



Safety at thermoforming machines

Plastics Processing Sheet No 6

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 thermoforming 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 thermoforming 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.

Table 2 Causes of accidents

Part causing injury		Cause	
Drape table/mould/plug	23	Interlock failed or defeated during maintenance	7
		Operator defeated interlock	4
		Setter inadvertently actuated control while in machine	4
		Setter inside machine with guard closed	4
		Operator reached through defective guard	2
		Guards not interlocked	2
Guillotine/trimming knife	14	Fixed guards broken or inadequate	7
		Interlock defeated or fixed guards removed to free jam or remove product	4
		Setter did not isolate and make safe	2
		Setter defeated interlock to adjust stroke	1
Clamp	8	Interlocking defeated	4
		Defective interlocked guard	3
		Setter in machine with guard closed	1
Stacker mechanism	4	Inadequate guarding of the mechanism	4
Feeding mechanism	4	In-running nip inadequately guarded	3
		Cleaning feed conveyor without isolating	1
Heater unit	3	Heater not interlocked to guard	1
		Operator reaching over the top of the fixed guard	1
		Setter did not isolate machine and heater battery moved	1
Take-off conveyor	2	Traps not adequately guarded	2
Insufficient detail to classify	3		

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

Year	92/93	93/94	94/95	95/96
All	29	25	29	31
Major	3	3	3	4

Causes of accidents

Over 60 accidents at thermoforming machines were investigated by HSE inspectors from 1986-1996. Table 2 summarises the parts of the machine causing injury and the circumstances involved

The vast majority of failings involved can be reduced to 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.

Guarding standards for production

The standards outlined in Table 3 describe commonly accepted and practicable safeguards for the significant hazards on thermoforming machines, both new and second-hand. Safeguarding requirements for both manual and in-line machines have been incorporated into a single table, so reference should be made to the left-hand margin to identify which section of the table is applicable.

Table 3

<i>Hazard</i>	<i>Safeguard</i>
<div style="border: 1px solid black; padding: 2px; width: fit-content; margin-left: -50px; margin-top: -50px; transform: rotate(-90deg); transform-origin: left top;"> MACHINES WITH MANUAL LOADING AND/OR UNLOADING </div> <p>Forming section: machines that can be manually loaded and/or unloaded. Traps at the drape/table/plug/clamp</p>	<p>Large machines</p> <p><i>Either:</i></p> <ul style="list-style-type: none"> ● dual-channel interlocking with one position sensor in each channel (this may be control interlocking); <i>or</i> ● guard-inhibited power interlocking; <i>or</i> ● photo-electric systems. <p>The use of control guards (ie where closing the guard initiates platen closure) is acceptable on all thermoforming machines except for those where there is sufficient space for a person to stand between the operator's guard and the press.</p> <p>Small machines</p> <p>The standard for large machines should be applied unless the only powered motion is that of the drape table and/or heater battery. In such cases, two-hand control (with fixed guards at sides and rear) is acceptable.</p> <p>Where clamp frames are brought down with guard open to hold the material, a facility for two-stage clamping under low pressure should also be provided.</p>
<div style="border: 1px solid black; padding: 2px; width: fit-content; margin-left: -50px; margin-top: -50px; transform: rotate(-90deg); transform-origin: left top;"> IN-LINE MACHINES </div> <p>Movement of drape table at base of machine</p>	<p>Fixed guards, or drape table movement control interlocked with access door. (It is possible to connect the bottom access door to the operator's guard interlocking system.)</p>
<p>Heater bank</p>	<p>Trapping by heater unit(s) will be prevented by the guarding arrangements specified for elsewhere on the machine. To control the fire risk, the movement of the heater should be interlocked with the opening of the guard so that opening the guard causes the heater to return to its rest/rear position.</p>
<p>Material feed</p>	<p>Mechanical hazard at the intake (eg transmission machinery, nips at powered rollers, braking mechanisms) should be protected by fixed/interlocked guards (single channel with one position sensor) or other effective means.</p>
<p>Hot surfaces</p>	<p>Insulate where the temperature can exceed 80°C. Where hot parts are necessarily exposed, warning signs are required.</p>
<p>Forming section (in-line machines) - drape table/plug/clamp</p>	<p>Single-channel interlocked guards operating in the control circuit to prevent dangerous movement when the guard is opened.</p>
<p>Cutting/trimming unit</p>	<p>Interlocking as for forming section. Also access to the blade through the discharge opening should be prevented by:</p> <ul style="list-style-type: none"> ● safe design of the cutting device; <i>or</i> ● a distance guard, eg a tunnel guard; <i>or</i> ● a take-off device interlocked to the control system (single positively operated position switch) to prevent movement of the cutting device when the take-off device is removed.
<p>Stacking unit</p>	<p>Guards as for forming section.</p>
<p>Discharge</p>	<p>If the take-off device is removable and there is access to cutting/stacking units, the device should be interlocked (single positively operated position switch) to the control system to prevent any dangerous movement.</p>

