WISH
Waste Industry Safety and Health Forum
INFORMATION DOCUMENT

MACHINERY SAFETY INFORMATION GENERAL WASTE SHREDDERS

This WISH information document is aimed at health and safety improvements in the waste management industry. The Health and Safety Executive (HSE) provided support to WISH in producing this guidance. This guidance may go further than the minimum you need to do to comply with the law with regard to health and safety

Contents

This is one of a series of sheets covering specific items of machinery in common use at waste recycling plants/MRFs and similar. All of the sheets are available as free downloads from the WISH website at https://www.wishforum.org.uk/information/. In addition, specific machinery isolation and lock-off advice is available at (https://www.wishforum.org.uk/wp-content/uploads/2021/10/WISH-WASTE-29-Practical-isolation-and-lock-off-guidance-October-2021.pdf) and overarching waste and recycling machinery safety advice at https://www.wishforum.org.uk/wp-content/uploads/2023/04/WISH-WASTE-33-Principles-of-machinery-safety-recycling-recovery-plant-August-2022.pdf. This sheet does not aim to be comprehensive – you should also seek further guidance, such as from the HSE's website, and where required obtain competent advice. This sheet primarily covers the machinery hazards and risks associated with general waste shredders. Please note that this sheet does not comprehensively cover non-machinery risks, such as manual handling, and you should conduct an assessment to ensure you have identified all risks.

Case studies – the case studies in this information sheet are based on real accidents. However, they have been anonymised by the removal of names, company names, dates etc to prevent any distress to relatives, friends etc of the injured person/s.

Introduction

Contact with the moving parts of machinery, including shredders, has been the cause of multiple serious and fatal accidents at waste recycling and similar plants. HSE statistics show that machinery is one of the most common cause of fatal accidents at recycling plants. The safe design, use and maintenance of shredders is essential if we are to reduce this unacceptable toll of serious, life-changing, and fatal accidents.

This information sheet covers general shredders of the type in use at recycling and similar waste plants. Shredders come in various sizes and types, from small hand-fed units used to destroy computer hard drives to large machine fed shredders in use at organic treatment plants, tyre, wood etc shredding operations, refuse derived fuel production facilities, MRFs and other recycling facilities. Shredders may be fixed in place, sometimes as part of a larger recycling system, or moveable/mobile, such as being wheeled or tracked to allow them to be moved around a site or between sites. This information sheet does not specifically cover the specialised shredders, fragmentisers and similar used in metals and end-of-life vehicles recycling and treatment, although many of the principles will still apply.

Note - to reduce issues with operation and maintenance, it is essential that the correct shredder is selected for the purpose intended. Shredders vary in their speed of operation, size and power, number of elements, design of ‘teeth’ and ‘blades’ etc. The correct shredder should be used with the correct waste type – a ‘one-size-fits-all’ approach is not acceptable and may pose significant safety issues. Ensuring the suitability of work equipment is a legal requirement under Regulation 4 of PUWER (Provision and Use of Work Equipment Regulation). Adequate maintenance is also a legal requirement under Regulation 5 of PUWER and is covered in detail by BS14200 (due for release October 2023).

Case study – a fast spinning/moving shredder was in use at a plastics recycling plant. The machine was hand-fed via a chute designed to prevent human access (too narrow to allow whole body access and shredder elements well away from the chute entrance). This slowed-down loading and the manager decided to remove the chute. The shredder also had no means of isolation (hard-wired into the power supply with no isolation switch). As a result employees used an emergency stop to halt the machine when clearing blockages. The emergency stop system was defective and allowed start-up without a need to reset the system at the control panel. An employee was in the shredder clearing a blockage when the machine inadvertently started. The employee suffered fatal injuries.

Dangerous parts of shredders

Shredders vary in size and appearance but functionally they operate on the same principles – they mechanically break or cut material into smaller pieces either through impact, crushing or cutting actions. Typically, this is achieved by a rotating 'element' or multiple elements fitted with 'teeth', 'blades' or similar. Some shredders are slow-moving, others are fast-moving. The choice as to fast vs slow, teeth vs blades and the design of teeth and blades etc will depend on factors such as the waste type being processed. Careful consideration should be given to selection of shredder, and any change in waste type, composition etc should be formally assessed to ensure the shredder remains compatible with waste type/s being processed.

