Safe Guarding

Supporting the Safety Essentials

INTRODUCTION

"Historically, a persistent feature of all industries operating machinery and equipment has been the many injuries – including fatalities – caused by the inadequacy or absence of guarding. Although standards have improved significantly, it remains a fact that – for some – the basic principles are still not sufficiently understood, implemented or maintained." (UK Enforcing Authorities (HSE) – 2005)

There are still examples today where guards are found to be poorly designed, have been removed and not put back, are secured inadequately or are badly damaged.

This presentation is intended to raise awareness of the issues surrounding guarding, to prompt review of existing guarding by management and ensure guarding standards are to an acceptable level. Guarding requirements must be fully understood, if guards are not in place or adequate there is a significant potential for someone to be killed. The unauthorised removal and failure to replace guards securely are serious offences and will result in disciplinary action.

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Risk Assessment and Guarding Principles

A risk assessment must be carried out to identify the hazards relating to the equipment, the potential for injury, its severity and the likelihood of occurrence for each hazard identified.

The following control measures, ranked in the order that they should be implemented, must be in place to protect all dangerous parts of machinery:

- **Close-fitting guards** – Wherever possible machinery should be close guarded to prevent personnel being able to work inside the guarded area.
- **Other guards or protection devices such as interlocked distance guards, pressure mats and induction loops** – Where machinery cannot be close guarded a suitable electrically interlocked perimeter guard should be fitted where possible. This should be applied along with a Safe System of Work involving isolation and lock off so that no one is able to enter the guarded area unless they have locked out and tagged out.
- **Light beams and light curtains**
- **Protection appliances such as jigs, holders and push sticks.**

Suitable information, instruction, training and supervision must be in place to ensure that all personnel are aware of the necessary safe systems of work.

In addition to preventing access to dangerous parts of moving machinery, guarding may also be required to provide protection from extreme temperatures of machinery, the potential for ejected particles and the potential for falls into storage hoppers, silos, etc.

Design & Installation of Guarding

Principal features for the design of guards include:

- Robust construction
- Use of sound materials
- Be suitable for the conditions in which they are used
- To allow moving machinery to be seen where necessary
- Avoid the introduction of additional risks
- Endeavour to prevent by-pass or rendering non-operational
- Be designed, located and installed to ensure that access is prevented by any person, their body parts or clothing.

NB: Where guards are fitted to the underside of conveyors there may be a risk of spillage accumulating within the guard. In such situations, the guard mesh should be of a size sufficient to allow spillage to fall through (where safe to do so) whilst preventing access to the moving parts within the guard.

Fixed Close Guards

• Must be held in place be fastenings which require a tool to release them. This excludes cable ties and wire or other such bindings.

• Where possible, should not remain in place once their fastenings are removed.

Perimeter / Distance Guards

• Guards should be secured to a solid foundation or adjacent structure.

• Be equipped with a suitable interlocking device to prevent moving parts starting up whilst those parts can be accessed. Electrical interlocks must be on mains voltage, not control voltage.

All Guards

• Where possible, to be installed to allow routine adjustment and maintenance of the guarded machinery without the need to remove the guard. (e.g. Remote greasing points, External adjusters for tracking) If this is not possible then a strict safe system of work should be enforced.

• Be subject to an initial commissioning examination and subsequent routine inspection regime to ensure they are - and remain - fit for purpose.

Cleaning, maintenance, repair & adjustment

Before the removal of guards for the purpose of carrying out cleaning, maintenance or adjustment on any machinery, the power source should be isolated and locked off.

Isolation and lock off should be considered from ALL forms of energy in static and mobile plant, i.e.:

• Electrical
• Pneumatic
• Hydraulic
• Mechanical

All forms of stored (‘potential’) energy should be assessed and safely dissipated/released/ locked before the removal of guards from machinery.

All relevant personnel shall be trained in isolation and lock-off procedures to include a practical demonstration of the isolation and lock off. On completion of training, a record of training shall be completed and filed.

Isolation lock off shall only be carried out by individuals using their own personal isolation padlocks.

When entering guarded enclosures personnel must fit their own personal isolation padlocks, even where a key exchange system is operational. When personal locks are installed these must prevent guard openings or access gates being closed and re-energised.

Automatic isolation systems such as ‘key exchange systems’, which disconnect all three electrical phases, may be considered to provide effective electrical isolation, and may be used for repeated activities of short duration inside guarded enclosures.

Where it is necessary for numbers of personnel to enter guarded areas, all individuals will fit their own lock by means of a multi hasp. Pull wires and emergency stops are not considered as providing sufficient isolation.

No employee or contractor should remove any isolation padlock other than the one allocated to them personally.

Spare or duplicate keys shall only be used by management for the removal of isolation locks, following the necessary checks/head count of all relevant personnel.

When work is expected to last longer than one shift or day, it is recommended that the responsible person for operations (Manager, Foreman, or Electrician) should fit a Passover padlock to the multi-hasp to ensure the equipment remains locked between the shift change.

