



# Machine Guards

## White Paper 5 Conveyor Guarding

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### Safeguarding the hazards presented by conveyors

Jeremy Procter, a Member of standards committees ISO/TC 199/WG 6 (Safety distances and ergonomic aspects) and BSI MCE/3 (Safeguarding of machinery), and Managing Director of Procter Machine Guarding, discusses the hazards associated with conveyors, the regulations and standards relating to conveyor guarding, and the best approaches for adequately and cost-effectively safeguarding conveyors without adversely affecting productivity.

## Background

Conveyors are highly efficient for transferring discrete items or bulk solids from one location to another. Nevertheless, despite their apparent simplicity, conveyors account for a large number of injuries to workers, sometimes with fatal consequences. Many of these incidents occur during normal operations such as production activities, clearing of blockages, cleaning and maintenance. Typical injuries resulting from accidents involving conveyors include severe crush injuries, soft tissue damage, broken bones, severed fingers and severed limbs. The following examples of recent prosecutions by the HSE (Health and Safety Executive) illustrate why there is a need for conveyor guarding:

### ***Worker severed arm at the shoulder while clearing conveyor blockage***

A recycling firm was prosecuted under the Health and Safety at Work etc Act 1974 and was fined £118,000 after a worker's arm was severed at the shoulder. While manually sorting materials on the conveyor, the worker noticed a metal container that had caught on the edge of the conveyor belt's pulley. He opened an unsecured hinged guard to access the blockage but, when he attempted to remove the container, his left hand and arm came into contact with the moving belt and the bottom of the pulley – resulting in his arm being severed at the shoulder. On hearing his screams, a colleague pulled the 'stop cord' that was installed along the conveyor to switch off the machinery. The worker was taken to hospital but doctors were unable to reattach his arm.

### ***Unguarded 'running nip' caused traumatic and debilitating hand injuries***

A firm in the food industry was fined £7000 and ordered to pay costs of £2909.25 after pleading guilty to two breaches of the Provision and Use of Work Equipment Regulations 1998 and a single breach of the Management of Health and Safety at Work Regulations 1999. While a worker was cleaning a conveyor, his hand was pulled into the 'running nip' that was unguarded. Being unable to reach an emergency stop switch, he had to rely on a colleague to stop the conveyor. As a result of his injuries, the worker had to spend seven days in hospital, underwent two operations, needed several months off work and now has only limited use of that hand.

### ***Maintenance worker's hand injured by running conveyor***

A baking firm has been fined £5000 and ordered to pay £1162.50 in costs after pleading guilty to breaching Section 2(1) of the Health and Safety at Work etc Act 1974. A maintenance worker was lying on the floor holding a torch, which was clipped by the conveyor and knocked out of the worker's hand. As he reached to grab the torch, his hand was drawn into the roller on the underside of the machinery, resulting in an open fracture to his right hand and tissue damage. Following surgery, the worker was off work for more than two months and is still suffering from side-effects relating to the injury.

Not only can conveyors cause serious injuries, but an accident is also likely to result in prosecution, fines, costs awarded against the employer, lost production, overtime costs (to make up for lost production), loss of reputation, management costs and more. Of course, there is also the moral argument for providing safe work equipment.

## Regulations, standards and guidance

Since 1998, users of conveyors have been legally obliged to perform a PUWER assessment – which often reveals that existing safeguards are inadequate and that additional measures are needed. Furthermore, companies purchasing standard or custom-built conveyors frequently find they have to fit extra guarding, either to rectify shortcomings in the as-provided guarding or to protect workers from dangerous in-running nips where the conveyors meet adjacent machines.

PUWER 98 (Provision and User of Work Equipment Regulations 1998) has already been mentioned, but there are several other regulations, standards and codes of practice that need to be considered. First, the Supply of Machinery (Safety) Regulations 2008 is the UK implementation of the Machinery Directive 2006/42/EC, requiring machinery – including powered conveyors – to be CE marked. While this is of interest mainly to manufacturers, there are situations in which the user might be responsible for CE marking, such as if the conveyor is effectively incorporated with another machine and controlled by it (see below). Second, employers have obligations under the Health and Safety at Work etc Act 1974. For example, Section 2(1) states: “It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.” Third, employers have obligations under the Management of Health and Safety at Work Regulations 1999. For example, Regulation 3(1)(a) states: “Every employer shall make a suitable and sufficient assessment of the risks to the health and safety of his employees to which they are exposed whilst they are at work.”