Some shredders are fed direct such as via a chute or hopper by hand or heavy mobile plant such as a grab crane. Some units are fed by conveyor, and often shredded material is removed via an output conveyor (for the hazards associated with conveyors see WISH information sheet INFO 20 available at https://www.wishforum.org.uk/information/). Some shredders are integrated into larger recycling machine assemblies, others are stand-alone items of machinery. Some are open-top while others are enclosed with hatches for access for cleaning etc. You should assess the risks posed by your shredder/s including how and why a person could gain access to a danger zone. Whatever the design, feed system etc, the primary machinery safety hazards associated with shredders include:

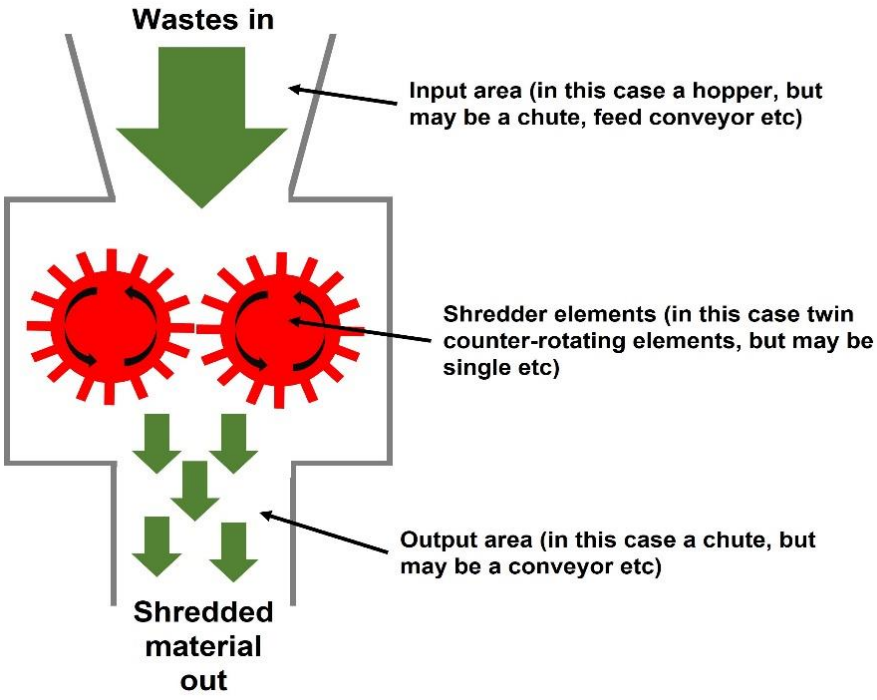
- Entanglement, cutting, impact and similar hazards from rotating element/s – these are the obvious and most common causes of serious and fatal accidents involving shredders. Contact with moving shredder elements is nearly always serious or worse
- For some fast-moving shredders their rotating element/s may take time to 'run-down' because of the stored energy involved – the element/s continue to rotate for a time after power has been removed from the machine
- Entanglement and other hazards associated with the drive and transmission systems of the shredder. These may be chain, cog, belt, or other form of drive

Left to right: tyre shredder fed via a load hopper with output conveyor, twin shredding elements of a computer hard drive shredder, installation of a large twin element shredder at a recycling plant, chain drive on a moveable shredder

- Ejecta from feed hoppers, chutes etc – shredders are aggressive items of machinery and materials can sometimes be ejected at significant/hazardous speeds and cover considerable distances
- Hazardous materials/items being inadvertently fed into shredders, such as gas cylinders, aerosols, automotive and other batteries etc

Note – the above is a summary. Your shredder may have other or different dangerous parts. You need to identify all of the dangerous parts and ensure they are adequately safeguarded.

Below: simplified diagram of the basic components of a shredder



Left to right: shredder being fed by a grab crane, conveyor fed shredder at a recycling plant, moveable/mobile wood shredder, enclosed integrated shredder at a waste recovery plant with conveyor feeds in and out

Safeguarding of shredders

Shredders used in waste and recycling can differ significantly in their design, although most are similar in their general operation. The safeguarding advice given below covers the primary hazards and is not intended to be comprehensive: you need to look at your shredder and consider the need for access, both during normal operation and interventions, such as clearing blockages. For interventions which potentially expose persons to a danger zones isolation/lock-off is a key control – see (https://www.wishforum.org.uk/wp-content/uploads/2021/10/WISH-WASTE-29-Practical-isolation-and-lock-off-guidance-October-2021.pdf) for detail. For some automatically fed and processed shredders the manufacturer may not intend any access to take place – you should read and understand fully the operating manual for your shredder.