Nip Points

BSEN 620:2002

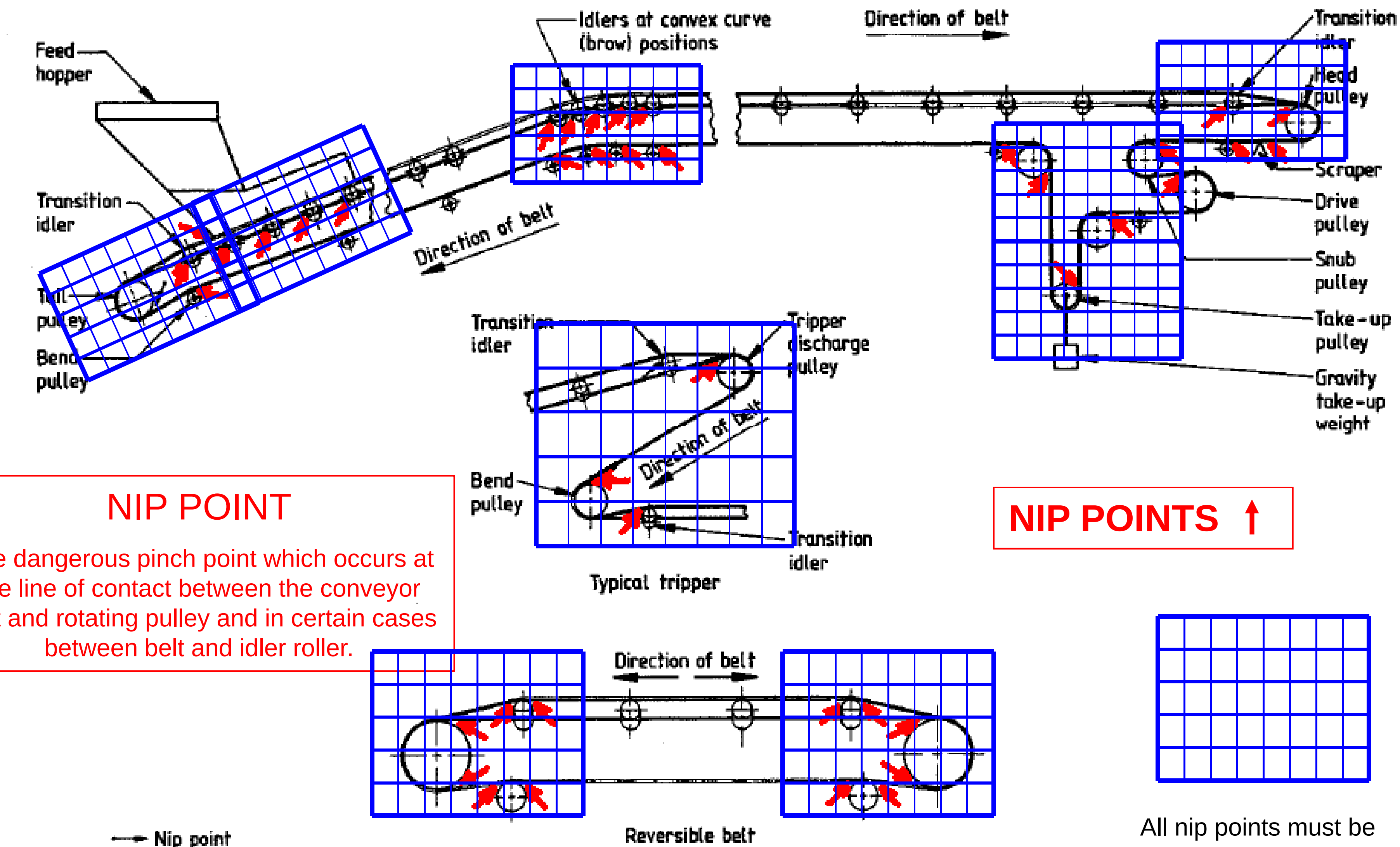


Figure 1 Location on nip points

NIP POINT

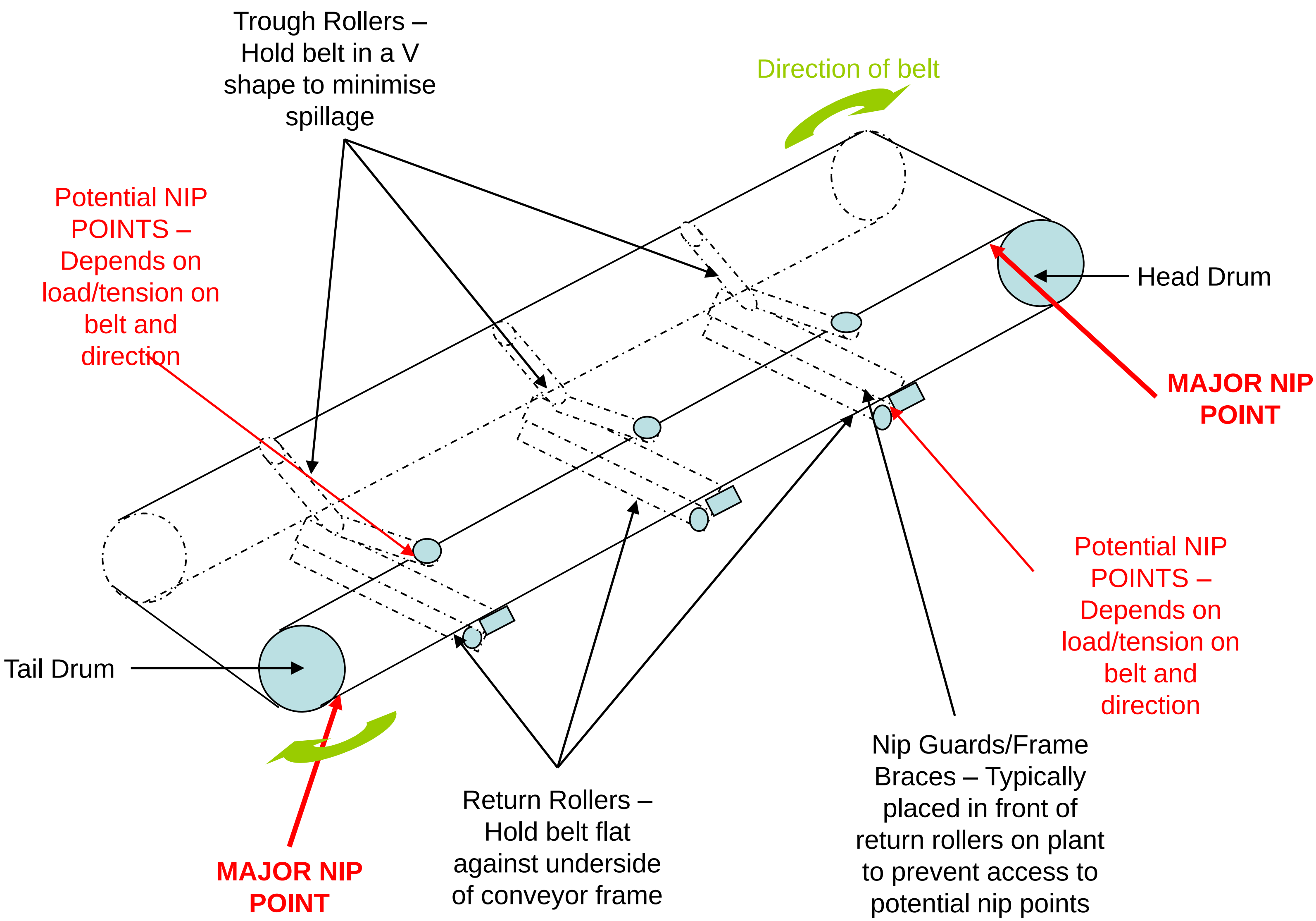
The dangerous pinch point which occurs at the line of contact between the conveyor belt and rotating pulley and in certain cases between belt and idler roller.

NIP POINTS ↑

All nip points must be guarded (guard simulation not to scale)

Nip Points

3D Representation of Typical Conveyor



Conveyors (Click on headings to go to section required)

