



Safety at the winding zones of winding machines for plastic sheet and film

Plastics Processing Sheet No 11

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 the winding zones of winding machines, and details safeguarding standards and safety checklists. It has been designed to be read in conjunction with Plastics Processing Sheet No 3 Managing machinery safety in small plastics factories.

In this document the term 'nip' is used to refer to the intake between two rollers (whether driven or not). 'Running nip' is used to refer to the trap created between the material and any roller, reel, mandrel or core.

Accident history

Table 1 shows the number of accidents at plastics industry winders that have been reported to HSE from 1992-1996 under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR). It shows that, on average, there is a reportable accident on these machines somewhere in the UK three weeks out of every four.

Table 1 Reeling/winding accidents reported by the plastics industry under RIDDOR 1992/93 - 1995/96

| Year | 92/93 | 93/94 | 94/95 | 95/96 |
|-------|-------|-------|-------|-------|
| All | 48 | 28 | 38 | 44 |
| Major | 4 | 1 | 1 | 8 |

Causes of accidents

Over 130 accidents at winding machines have been investigated by HSE inspectors in the 10 years up to 1996. Table 2 summarises the circumstances involved.

The table shows that there are three main types of accident: being drawn in at a nip; being drawn in at a running nip; and being injured by a falling mandrel/reel. The falling mandrel/reel accidents do not require detailed guidance and are not dealt with in the safeguarding standards which follow.

HSE's investigation experience is that employees are often placed at risk when deliberately intervening in the winding process. The tasks they are carrying out commonly include: threading up; smoothing material; cutting samples from the web; splicing onto the new core; adjusting slitters; and fault diagnosis. The safeguarding options listed in this sheet, together with other aids such as 'scrolling rolls' to smooth creases, will provide the most practicable levels of operator protection when any of these tasks need to be done.

Guarding standards

Applying these standards

Both nips and running nips should normally be presumed to be dangerous. For example, one fatality has occurred on a machine running as slow as 5 m per minute. The safeguarding standards described in this sheet should be applied.

However, there may be circumstances where the nips and running nips are not a danger and so some precautions described in this sheet will not be needed. For example:

- where the rollers are of such low torque that they can be stopped by one hand;
- where they are positioned out of reach; or
- in the case of running nips, where easy withdrawal of the hand from the trap is possible.

The use of trip wires

A number of different safeguards are currently found in use at winders, ranging from fixed and interlocked guards to simple trip wires. While trip wires can minimise accidents and injuries, they do not always prevent them and the law requires a more effective form of safeguarding where this is practicable. **Trip wires should not therefore be used as primary safeguards other than in the defined circumstances set out in Tables 3, 4 and 5.** When trip wires have to be used, their positioning is critical and they need to be very deliberately sited so that they are activated by an involuntary action rather than a conscious act.

The sensitivity of the trip wire and the speed of the machine's braking mechanism must always be checked to ensure that involuntary activation of the trip will stop the winder almost instantaneously (ie quickly enough to prevent a serious injury).

Table 2 Causes of accidents

| Part causing injury | No | Cause/reason | No |
|--|----|--|----|
| NIPS Either: nips between a roller and the reel/mandrel/core (eg driving roller or pressure roller); or nips between rollers not in contact with the reel/mandrel/core | 45 | No safeguards provided. | 25 |
| | | Opening in fixed guard too large. | 7 |
| | | Guard removed or safety device off during setting. | 4 |
| | | Electro-sensitive protective equipment (ESPE) ineffective because wrongly positioned. | 3 |
| | | Trip wire/device only activated after person drawn into nip. | 2 |
| | | Unsafe system of work. | 2 |
| | | Nip guard ineffective because wrongly positioned. | 1 |
| | | Other. | 1 |
| RUNNING NIPS Running nip between the material and the reel/mandrel/core | 38 | No safeguards provided. | 14 |
| | | Trip wire/device not activated, or only activated after person drawn into the running nip. | 12 |
| | | Fixed guard removed. | 2 |
| | | Interlocked guard defeated. | 2 |
| | | Fixed guard ineffective because wrongly positioned. | 1 |
| | | Other. | 7 |
| Running nip between the material and any other roller | 3 | No safeguards provided. | 3 |
| Mandrel/reel | 33 | Dislodged from bearings. Not secured in position. | 13 |
| | | Dropped while being manually handled. | 10 |
| | | Dropped due to failure of inadequately maintained lifting equipment. | 5 |
| | | Caught on protruding end screws while rotating. | 2 |
| | | Other. | 3 |
| Knives | 4 | Automatic flying knife jammed in raised position leaving blade exposed. | 1 |
| | | Hinged guard raised, blade fell during cleaning. | 1 |
| | | Interlocked guard removed for blade change. Usual protective plastic cover not in place. | 1 |
| | | Hinged guard fell due to poor positioning. | 1 |
| Arms of winder | 4 | Trapped between arms and frame of machine. | 2 |
| | | Struck by arm. | 2 |
| Transmission machinery | 2 | No fixed guard provided. | 2 |
| Miscellaneous | 22 | Individual circumstances. | 22 |