Access to rotating shredder elements, teeth, blades etc

Access to shredder elements can be:

- At the **input area** to the shredder, such as via a load hopper or chute, or feed conveyor etc. Typically, at the top of the shredder, but not always (for example, some shredders are fed via a horizontal conveyor, inclined chute etc). Whatever the design, access to the dangerous parts (teeth or blades) via the input area is the most common cause of serious and fatal accidents
- **Direct access** to the shredder element/s from the side, such as by the removal or opening of guards. Some shredders have hinged hatches (typically interlocked) to allow easier access to clear blockages etc
- At the **output area** where shredded material leaves the shredder. For example, by reaching up through an output chute to the rotating element/s or via an output conveyor towards the shredder element/s

In terms of safeguarding access to shredder element/s via the **input area** of a shredder:

- For manually fed shredders, load chutes, apertures etc should be designed to prevent access to shredder elements, such as by the load aperture being too small to allow access and the shredder element/s being too far away to allow a person to reach them. Chutes, apertures etc should not be removed, shortened, widened, or otherwise modified without a formal and recorded assessment to ensure that the reaching distances, aperture sizes etc in standards such as BS EN 13857 are maintained and that shredder elements cannot be reached

- For larger hopper-fed shredders, such as those loaded by heavy mobile plant, the height of the hopper walls should be sufficient to prevent climbing access to the hopper. Shredder structures and sides should be designed or retro-fitted to prevent persons from easily climbing using protrusions (such as strengthening ribs, flanges etc), openings or other 'hand and foot holds' etc. You may need to retro-fit plates over any openings or protrusions which could potentially be used as climbing aids
- Hopper height should be considered from the nearest easily accessible point. This is not always the ground. For example, if a moveable shredder has tracks or wheels which can be easily used as climbing aids then height should start from the top of these and not the ground. Consideration should also be made of any surrounding structures, such as walls, which may allow climbing access to the hopper and likewise piles of waste which may accumulate in the area. For example, if waste routinely piles-up next to a shredder can a person climb up the pile to gain access to the top of the hopper
- Climbing on input or output conveyors to defeat hopper wall height or to access shredder elements direct should be as difficult as practicable and employees should be instructed not to use conveyors as a means of access – climbing on and/or walking up conveyors is not acceptable practice. For further information on conveyor machinery safety see WISH INFO 20, available at: https://www.wishforum.org.uk/wp-content/uploads/2022/08/WISH-INFO-20-Machinery-safety-belt-conveyors-August-2022.pdf

Note – damage to shredder hopper side walls etc, such as holes and tears, can also result in easier access to the feed/input area. Damage should be monitored for, and not only at hoppers, to ensure machinery remains in a safe condition. Looking for damage should be part of your routine checking systems.

Case study – a recycling plant used a mobile shredder as pre-treatment (reduction of particle size) before separation of waste types using screens, an over-band magnet, and a picking cabin. The shredder was used for a variety of waste types, some of which it was not designed for – blockages were frequent. Loading was via a feed hopper at the top of the machine using a wheeled loading shovel. No secure isolation/lock-off procedure was in place, and it was common for employees to climb into the load hopper to clear blockages with the machine simply 'turned-off' at the control panel. One day an employee was in the hopper clearing a blockage. The inside of the hopper was not visible from the control panel. A second employee started the machine not knowing someone was in the hopper, with fatal consequences.

In terms of safeguarding **direct access** to shredder elements, such as from the side via the removal or opening of guards:

- Fixed and hinged guards should be robust and require the use of a tool or unique key to remove or open. For hinged guards, some shredders use an 'ignition key' in the control panel. This is the same key which opens the hinged guard and must be removed from the control panel to allow the guard to be opened. This type of system should not be used on its own as a means of isolation/lock-off (see WISH WASTE 29 on isolation and lock-off and section below on safe access and blockage clearance, including the use of battery isolator switches on some shredders, for detail)
- Access hatches etc used for blockage clearance and similar should either require a tool or unique key to open, or should be interlocked to an appropriate, usually high, safety performance level. The choice of fixed or interlocked will depend on factors such as the frequency of access

