

Plastics and rubber machines — Injection moulding machines — Safety requirements

ICS 83.200

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 It supersedes BS EN 201:1997 which is withdrawn.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.

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Safety requirements**

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Machines de moulage par injection - Prescriptions de
sécurité

Kunststoff- und Gummimaschinen - Spritzgießmaschinen -
Sicherheitsanforderungen

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Contents

Page

Foreword.....	6
Introduction	7
1 Scope	8
2 Normative references	8
3 Terms and definitions	10
4 List of significant hazards	16
4.1 General.....	16
4.2 Mould area	18
4.3 Clamping mechanism area or area behind the mobile platen	19
4.4 Area of movement of core and ejector drive mechanisms outside both the mould area and the clamping mechanism area	19
4.5 Nozzle area	19
4.6 Plasticising and/or injection unit area	20
4.7 Discharge area	20
4.8 Hazards not associated with a particular area of the machine	20
4.8.1 Whiplash of flexible hoses.....	20
4.8.2 Release of fluids under pressure	20
4.8.3 Hazards during adjustment and servicing	21
4.8.4 Electrical hazards and hazards due to electromagnetic interference	21
4.8.5 Thermal hazards	21
4.8.6 Hazards generated by noise	21
4.8.7 Hazards generated by gases, fumes and dusts	21
4.8.8 Slip, trip and fall hazards	21
4.8.9 Hydraulic and pneumatic systems.....	21
4.8.10 Power operated guards	21
4.9 Additional hazards associated with specific machine design	22
4.9.1 Carousel machines	22
4.9.2 Shuttle-table machines/machines with sliding lower platen and turn-table machines	22
4.9.3 Multi-station machines with mobile injection unit	22
4.9.4 Cellular foam injection moulding machines	22
4.10 Additional hazards when using ancillary equipment.....	22
4.10.1 Power operated mould changing equipment.....	22
4.10.2 Power operated mould clamping devices	22
4.10.3 Fluid injectors	22
4.10.4 Other ancillary equipment	23
5 Safety requirements and protective measures.....	23
5.1 General.....	23
5.1.1 Emergency stop	23
5.1.2 Guards	24
5.1.3 Electro-sensitive protective equipment (ESPE) in the form of light curtains	25
5.1.4 Two-hand control devices	25
5.1.5 Hold-to run control devices associated with reduced speed of the dangerous movement.....	26
5.1.6 Pressure sensitive mats, floors and edges.....	26
5.1.7 Common requirements for automatic monitoring.....	26
5.1.8 Movements caused by gravity during production	26
5.2 Mould area	27
5.2.1 Hazards due to the closing movement of the platen during production	27
5.2.2 Sides of the machine where a cycle cannot be initiated	28