Safe operating procedures

It must be recognised that the safeguarding standards in Tables 3, 4, 5 and 6 will not provide complete protection at all times, and so heavy reliance must also be placed on safe operating procedures. The following issues in particular need to be addressed:

- Do not allow people to wear loose jewellery and clothing, eg long laboratory coats, ties etc.
- Ensure there are enough emergency stops so that one is accessible from all working positions in the winding zone.

- Pre-plan for foreseeable malfunctions, eg blockages and loss of sequence.

Safeguarding standards

The remainder of this section describes practicable and acceptable safeguarding standards for the four different types of winder. Each is complete in itself, so you need only refer to the type(s) which best describes your plant. The four types are:

- fully automatic machines on continuous production lines (eg blown film), where the need for manual intervention is limited to initial start-up or fault conditions;
- semi-automatic machines on continuous production lines, where the motion of the flying knife and/or the reel change is manually initiated;

- manually operated machines on continuous production lines, where the operator has to cut the web manually; and
- rewind machines where the material is fed from reel to reel for printing, slitting, inspection or similar processes.

Terms used in Tables 3 to 6

'Slow' speed - the indicative slow speeds are for film (250 microns or less) 10-15 m/min, or for sheet (greater than 250 microns) 5-10 m/min.

Hierarchy - the precaution hierarchies referred to in the table are in the context of the Provision and Use of Work Equipment Regulations 1998 (PUWER 98). Regulation 11 specifies the measures to be taken to prevent access to dangerous parts of machinery and ranks them in the order they should be implemented.

Table 3 Fully automatic machines

| Hazard | Precaution |
|--|---|
| Traps at nips and running nips during normal operation | <p>The following should be used either singly or in combination:</p> <ul style="list-style-type: none"> ● perimeter fencing with interlocked access doors and either a scanning device or pressure-sensitive mats if internal access is foreseeable; ● electro-sensitive protective equipment (ESPE) using light curtains and light beam devices; or ● localised fixed/interlocked guarding. <p>A safe means of loading mandrels etc should be provided, eg a hoist controlled from outside the winding zone.</p> |
| Start-up | <p>If practicable, the machine should either be threaded up when it is stationary, or with all the safeguards in position and functioning.</p> <p>If this is not practicable, and the machine can only be threaded up in motion with parts of the normal safeguarding system inoperative, then one of the following options should be used via the use of a mode selector key, either</p> <ul style="list-style-type: none"> ● the slowest speed practicable together with the use of local ESPE or a trip device specifically positioned to be activated by the operator if they get too close to the nip; or, if applicable ● a hold-to-run device incorporating slow speed or limited movement. |
| Product verification and adjustment | <p>Always consider whether the sample can be taken from a completed reel rather than the running web.</p> <p>What follows should only be applied where manual intervention with the machine running is necessary (eg sampling material, minor adjustments). If the machine has an accumulator these operations should be performed with the winding parts stationary.</p> <p>If the machine does not have an accumulator then use the highest practicable measures from the following hierarchy depending on machine operation:</p> <ul style="list-style-type: none"> ● take the sample from a safe position upstream of the winding zone; ● use a mode selector switch to override the normal guarding and activate ESPE, specifically positioned to be activated by the operator if they get too close to the nip, as well as an audible alarm and/or visual signal; ● use a mode selector switch to override the normal guarding and activate a trip wire, specifically positioned to be activated by the operator if they get too close to the nip, as well as an audible alarm and/or visual signal. |

