioning of the acknowledgement switch shall be automatically monitored, at least once after each cycle of the movable guard or every time the associated light curtain has been interrupted, so that a fault in the acknowledgement switch is automatically recognized and prevents the initiation of any further dangerous movement.

Automatic monitoring of the acknowledgement system may be carried out by the programmable controller.

J.2 Double acknowledgment system

A double acknowledgment system shall consist of a push button (1) located inside of the protected area in full view of the mould area and a second push button (2) located outside of the protected area and with a clear view of this area, which cannot be actuated from inside the protected area.

The start of a cycle shall be possible only after the following sequence has been completed within a time interval:

— Push button (1);

— Close operator's gate or exit the protected area interrupting the light curtain;

— Push button (2).

A monitoring circuit shall be provided to check the operation of each push button. If improper operation or sequencing is detected, the cycle of the machine shall be inhibited and an alarm shall be activated.

Automatic monitoring of the acknowledgement system may be carried out by the programmable controller.

Annex K
(normative)

Noise test code

K.1 Introduction

This noise test code specifies all the information necessary to carry out efficiently and under standardised conditions the determination, declaration and verification of the airborne noise emission values of injection moulding machines.

It specifies the noise measurement methods and operating and mounting conditions for the test.

The use of this noise test code ensures the reproducibility of the measurements and the comparability of the airborne noise emission values within specified limits determined by the grade of accuracy of the basic measurement method used.

K.2 Measurement of the A-weighted emission sound pressure level at the usual operating position

For any injection moulding machine, the measurement shall be carried out at each usual operating position specified by the manufacturer, in a height h = (1600 $\pm$ 25) mm (height of microphone above the reference plane) and a distance from the outer surface of the machine d = (500 $\pm$ 25) mm, using preferably EN ISO 11201:2009 or EN ISO 11202:2009. However, other EN ISO standards for measuring the A-weighted emission sound pressure level are acceptable.

Measurements shall be carried out for 5 test cycles as defined in K.5.

K.3 Determination of the A-weighted sound power level

If the A-weighted emission sound pressure level at the measurement position defined in K.2 exceeds 80 dB, the determination of the A-weighted sound power level shall be carried out using preferably one of the standards EN ISO 3744:2009, EN ISO 3746:2009 or EN ISO 3747:2009. However, other EN ISO standards for determining the A-weighted sound power level are acceptable.

NOTE Until Directive 2006/42/EC comes into force, this value is 85 dB.

Measurements shall be carried out once at each microphone position. The duration of each measurement is given in K.5.

When EN ISO 3744:2009 or EN ISO 3746:2009 is used the measurement surface shall be a parallelepiped and the measurement distance shall be 1 m.

K.4 Installation and mounting conditions for noise measurement

The injection moulding machine shall be mounted and connected as indicated by the manufacturer in the instruction handbook.

If elastic mounts are placed between the machine and the supporting surface their technical characteristics shall be recorded.

The installation and mounting conditions shall be identical for the determination of both emission sound pressure level and sound power level.

Any test block or mould may be used.

K.5 Operating conditions

The test shall be carried out on the machine without ancillaries. However, measurements shall be carried out on the machine and ancillary equipment if the machine is intended to be operated only with that ancillary equipment.

The measurement shall be taken on a machine running on a dry cycle under the conditions specified in K.5.1.2 or K.5.2.2.

NOTE The cycles specified in K.5.1.2 and K.5.2.2 are representative of real machine cycles. On plastics processing machines, the noise emission values during a production cycle will usually be not more than 3 dB higher than during a dry cycle; on rubber processing machines, the noise emission values during a production cycle will generally be lower than during a dry cycle.

The operating conditions shall be identical for the determination of both emission sound pressure level and sound power level.

K.5.1 Plastic processing machines

K.5.1.1 Preparation

The machine shall be at its operating temperature, including the hydraulic fluid where applicable.

