Safety at extruders with caterpillar, belt or roller haul-offs

Plastics Processing Sheet No 7

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 with extruders and haul-off machines, and details safeguarding standards, checklists and safety precautions for use during setting.

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

Table 1 Accidents reported under RIDDOR 1992/93-1995/96

Year		*92/93*	*93/94*	*94/95*	*95/96*
Extruders	All	48	71	63	44
	Major	11	9	7	7
Haul-offs	All	48	28	45	44
	Major	4	1	7	8

Causes of accidents

About 80 accidents at extruders and haul-offs have been investigated by HSE inspectors from 1986-1996. Tables 2(a) and 2(b) summarise the parts of the machine and the circumstances involved.

Most of the accidents were caused by one of the following:

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

Table 2(a) Causes of accidents at extruders

Part causing injury		*Cause*	
Feed rolls and hopper	15	Access to moving parts in hopper to clear blockages	7
		Access to associated crammer/roll feed systems to clear blockages	8
Barrel unit/screw	6	Access through openings to retrieve foreign bodies	2
		Material burns during set up or purging	2
		Burns from contact with die head	1
		Feeding with guard removed	1
Screen changer	2	Failure of safety device	1
		No guard	1
Ancillary at die end (eg including calenders and sheet rollers)	17	In-running nips	17
Transmission machinery	3	Adjusting in motion	2
		No guard	1

Table 2(b) Causes of accidents at haul-offs

Part causing injury	*Cause*	
Haul-off	Feeding in sheet/strip to haul-off and inadequate guard	21
	Operator clearing waste, snagged material or cleaning belt with either no guard in place or with the guard open	13
	Trapped in running nip between sheet and roller due to inadequate guarding	4
	Aligning/adjusting extrusion in haul-off	3
	Setting - no guard or guard removed or guard defeated	3
Cross-cut saw	Access to saw due to inadequate guard	2
	Guard fell down on hand when clearing blockage	1
Insufficient detail to classify		6
Total		**53**

Guarding standards for production

The standards outlined in Tables 3(a) and 3(b) describe commonly accepted and practical safeguards for the significant hazards on extruders and haul-off machines. For the guarding of newer extruders from 1997, see BS EN 1114-1:1997 *Extruders and extruder lines. Part 1: Safety requirements for extruders*. Draft European Standard prEN 1114-3 *Extruders and extrusion lines. Part 3: Safety requirements for haul-offs,* when published, will specify safety requirements for new haul-offs. British Standards are available from BSI Customer Services, 389 Chiswick High Road, London W4 4AL Tel: 0181 996 7000 Fax: 0181 996 7001.

Table 3(a) Extruders

Hazard	*Safeguard*
Traps at main feed opening	Access to the rotating screws (main drive and feed) should be prevented by design, eg a hopper construction providing a safe distance. Alternatively, fixed guarding (eg a grille) can be provided 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	Hot parts above 80°C need to be protected 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	Splash guards to be used at the die.
Trapping by crammer feed system elements	Protection of 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	Interlocked guards required.

Table 3(b) Haul-offs (caterpillar, belt or roller)

Hazard	*Safeguard*
Trap at feed nip during normal operation (ie other than start-up/feeding)	Access to the nip formed by the conveyor infeed should be prevented by: ● Fixed guards in the form of protective structures preventing access to the danger zone. ● 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. ● Where the above is not practicable, interlocked guards may be used which stop all movement of the haul-off when opened. ● *Only* if none of the above options are practical may an adjustable guard be used. In this case, guards should be regularly checked to ensure they are properly adjusted to the size of the profile (see 'Safety checks').
Traps during start-up/setting	During feeding, access to the dangerous movements of the haul-off should be prevented 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; or ***Haul-off running*** (with the usual operator 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; and ● 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). 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.
Traps at discharge	If there are mechanical hazards at the discharge, eg between belt and rollers, these should be protected 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.
Saw blade	Fixed or interlocked guards, or tunnel guards with the appropriate safety distance. Manually adjustable guards are not acceptable.
Hot surfaces	Hot parts above 80°C need to be protected against accidental contact using insulation or guards. Where hot parts are necessarily exposed, warning signs are required.
Instability/overturn	The machine should be restrained to prevent movement.

Safety checks

Many accidents occur at extruders and haul-offs because of inadequate guarding. The following minimum checks should be made to ensure that safety is maintained.

Operational checks: *(suggested frequency: weekly/after setting)*

- Are all fixed and interlocked guards in place and secure?
- Does opening an interlocked guard immediately stop the dangerous parts it protects?
- Can the dangerous parts be started with the guards open?
- Are all control unit enclosures closed, locked and the keys removed?
- Do the trip devices function correctly? (haul-off only)
- If fitted, are adjustable guards correctly adjusted (haul-off only)

Maintenance inspections: *(suggested frequency: monthly)*

- Are all fixed guards held in place with fastenings that require a tool to undo them?
- Are all interlocks correctly aligned, attached to guards and operating correctly?
- Is insulation in good condition and temperature warning signs in place?
- Is the machine stable? (haul-off only)
- From a visual inspection is any electrical wiring showing signs of damage?
- Are the two hand /hold-to-run controls working as intended?
- Does operation of the emergency stop(s) prevent all movement of the machine?
- Is it possible to operate any dangerous parts after activation of the emergency stop, before the machine is reset?
- Are all fastenings to pressurised flexible hoses secured in place? (extruders only)
- Are all temperature controls working correctly? (extruders only)
- Are all control unit enclosures closed, locked and the keys removed, and retained by a designated person?
- If fitted, are adjustable guards capable of proper adjustment? (haul-off only)
- Is there any indication that safeguarding systems have been tampered with?

Safety during setting

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

Extruders

- Purging should be carried out at slow speed and reduced pressure.
- Use heat-resistant gloves/gauntlets and if necessary arm protection while handling hot machine parts or extrusion.
- Wear full-face visors and head protection for all operations where there is a risk from molten plastic.
- Minimise the need to stand directly in front of the die either when removing it or if making process checks on new extrusion.
- Ensure there is appropriate lifting equipment for the dies.

Haul-offs

- Make all pre-adjustments on the haul-off, eg alignment, with the machine 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 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, further safety measures should be taken (see ‘Guarding standards for production - Traps during start-up/setting’).

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.

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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