Table 4 Semi-automatic machines

| Hazard | Precaution |
|--|---|
| Traps at nips and running nips during normal operation | <p>The following should be used either singly or in combination:</p> <ul style="list-style-type: none"> ● perimeter fencing with interlocked access doors and pressure-sensitive mats if internal access is foreseeable; ● localised fixed/interlocked guarding (eg for side panels); or ● ESPE using light curtains and light beam devices with a muting function enabled where necessary, eg at reel bar changeover. If access to the dangerous parts is needed when such devices are muted then a trip wire should also be provided. <p>A safe means of loading mandrels etc should be provided, eg a hoist controlled from outside the winding zone.</p> |
| Start-up | <p>If practicable, the machine should either be threaded up when it is stationary, or with all the safeguards in position and functioning.</p> <p>If this is not practicable, and the machine can only be threaded up in motion with parts of the safeguarding system inoperative, then one of the following options should be used, either:</p> <ul style="list-style-type: none"> ● the slowest speed practicable together with local ESPE or a trip device specifically positioned for this purpose; or, if applicable ● a hold-to-run device incorporating slow speed or limited movement. |
| Product verification and adjustment | <p>Always consider whether the sample can be taken from a completed reel rather than the running web.</p> <p>What follows should only be applied where manual intervention with the machine running is necessary (eg sampling material, minor adjustments). If the machine has an accumulator these operations should be performed with the winding parts stationary.</p> <p>If the machine does not have an accumulator then use the highest practicable measures from the following hierarchy depending on machine operation:</p> <ul style="list-style-type: none"> ● take the sample from a safe position upstream of the winding zone; or ● from the winding zone with the normal safeguards in position; or ● from the winding zone but having used a mode selector switch to override the normal guarding and activate a trip wire specifically positioned to be activated by the operator if they get too close to the nip. The mode selector switch should also activate an audible alarm and/or visual signal. |
| Traps from reel change mechanism | <p>If reel change is initiated automatically, access to the dangerous parts should be prevented by one of the safeguarding options listed under nips/running nips (above).</p> <p>If movement is initiated manually, then initiation should be by a two-hand control incorporating a hold-to-run requirement and the control point should be positioned to allow the operator a clear view of the danger area.</p> |
| Flying knife | <p>If movement of the flying knife is initiated automatically, access to the knife should be prevented by one of the safeguarding options listed under nips/running nips (above).</p> <p>If movement is initiated manually, and if the knife can be reached from the control point, then initiation should be by a two-hand control.</p> <p>If movement of the knife is initiated manually but the knife cannot be reached from the control point, the control point should be positioned to allow the operator a clear view of the danger area.</p> |