5.2.3	Hazards due to movements other than the closing movement of the platen during production	28
5.2.4	Use of control guards	30
5.2.5	Thermal hazards	30
5.2.6	Additional safety requirements for machines with a downstroking platen	30
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.....	31
5.2.8	Additional requirements for machines where whole body access is possible to the mould area	34
5.2.9	Additional requirements for machines with L-Type configuration during production	35
5.3	Clamping mechanism area or area behind the mobile platen	36
5.3.1	Basic safety requirements	36
5.3.2	Additional safety requirements for machines with an upstroking platen	36
5.4	Area of movement of core and ejector drive mechanisms outside the mould area and outside the clamping mechanism area	37
5.5	Nozzle area	37
5.5.1	Mechanical hazards	37
5.5.2	Thermal hazards	37
5.6	Plasticising and/or injection unit area	38
5.6.1	Mechanical hazards	38
5.6.2	Thermal hazards	38
5.6.3	Mechanical and/or thermal hazards	39
5.7	Discharge area	39
5.8	Safety requirements and/or protective measures against hazards not associated with a particular area of the machine	40
5.8.1	Whiplash of flexible hoses	40
5.8.2	Release of fluids under pressure	41
5.8.3	Hazards during adjustment and servicing	41
5.8.4	Electrical hazards and hazards due to electromagnetic interference	41
5.8.5	Thermal hazards	41
5.8.6	Hazards generated by noise	41
5.8.7	Hazards generated by gases, fumes and dusts	42
5.8.8	Slip, trip and fall hazards	42
5.8.9	Hydraulic and pneumatic systems	42
5.8.10	Power operated guards	42
5.9	Additional safety requirements and/or protective measures associated with specific machine design	43
5.9.1	Carousel machines	43
5.9.2	Shuttle-table machines / machines with sliding lower platen and turn-table machines	43
5.9.3	Multistation machines with mobile injection unit	43
5.9.4	Cellular foam injection moulding machines	44
5.10	Additional safety requirements and/or protective measures when using ancillary equipment	44
5.10.1	Power operated mould changing equipment	44
5.10.2	Power operated mould clamping devices	44
5.10.3	Fluid injectors	46
5.10.4	Other ancillary equipment	46
6	Verification of the safety requirements and/or protective measures	47
7	Information for use	49
7.1	Instruction handbook	49
7.1.1	Emergency stop	49
7.1.2	Stopping performance	49
7.1.3	Stopping time	49
7.1.4	Light curtains	49
7.1.5	Parking brakes	49
7.1.6	Moulds and extensions	50
7.1.7	Movements of cores and ejectors	50
7.1.8	Thermal hazards in the mould area	50

7.1.9	Maintenance operations on vertical machines.....	50
7.1.10	Machines where whole body access is possible	50
7.1.11	Presence detecting devices in the mould area.....	50
7.1.12	Plasticising and/or injection unit	50
7.1.13	Machines with L-Type configuration	51
7.1.14	Flexible hose assemblies.....	51
7.1.15	Adjustment and servicing	51
7.1.16	Exhaust system.....	51
7.1.17	Designated access and working positions	51
7.1.18	Non-permanent safe means of access	51
7.1.19	Automatic feeding of material	52
7.1.20	Manual feeding of material	52
7.1.21	Magnetic mould clamping.....	52
7.1.22	Ancillary equipment	53
7.1.23	Applying ergonomic principles when using ancillary equipment	53
7.1.24	Bursting of moulded parts	53
7.1.25	Cellular foam injection moulding.....	53
7.1.26	Hydraulic system cleaning	53
7.1.27	Noise emission.....	54
7.1.28	Splashing hazards where two-hand control devices are used	54
7.2	Marking	54
Annex A	(normative) Movable interlocking guards type I (non-electrical axis)	56
A.1	Interlocking function	57
A.2	Quality of the components	57
Annex B	(normative) Movable interlocking guards type II (non-electrical axis)	58
B.1	Interlocking function	59
B.2	Quality of the components	59
B.3	Automatic monitoring requirements.....	59
Annex C	(normative) Movable interlocking guards type III (non-electrical axis)	60
C.1	Movable interlocking guard with three position detectors	60
C.1.1	Interlocking function	61
C.1.2	Quality of the components	61
C.1.3	Additional requirements for the second shut-off device in Figure C.1.....	61
C.2	Movable interlocking guard with two position detectors	62
C.2.1	Interlocking function	63
C.2.2	Quality of the components	63
C.2.3	Additional requirements for the second shut-off device in Figure C.2.....	63
C.3	Automatic monitoring requirements.....	63
C.3.1	Common requirements (see also 5.1.7).....	63
C.3.2	Additional automatic monitoring requirements (Figure C.1)	64
C.3.3	Additional automatic monitoring requirements (Figure C.2)	64
Annex D	(normative) Movable interlocking guards type I (electrical axis)	65
D.1	Principle of interlocking corresponding to type I, using one electromechanical component.....	65
D.2	Principle of interlocking corresponding to type I, using the motor control unit	67
Annex E	(normative) Movable interlocking guards type II (electrical axis).....	69
E.1	Principle of interlocking corresponding to type II, using one electromechanical component.....	69
E.2	Principle of interlocking corresponding to type II, using the motor control unit (version A)	71
E.3	Principle of interlocking corresponding to type II, using the motor control unit (version B)	73
Annex F	(normative) Movable interlocking guards type III (electrical axis).....	75
F.1	Principle of interlocking corresponding to type III, using electromechanical components.....	75
F.2	Principle of interlocking corresponding to type III, using one electromechanical component and the motor control unit.....	77
F.3	Principle of interlocking corresponding to type III, using the motor control unit (version A)	79

