WISH
Waste Industry Safety and Health Forum
INFORMATION DOCUMENT

MACHINERY SAFETY INFORMATION HORIZONTAL PLANE BALERS

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

Introduction and scope

This is one of a series of information sheets covering specific items of machinery in common use at recycling plants/MRFs. All are available as free downloads from the WISH website (https://www.wishforum.org.uk/information/). General guidance on recycling plant safety is also available (https://www.wishforum.org.uk/wish-guidance/), and on isolation and lock-off (https://www.wishforum.org.uk/wp-content/uploads/2021/10/WISH-WASTE-29-Practical-isolation-and-lock-off-guidance-October-2021.pdf). This sheet does not aim to be comprehensive – you should also seek further guidance, such as that available on the HSE's website, and where required obtain competent advice. This sheet covers horizontal plane balers of the type typically used in recycling plants to bale paper, card, plastics, metals etc. and builds on HSE publication INDG392 (https://www.hse.gov.uk/pubns/indg392.pdf).

Case studies – the case studies in this information document 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

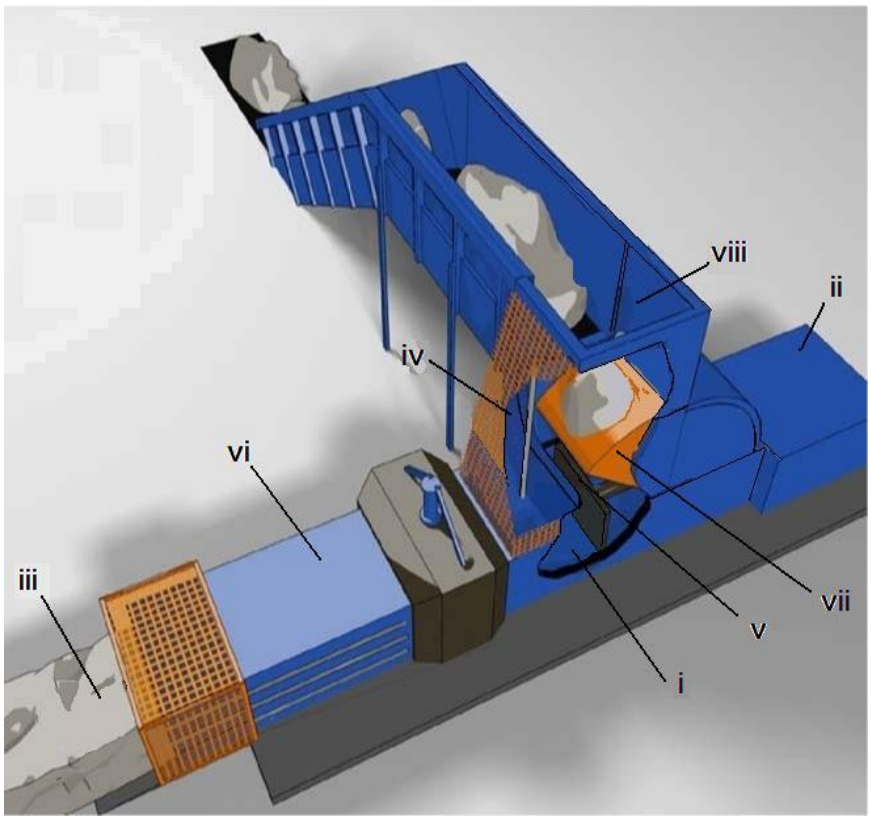
Contact with the moving parts of machinery, including horizontal balers, has been the cause of multiple serious and fatal accidents at waste recycling plants. The latest HSE statistics available show that machinery safety is the most common cause of fatal accidents at recycling plants (https://www.hse.gov.uk/statistics/industry/waste-recycling.pdf). The safe design, use and maintenance of horizontal plane balers is essential if we are to reduce this unacceptable toll of serious, life-changing, and fatal accidents.

Note - to reduce issues with operation and maintenance, it is essential that the correct baler is selected for the purposes intended. Baling involves cyclic loading, compression, and discharge of material – the variability of material, how it is held together in a bale (through wrapping, twine, or wire) are key points in selecting a suitable machine.

Case study - a mobile agricultural baler was being used to compact and bale general household waste, including cardboard, plastic, wood, metal, glass, and paper. The baler was originally designed to compress soft organic materials into bales, then wrapping these in plastic film for storage and transport. As a result of this mismatch between intended and actual use, significant repeated blockages occurred, along with wrapper splitting and aggressive wear to machine parts. Whilst performing maintenance/operating duties on the baler, a worker went missing and was later found fatally injured in the baling chamber of the machine. Isolation was unconventional (the machine was powered via PTO – power take-off shaft) and had not in any case been undertaken. An after-market access platform was located over the baler's feed hopper assembly for viewing and/or intervention purposes such as blockage clearance. However, barriers at the access platform were damaged and not interlocked meaning access to the baling chamber was possible during operation. Because of the frequency of blockages, it is believed the worker had become frustrated and intended to intervene quickly so as to maintain production.