There are several general machinery safety standards that are likely to be applicable to powered conveyors. These are:

- BS EN ISO 12100:2010 *Safety of machinery. General principles for design. Risk assessment and risk reduction*
- BS EN 953:1997+A1:2009 *Safety of machinery. Guards. General requirements for the design and construction of fixed and movable guards* \*
- BS EN ISO 13857:2008 *Safety of machinery. Safety distances to prevent hazard zones being reached by upper and lower limbs*

\* BS EN 953 will shortly be replaced/superseded by ISO 14120 *Safety of machinery. Guards. General requirements for the design and construction of fixed and movable guards.*

In addition, there are standards relating specifically to powered conveyors:

- BS EN 618:2002+A1:2010 *Continuous handling equipment and systems. Safety and EMC requirements for equipment for mechanical handling of bulk materials except fixed belt conveyors*
- BS EN 619:2002+A1:2010 *Continuous handling equipment and systems. Safety and EMC requirements for equipment for mechanical handling of unit loads*
- BS EN 620:2002+A1:2010 *Continuous handling equipment and systems. Safety and EMC requirements for fixed belt conveyors for bulk materials*
- BS 4531:1986 *Specification for portable and mobile troughed belt conveyors*
- BS 5667-1:1979 *Specification for continuous mechanical handling equipment - safety requirements. General* (equivalent to ISO 1819-1977)

Other conveyor-related standards cover electrical and flammability safety, and specific conveyor applications such as opencast lignite mining. Readers can check for these standards and decide whether or not they are applicable by visiting the BSI website at [www.bsigroup.co.uk](http://www.bsigroup.co.uk).

New conveyors should comply with the applicable standards although compliance is not mandatory; however, complying with the standards is usually considered to be the best way for a manufacturer to demonstrate that the essential health and safety requirements of the Machinery Directive have been met. For existing conveyors – and there are many thousands in use throughout the UK today – advice and guidance is contained in BSI's Published Document PD 5304:2014 *Guidance on safe use of machinery*. This provides practical measures and techniques that can be used to safeguard machinery operators, maintenance personnel and others. The guidance deals with issues ranging from risk assessment through safeguarding to maintenance and safe working practices, with examples and illustrations.

## CE marking and risk assessments

Ensuring that a conveyor complies with the relevant standards and codes of practice is relatively straightforward, but the question of CE marking is a more difficult area. While there are some situations where a conveyor will be supplied as a standalone machine – and will therefore need to be CE marked – there are others where the conveyor needs a Declaration of Conformity so it can be incorporated within a larger machine that is CE marked as a whole. If in doubt, seek advice from machinery safety consultants, guarding specialists or conveyor suppliers – but satisfy yourself that the conveyor manufacturer truly understands the machinery safety issues, as some may not.

Remember that the CE mark on a new or existing conveyor is not a guarantee that it is safe, just a claim of compliance. Furthermore, the validity of that claim depends very much on how the conveyor is being used.

Whatever course of action is taken, the ultimate goal is to ensure that the conveyor is safe, so users should undertake a risk assessment and install the necessary safeguards to reduce the risks to an acceptable level. In fact the correct approach is to carry out a formal risk assessment to establish the hazards and determine what measures are required to reduce the risks. Then the hazards should be re-assessed to check that the risk-reduction measures are sufficient. If unacceptable hazards still exist, then further measures will be necessary before the residual risks are assessed once more.

To help with risk assessments, Procter Machine Guarding offers a free Risk Assessment Calculator that is based on the relevant standard, BS EN ISO 12100:2010. This Risk Assessment Calculator can be downloaded from the company's website at [www.machinesafety.co.uk](http://www.machinesafety.co.uk) or requested by sending your email address to [RA@procterbedwas.co.uk](mailto:RA@procterbedwas.co.uk).

## Conveyor hazards and safeguards

In line with general good practice, the objective should be to design-out hazards rather than safeguarding them but, in reality, this is unlikely to be feasible where conveyors are already operating or have been purchased as standard or configured-to-order units.

Most hazards associated with conveyors relate to the in-running nip points, which can easily draw in clothing, tools, fingers or limbs, depending on the size, speed and power of the conveyor. PD 5304 and the standards listed above highlight where nip points typically exist, but be aware that reversible belt conveyors need nip points guarded for both directions of travel (unless reversing is only used for maintenance and cleaning operations, in which case safe working practices, hold-to-run and reduced speed/power controls may be adequate, depending on the result of the risk assessment).

Other hazards exist in the vicinity of transmission components, couplings and tensioners. The moving edge of the belt can, itself, be a hazard, and personnel need to be protected from spilt, ejected or falling material, especially where conveyors run overhead.

Having identified the hazards by means of a risk assessment, appropriate safeguards need to be selected. It is highly likely that fixed guards (ie those requiring the use of tools for their removal) or interlocked movable guards will be chosen, depending on the frequency with which access is required. In some cases tunnel guards can be used to ensure dangerous parts cannot be reached, and these might be interlocked movable tunnel guards to ease access during maintenance. For long conveyors, such as are typical in quarrying, it is seldom practical to install guarding along the entire length, let alone fit interlocked movable guards. In such situations, isolation procedures, safe working practices and pull cord-operated emergency stop controls can all play an important role.