In terms of safeguarding access to shredder element/s via the **output area** of a shredder:

- Some smaller, usually hand-fed, shredders have hoppers/bins to collect shredded material. When the hopper/bin is full it needs emptying. Unless it is not possible to reach-up from the hopper area to the shredder element/s, access to hoppers for emptying should either be via the use of a tool or unique key, or the hopper should be interlocked to prevent its removal with the shredder still operational
- Guarding at the base of shredders should prevent a person from being able to reach-up through the output area to access shredder element/s
- Output conveyors should be designed to prevent access to the shredder elements by climbing, crawling, or walking along a conveyor. Some shredders have guarding at output conveyors designed around preventing 'reaching-over' access to shredder element/s – these may not deter climbing access and you may need to consider extending such guards on the basis of your risk assessment

Left to right: two examples of battery isolator switches on the lower/under carriages of shredders, waste wood shredder with output conveyor, small hand-fed IT disc/drive shredder with removable output bins

Fast-moving elements and ‘spin-down’

Some fast-moving shredder element/s continue to spin even after power has been removed from the system – they continue to rotate under their own momentum for a period of time. The risk here is that a person could access the element/s when it is still moving even if they have isolated and locked-off the shredder.

- Time delay interlocks and/or motion sensors can be used to prevent access until fast-moving shredder elements have ‘spun down’ and stopped. For example, a shredder may be in a machine fence enclosure with an interlocked access gate. The interlock system at the gate is fitted either with a timer or a motion sensor which will not allow the gate to be opened until the shredder has stopped. The same principle can be applied to a hinged guard covering shredder elements
- Where electronic time delayed/motion sensor interlocks are not practical, a mechanical time delay should be used as reliance on systems of work/procedures for such high-risk areas is not acceptable practice

Access to drive and transmission components

Shredder drive and transmission can be via belt, chain, cog etc. Drive and transmission components usually require maintenance, such as oiling/greasing, and adjustment.

- The need to remove or open guards, access panels etc to grease, oil, adjust etc drive and transmission components should be reduced so far as is practical. For example, by the use of automatic oiling systems, remote greasing points, tension/alignment adjusters accessible without removing or opening guards etc
- Fixed guards over drive and transmission components should be robust, adequately cover all dangerous parts, and require a tool or unique key to remove
- Hinged guards/panels should require a tool or unique key to open or be interlocked – over-centre catches etc which do not require a key or tool to open are not acceptable

Left to right: example of a (very) badly safeguarded shredder hopper (easy to access), exposed shredder element during cleaning, belt drive on a large moveable shredder, shredder element on a hopper fed shredder

Ejected materials from shredders

Dependent on factors such as the waste type being processed, some shredders, in particular those fed via an open-top hopper, can suffer from ejected materials, such as lengths of timber or other items being ejected. Industry experience is that in some cases material can be ejected many metres. There is also potential for explosive release when pressurised cannisters or cylinders are contained within the waste (see below on hazardous items).

- If ejecta is an issue for your shredder first investigate why, such as:
  - Has the machine been set for an inappropriate density of material?
  - Is it being run too fast/too slow or are the shredding drums or gap between drum and fixed structure incorrect for the application?
  - Is the waste type/s being shredded compatible with the shredder being used?
  - Is a pre-sort required to remove items which may result in ejecta etc?
- Establish an 'exclusion zone' around the shredder. In some cases operating manuals specify an exclusion zone – check in your manual. If practical, zones should be physical, such as block bunker walls enclosing the shredder area. At the least, employees should be instructed on any exclusion zone and compliance monitored
- Dependent on the nature of ejected materials, the fitment of 'trash guards' (bars, robust mesh etc) over the windscreens of heavy mobile plant used to load shredder hoppers etc and/or on loading shovel bucket tops should be considered

Hazardous items and materials

This information sheet primarily covers machinery hazards. However, hazardous materials and items can present a significant risk and need to be actively managed, such as by:

- Visually checking waste streams for hazardous items and materials, such as gas cylinders, containers of flammable liquid etc should be undertaken. Workers such as mobile plant operators loading shredders should be instructed and trained to watch-out for such items and to stop loading if detected. Moving wastes around to 'flatten' piles of received wastes can assist in spotting hazardous items and materials

Left to right: trash guard on a loading shovel, fire in a shredder caused by non-conforming flammable materials, mirror above feed hopper to a shredder (see below), damaged emergency stop on a hand-fed shredder (see below)