F.4	Principle of interlocking corresponding to type III, using the motor control unit (version B)	81
Annex G	(normative) Electro-sensitive protective equipment in the form of a light curtain	83
G.1	Mode of operation of the light curtain	83
G.2	Automatic monitoring requirements	84
Annex H	(normative) Two-hand control device	85
H.1	Mode of operation of the two hand control	85
H.2	Automatic monitoring requirements	86
Annex J	(normative) Acknowledgement systems	87
J.1	Single acknowledgement system	87
J.2	Double acknowledgment system	87
Annex K	(normative) Noise test code	88
K.1	Introduction	88
K.2	Measurement of the A-weighted emission sound pressure level at the usual operating position	88
K.3	Determination of the A-weighted sound power level	88
K.4	Installation and mounting conditions for noise measurement	88
K.5	Operating conditions	89
K.5.1	Plastic processing machines	89
K.5.2	Rubber processing machines	90
K.6	Information to be reported	90
K.7	Declaration and verification of noise emission values	91
Annex L	(normative) Warning signs	92
Annex M	(normative) Use of proportional valves for the platen movement	93
M.1	Design	93
M.2	Mode of operation	93
Annex ZA	(informative) Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC	94
Annex ZB	(informative) Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC	95
	Bibliography	96

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)

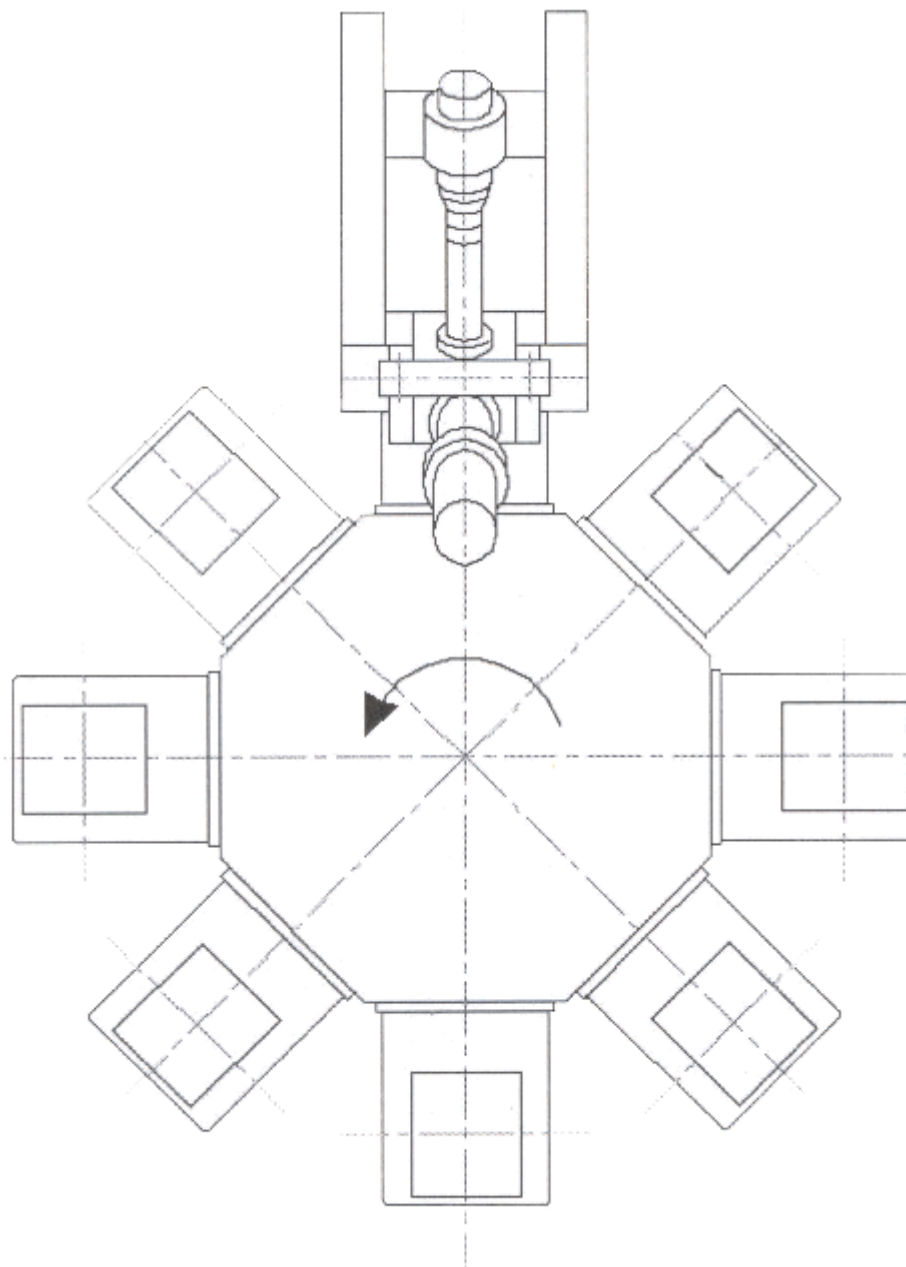


Figure 1 — Example of a carousel machine

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).

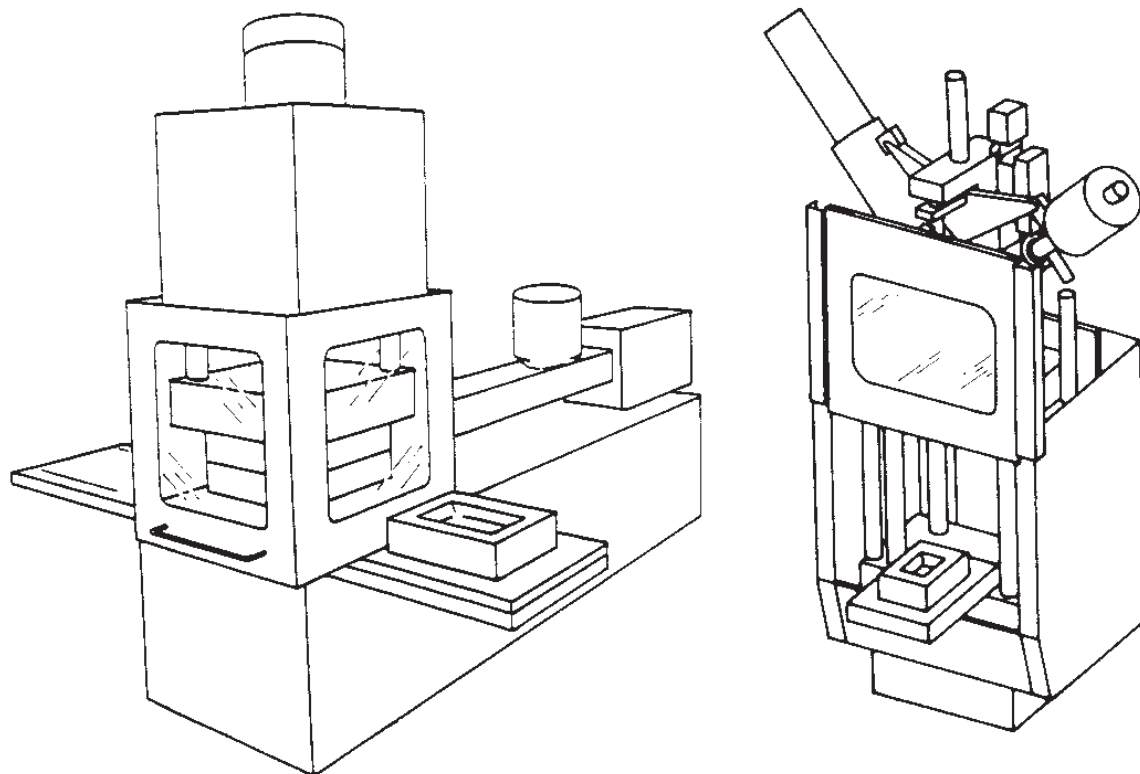


Figure 2 — Examples of shuttle-table machines (two stations left; single station right), shown without guards for the movements of the table

