

Safety at injection moulding machines

HSE information sheet

Plastics Processing Sheet No 4 (Revision 1)

Introduction

This information sheet is one of a series produced by HSE's manufacturing sector and gives practical advice for owners and users of injection moulding machines. It gives information on commonly accepted and practicable safeguards for significant hazards on injection moulding machines *supplied before* the publication of BS EN 201:1997. This standard was replaced by BS EN 201:2009¹ and represents current 'state of the art' for these machines. This guidance can also be used as a check for machines manufactured after 1997 to make sure that they meet the minimum levels of protection required.

The main UK legal requirements covering the safe use of injection moulding machines are the Provision and Use of Work Equipment Regulations 1998.²

Since 1995, all new machinery has been subject to the European Machinery Directive, which requires machines to be safe by design and construction. When first placed on the market or first put into

service, machinery must meet all relevant Essential Health and Safety Requirements (EHSRs) in the Directive. The machine should be designed to the 'state of the art', and be accompanied by user instructions, a Declaration of Conformity, and bear a CE marking. Further guidance on the Directive and the UK Supply of Machinery (Safety) Regulations is available from HSE's website and in *Buying new machinery*.³

Guarding standards

In the tables below are the practical safeguards that you can apply. Current standards are quoted to illustrate acceptable levels of safety. Where the publication date of standards is after the machine manufacturing date you should ensure that standards that were current at the time of manufacturing are met. For pre-1995 machinery, safeguards that meet PD 5304:2005⁴ are acceptable alternatives to the more recent BS ENs quoted.

Table 1 Minimum practical safeguards

Hazard	Safeguard
Moving platens via the front guard	<p>Dual-channel interlocking comprising:</p> <ul style="list-style-type: none"> ■ one channel consisting of an interlocking system acting on the control circuit, with two guard position sensors (one positive/one negative); ■ a second channel consisting of a device which interrupts the power medium, either directly or via a pilot system (hydraulic, electrical or pneumatic), when the guard is opened. <p>The two guard position sensors and the second interlocking device should be monitored so that any fault will be detected and the machine stopped. On machines manufactured before 1985 it is acceptable to have an effective mechanical restraint instead of monitoring.</p>
Moving platens via the rear guard	<p>If access from the rear is only for setting or maintenance, then two position sensors are required with interlocking arrangements that interrupt the cycle, switch off the main drive to the platen, shut off any energy accumulators and release stored energy. If the cycle can be initiated from the rear then provide safeguards as for front guard.</p>