Dangerous parts of horizontal balers

The diagram below illustrates the main dangerous parts of a typical horizontal baler.



(i). Compaction area (baling chamber)
(ii). Area behind retracted compaction plate (rear of baler ram)
(iii). Bale ejection area
(iv). Wire tie/needle area
(v). 'Ruffling' etc area
(vi). Baling channel/tunnel
(vii). Pre-compaction plate
(viii). Feed opening (feed chute, hopper or similar)

Note – your baler may differ from this example, or not have some features shown, such as a pre-compaction plate, or may be fed in a different way such as direct to a hopper rather than via a feed conveyor. However, all horizontal plane balers have a bale chamber, rear of ram area and some form of feed opening and bale output area.

Not all of the dangerous parts shown in the diagram may be present on your baler. Your baler may not have a 'ruffler', may have manual wire tying rather than a powered automatic system, may be fed direct rather than via load conveyor etc. Whatever the specifics, you need to know what the dangerous parts are on your baler.

Note – the baler shown above is feed via an inclined load conveyor. The machinery hazards associated with conveyors are covered in a separate WISH information sheet (INFO 20 Machinery safety – conveyors) available at: https://www.wishforum.org.uk/information/.

Compaction area (baling chamber) – perhaps the most obvious dangerous part on horizontal plane balers is the compaction area crush zone. Once someone is in the chamber, there are limited means of escape. Contact with the moving compaction ram in the compaction chamber of a baler is very likely to be serious at the least.

Area behind compaction plate (rear of baler ram) – baler compaction rams move forward to bale wastes and backwards to clear the bale chamber for more waste. They move backwards with as much force as they move forwards posing a significant crush hazard.

Bale ejection area – entry into and around bale ejection areas can pose potential crush and trap hazards if bales are being ejected during access.

Wire tie/needle area – the movement of baling wire needles poses obvious risks. Movement of baling wire can also pose hazards such as traps as the wire tightens on a bale. Wire has also been known to 'jump' off its track posing significant puncture wound risks. Wire routing/runs can also pose hazards such as where wire passes around a pulley, and the movement of wire as it is pulled from its spool can in itself pose hazards.

Ruffling etc area – rufflers 'stir' wastes up to make baling easier. Other devices aimed at achieving easier baling can also be located in or around this area, such as shredders, spikers (for example, to puncture plastic bottles), aerators etc. Some devices also include conveyors, posing nip hazards. The specific hazards presented will vary. You may also need to consider:

- Some devices take time to 'spin-down'. They do not stop straightaway when power is isolated and may continue to rotate for a period of time
- Devices such as rufflers are sometimes additions to an existing baler and may have a separate power supply resulting in isolation and lock-off at multiple switches being required to isolate the whole of a baler assembly

Baling channel/tunnel (bale output area) – bale ejection channels/tunnels can pose significant trap and crush hazards during use and when cleaning or clearing blockages.

Pre-compaction plate – pre-compaction plates and similar are often enclosed by the same structure that encloses the baling chamber itself. They can pose additional risk from gravity fall (dropping by themselves) if stopped during their cycle. In addition, some have external moving levers or other external moving parts which can pose trap and other hazards.

Feed opening (feed chute, hopper or similar) – feed chutes do not in themselves pose a machinery hazard, but they can provide a ready means of access to baling chambers especially if bridging of feed material occurs (feed chutes are a common blockage point). They can also allow access to other devices such as rufflers and pre-compaction plates.

Note – the above is a brief summary. Your baler may have other or different dangerous parts. You need to identify all of the dangerous parts on your baler and ensure they are all adequately safeguarded. You may need to seek competent advice to achieve this.

Case study – a typical arrangement for larger balers is that they are loaded via a feed chute. These are often themselves fed by an inclined conveyor which lifts wastes to the top of the chute, from where they drop down inside the chute into the baler mechanism. At one such assembly at a recycling plant blockages at the top of the feed chute were common – larger sized wastes tended to 'bridge' across the chute, other wastes then piled-up on top of the 'bridge' causing a blockage. No fixed or mobile platform was provided to allow safe access to the top of the chute. As a result workers resorted to walking up the inclined conveyor to access the chute top to clear blockages. When workers did this, they turned the conveyor off at its main isolation switch. They mistakenly believed this also isolated the baler itself – it did not. Usually, workers could clear a blockage using reach tools (poles, brooms etc), but this did not always work and in these cases they then 'kicked' at the blocked wastes in an attempt to clear the blockage. One day a blockage cleared suddenly and the worker who was kicking at it fell through the blockage, down the feed chute and into the baler mechanism. The baler's 'magic eye' sensor automatically registered that the baling chamber was full, in this case by the worker, and activated the baler ram, crushing the worker and fatally injuring him.