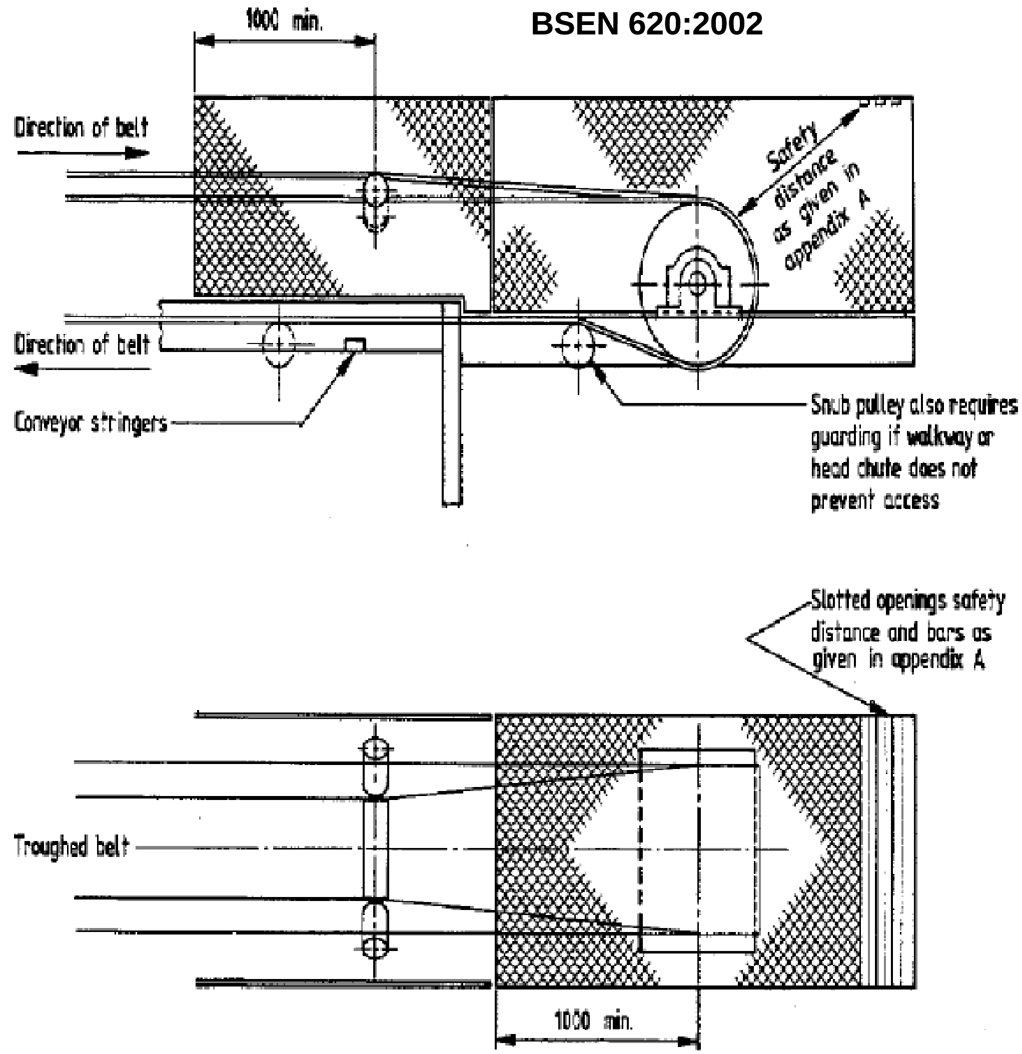
Conveyors

Head Drum Guarding

Suggested Guarding

Guards should be provided to prevent access to head drums and all associated nip points. The distance from the guard end to the centre shaft of the head drum should be a minimum of 1000mm. Where troughing idlers are positioned close to the head drum and place the belt under tension, the guard should be extended at least a further 1000mm beyond such idlers.

BSEN 620:2002

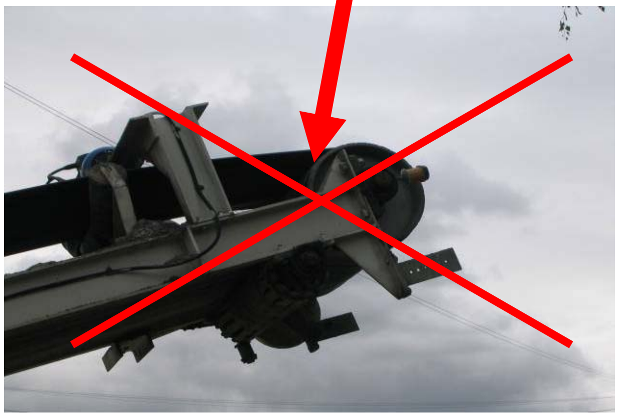


All dimensions are in millimetres.

Figure 3. Typical guards for head pulley and adjacent transition idler set

Conveyors

NIP POINTS WHERE A PERSON COULD BE DRAGGED IN



Head Drum Guarding

There is potential access to nip points at the head end of conveyors if persons climb stockpiles. Also in some cases return idlers can present risks where the belt changes direction.

Access to the main nip point where the belt meets the head drum can potentially be made from the side or from above at the edge of the belt. Access cannot normally be made directly from below because the return of the belt prevents access from this direction.

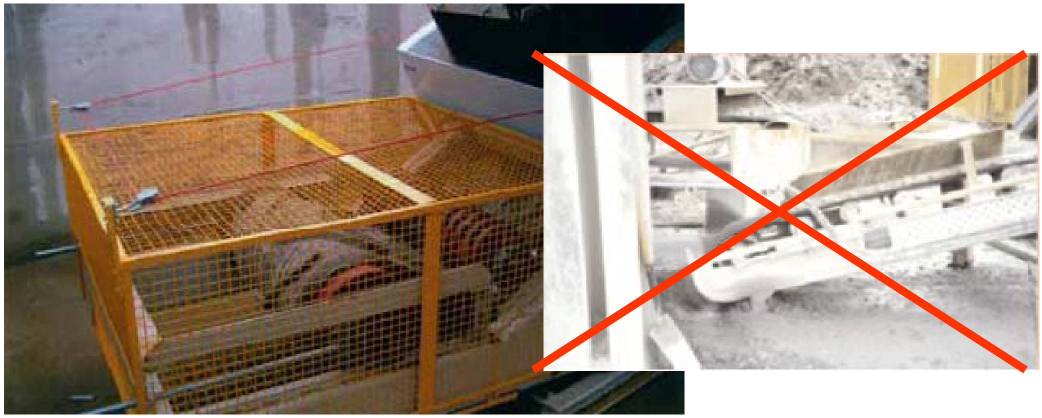
In these circumstances additional guarding should be added:

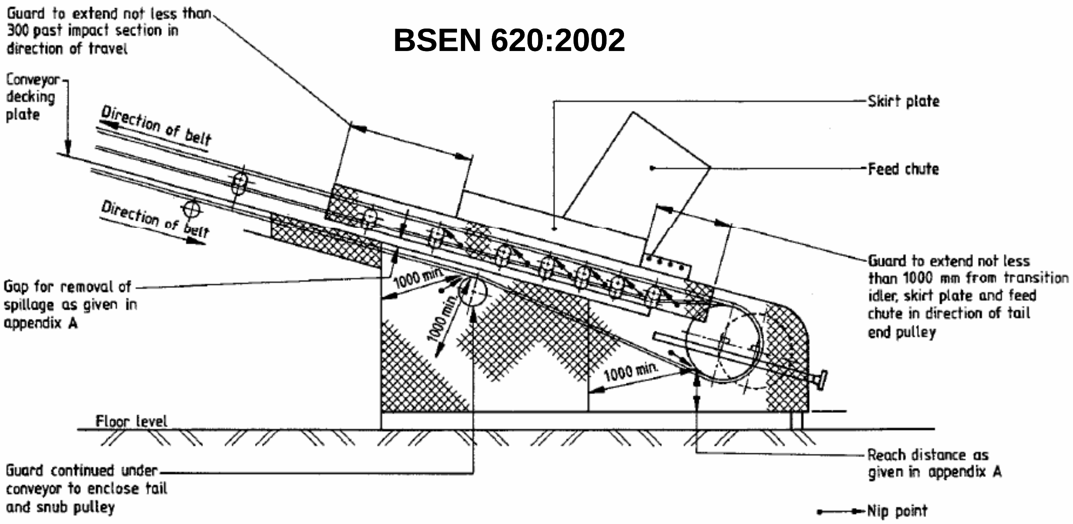
Conveyors

Tail Drum Guards

Suggested Guarding

Guards should be provided to prevent access to tail drums and all associated nip points. The distance from the guard end to the centre shaft of the tail drum should be a minimum of 1000mm. Guards should be provided on the underside of the conveyor to prevent access to the return nip of the tail drum. All guards should be designed such that lubrication and adjustment can be carried out without removing the guard. Pull cords where possible should be linked through all sections of guard as a further safeguard, so that the pull cord system is activated/dismantled when maintenance is taking place. This should not be regarded as a method of isolation. The guard should be of robust construction with a mesh of sufficient size to prevent the accumulation of spillage within the guard and yet prevent finger or hand contact with the trap points within.





All dimensions are in millimetres.

Figure 4. Typical guards at tail end pulley

Skirting Guards

Suggested Guarding

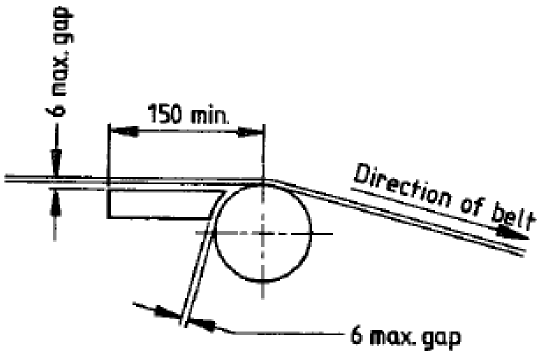
In situations where fixed skirts are fitted above conveyor idlers, a trap point exists between the idler and the belt. Panels of guards should be fitted to prevent access to the trap points associated with the skirts of the conveyor.

Conveyor Return Rollers

BSEN 620:2002

Plate Type Guard

Open Mesh Guard



All dimensions are in millimetres.

Figure 11. Nip guards for return idler

Suggested Guarding

Conveyor return rollers do not generally present a nip hazard. However, in the following situations a trap hazard exists.

- Where the belt cannot freely lift sufficiently it presents a nip point because a structure is positioned above the belt.
- Where a tensioning roller has been positioned on the upper side of the return belt, the belt is under tension and several nip points are created.

There are varying types of guard available to guard nip points relating to return rollers.

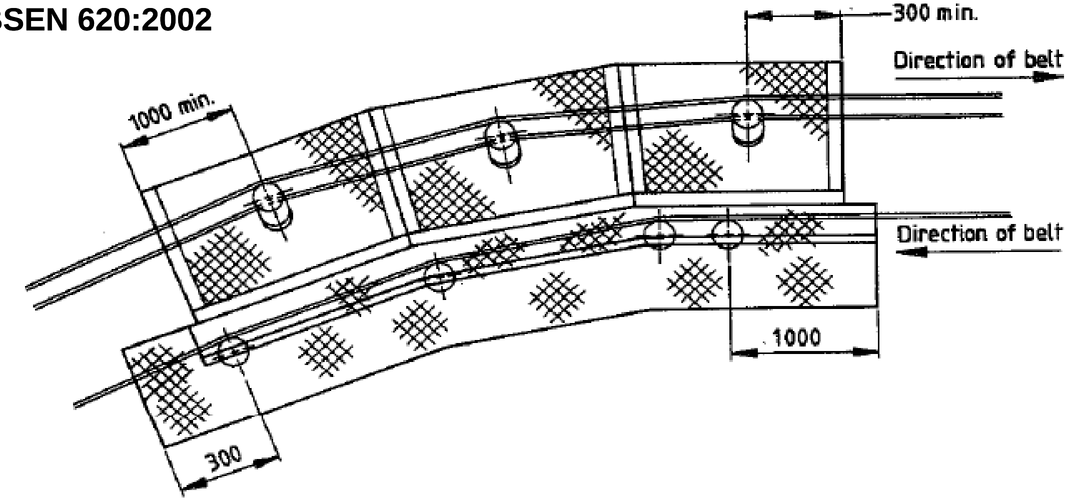
- Plate type guards can be fitted along the full length of the roller in front of the in-running nip point. Measures should also be taken to prevent access to the nip from each side of the roller.
- A suitable open mesh guard can be provided to totally enclose the roller. The guard should be of robust construction with a mesh of sufficient size to prevent the accumulation of spillage within the guard and yet prevent finger or hand contact with the trap points within.