K.5.1.2 Test cycle

The test cycle shall be composed of the following elements:

— closing of the platen: stroke = if possible 70 % of the opening stroke, maximum acceleration, maximum speed, maximum deceleration, clamping force = 100 % of the maximum clamping force;

— no nozzle approach or withdrawal;

— rotation of the screw for a time t_M:

$$t_M = \frac{m_{\max}}{2P_{\max}} \bullet \frac{n_{\max}}{n_{Tab}}$$

where

t_M: metering time;

m_{max}: maximum shot mass;

P_{max}: maximum plasticizing rate (mass/time);

n_{max}: maximum screw rotation speed;

n_{Tab}: screw rotation speed according to Table K.1.

NOTE Parameters are based on PS processing.

— backward movement of the screw corresponding to 2D (D: diameter of the screw);

— forward movement of the screw in a time $t_i = t_M / 2$ (t_i = injection time);

— holding time = injection time, holding pressure = 50 % of the maximum injection pressure;

— opening of the platen: same conditions as for closing;

— no ejector movements;

— total test cycle time = $4 \cdot t_M$.

For an injection moulding machine with more than one injection unit, all the screws shall be operated during the measurement.

Table K.1 — Machine data for test cycle

Screw diameter [mm]	Screw rotation speed [min^{-1}] a)
D ≤ 45	200
45 < D ≤ 55	150
55 < D ≤ 95	100
95 < D ≤ 115	85
115 < D ≤ 140	70
D › 140	40
a) or the maximum value available on the machine.	

K.5.2 Rubber processing machines

K.5.2.1 Preparation

The machine shall be at its operating temperature, including the hydraulic fluid where applicable.

K.5.2.2 Test cycle

The test cycle shall be composed of the following elements:

— closing of the platen: stroke = if possible 70 % of the opening stroke, maximum acceleration, maximum speed, maximum deceleration, clamping force = 70 % of the maximum clamping force;

— holding pressure: two subsequent levels: maximum pressure available on the machine during 15 s, then 150 bar during 20 s;

— curing time = 60 s, clamping force maintained, all parts of the machine at rest;

— opening of the platen: same conditions as for closing.

K.6 Information to be reported

The information to be reported includes:

— type, serial number if any, year of manufacture of the injection moulding machine;

— date of test, location, person in charge;

— acoustic environment;

— characteristics and references of the measuring instruments used;

— maximum clamping force;

— calculated injection volume;

— screw/piston diameter;

— holding pressure;

— measurement standards used;

— mounting and operating conditions as defined in K.4 and K.5;

— location of measurement position(s);

— noise emission values and associated uncertainties.

Any deviation from this noise test code shall be reported.

K.7 Declaration and verification of noise emission values

The noise declaration shall be a dual-number declaration as defined in EN ISO 4871:2009 i.e. the measured value and the measurement uncertainty shall be indicated separately. It shall include the following:

— the value of the measured A-weighted emission sound pressure level at the position specified in K.2 where this exceeds 70 dB. Where the A-weighted emission sound pressure level does not exceed 70 dB, this fact shall be indicated;

— the value of the A-weighted sound power level, only where the measured value of the A-weighted emission sound pressure level at the position specified in K.2 exceeds 80 dB.

NOTE Until Directive 2006/42/EC comes into force, this value is 85 dB.

The noise declaration shall mention explicitly that noise emission values have been obtained under dry cycle conditions according to this noise test code and indicate which basic measurement standards have been used. The noise declaration shall clearly indicate any deviation from this noise test code and/or from the basic standards used.

For plastics processing machines, it shall be stated in the noise declaration that noise emission values for real machine cycles may be higher than the values obtained under dry cycle condition by a maximum of 3 dB, depending on the kind of material, mould and processing parameters.

For rubber processing machines it shall be stated in the noise declaration that noise emission values for real machine cycles are usually lower than the values obtained under dry cycle condition.

If undertaken, the verification of declared values shall be conducted according to 6.2 of EN ISO 4871:2009 by using the same mounting and operating conditions as those used for the initial determination of noise emission values.