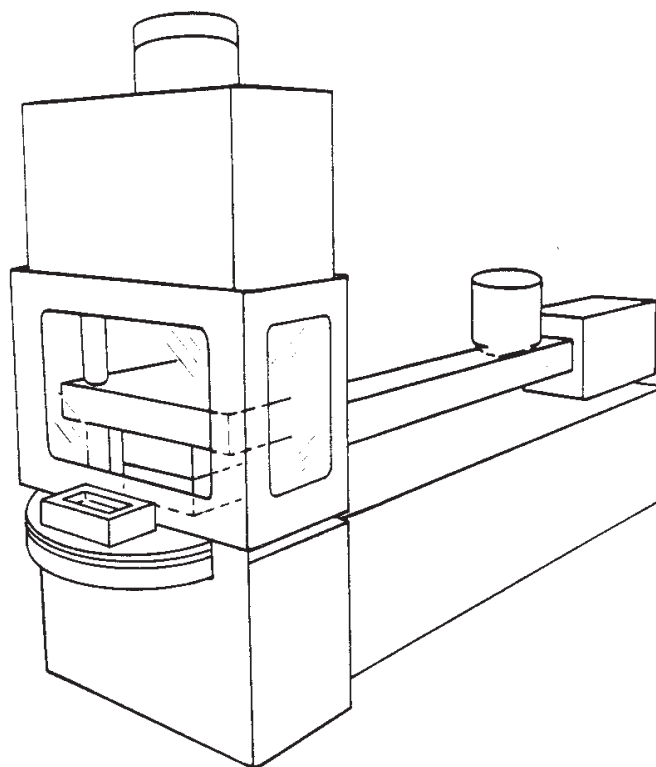


Figure 3 — Example of a turn-table machine, shown without guards for the movements of the table

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)

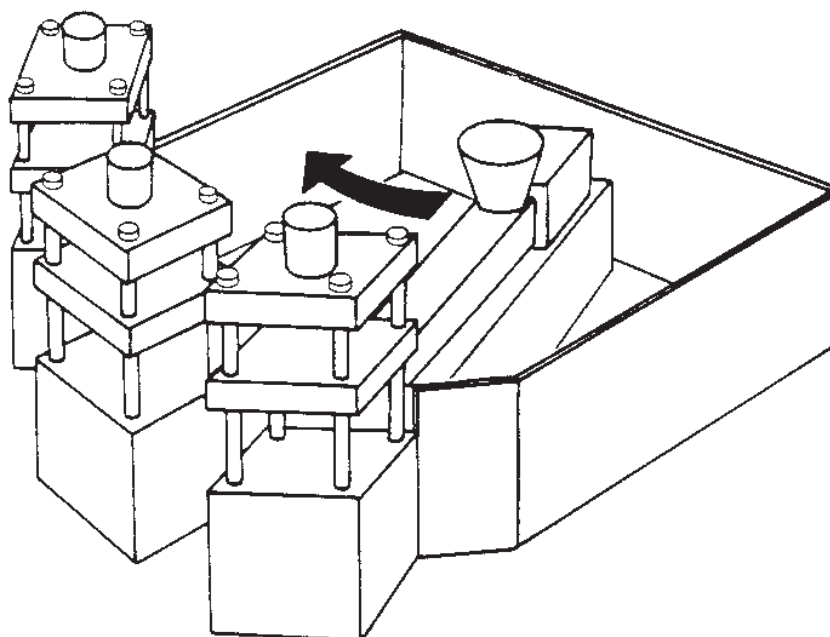


Figure 4 — Example of multi-station machine with mobile plasticising and injection unit, shown without guards for the clamping units

