



Safety at injection moulding machines

Plastics Processing Sheet No 4

Introduction

This sheet was produced by the Health and Safety Executive (HSE) in consultation with the Plastics Processors Health and Safety Liaison Committee. This committee comprises HSE, employers and employee representatives in the plastics industry. It is one of a series dealing with safety at specific machines used within the plastics industry. It describes the causes of accidents at injection moulding machines (IMM) and details safeguarding standards, inspection checklists and safety precautions for use during mould changing.

These sheets have been designed to be read in conjunction with Plastics Processing Sheet No 3 *Managing machinery safety in small plastics factories*.

Accident history

Table 1 IMM accidents reported under RIDDOR 1992/93-1995/96

Year	92/93	93/94	94/95	95/96
All	83	95	96	103
Major	12	10	12	11

Table 1 shows the number of accidents at injection moulding machines reported to HSE from 1992-1996 under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR). It shows these machines continue to injure very similar numbers of employees each year.

Causes of accidents

Over 200 accidents at injection moulding machines were investigated by HSE inspectors from 1986-1996. Table 2 summarises the operations being undertaken and the types of accident/parts involved.

Table 2

Area	Cores and ejectors	Burns and splashes	Front guard	Top guard	Dis-charge area	Clamp area	Rear guard	Other	Total
Operation									
Normal operation	45	30	27	10	9	6	2	29	158
Setting/maintenance	22	9	11	6	0	3	2	15	68

More detailed analysis has shown that most of the accidents were caused by:

- inadequate safeguarding fitted;
- the safeguarding had been removed or fallen into disrepair; or
- the safeguarding had been overridden, usually for setting.

Guarding standards for production

The standards outlined in Table 3 describe commonly accepted and practicable safeguards for the significant hazards on injection moulding machines in use before July 1997 (when European Standard BS EN 201:1997 was published for new machinery).

Table 3

<i>Hazard</i>	<i>Safeguard</i>
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); and ● 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 originally designed before 1985, it is acceptable to have a mechanical restraint instead of monitoring.</p> <p>The use of control guards (ie where closing the guard initiates platen closure) is acceptable on all machines except for those which are large* and have powered guard closure.</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>
Moving platens on 'large machines'*	<ul style="list-style-type: none"> ● Where bodily access is possible between the mould faces, a person-sensing device, monitored once a cycle, should be provided (eg electro-sensitive protective device, pressure-sensitive mat, scanning device). Emergency stops should be provided on both sides of the mould. ● If a person can stand between the operator's guard and the mould, one of the following should be provided: <ul style="list-style-type: none"> - a person-sensing device (eg electro-sensitive protective device, pressure-sensitive mat, scanning device) monitored once a cycle, which prevents the closing movement of the platens; or - a chock/latch which is monitored once a cycle, which prevents closing of the guard. Suitably placed emergency stop(s) should be provided. These may be the same as those described above provided they are accessible. <p>Guards closed under power must be controlled by a hold-to-run control device positioned to give a clear view of the mould.</p>
Moving platens via the top of the mould	<p><i>Either</i> fixed guards <i>or</i> interlock guarding to the standard for a setter's rear guard. The choice will depend on frequency of access.</p>
Moving platens via the mould discharge	<p>The design of the machine frame may prevent the operator reaching into the tools. If not, one of the following should be provided:</p> <ul style="list-style-type: none"> ● fixed guarding; ● single-channel interlocked guarding which can be control interlocking; ● distance guarding; or ● electro-sensitive protective device.
Traps at cores and ejectors (if movement of cores/ejectors is necessary with the operator's guard open)	<p>A lockable mode selector facility should be provided which will allow movement <i>only</i> of the core/ejector mechanisms (ie not the tools) and the following precautions taken against traps in the area:</p> <ul style="list-style-type: none"> ● the safe design of core/ejector mechanisms; or ● 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 be engaged automatically.</p>
Hot surfaces, splash of plasticised material and the trap between the nozzle and the fixed platen	<ul style="list-style-type: none"> ● 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. ● 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. 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.
Movement of the clamping mechanism	<p>The interlocked front/rear guard should also prevent operator access to the clamping mechanism. (If it opens faster than the platen, an arrester bracket will be needed.) For setter/maintenance access, <i>either</i> a fixed guard <i>or</i> an interlocked guard with two position sensors acting on the control circuit will be required.</p>
Trap at material feed	<p><i>Either</i> a fixed guard at the feed throat (usually a grid) <i>or</i> a distance guard (usually the hopper).</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). Supplementary fixed guarding should be provided if the pick and place device can be reached over the top of 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.