<p>Moving platens on 'large machines'**</p>	<p>Where whole-body access is possible between the mould faces, provide a presence-sensing device with continuous monitoring (eg electro-sensitive protective device, pressure-sensitive mat, scanning device) and emergency stops on both sides of the mould.</p> <p>If a person can stand between the operator's guard and the mould, also provide <i>one</i> of the following:</p> <ul style="list-style-type: none"> ■ a presence-sensing device (eg electro-sensitive protective device, pressure-sensitive mat, scanning device) with continuous monitoring, which prevents the closing movement of the platens; ■ a device which is continuously monitored that prevents closing of the guard, and suitably placed emergency stop(s). These may be the same as those described above, provided they are accessible. <p>Guards closed under power should be controlled by a hold-to-run control device positioned to give a clear view of the mould.</p>
<p>Moving platens via the top of the mould</p>	<p><i>Either</i> fixed guards <i>or</i> interlocking guards to the standard for a setter's rear guard. The choice will depend on frequency of access.</p> <p>If access is required to the top of the machine for accessing ancillary equipment such as robots or for mould change, setting or maintenance purposes then:</p> <ul style="list-style-type: none"> ■ provide access platforms or appropriate access equipment; ■ complete a risk assessment to identify where there is access to dangerous parts and to identify appropriate fixed or interlocking guards; ■ isolate the machine before accessing the top of the machine.
<p>Moving platens via the mould discharge</p>	<p>The design of the machine frame may prevent the operator reaching into the tools. If not, provide one or a combination of the following:</p> <ul style="list-style-type: none"> ■ fixed guarding; ■ dual-channel interlocked guarding which can be control interlocking; ■ distance guarding in accordance with BS EN ISO 13857.⁵
<p>Moving feed screw</p>	<p>Access to the rotating screws (main drive and feed) should be prevented, eg a hopper construction providing a safe distance that complies with BS EN ISO 13857. Alternatively, you can provide fixed guarding (eg a grille) at the openings. If the hopper and/or the feed throat is removable, then these should either be interlocked with the screw drive, or access to the screw should be prevented by a fixed grille.</p> <p>If there is access to the dangerous movement of the screw, then this should be prevented by design and/or the use of fixed or interlocked guards.</p>
<p>Traps at cores and ejectors (if movement of cores/ ejectors is necessary with the operator's guard open)</p>	<p>Primarily this task should be done with the guard shut. Only when it is not possible to do this with the guard closed should you consider carrying out this task with the operator's guard open.</p> <p>A lockable mode selector should be provided which will allow movement <i>only</i> of the core/ejector mechanisms (ie not the tools) and <i>one</i> of the following precautions taken against traps in the area:</p> <ul style="list-style-type: none"> ■ the safe design of core/ejector mechanisms; ■ localised fixed guarding. <p>If neither of these is practicable, additional safety systems such as two-hand controls, hold-to-run or limited movement should engage automatically.</p>

Hot surfaces, splash of plasticised material and the trap between the nozzle and fixed platen	<p>The injection unit and other accessible parts should be insulated or guarded where maximum temperatures can exceed 80 °C. Where hot parts are necessarily exposed, warning signs are required.</p> <p>To prevent splash, there should be a sliding or hinged nozzle guard with one position sensor which interrupts all movements associated with pressurising plastic material, and movement of the injection unit. The position sensor should not easily be defeated and should fail to safety. For purging outside the guarding area, there should be a manual control and a reduced speed facility. This guard should also prevent access to the trap between the forward movement of the injector unit and the fixed platen.</p>
Movement of the clamping mechanism	<p>The interlocked front/rear guard should also prevent operator access to the clamping mechanism. The interlocked guard should open only after the platen movement is complete. In exceptional circumstances, where the guard can open faster than the platen, you will need an arrester bracket to ensure it opens at the same time as the platen. You will also need to complete a risk assessment to make sure the process is safe.</p>
Movement of pick and place devices	<p>Dangerous movement of the pick and place device should be interlocked with the operator's guard (front and possibly rear if cycle can be initiated from there). Provide supplementary fixed guarding if the pick and place device can be reached over the top or beyond the interlocked guards.</p>

* Large machines are defined as those with ≥ 1.2 m between the tie bars, or the equivalent distance which limits access on machines without tie bars, or those where it is possible to stand between the guard and mould.

Often ancillary equipment is added to the injection moulding machine production line. You should ensure when including such equipment that it does not create new risks, either individually or in combination with the other machinery.

Operator safety checklist

Regular checks by the operator are a good way of identifying problems as well as making sure machinery is safe for use. Checks should be carried out at regular intervals, as a suggestion daily or after mould changes. The table below contains the recommended minimum checks the operator should carry out on a regular basis. You may also want to consult the manufacturer's instructions to see if any additional operator checks should be carried out.

Table 2 Recommended minimum checks for the operator to carry out

The answer to all questions should be 'yes' or action needs to be taken	Yes	No
Are all fixed and interlocked guards in place, in good condition and secure?		
Are all interlocking devices correctly aligned and securely attached to guards?		
Does opening an interlocked guard immediately stop the parts it protects?		
When an interlocked guard is open do all dangerous parts remain stationary if a start control is pressed?		
Where time-delay interlocks are fitted do they prevent access until rotation of dangerous parts has stopped?		
Are fixed guards held in place with fastenings that require a tool to undo them?		
Where pressure-sensitive mats are fitted does the pressure-sensitive mat indicator work when the mat is stepped on?		
Do any trip devices function correctly?		
Are all control unit enclosures closed, locked and the keys removed?		

