WISH

Waste Industry Safety and Health Forum

INFORMATION DOCUMENT

MACHINERY SAFETY INFORMATION METALS SHREDDERS AND FRAGMENTISERS

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 advice. This advice 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 used at waste recycling plants/MRFs and similar. All of the sheets are available from the WISH website at https://www.wishforum.org.uk/information/. In addition, specific isolation and lock-off advice is available at WASTE 29 and overarching waste and recycling machinery safety advice at WASTE 33. This sheet does not aim to be comprehensive – you should also seek 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 metals shredders and fragmentisers. Please note this sheet does not cover non-machinery risks, such as manual handling, and you should conduct assessments to ensure you have identified all risks.

Tips, discussions, case studies, and notes – in WISH documents tips, discussions, case studies, and notes are sometimes provided in green tint boxes. Tips, discussions, and case studies are informal advice, experience, and ideas aimed at helping operators manage risk. They are not part of formal advice. Notes expand on specific issues, give clarification, highlight issues, and provide explanations. Notes are part of formal advice.

Introduction

Contact with the moving parts of machinery, including waste metals shredders and fragmentisers, has been the cause of many serious accidents at waste recycling and similar plants. The safe design, use and maintenance of machinery such as metals shredders and fragmentisers is essential if we are to reduce this unacceptable toll of serious accidents.

This information sheet covers waste metals shredders, fragmentisers, grinders and similar machinery commonly used at metals recycling plants. The terms shredders, fragmentisers etc are often, and at times confusingly, used interchangeably. Typically, fragmentisers are larger than shredders, but this is not always the case. Whatever term is used, and while fragmentisers and shredders vary in size and appearance, functionally they are very similar: they mechanically break or cut material into smaller pieces either through impact or cutting actions. These mechanisms are powerful and capable of causing serious injury.

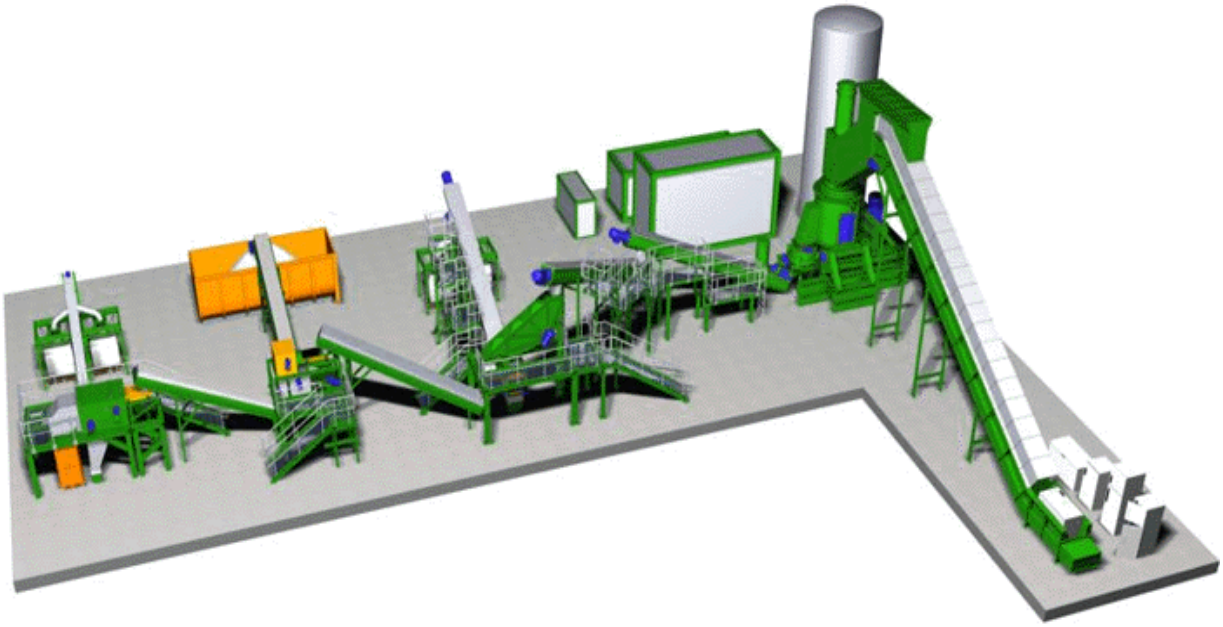
This document concentrates on waste metals shredders, fragmentisers etc. However, many of the hazards, risks, and control measures are the same as for general shredders used for other types of waste. Readers should download and consider WISH's information sheet on general waste shredders (available at WISH INFO 24 General waste shredders) alongside this specific sheet. Larger shredders, fragmentisers etc often have feed and output conveyors. Advice on belt conveyors is available in WISH's information sheet on the topic, available at WISH INFO 20 belt conveyors.