- While an important control, the effectiveness of visually checking waste streams for hazardous items and materials will depend on factors such as reception facility type. For example, it is usually easier to spot items where waste is loose-tipped onto a floor than in pit-type waste reception systems. Whatever the reception system, checking of wastes for hazardous items is rarely 100% effective and you should consider this. Where there is a risk of hazardous items such as gas cylinders being inadvertently being fed into a shredder:
    - If there is there an occupied space, such as a picking cabin or control room, near to the shredder which could be affected then it may need protecting
    - Shredder feed hoppers etc should be sufficiently robust to contain the effects of items such as gas cylinders rupturing in the shredder
    - Consideration should also be given to the robustness of structures surrounding and/or near to shredders
    - A stand-off zone prohibiting the presence of pedestrians around the shredder may be required
- Fire suppression systems may be required in some cases, and for specialist shredding operations (for example some WEEE – waste electrical and electronic equipment – shredding operations) inert atmosphere systems may need to be considered. This is a specialist area and outside of the scope of this document – you are likely to require specialist competent advice in these situations
- The shredding of some wastes may result in the generation of dusts, aerosols etc which may pose a hazard to health. For example, shredding biological materials may result in the generation of bioaerosols. You should consider this type of issue in your risk assessment

Emergency stop provision

Emergency stops should be provided at control panels and at access points such as hatches, hinged guards etc. For larger shredders, emergency stops should also be provided around the machine to allow easy access. Emergency stops should be tested as part of routine daily/weekly checks.

- For detail on emergency stop provision at feed and output conveyors to shredders see the separate WISH information sheet INFO 20 'Machinery safety – belt conveyors, available at: https://www.wishforum.org.uk/wp-content/uploads/2022/08/WISH-INFO-20-Machinery-safety-belt-conveyors-August-2022.pdf
- As noted above, with some fast-moving shredders the shredder element/s can take time to 'spin-down' and stop. Sometimes in these cases a braked emergency stop system is fitted - when an emergency stop is used a braking system is activated to stop the shredder element/s as quickly as possible. In these cases, repeated 'live testing' (activating an emergency stop and seeing what happens) may result in damage because of the stresses involved. ''Dead testing' (switching the shredder off, activating an emergency stop and attempting a restart) may be more appropriate – check your shredder's operating manual. However, dead testing does not test the braking system itself, which should be checked, tested, and maintained in line with the machine's operating manual

Case study – a household recycling plant producing refuse derived fuel included a shredder as part of its processing system. The shredder was fed via a conveyor which deposited wastes into a trommel screen which in turn fed the waste into the shredder itself. The feed conveyor was fitted with machine fencing and an access gate. However, this had been removed allowing access to the conveyor. An employee was cleaning the conveyor when the plant started-up. He was drawn along the conveyor, through the trommel screen and into the shredder resulting in fatal injuries.

Safe access and blockage clearance

The majority of serious and fatal machinery accidents occur during 'interventions' such as cleaning, maintenance etc. This is as true for shredders as for other types of machinery, and in particular for waste shredders during blockage clearance. Key to avoiding such accidents is adequate isolation/lock-off during interventions – see WISH guidance WASTE 29 'Practical guidance on secure isolation (lock-off) for recycling and recovery machinery' available at: https://www.wishforum.org.uk/wp-content/uploads/2021/10/WISH-WASTE-29-Practical-isolation-and-lock-off-guidance-October-2021.pdf.

Your shredder may have specific isolation/lock-off systems. For example, many moveable/mobile shredders have a key in the control panel which can be turned to the 'off' position, removed and kept secure by the person working during interventions (or placed in a lock-off box for multiple person working). However, there is often also a main battery isolator switch/lever. These are sometimes located low on the shredder chassis and may not be easy to locate (see photographs above for examples of battery isolator switches).

Battery isolator switches can either be turned to 'off' and secured with a padlock (or lock-off plate/hasp for multiple person working) or turned to 'off', removed and kept by the person working (or placed in a lock-off box with the control panel key for multiple person working). Some shredders also have pins or similar ('scotches') which can be inserted to prevent movement of elements. You need to know this type of detail – consult your shredder's operating manual and use such information into your own isolation/lock-off procedures. For detail of lock-off plate and box use see the above WISH guidance on isolation and lock-off.