Conveyors

BSEN 620:2002

Belt tension nip points

Where a conveyor changes angle such as is shown in this picture a series of nip points is created. These will draw a person in if they become entangled and could result in a fatal or major injury. These points must be guarded properly to prevent this happening.



All dimensions are in millimetres.

Figure 10. Typical guards at bend of conveyor

Belt under tension where there is a change of direction

Screw Conveyor

Suggested Guarding

Where screw conveyors are provided with inspection covers all covers should be secured with fastenings that require a tool for their removal. Exposed rotating shafts on the ends of screw conveyors should be fitted with adequate secure covers.

Batch Feeder Belts

Suggested Guarding

Batch feeder belts whilst generally slower possess the same hazards as a normal conveyor.

The feeder and all associated nip points should be enclosed within suitable mesh guards fitted along the full length of the feeder. Guards should be provided on the underside to prevent access to tail and head drums. Guards should be designed such that routine maintenance and adjustment can be carried out without removal of the guards.

Snub Drums - Conveyors

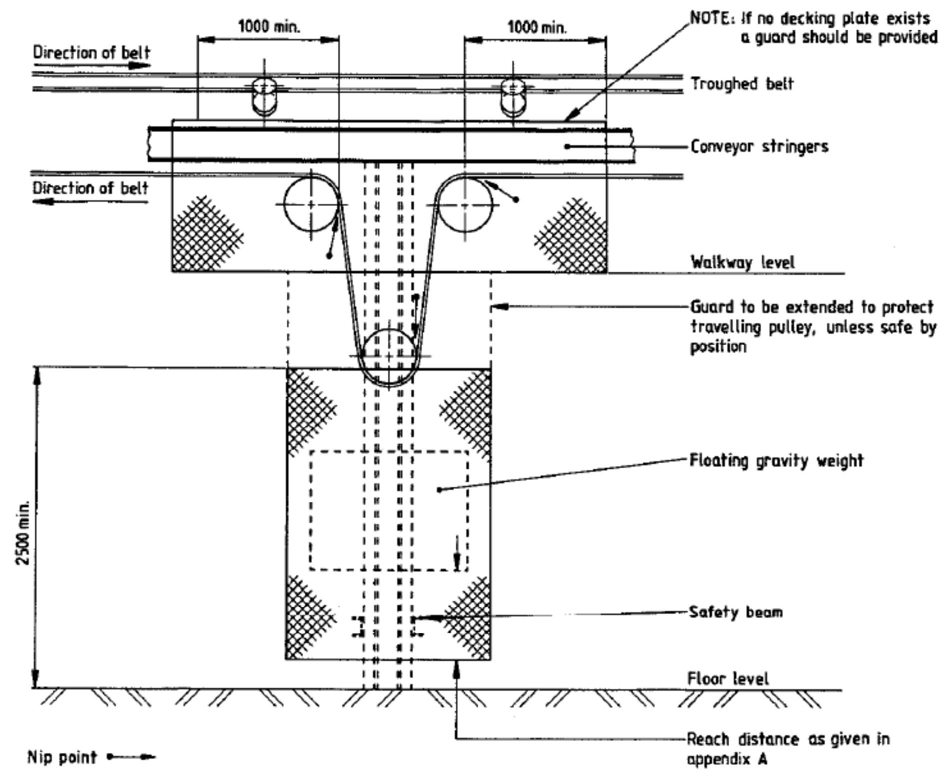
Suggested Guarding

Conveyor Snub drums/pulleys are generally situated on the underside of a conveyor directly behind the head drum and serve the purpose of providing a maximum contact area between the drum and belt. Trap points exist between the underside of the belt and the in-running nip of the drum.

A suitable open mesh guard should be provided to prevent access to the in-running nip of the belt and drum from the underside of the conveyor and each side. The guard should be of robust construction with a mesh of sufficient size to prevent the accumulation of spillage within the guard and yet prevent finger or hand contact with the trap points within.

Gravity Take-Up Unit Guarding

BSEN 620:2002



All dimensions are in millimetres.

Figure 5. Typical gravity take-up guards

Suggested Guarding

Conveyor gravity take-up units should be enclosed with mesh panels which prevent access to moving parts within the tower including the risk of the gravity take-up weight falling to ground level in the event of the belt breaking. All panels should be secured such that they require a tool for removal.

Conveyors

Remote Greasing and Conveyor Adjustment

All guards should be designed such that lubrication and adjustment can be carried out without removing guards wherever possible

Hot Storage Skip Winch (sited at ground level)

Suggested Guarding

A mesh panel guard fence should surround the mechanism and be securely fixed to the structure or foundations. An access gate will be required which should be secured by means of a suitable electrically interlocked system.

Skip Loading Point Distance Guarding

Suggested Guarding

A mesh panel guard fence should surround the mechanism and be securely fixed to the structure or foundations. An access gate will be required which should be secured by means of a suitable electrically interlocked system.