Annex L
(normative)

Warning signs

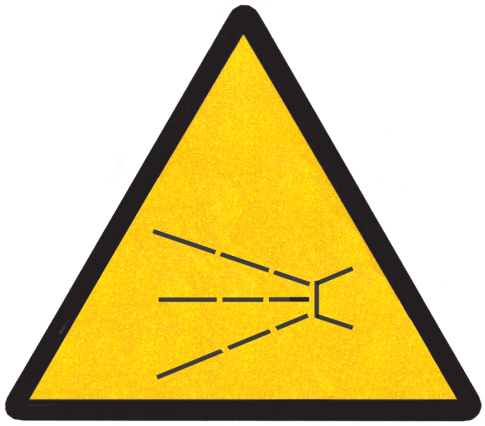


Figure L.1 — Splashing hazard

Figure L.2 — Thermal hazard

NOTE The content of this annex is taken from EUROMAP recommendation 64:2008. EUROMAP recommendations are elaborated by the European Committee of Machinery Manufacturers for the Plastics and Rubber Industries.

Secretariat's address:
EUROMAP
c/o VDMA e.V., FV Kunststoff- u. Gummimaschinen
Postfach 71 08 64
D-60498 Frankfurt
Fax: ++49 69 66031840
URL: www.euromap.org

Annex M
(normative)

Use of proportional valves for the platen movement

NOTE This Annex is only applicable for machines where access to the mould area is prevented by guards.

M.1 Design

M.1.1 In case of an energy failure proportional valves shall return to the basic position by means of springs.

M.1.2 In its basic position, the pressure connection side of the proportional valves shall either be blocked or exhausted to tank.

M.1.3 No leakage which may cause a dangerous movement shall be present when the proportional valves are in their basic positions. This may be achieved e.g. by close tolerance valves or exhausting leakage from the proportional valves directly to tank.

M.2 Mode of operation

M.2.1 The basic position of the proportional valves shall be achieved at least once during each cycle.

M.2.2 The proportional valves which control the platen movement shall not be used for controlling any other movement.

M.2.3 When the movable guards of the mould area are open the position switches shall:

— directly interrupt the energy supply to the solenoid of the proportional valve responsible for the closing movement of the platen; or

— directly switch off the energy supply to the control card of the proportional valve. In this case, it shall be ensured that any residual value existing in the control card cannot give rise to a closing movement of the platen.

M.2.4 Alternatives to M.2.3 which may be used are e.g.:

— an additional valve (not proportional) to interrupt the control oil to the proportional valve; or

— an additional valve (not proportional) to position the proportional valve in its basic position; or

— an additional valve (not proportional) which inhibits platen closing movement.

In all these cases the energy supply to the solenoid of the additional valve shall be directly interrupted by the position switches of the movable guards for the mould area when these guards are opened.

A fault of the additional valve shall not affect the safety function of the proportional valve and shall be automatically detected by the control system; otherwise the additional valve shall be automatically monitored.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide one means of conforming to Essential Requirements of the New Approach Directive.

For Machinery Directive 98/37/EC amended by Directive 98/79/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Annex ZB
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide one means of conforming to Essential Requirements of the New Approach Directive 2006/42/EC on machinery.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

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

[2] EN ISO 11688-2, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 2: Introduction to the physics of low-noise design (ISO/TR 11688-2:1998)*

[3] EUROMAP 64, *Injection moulding machines — Warning signs*

[4] EUROMAP 67, *Electrical interface between injection moulding machine and handling device/robot*

[5] EUROMAP 68, *Injection moulding machines — Prohibition signs*

[6] EUROMAP 69, *Injection moulding machines — Mandatory action signs*

This page has been intentionally left blank

BSI - British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001 Email: orders@bsigroup.com You may also buy directly using a debit/credit card from the BSI Shop on the Website http://www.bsigroup.com/shop

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact Information Centre. Tel: +44 (0)20 8996 7111 Fax: +44 (0)20 8996 7048 Email: info@bsigroup.com

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002 Fax: +44 (0)20 8996 7001 Email: membership@bsigroup.com

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsigroup.com/BSOL

Further information about BSI is available on the BSI website at http://www.bsigroup.com.

Copyright

BSI Group
Headquarters 389
Chiswick High Road,
London, W4 4AL, UK
Tel +44 (0)20 8996 9001
Fax +44 (0)20 8996 7001
www.bsigroup.com/
standards