Safety checks

About 50% of accidents at thermoforming machines occurred because of inadequate or damaged guarding, and about another 25% were due to interlocks that had been defeated. The following minimum checks should be made to ensure that safety is maintained.

Operational checks (suggested frequency: every shift)

- Are all fixed and interlocked guards in place and secure?
- Does opening an interlocked guard stop the dangerous parts it protects?
- Can any dangerous parts be started with the interlocked guards open?
- Does the heater return to its rest or rear position when the interlocked guard is opened?
- For small stand-alone machines with two hand controls, do both buttons have to be pressed together for the machine to operate?
- If fitted, and with the machine at rest, does breaking the electro-sensitive curtain with the test piece cause the indicator to change state.
- If required, is there a scotch/chock readily available for every machine?

Maintenance checks (suggested frequency: monthly)

- Are all fixed guards held in place with fastenings that require a tool to undo them?
- Are all interlocking devices correctly aligned and attached to the guards?
- Does opening an interlocked guard stop the dangerous parts it protects?
- Can any dangerous parts be started with the interlocked guards open?
- Does the movement of the interlocked guards actuate the sensors of the associated hydraulic, pneumatic or electrical mechanisms? (Visual check)
- Is there any visible evidence of tampering with the guards/interlocks?
- If fitted, does the trip device on the leading edge of a power-operated guard operate when activated?

- If there is a setter's mode selector, does selecting the mode only allow operation with the additional safety systems engaged (slow speed, two-hand control, hold-to-run, limited movement etc)?
- Does the emergency stop(s) prevent all continued movement of the machine?
- From a visual inspection, is any electrical wiring showing signs of damage?
- Is the heat insulation in good condition and are temperature warning signs in place?

Guidance on setting procedures

Accidents often happen at setting because parts of the interlocking guarding arrangements have been overridden. On thermoforming machines about 33% of all accidents investigated by HSE happened at setting operations.

A written safe system of work for tool changing and setting should be devised in consultation with your setters, based on the following.

- No mould changing, setting or try-out operation should be undertaken without first checking that the platens/moulds will not move when the operator's guard is open.
- If the table or the cutting head is in the raised position, and if there is a danger of gravity fall, a scotch/block should be inserted.
- Isolation requirements will depend on the machine size and type, as well as on the length of the tool change procedure. Advice by category is as follows:
 - On **small manual machines**, with quick tool changing facilities and where the setter is working outside the machine, there may be no need for power isolation when tool changing, and use of the operator's safeguards alone will be sufficient.
 - On **in-line machines**, where the tool change operation takes a relatively short period of time and the setter is either outside the machine or can be seen easily from the control panel, the emergency stop should be used in conjunction with the operator's safeguards.
 - On **larger manual or in-line machines**, where there is either a need to work between the tools/platens, or where the setter is out of view from the control panel, all power supplies should be isolated and locked off, and stored energy dissipated.

- It should be possible in most cases to remove all mould-securing bolts and pipework connections without requiring powered movement of the drape table. Using locating lugs on the table should ensure that the tool matches exactly the opening in the 'window frame'.
- On machines where it is not practicable to change the mould, clean, fault-find etc without powered movement with the guards open, such operations should only be permitted if suitable override facilities have been built in to the machine controls. To be suitable, such facilities should include slow speed with two-hand control or hold-to-run, which should be engaged automatically, on selection of the override mode.

Further reading

BPF *Code of practice for safety in the use of thermoforming machines* 1987 Available from British Plastics Federation, 6 Bath Place, Rivington Street, London EC2A 3JE Tel: 0171 457 5000 Fax: 0171 457 5045

prEN 12409 *Thermoforming machines, safety requirements* October 1997

British Polymer Training Association *Thermoforming* 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.

This publication may be freely reproduced, except for advertising, endorsement or commercial purposes. The information is current at 6/99. Please acknowledge the source as HSE.