Table 5 Manually operated machines

| Hazard | Precaution |
|---|--|
| Nip/running nip at the reel-up - general precautions | <p>To reduce the likelihood of inadvertent access to the nips/running nips from the side or front of the machine, select protection methods from one of the following:</p> <ul style="list-style-type: none"> ● at the sides - barriers, a raised platform, or the machine frame itself may act as a barrier; ● at the front - a raised platform or matting which gives a visual or audible warning when trodden on. <p>Warning signs could be used in addition to either of these.</p> |
| Nip/running nip at the reel-up: Safeguards for protecting the operator during web cutting operations | <p>Two arrangements which do not require additional safeguards are possible:</p> <ul style="list-style-type: none"> ● the nip/running nip may be safe by position (ie out of reach from the position where the web is cut); or ● if the machine has an accumulator, these operations should be performed with the winding parts stationary. <p>Where neither of the above possibilities can be used then the highest practicable measures should be adopted from the following hierarchies depending on machine operation.</p> <p>Nip position stationary as reel grows:</p> <ul style="list-style-type: none"> ● interlocked guard; ● ESPE; ● trip wires. <p>Nip position moves with growing reel:</p> <ul style="list-style-type: none"> ● interlocked guard; ● self-adjusting guard; ● ESPE; ● trip wires. <p>In the case of ESPE and trip wires they should be specifically positioned to be activated by the operator if they get too close to the nip.</p> |
| Operator protection when sampling | <p>The above precautions would also apply to sampling, but cutting from the completed reel or upstream away from the reel-up point is recommended. Sampling should be done at the slowest speed practicable.</p> |
| Start-up | <p>If practicable, the machine should either be threaded up when it is stationary, or with all the safeguards in position and functioning.</p> <p>If the machine has to be threaded up in motion and any interlocked or self-adjusting guard has to be overridden for this purpose, then a trip wire should be provided close to the nip/running nip and the process of overriding the guard should activate the trip wire. Threading up should then be undertaken at the slowest speed practicable and the operating procedure should be specified in a written work instruction.</p> <p>If the machine has to be threaded up in motion and the safeguard provided at the nip/running nip is locally positioned ESPE or a trip wire, then this work should be undertaken at the slowest speed practicable and the operating procedure should be specified in a written work instruction.</p> <p>NB If it is practicable to use ESPE to safeguard any nip/running nip at the reel-up for web-cutting operations, but not for start-up (because loose ends would trip the beam), then it is acceptable to use a trip wire for both purposes.</p> |
| Traps from any reel change mechanism | <p>If mechanised reel change arrangements are fitted and are reachable from the control position, then the controls for these parts should be:</p> <ul style="list-style-type: none"> ● two-hand control; and ● positioned so as to allow the operator a clear view of the danger area. <p>If mechanised reel change arrangements are fitted and are not reachable from the control position, then the controls for these parts should be:</p> <ul style="list-style-type: none"> ● positioned so as to allow the operator a clear view of the danger area; and ● hold to run. |
| Nips and running nips other than those at the reel-up | <p>If access to these is possible (ie not safe by position), then the highest practicable measures should be adopted from the following hierarchy</p> <ul style="list-style-type: none"> ● localised fixed/interlocked guarding; ● perimeter fencing with interlocked guards; ● self-adjusting guards; ● ESPE; ● pressure-sensitive mats. |

Table 6 Unwind/rewind machines

| Hazard | Precaution |
|--|---|
| Traps at nips, running nips and knives | Access to these dangerous parts should be prevented by any of the following, either singly or in combination: <ul style="list-style-type: none"> ● perimeter fencing with interlocked access doors; ● localised fixed/interlocked guarding; ● ESPE; or ● pressure-sensitive mats. |
| Start-up | The machine should either be threaded up when it is stationary, or with all the safeguards in position and functioning. |
| Manual intervention | If manual intervention is necessary (eg for minor adjustments), then where practicable the machine should be stopped. If it is necessary to intervene with the machine running, then a hold-to-run device incorporating slow speed or limited movement will be required. |

Operational checks (Suggested frequency: Daily)

- Are all fixed and interlocked guards in place, in good condition and secure?
- Are all control unit enclosures closed, locked and the keys removed?
- If ESPE is fitted, does the indicator work when the test piece is inserted into the light curtain or area scanned by light beams?
- If a pressure-sensitive mat is fitted, does the mat indicator work when a weight is applied?
- If applicable, is the reel lifting equipment available and in working order?

Maintenance checks (Suggested frequency: Monthly)

- Are all fixed guards secured in place with fastenings that require a tool to undo them? (You may wish to consider the use of restricted tools).
- Are all interlocking devices correctly aligned and securely attached to the guards?
- Can the dangerous movements be started with the interlocked guards open?
- Does activation of any trip wire stop the machine almost instantaneously?
- Do any emergency stops fitted prevent all continued movement of the machine?
- Is it possible to initiate any dangerous movement after activation of the emergency stop(s) before the machine is reset?
- Are control unit enclosures closed, locked and the keys removed and retained by a designated person?
- Are the two-hand/hold-to-run controls working as intended?

- Is there any indication that safeguarding systems have been tampered with?
- Is movement of dangerous parts prevented while either:
 - there is a test piece within the ESPE's curtain/beam; or
 - a weight is applied to the pressure-sensitive mat.
- Does removal of power to either the ESPE and/or the pressure-sensitive mat prevent further operation of the machine and reactivation until power is restored and the device reset?
- Are the seating arrangements for the mandrels secure?
- If applicable, is the lifting equipment serviceable?

Further information

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