Shredders, fragmentisers etc come in various sizes and types, from small hand-fed units to large machine fed equipment. Shredders, fragmentisers etc 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.

Note – to reduce issues with operation and maintenance and to ensure safety it is essential that the correct shredder, fragmentiser etc is selected for the intended purpose. Shredders, fragmentisers etc vary in speed of operation, size and power, design of 'teeth', 'blades', 'hammers' etc. The correct machine should be used with the correct waste type – a 'one-size-fits-all' approach is not acceptable. For example, a shredder designed for non-ferrous metals may block, generate ejecta etc if fed with ferrous metals. Ensuring the suitability of work equipment is a legal requirement under PUWER (Provision and Use of Work Equipment Regulations). Adequate maintenance is also a requirement under PUWER and is covered in detail by standards such as BS14200.

General machinery hazards shredders/fragmentisers

As noted above, waste metals shredders, fragmentisers etc come in various sizes, designs etc. The graphic below shows a typical larger installation, including feed and output conveyors (see above for link to WISH's information sheet on belt conveyors).



In general, the primary hazards associated with metals shredders, fragmentisers etc potentially include:

- Entanglement, cutting, and impact hazards from the rotor hammer or cutting mechanism and potentially between the rotor and machine body
- Run-down time as a result of the size and energy contained in the mechanism
- Contact with dangerous parts of machinery at sampling points
- Other entanglement hazards associated with drive and transmission systems
- Conveyor hazards from the conveyors feeding or taking material away
- Material ejection – from feed or other openings
- Entanglement with material being fed into machine or during processing
- Where relevant inert atmospheres and confined spaces hazards in sections of the plant where this is part of the process, such as in refrigerator recycling
- Where relevant mobility if the machine can be moved to different locations
- The movement of pedestrians and mobile plant in and around the plant, including if the machine is mobile from the movement of the machine

- Other potential hazards may be associated with the waste being processed, for example petrol tanks, pressurised/flammable gas cylinders, aluminium dust etc

As noted above, general guidance on waste and recycling machinery safety is available in WISH WASTE 23 at WASTE 33, and on secure isolation and lock-off, including on interventions such as blockage clearance, in WISH WASTE 29 at WASTE 29.

Note – this information sheet covers machinery hazards and risks. Issues such as dust, fumes, fire, explosion etc are outside of the scope of this document and are not directly covered in any detail. However, you should assess whether this type of risk is relevant to your machinery, and if so then they should be included in your risk assessment/s and safe ways of working – both for normal operation and during cleaning, blockage clearance, maintenance, repair etc. Guidance and advice on hazards and risks such as the above is available from the WISH website at https://www.wishforum.org.uk/ and on the HSE's website at https://www.hse.gov.uk/waste/index.htm.

Safeguarding – general and specific issues

General issues

General safeguarding issues associated with waste metals shredders, fragmentisers etc include, but are not limited to (see also WISH's information sheet on general waste shredders available at WISH INFO 24 General waste shredders):