Drive Guard - Primary Jaw Crusher

Suggested Guarding

A mesh guard totally enclosing the drive with the outer section manufactured from steel sheet. Where joints are necessary for easy removal of the guard sections should be joined by flat metal or angle iron welded to each section and drilled to secure the bolts. Gaps at the point where shafts enter the guard (which may be necessary for adjustment) should be kept to a minimum. Consideration should be given to manual handling requirements when maintenance is being carried out. The provision of lifting attachments should be considered where mechanical means of lifting may be required. Similar guards will generally be provided to enclose the flywheel on the opposite side to the crusher drive.

Primary Jaw/Toggle Plate Guarding

Suggested Guarding

A panel of guard is required to prevent access to the area immediately behind the crusher swing jaw where movement of the jaw presents a trapping hazard between the jaw and the crusher frame.

Guarding over Resonance Type Screens/Vibrators

Suggested Guarding

Totally enclosing sheet metal guards should be provided over each of the vibrating units with additional sheet metal guards over the associated shafts and couplings.

Vibrating Screen Vee Belt Drive and Flywheel Guards

Suggested Guarding

Drive guards with mesh sides and sheet metal around the guard should be provided. In addition a sheet metal guard should be provided to enclose the flywheel.

Feed Hoppers

Man Protective Grids in Feed Hoppers

Suggested Guarding

Steel grids, to prevent unauthorised or inadvertent entry, should be provided in the top of all process plant feed hoppers (with the exception of primary dump hoppers or where products of a large dimension are being processed which may obstruct the grid). The grids should be secured such that they require a tool for their removal. The aperture size of the grid should be designed to enable process material to pass through and be of sufficient strength to withstand any anticipated loads.

Points for Consideration

- *If access hatches are built in the grid then they should be secured to require a tool to open them.*

- *Fitment of grids on elevated hoppers may encourage people to walk on them next to an unprotected edge. Appropriate access prevention measures should be incorporated in the design*

- *Storage bins do not normally have protective grids but where they are fed direct by loading shovels grids should be considered. Where such bins cannot be easily accessed and it is not practical to fit grids then there shall be clear signs prohibiting access without a Permit to Work.*

Ground Feed Hopper
Protective Grids

Suggested Guarding

Steel grids, to prevent unauthorised or inadvertent entry, with sufficient strength to withstand any anticipated loads, should be provided in the top of all ground feed hoppers (with the exception of primary dump hoppers or where products of a large dimension are being processed which may obstruct the grid).

The grids should be secured such that a tool is required for their removal. The aperture size of the grid should be designed to enable process material to pass through. Provision should be made to enable lorry drivers to release tail gate latches from a position of safety.

Asphalt Mixer driven by direct drive from two electric motors

Suggested Guarding

A fixed guard is required to enclose the drive shafts and flexible couplings connecting the electric motors to the mixer shafts.

Mobile Asphalt Dryer

Suggested Guarding

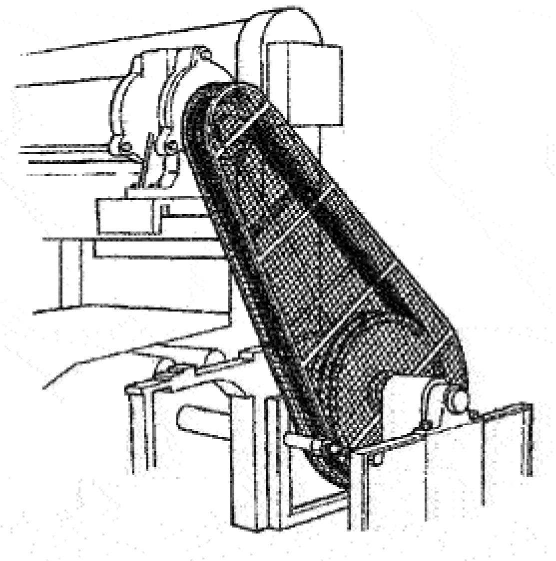
Panel type guards need to be securely fastened to the main dryer chassis on both sides and running the full length of the dryer cylinder. The guards should be attached such that a tool is required for removal. Guards should extend upwards as a minimum to the centre line of the cylinder. Measures must be taken to prevent access to moving parts of the machine from underneath the chassis.

Perimeter Guarding around Asphalt plant dryer

Suggested Guarding

Panel type guards are required which should be secured to fixed uprights. The minimum height of the guard above ground level should be a minimum of two metres. All access gates should be secured with a suitable electrically interlocked system. Remote greasing lines should be provided to enable lubrication of bearings to be carried out without entering the guarded area. (See also page 20).

Guarding of Motors



Vee Belt Drive Guard

Suggested Guarding

Vee belt drives are commonly used on various items of equipment on process plants. The type illustrated with open mesh enables more efficient cooling of the Vee belts and pulleys and allows Vee belt tension to be visually checked without removal of the guard. A mesh guard totally enclosing the drive with the outer section manufactured from steel sheet. Where joints are necessary for easy removal of the guard, sections should be joined by flat metal or angle iron welded to each section and drilled to secure the bolts. Gaps at the point where shafts enter the guard (which may be necessary for adjustment) should be kept to a minimum.

Motor and Reduction Box drive Coupling

Suggested Guarding

Where using electric motor and worm reduction gearboxes for driving equipment, the drive assembly utilises directly coupled shafts with flexible couplings. Guards are required to enclose the couplings.

