Safety at extruder lines

HSE information sheet

Plastics Processing Sheet No 7 (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 extruders. It gives information on commonly accepted and practicable safeguards for significant hazards on extruders and caterpillar, belt or roller haul-offs *supplied before* the publication of BS EN 1114-1:1997 and BS EN 1114-3:2001. BS EN 1114-1 was replaced by BS EN 1114-1:2011[1] and represents 'state of the art' for these machines. This guidance can be used as a check for machines manufactured after 1996 to make sure that they meet the minimum levels of protection required.

The main UK legal requirements covering the safe use of extruders 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]

Safeguards for extruders

In the tables below are practical safeguards that can be applied. 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 5304:2005[4] are acceptable alternatives to the more recent BS ENs quoted.

Table 1 Practical safeguards for extruders

Hazard	Safeguard
Trap at feed nip during normal operation (ie other than start-up/ feeding)	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, 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.
Traps at other openings in the barrel	If there is access to the dangerous movement of the screw, then these should be protected by design, fixed or interlocked guards.
Burns from hot surfaces	Protect hot parts above 80 °C against accidental contact using guards or insulation. Where hot parts are necessarily exposed (eg at the die head), warning signs are required.
Burns from molten splash, in particular at start-up with material in the barrel	Where practical, use splash guards at the die. Operators will also need to wear personal protective equipment to prevent burns. Fencing, barriers or other measures may also be necessary to exclude other people from entering the area to reduce the risks when starting the machines.

Trapping by crammer feed system elements	Protect danger areas by design, fixed or interlocked guards. Any openings in the barrel exposed by movement of the crammer system should be guarded as for main feed opening.
Access to mechanical screen changer	Fixed and/or interlocked guards required.

Safeguards for caterpillar, belt or roller haul-offs

Table 2 Practical safeguards for caterpillar, belt or roller haul-offs

Hazard	Safeguard
Trap at feed nip during normal operation (ie other than start-up/ feeding)	Prevent access to the nip formed by the conveyor in-feed by: ■ fixed guards in the form of protective structures preventing access to the danger zone (see BS EN 953[5] and ISO 14120[6]); ■ tunnel guards extending from the inlet along the product line. The length of the tunnel guard should be determined by the aperture required to admit the largest product. BS EN ISO 13857[7] can be used to determine minimum reach distances needed; ■ where the above is not practicable, interlocked guards in accordance with BS EN 1088[8] may be used to stop all movement of the haul-off when opened; ■ only if none of the above options are practicable, an adjustable guard can be used. In this case, check guards regularly to make sure they are properly adjusted to the size of the profile (see the safety check sheet).
Traps during start-up/ setting	During feeding, prevent access to the dangerous movements of the haul-off by: ***Haul-off stationary*** ■ Feeding with the haul-off stationary, eg where the extrusion can be drawn through by hand or by a winch system. ***Haul-off running (with the above safeguards in place)*** ■ Using a 'rope' or length of product, which can be threaded through the line, attached to the extrusion and used to pull it through the haul-off, with the safeguarding in place. ■ With some profiles that are not self-supporting, it may, however, be necessary to approach the danger areas (eg if the profile twists in the haul-off). For such products it is acceptable to temporarily override the operator's guard, but only if additional safety devices are provided, eg: – trip devices, such as a pressure-sensitive edge, or a telescopic trip positioned before the in-running nip which stops the movement of the haul-off should an operator be pulled towards the danger zone; – a hold-to-run device (which may be operated by a stop-on-release foot pedal or an alternative device). The extruder should be operated at the slowest speed practicable for the product. If the haul-off can be fed from both sides, you should ensure that emergency stops are accessible from all feeding positions. For a haul-off with a fixed nip point, ie one that doesn't release the material when stopped, then this area should be fully guarded.

Traps at discharge	If there are mechanical hazards at the discharge, eg between belt and rollers, protect these by fixed or interlocked guards. If the traps are only present when the haul-off runs in *reverse*, then the operator may use a hold-to-run device at slow speed, provided there is a clear view of the danger area (this may be useful when feeding large-diameter finished product back up the line, to provide a 'rope' for pulling through new extrusion).
Mechanical hazards at the side of machines	Fixed or interlocked guards.
Cutting devices, eg saw blade, guillotine, laser	Fixed or interlocked guards, or tunnel guards with the appropriate safety distance in accordance with BS EN ISO 13857. Manually adjustable guards are not acceptable. Protect the blade when the guard is open. Where there is a trapping point created by the saw carriage (if fitted) then this area should be protected.
Hot surfaces	Protect hot parts above 80 °C against accidental contact using insulation or guards. Where hot parts are necessarily exposed, warning signs are required.
Instability/overturn	Restrain the machine to prevent movement.

Often ancillary equipment such as profile wrappers, corrugators, printing machines and belling machines are added in to the 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.

Safety during setting

A significant number of accidents happen at extruders during purging and die changing, and at haul-offs during the feeding operation. You should devise a written safe system of work for tool changing and setting in consultation with your setters, based on the following:

Extruders

- Carry out purging at slow speed and reduced pressure.
- Use heat-resistant gloves/gauntlets and, if necessary, arm protection while handling hot machine parts or extruded plastic.
- Wear full-face visors and head protection for all operations where there is a risk from molten plastic.
- Do not stand directly in front of the die while it is in operation either when removing it or if making process checks on new extrusion.
- Minimise the number of people in the area.
- Ensure there is appropriate lifting equipment for the dies.

Haul-offs

- Make all pre-adjustments on the haul-off, eg alignment, with the machine and line equipment, eg saw/guillotine, stopped.
- Adjust all components in the line before starting up.
- If the temperature of the material does not require the use of gloves, do not wear them when threading up haul-off machines as they can be caught in moving parts. If the temperature of the material means gloves need to be worn then choose close-fitting gloves to reduce entanglement risks.
- If, for practical reasons, the haul-off cannot be fed while stationary, use a 'rope' or length of finished product to pull the new extrusion through.
- If it is necessary to approach the danger area with the haul-off in motion, take further safety measures (see safeguards for the 'Traps during start-up/ setting' hazard in Table 2).
- If necessary, the profile can be turned using size-specific blocks without using tools.
- Provide a safe means to cut off deformed profile once it has come through the saw/guillotine.

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. It is recommended that operator checks are carried out at regular intervals, as a suggestion daily or after mould changes. Table 3 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 the operator should carry out any additional checks.

Table 3 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 then 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?		

Monthly machine inspections

It is recommended that monthly machine inspections are carried out. The checklist in Table 4 provides a suggested minimum list of checks to do, but you should also consult the manufacturer's instruction manual to see if you should carry out any additional maintenance inspections.

Table 4 Suggested minimum checklist

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 any 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?		
Is insulation in good condition and temperature warning signs in place?		
Is the machine stable? (Haul-off only)		
Are all temperature controls working correctly? (Extruders only)		
If fitted, are adjustable guards capable of proper adjustment? (Haul-off only)		

References and further reading

References

1 BS EN 1114-1 *Plastics and rubber machines. Extruders and extrusion lines. Safety requirements for extruders* 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 953 *Safety of machinery. Guards. General requirements for the design and construction of fixed and movable guards* British Standards Institution

6 ISO 14120 *General requirements for the design and construction of fixed and movable guards* British Standards Institution

7 BS EN ISO 13857 *Safety of machinery. Safety distances to prevent hazard zones being reached by upper and lower limbs* British Standards Institution

8 BS EN 1088 *Safety of machinery. Interlocking devices associated with guards. Principles for design and selection* British Standards Institution

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

For PUWER and CE marking 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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