Welded wire mesh is frequently used to guard conveyors or parts thereof, with a mesh aperture size and guard geometry to suit the requirements of BS EN ISO 13857:2008 *Safety of machinery. Safety distances to prevent hazard zones being reached by upper and lower limbs*. For couplings, power transmission components, and conveyors where there is a risk of parts being ejected, sheet metal may be more appropriate. In some cases it is simpler and more cost-effective to use physical perimeter guarding to deny access to the conveyor, with suitable access control systems for use during maintenance and cleaning. The height of the perimeter guarding and the distance from the hazards need to comply with the requirements of BS EN ISO 13857. To help users determine safety distances, Procter Machine Guarding offers a free Safety Distance Calculator that is based on BS EN ISO 13857. This Safety Distance Calculator can be downloaded from the company's website at [www.machinesafety.co.uk](http://www.machinesafety.co.uk) or requested by sending your email address to [SDC@procterbedwas.co.uk](mailto:SDC@procterbedwas.co.uk).

To protect personnel from objects that might fall from overhead conveyors, guarding must be designed and constructed to withstand the forces that might be involved. Materials of construction typically include steel channel and heavy-duty expanded metal or open grip steel flooring. Alternatively, fencing can be used to prevent access to the hazardous areas at ground level.

## Conveyor control

Due consideration should be given to the control system, with the requirements depending on whether the conveyor operates as standalone equipment or is controlled with a machine (for example, as an infeed or outfeed infeed conveyor). The conveyor control will need to be linked to the machine control if it is necessary for the conveyor to stop if the associated processing equipment stops; similarly, if the processing equipment is required to stop in the event of an emergency stop button being operated on the conveyor. Depending on the circumstances, one of these standards might be applicable:

- BS EN ISO 13849-1:2008 *Safety of machinery. Safety-related parts of control systems. General principles for design*
- BS EN 62061:2005+A1:2013 *Safety of machinery. Functional safety of safety-related electrical, electronic and programmable electronic control systems*

## Maintaining productivity

Care has to be taken when installing guarding to ensure that no new hazards are introduced and that plant efficiency does not suffer. It is therefore essential to consult with managers and workers before designing guarding. Additional measures can also be taken, such as fitting remote greasing points so the conveyor can be lubricated without having to remove guards, and belt alignment mechanisms that can be operated from outside the guards. Guarding should also be designed, so far as possible, such that routine cleaning and clearing of spillages can take place without disturbing the guarding – for example, by incorporating rodding access points. Lastly, the importance of education, training, safe systems of work, power lock-offs and effective supervision should not be underestimated. Safe start-up procedures, typically with warning sounders and a time delay, are an example of how to improve safety where it is not possible to view all the hazardous areas from the control station.

## Cost-effective measures

For somebody who has undertaken a PUWER assessment and concluded that additional conveyor safeguarding is required, the task may seem daunting. Nevertheless, it is possible to save time and money without cutting corners. Specialist guarding contractors, such as Procter Machine Guarding, can survey, design, fabricate and install guarding far more quickly and cost-effectively than non-specialists. For instance, Procter's design engineers typically create guard drawings in a fraction of the time that it would take draughtsmen more used to working with general machinery. Experience and an in-depth knowledge of the appropriate standards also help to get the designs right so that they meet the operational and safety requirements first time, without having to be modified *in situ*.

Procter offers free on-site surveys, after which detailed quotations are prepared. Fabrication takes place in Procter's own facilities, and finishes can be applied in the customer's choice of colour. The company also supplies and installs remote grease points, guard interlocks or any other associated hardware that may be required to complete the project. For perimeter guarding, Procter offers a choice of modular systems, either the aluminium EcoSafe system from Bosch Rexroth or the steel systems from Satech. Both types are quick and simple to specify and install, and Procter can fabricate infill panels or other custom components if these are more appropriate than trying to complete the project using only standard modular components.

In addition to the bespoke and modular guarding, Procter Machine Guarding also surveys, designs, fabricates and installs access platforms, steps and other equipment that may be required for compliance with the Working at Height Regulations.

## Conclusion

Conveyors are prevalent in most industries and are often taken for granted. Nevertheless, for various reasons – including in-running nips, transmission elements and the fact that manual cleaning is often undertaken – conveyors can be the source of significant hazards. Adequate guarding will improve safety considerably, though safe working practices and other measures are also important, particularly if fixed guards need to be removed for maintenance.

Procter Machine Guarding is the UK's leading machinery guarding specialist. The company has published numerous guides, calculators and White Papers relating to machine guarding and machinery safety standards, all of which can be downloaded free of charge from the website at [www.machinesafety.co.uk](http://www.machinesafety.co.uk). Alternatively, contact Procter Machine Guarding to discuss specific machine guarding requirements by telephoning 02920 855758 or emailing [guards@procterbedwas.co.uk](mailto:guards@procterbedwas.co.uk).

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The information contained in this publication is intended as a guide only and is believed to be correct at the time of going to press. However, it is the reader's responsibility to ensure that all applicable legislation is complied with when specifying, designing or modifying machinery guarding.

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