Safety checks

A significant number of accidents have happened because the safety devices supplied with machines have deteriorated in use or have been removed and not replaced. The following minimum checks should be made to ensure that safety is maintained.

Operational checks (*suggested frequency: daily/after mould change*)

- Are all fixed and interlocked guards in place and secure?
- Can the platens close when the operator's guard is open?
- Are all control unit enclosures closed, locked and the keys removed?
- If fitted, is the mechanical restraint correctly positioned, particularly after mould change?

Maintenance inspections (*suggested frequency: monthly*)

- 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 the guards?
- Can the dangerous movements be started with the guards open?
- Do the interlocked guards activate the associated hydraulic, pneumatic or electrical mechanisms? (Visual check only)
- 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?
- If fitted, are anti-whip fastenings to pressurised flexible hoses secured in place?
- If fitted, is the lockable switch for movement of cores and ejectors operating correctly?
- Do the emergency stops prevent all continued movement of the machine?
- Is it possible to operate any dangerous movement after activation of the emergency stop(s) before the machine is reset?

- Where fitted, is the mechanical restraint sound, properly secured and adjusted, and functioning correctly?
- If fitted, does the guard arrester bracket prevent the front guard from opening past the moving platen?
- From a visual inspection, is any electrical wiring showing signs of damage?
- Are control unit enclosures closed, locked and the keys removed and retained by a designated person?
- Is the heat insulation on the injection unit in place and undamaged; and are temperature warning signs in place?
- Are any person-sensing devices in the mould area working correctly?

Safety during mould changing

Accidents often happen during setting because parts of the interlocking guarding arrangements have been overridden. A written safe system of work should be provided for your setters based on the following.

Before mould changing

- The injection unit should be retracted from the mould and set at a holding temperature, suitable for the material held within it, with the nozzle shut-off valve (if fitted) left open.
- The power source to the core-pulling mechanism and ejector couplings should be isolated before access to them is attempted.
- Suitable lifting equipment should be available for mould removal and replacement.

Mould changing with guards/interlocks in use (*preferred method*)

- No mould changing, setting or try-out operation should be undertaken without first checking that the platens and core/ejector mechanism will not move when the operator's guard is open.
- If it is necessary to work within the guarded area, all machine movements should be rendered inoperative by the emergency stop control (despite the fact that all the guards and interlocks are operational).
- If there are prolonged periods during the mould changing procedure when powered movement is not required, the machine should be isolated from its power supply, locked off and stored energy dissipated.

***Mould changing with guards/interlocks removed
(only if essential)***

- If any of the guards or interlocks have to be removed, the machine should be isolated from its power supply, locked off and any stored energy dissipated.

After mould changing

- Ensure that the hoses used are correct for the medium and the temperature.
- When the guards/interlocks are reinstated and before returning the machine to the operator, relevant checks from the monthly maintenance list should be carried out to prove the guards are functioning properly.
- The operator should carry out the operational checks independently before starting production on the machine.

Further reading

BS EN 201: 1997 *Rubber and plastics machines. Injection moulding machines. Safety requirements*

BPF *Safety guidance on the guarding and use of injection moulding machines in the plastics and rubber industries* 238/3 1991 Available from British Plastics Federation, 6 Bath Place, Rivington Street, London EC2A 3JE Tel: 0171 457 5000 Fax: 0171 457 5045

British Polymer Training Association *Injection moulding operator handbook* Available from BPTA, Coppice House, Halesfield 7, Telford, Shropshire TF7 4NA: Tel: 01952 587020

Further information

HSE priced and free publications are available by mail order from HSE Books, PO Box 1999, Sudbury, Suffolk CO10 6FS. Tel: 01787 881165 Fax: 01787 313995.

HSE priced publications are also available from good booksellers.

British Standards are available from BSI Customer Services, 389 Chiswick High Road, London W4 4AL Tel: 0181 996 7000 Fax: 0181 996 7001.

For other enquiries ring HSE's InfoLine Tel: 0541 545500, or write to HSE's Information Centre, Broad Lane, Sheffield S3 7HQ.

HSE home page on the World Wide Web:
<http://www.open.gov.uk/hse/hsehome.htm>

This leaflet contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.

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