It is necessary to guard the flexible couplings on both the input and output shafts of the gearbox. The guards can be constructed in sheet metal or by welding expanded mesh to a steel framework. Where guards obscure lubrication points extension pipes should be fitted to avoid removal of the guard when lubricating the equipment.

Pan Mixers

Pan Mixer Guarding and Interlock

Pan mixer with fibre hatch and interlock System

Suggested Guarding

The mixer top door should be provided with a suitable electrically interlocked device to prevent the cover being opened unless the electrical power is disconnected. However full isolation of the mixer should be undertaken when working on the mixer. Inspection hatches on the mixer cover should be provided with secondary grids to prevent contact with the moving paddles within, when the mixer is in operation.

Mixer discharge guarding

Suggested Guarding

A guard manufactured from sheet metal with a hinged mesh access cover should be provided to prevent access to moving parts of the mixer at the discharge point. The hinged mesh top cover should be secured and require a tool for it to be opened, if frequent access is required to this area it should be electrically interlocked. Where appropriate, lifting eyes should be attached to the pan mixer lid.

Pan Mixers

Small Pan Mixer

Suggested Guarding

This equipment is normally used in laboratories.
A cover should be provided over the mixer drum which is electrically interlocked to prevent the mixer operating unless the guard/cover is in position.

Ladders & Gates

Fixed Ladder Gate Systems

Suggested Guarding

Where access to ladders needs to be controlled, a hinged lockable gate should be provided to prevent unauthorised access. If required, such gates can be fitted with a suitable electrically interlocked system.
NB: Wherever possible, consideration should be given to replacing vertical-rung ladders with inclined stairways. New designs should incorporate inclined stairways in preference to vertical-rung ladders.

Ladders & Gates

Fixed Ladders

Suggested Guarding

Fixed permanent vertical access ladders to platforms, landings and walkways.
Ladders rising more than 3.5m should be fitted with hoops commencing at 2.5m from ground level. The hoops should be spaced at 1.2m intervals and connected by three vertical flats attached so as to support the weight of the hoops and the user. The internal clearance of hoops should be in the region of 0.8m.

The Workplace, Health, Safety and Welfare Regulations (1992) specify that high rise fixed ladders be provided with rest platforms at distances not exceeding 6m.

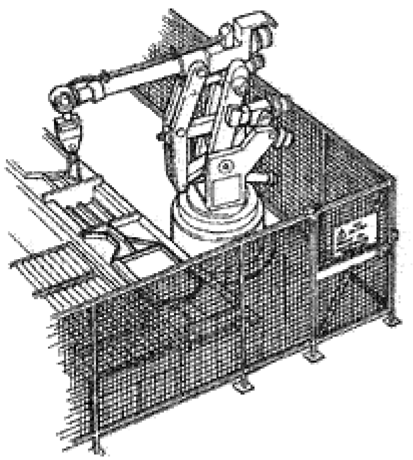
A physical device should be provided to ensure that there is no risk of personnel falling into the ladder-way from the top of the ladder.

NB: Wherever possible, consideration should be given to replacing vertical-rung ladders with inclined stairways. New designs should incorporate inclined stairways in preference to vertical-rung ladders

Robot Guarding

Suggested Guarding

A fixed perimeter fence should be provided around the working area of the robot. Entry gates into the fenced area should be provided with a suitable electrically interlocked system.
Light curtains may be installed as an additional safeguard to protect personnel if they enter the robot's immediate working area.



Entry to Guarded Enclosures around Robots

- Before entering the guarded enclosure for teaching purposes, the system must incorporate the facility to request access to the enclosure via a control which will park the robot in a safe position such as home or datum point. The key exchange system must disable the ability to remove the key until such time as the robot arm has returned to this safe point.
- Facility to enable switching from auto mode to 'teach' mode must be provided within the guarded enclosure using the previously released key. This will be possible with the guarded enclosure access gate open utilising a sentry to prevent unauthorised access.
- The robot must operate at no more than 10% of its maximum speed in the 'teach' mode.
- If the 'teach' mode pendant is to be operated within the guarded enclosure, a clear working space of 500mm safety zone must be provided around the robot operating envelope. This safety zone must be clearly marked on the floor and communicated to all relevant personnel.
- The robot will be fitted with physical stops to ensure it remains within the necessary safety zone. The physical stops must also prevent the robot extending outside the guarded enclosure.
- Operation of the 'teach' pendant will disable the operation of the robot from any other control point.
- If all of these points cannot be complied with, the operation of the 'teach' mode from within the guarded enclosure is prohibited.
- The 'teach' mode can only be operated by personnel who have received the relevant training from either the robot manufacturer or someone who is an authorised trainer.

Ready-Mixed Concrete
Recycling Plant Discharge Point

Suggested Guarding

A substantial mesh guard is secured at the discharge point of the aggregates recycling equipment on a ready-mixed concrete plant. The mesh guard should be provided such to prevent access to the screw mechanism of the recycler.

Fines Dewaterer

Suggested Guarding

Fines dewaterer using slowly rotating scraper blades to extract the finer particles.
In addition to a sheet metal guard on the main dewatering section, a mesh guard should be provided around the trough of the scraper blade section. This should be fitted high enough to avoid personnel falling into the trough or being able to reach the scraper blades and be at least 2 metres above ground level.