- Feed hoppers and/or feed openings should be 'safe by position' and meet the relevant 'reach and access distances' contained in the relevant standards and be designed to reduce the likelihood of material being ejected, such as via the feed pathway, flap etc
- Transmission and drive systems should be fully enclosed
- When shutdown/turned-off spinning elements such as shredder fly wheels can take a significant time to 'spin-down' and stop (in some cases up to 45 minutes). If an invertor drive is fitted, this might be reduced significantly (perhaps down to down to 2 minutes). Some machines have braked systems, but these are typically associated with emergency stopping (see section below). Whichever is the case, no person should approach a dangerous part until it has stopped moving, by means such as:
  - Motion sensors which prevent a dangerous part being accessed until all motion has stopped. For example, a speed sensor on rotating part/s within a mill connected to a hydraulically operated access door which prevents the door opening until the rotating part/s have stopped
  - Timing mechanisms which prevent access until a given time period has elapsed to allow spin-down to occur. If timers are used, they should be set with a safety margin and a means of checking all motion has ceased should be in place
  - Instructions to workers not to enter until a given time period has elapsed – in common with other 'human-based' controls this approach may be prone to failure and close monitoring is required to ensure compliance. Physical means such as the above are preferred where practical
- Access into hammer, shredding, grinding etc chambers should be prevented by:
  - Where access is infrequent by the use of robust fixed guards
  - Where access is frequent by the use of interlocked guards. Considering the likely severity of any access while parts are in motion any interlocking system should be of a high integrity and 'safety performance level', likely at performance level PLd or higher – if in doubt consult a competent advisor
- Whether fixed or interlocked guards are used, also see the requirements in WISH WASTE 29 on isolation and lock-off (at WASTE 29)

- If discharge bins or other equipment is required to be in place to prevent access their location to the machine should be interlocked such that removal of a bin stops the machine and prevents it from being restarted
- Sampling points should be safeguarded if they provide access to hazards
- Conveyors (including magnetic cross conveyors) should be guarded
- Access to pits under shredders etc should be controlled. Depending upon the scale of hazard, such as the depth of the pit and its location, pits may need to be protected by machine fencing and interlocked gates (pits can also potentially pose hazards other than machinery hazards, such as oxygen depletion, which should be accounted for in your risk assessment/s and safe ways of working)
- Safe isolation, lock-off, and safe ways of working should be applied where entry to clear blockages, maintenance or cleaning is being undertaken (see section below)
- Where relevant, confined space entry processes, purging of inert gas etc may need to be in place. For example, oxygen deficient atmospheres as a result of the use of inert gases (e.g. nitrogen) in shredders etc. for example in refrigerator recycling.

Fragmentisers

Waste metal fragmentisers and associated separation plants commonly differ from other shredders in both type and size (typically they are more complex and mostly larger). In addition to the general safeguarding points outlined above:

- Fragmentisers should be sited in a location where noise, explosion and ejection (projectile) hazards, if relevant, will have the least effect. Additional screening should be provided where necessary, which may require full enclosure
- The mill should never be opened during operation, to prevent access to dangerous moving machinery and also enabling projectiles of hot metal to be emitted
- Use of ‘full’ feed systems – that is keeping the feed conveyor belt full and feed rollers in contact with the material being processed
- Use of heavy-duty curtains, ‘splinter cages’ etc over the feed conveyor to reduce the likelihood of anything ejected from the fragmentiser progressing back along the feed conveyor
- Enclosure steel grid/plate walls/roof may be required to mitigate the emission of projectiles and all new metal shredders (commissioned after August 2022) should be fully enclosed in line with Environment Agency requirements (see SEPA and NRW for sites in Wales and Scotland) and the relevant Appropriate Measures
- Safeguard against ejecta: in addition to direct ejecta potential ricochets and deflections should also be considered

- The mill should be mounted on rubber/spring dampers to reduce noise, vibration and potential damage due to any fire or flame event
- Pre-inspection of waste should be in place to remove materials not suitable for the machinery, such as fuel containers, pressurised gas bottles; wire ropes, ingots, over-thick steel/metals etc.
- Continuous monitoring of material entering the machine should be considered; for example by the use of CCTV and the identification of prohibited items such as gas bottles.
- Robust waste metal material acceptance, inspection, and rejection procedures should be implemented to reduce the likelihood of explosive and flammable items being introduced into the mill
- Air cyclone plants should be fully enclosed to prevent the inadvertent release of dust
- If fitted, water injection systems should be operated and maintained to optimum conditions to facilitate reduction of dust and cooling of the fragmentiser process. Injection of water into the mill can also mitigate against the generation of hot lumps of metal (a potential ignition source for a fire)
- Use of permit to work systems for access into areas where confined space hazards may be posed, such as potential oxygen deficient areas, and considered for access into areas to clear a blockage in the discharge area, or scrap drop-out areas
- The area around the machine should be restricted regards pedestrians. For example, banning walking under conveyors (in case of metals etc. falling from conveyors)