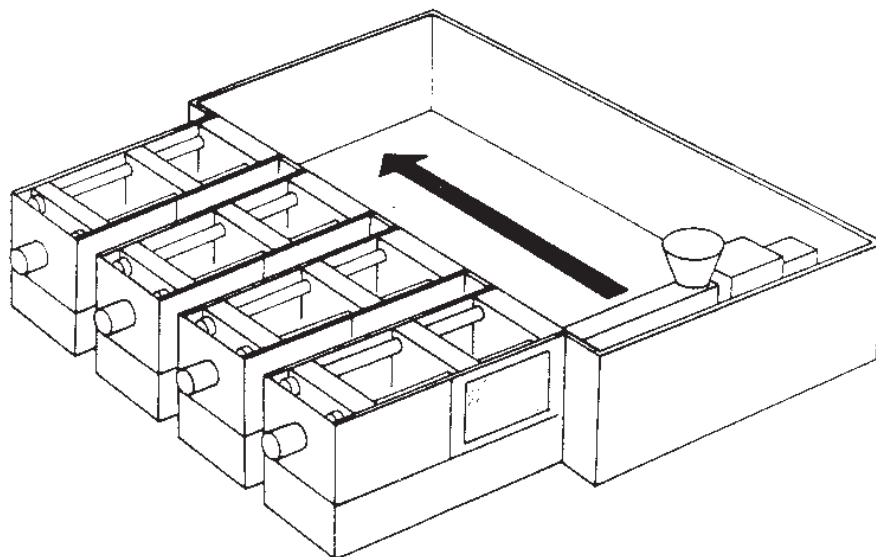


Figure 5 — Example of multi-station machine with mobile plasticising and injection unit, shown with guards for the clamping units

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)

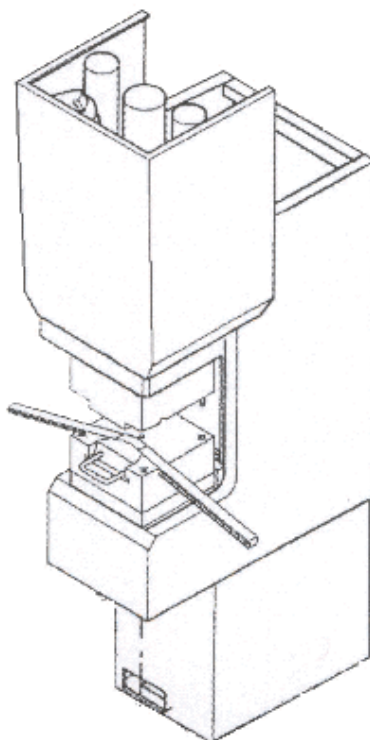


Figure 6 — Example of an injection assembling machine, shown without protective devices for the mould area