Where two-hand controls are provided do both buttons have to be pressed together for the machine to operate?		
Where hold-to-run controls are provided, if you release the button does the machine stop?		
Where fitted, are adjustable guards adjusted correctly?		
Are safety devices, interlocks and guards free from evidence of being tampered with?		
When the operator's guard is open do the platens remain open?		
If fitted, is the mechanical restraint correctly positioned?		

Monthly machine inspections

Monthly machine inspections should be carried out. The checklist below provides a suggested minimum list of checks, but you should also consult the manufacturer's instruction manual to see if any additional maintenance inspections should be carried out.

The answer to all questions should be 'yes' or action needs to be taken	Yes	No
Are all fixed guards held in place with fastenings that need a tool to undo them?		
Are all interlocking devices correctly aligned and securely attached to guards?		
Does opening an interlocked guard immediately stop the parts it protects?		
When an interlocked guard is open do all dangerous parts remain stationary if a start control is pressed?		
Where time-delay interlocks are fitted do they prevent access until rotation of dangerous parts has stopped?		
When an emergency stop button is pressed does it stop all movement of the machine?		
Once an emergency stop button has been pressed does all machine movement remain stopped until the button has been reset?		
Do any trip wires stop the machinery almost instantaneously?		
Are control unit enclosures closed, locked and the keys removed and retained by a designated person?		
From a visual inspection, is all electrical wiring in good condition and free from damage?		
Are safety devices, interlocks and guards free from evidence of being tampered with?		
Where two-hand controls are provided do both buttons have to be pressed together for the machine to operate?		
Where hold-to-run controls are provided, if you release the button does the machine stop?		
Does the movement of the interlocked guards actuate the sensors of the associated hydraulic, pneumatic or electrical mechanisms? (Visual check)		
Are all pressurised flexible hoses in good condition and their fastenings secured in place?		

Where there are dual-channel interlocking systems (eg hydraulic and electric) is each channel able to stop the dangerous movement it safeguards?		
On power-operated guards does the sensitive edge operate correctly?		
Where fitted, is the lockable switch for movement of cores and ejectors operating correctly?		
Where fitted, is the mechanical restraint sound, properly secured and adjusted, and functioning correctly?		
Where fitted, does the guard arrester bracket prevent the front guard from opening past the moving platen?		
Is the heat insulation on the injection unit in place and undamaged, and are temperature warning signs in place?		
Are any presence-sensing devices in the mould area working correctly?		

References and further reading

References

- 1 BS EN 201 *Plastics and rubber machines. Injection moulding machines. Safety requirements* British Standards Institution
- 2 *Safe use of work equipment. Provision and Use of Work Equipment Regulations 1998. Approved Code of Practice and guidance L22* (Fourth edition) HSE Books 2014 www.hse.gov.uk/pubns/books/l22.htm
- 3 *Buying new machinery: A short guide to the law and your responsibilities when buying new machinery for use at work* Leaflet INDG271(rev1) HSE Books 2011 www.hse.gov.uk/pubns/indg271.htm
- 4 PD 5304 *Guidance on safe use of machinery* British Standards Institution
- 5 BS EN ISO 13857 *Safety of machinery. Safety distances to prevent hazard zones being reached by upper and lower limbs* British Standards Institution

Further reading

Safety guidance on the guarding and use of injection moulding machines in the plastics and rubber industries 238/3 British Plastics Federation 1991 www.bpf.co.uk

For health and safety in plastics manufacturing premises see HSE's plastics webpages: www.hse.gov.uk/plastics/

For PUWER and CE marking information see HSE's work equipment/machinery webpages: www.hse.gov.uk/work-equipment-machinery/

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

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