Access may also be an issue. For general advice on access for interventions see WISH guidance WASTE 13 'Safe design and operation of materials recovery facilities' available at: https://www.wishforum.org.uk/wp-content/uploads/2023/04/WASTE-13-Design-and-operation-of-MRFs-V2-June-2022.pdf and in the WISH guidance WASTE 33 'Principles of machinery safety – recycling & recovery plants' available at: https://www.wishforum.org.uk/wp-content/uploads/2023/04/WISH-WASTE-33-Principles-of-machinery-safety-recycling-recovery-plant-August-2022.pdf.

Safe access needs to be provided where maintenance, cleaning, blockage clearance etc require working at a height. This can be by the use of fixed or mobile (for example, wheeled stairs) access systems. If mobile systems are used, they should be secured away from machinery when not in use. For example, by being padlocked to a fixed structure in a safe position to prevent unauthorised use. For frequently required tasks fixed access is preferred.

Care should be taken when designing fixed access systems/platforms as they may inadvertently also allow access to dangerous machinery parts. For example, a fixed access platform to allow blockage clearance at the top of a shredder feed hopper may provide access to shredder element/s. In these cases, access may need to be safeguarded such as by being enclosed by machine fencing or hinged plates over vertical fixed access ladders etc.

Specifically regarding blockages clearance on shredders:

- Using the right shredder with the right waste type/s will very likely reduce the frequency of blockages, lowering the likelihood of an accident occurring during blockage clearance
- If practical assess the nature of the blockage to allow clearance to be planned more effectively. For example, by the use of a mirror or CCTV over the feed hopper of a shredder. For hopper fed shredders loaded using a grab crane, a 'rising cab' (cab which elevates) can be useful to allow the plant operator to see into the hopper
- Many shredders have systems to assist in blockage clearance. For example, reversable shredder element/s, combs, grids etc under shredder output areas which can be lowered or moved out of the way mechanically to allow detritus to drop-out etc. Consult your operating manual to see if your shredder has these types of system. Attempt to clear blockages by such mechanical means before intervening manually. Even if mechanical means do not clear a blockage completely, they may make manual clearance easier
- Non-machinery hazards may also be present, such as exposure to biological or harmful substances in wastes, sharp edges etc. This document does not cover non-machinery issues in any detail – you should include them in your risk assessment
- If manual intervention is required, plan in advance and make sure your workers have not invented ad-hoc, and potentially unsafe, ways of working

Case study – a mobile/moveable shredder at a recycling plant was equipped with an over-band magnet at its output conveyor. Waste had become trapped between the conveyor and the magnet. Two employees tried to manually clear the blockage. One removed the locking pins which held the magnet in place and was crushed when it then fell on him. He suffered fatal head injuries. The system was actually designed to be self-cleaning, and the blockage could likely have been cleared using the machine's controls, but employees were unaware of this and had made-up their own way of working.

Disclaimer and WISH

This information document has been prepared by health and safety practitioners to assist health and safety improvements in the waste management industry. It is endorsed by the WISH (Waste Industry Safety and Health) Forum. This information document is not formal guidance and represents good practice, which typically goes beyond the strict requirements of health and safety law.

Nothing in this information document constitutes legal or other professional advice and no warranty is given, nor liability accepted (to the fullest extent permitted under law) for any loss or damage suffered or incurred as a consequence of reliance on this document. WISH accepts no liability (to the fullest extent permitted under law) for any act or omission of any persons using this document.

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The Waste Industry Safety and Health (WISH) Forum exists to communicate and consult with key stakeholders, including local and national government bodies, equipment manufacturers, trade associations, professional associations, and trade unions. The aim of WISH is to identify, devise and promote activities to improve industry health and safety performance.

Useful links and further reading

WISH website: https://www.wishforum.org.uk/
HSE waste and recycling webpages: www.hse.gov.uk/waste/index.htm
BS 14100:2020 - Control of hazardous energy on machinery
BS 14200:2023 – Maintenance of machinery
WASTE 29 'Practical guidance on secure isolation (lock-off) for recycling and recovery machinery'
INFO 20 'Machinery safety – belt conveyors'

There are also dozens of EN and similar technical standards on machinery safety. You as an operator are unlikely to have access to all of these and would not be expected to have an in-depth knowledge of them. However, you should have access to competent advice which does have access and the required knowledge.