Pre-shredders

In addition to a main shredder, a pre-shredder is sometimes installed, primarily to enable the pre-treatment of ‘enclosed’, concealed items and wastes, for example car ‘bales. The pre-shredder, primarily comprises of slowly rotating blades which rip-open car bales (and release, concealed rogue items such as gas bottles to facilitate removal). This is designed to prevent potential explosions and smaller percussive events in the main shredder, which apart from presenting a significant hazard, can also damage plant and equipment, in addition to being an environmental nuisance. Hazards are similar to that for the main shredder:

- Pre-shredders should be housed behind steel, or similar, housing/guarding with, as required, locked/interlocked access doors
- The start-up sequence for pre-shredders should only be carried out by an authorised person – there is typically an order that start-up needs to occur in.
- If ‘ignition. Type keys are fitted they should be controlled by an authorised person/s and start-up restricted to key competent personnel

- Materials being fed into the shredder should be monitored at all times, such as by CCTV, and operatives should be instructed to be vigilant for oversize and heavy metal items, sealed containers and other problematic items and materials
- Pre-shredders can sometimes be on a separate power system to the main shredder. In these cases, all isolation points should be identified, including auxiliary power systems, and such factors included in isolation and lock-off procedures

Emergency stop provision

In general, 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 more detail on emergency stops see WISH WASTE 33 on general principles of safeguarding available at WASTE 33.

Where shredders etc. are fed by conveyors and/or have an output conveyor emergency stop provision should be inline with the WISH information sheet on machinery safety – belt conveyors, available at WISH INFO 20 belt conveyors.

As noted above, with some fast-moving shredders etc the shredder element/s can take a significant 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 – stopping a fast-spinning heavy element takes considerable force. ‘’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.

Emergency stops should not be used as a functional stop to turn the machine off after use etc – repeated use of emergency stops can result in excessive wear-and-tear leading to failure when they are really needed.

Safe access, blockage clearance, maintenance etc

Interventions, such as blockage clearance, cleaning, maintenance, repair etc, which involve persons being potentially exposed to dangerous parts should be planned in advance, risk assessed, and safe ways of working put in place. However, it is accepted that unforeseen issues may occur. In these cases processes such as a 'point of work risk assessment' may be appropriate. Whatever system is used, allowing workers to 'make-it-up-as-they-go-along' is not acceptable. Planning for interventions is covered in the WISH guidance note WISH WASTE 29 on isolation and lock-off, available at WASTE 29.

Where contractors will be used for interventions such as maintenance and repair robust controls should be in place to ensure interventions are conducted safely. Supervision and monitoring to ensure contractors work safely is critical, and the use of a formal permit-to-work (PTW) should be considered (also see below on confined space entry).

This information sheet concentrates on machinery hazards. However, interventions can pose other hazards and risks. Specifically for shredders, fragmentisers etc. these may include:

- Exposure to electrical hazards. There have been several serious incidents with metals shredders, fragmentisers etc where arcing and other electrical hazards have been a factor. A formal PTW system should be considered
- Where inert atmosphere systems are installed, such as on shredders used in refrigerator recycling, entering a shredder etc chamber may be considered a confined space task. In these cases a formal PTW system is mandatory, and the requirements of the Confined Spaces Regulations and its associated approved code of practice (ACOP) should be followed. This ACOP is available at HSE confined spaces ACOP

Other hazards include slips, trips and falls from access to and around the shredder and associated plant via metal steps, ladders and catwalks, with oil and debris on surfaces, potential fire from hot-works and the accumulation of combustible debris (fuel) and loose objects falling from height on to maintenance workers below. You should ensure your risk assessment covers all relevant hazards and risks.

Specific maintenance tasks include cleaning of cyclones (or dust/air plants) from the accumulation of (often hardened) dust and debris, which can introduce further hazards such as work at height, use of appropriate tools for cleaning (such as hammers, pick axes etc.) at height. Specific procedures and assessment/s for this activity are requirements.

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.

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This information document is not a substitute for duty holder and/or professional safety advisor's judgment, Notwithstanding the good practice in this document, duty holders are responsible for ascertaining the sufficiency and adequacy of their internal and independent procedures for verifying and evaluating their organisation's compliance with safety law.

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 13 'Safe design and operation of MRFs'
WASTE 29 'Practical guidance on isolation (lock-off) for recycling and recovery machinery'
WASTE 33 'Principles of safeguarding for recycling and recovery machinery'

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.