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

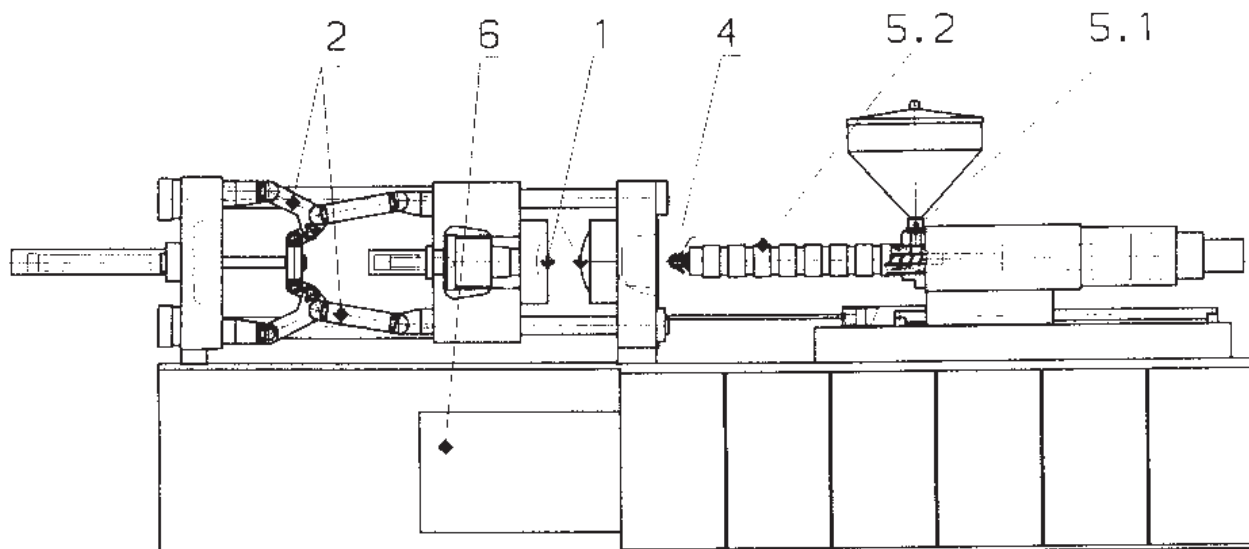
4 List of significant hazards

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.

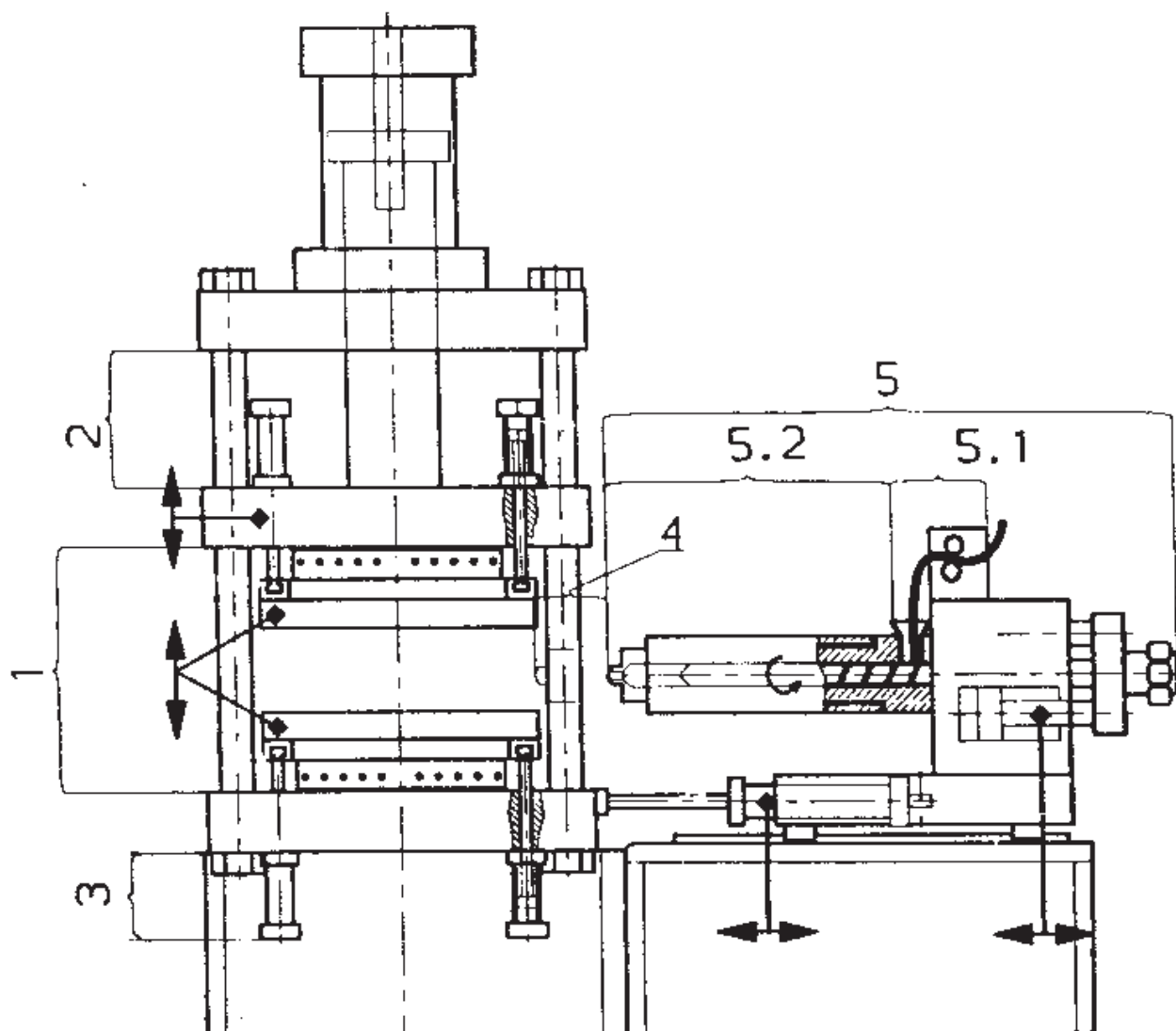
The principal danger areas are shown in Figures 7 to 9:



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

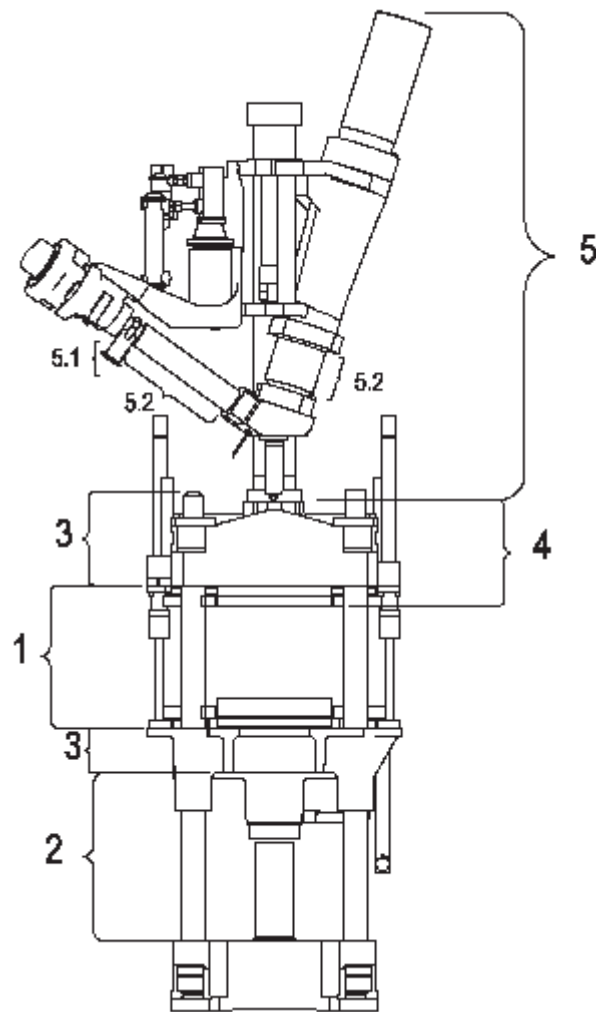
Figure 7 — Injection moulding machine with horizontal clamping unit and horizontal plasticising and injection unit, shown without guards



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 ($\text{gap} \leq 6 \text{ mm}$). 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, $\text{PL}_r = \text{d}$. The device inhibiting the safeguard shall conform with EN ISO 13849-1:2008, $\text{PL}_r = \text{e}$.

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, $\text{PL}_r = \text{e}$ may be replaced by interlocking guards in accordance with Annex B or EN ISO 13849-1:2008, $\text{PL}_r = \text{d}$.

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, $\text{PL}_r = \text{d}$. 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, $\text{PL}_r = \text{d}$ and two-hand control devices or light curtains shall be in accordance with EN ISO 13849-1:2008, $\text{PL}_r = \text{d}$.

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);