Left to right: two examples of interlocked access doors to baling chambers, inadequate guarding on a baler – well guarded from above but access possible underneath, example of perimeter/machine fencing at a baler, example of a smaller direct feed baler

Safeguarding of horizontal balers

The information given below is for a typical horizontal plane baler. As with other recycling machinery secure isolation and lock-off is a critical component of safeguarding. For further information see WISH WASTE 29 on isolation and lock-off available at https://www.wishforum.org.uk/wp-content/uploads/2021/10/WISH-WASTE-29-Practical-isolation-and-lock-off-guidance-October-2021.pdf.

Compaction area (baling chamber) – most compaction areas on balers are boxed-in by robust steel structures, if for no other reason than that they need to be to do their job. Many balers are fitted with an access door/hatch, usually just above the compaction area, to allow access for blockage clearance and similar. These doors need to be interlocked to a high 'safety performance level'. Established benchmarks often make use of a trapped/exchange key system (commonly called a Castel key system), but other high integrity interlocking systems may be used in combination with, or as equivalent to, a Castel key system. As with all interlocks, checks to ensure they remain operational should be part of routine daily/weekly checks. Other issues you may need to consider include:

- Compaction areas are often guarded well from the above and sides but sometimes less so from below, such as the gap between the baler and floor being too wide allowing crawling access to dangerous parts. Closing such gaps in guarding is usually straightforward, although you must ensure guarding conforms to the relevant standards and how spilled materials will be removed should also be considered – you may need to seek competent advice on this
- There can be retained energy issues which need considering. For example, a pre-compaction plate which could move under gravity even when the baler has been isolated and locked-off. This type of issue needs including in isolation and lock-off procedures and methods. Lock-pins and/or props or 'scotches' may be required
- Some access doors have Perspex or similar vision panels to allow the baler operative to see into the chamber. Over time these can become scratched and opaque, or even damaged to the extent that they may fail allowing access. If a vision panel is required, it should be replaced before it becomes ineffective or excessively damaged

Area behind compaction plate (rear of baler ram) – while most baling chambers are well guarded, the rear of the baler ram behind the compaction plate can sometimes be less well protected. Any potential crawl or other access into the area behind the compaction plate needs guarding adequately, typically by robust fixed or hinged guards. Again, consider how the removal of spilled materials will be achieved.

Case study – baler rams move forward and backward: forward to bale wastes and backward to allow more wastes to fall-into the baling chamber. The ram moves backwards with as much force as it moves forward. At a recycling plant a piece of waste metal jammed in the rear of a baler ram causing the baler to stop. The rear of the ram was inadequately guarded and crawling access to the ram was possible. A worker squeezed into the gap in one side of the guarding to remove the piece of metal. He did not isolate and lock-off the baler. He managed to free the piece of metal but at this point the baler started working again and the ram moved backwards towards him. The worker could not escape and suffered fatal crush injuries.

Bale ejection area – while bales are typically ejected progressively at slow speed they are ejected powerfully. Pedestrians should not enter the bale ejection area while the baler is operative. You may want to consider fencing, signage, floor markings etc. Ejected bales if not removed to storage promptly have also been known to cause structural damage when a 'line' of ejected bales is ignored and eventually reaches a wall or other structural feature.

Wire tie/needle area – needle and wire tie areas need to safe-guarded securely. Mesh guards are common, often integrated into a Castell key system or interlocked to an equivalent standard. The size of mesh aperture needs to be compliant with standards – you may need competent advice. Interlocks need to be checked to ensure they remain effective and operational. Other considerations include:

- Worker intervention is required to rethread new wire into tie systems. Some systems include a 'slow running' function: the 'box' in which new wire is threaded into its mechanism when opened activates an interlock which only allows the machine to run slowly. These systems need checking to ensure they still work correctly
- Wires can and have jumped out of their tracks and/or break when being threaded flying-off and posing a serious puncture wound risk. Wire tracks should include 'finger' type close-fitting guards at least at their corners to protect against this (if a wire comes off its track and/or breaks it is most likely that it will 'fly-away' from the machine at the corners of the wire track)
- Wire-tie systems sometimes include interlocked tunnel guards around the bale ejection area which provides physical means of keeping personnel away from the area during operation
- The movement of wires as they are fed into the tie system can also pose trap and nip hazards. Where wires pass around pulleys which are accessible finger guards should be provided

- Consideration should also be given, where practical, to the use of perimeter fencing around wire spindle areas. Such fencing will require a gate/s through which empty spindles can be removed and full spindles put in place

Note – while not a machinery risk, work on needle and wire tie mechanisms and rethreading new wire often requires work at a height. Safe access for such tasks should be provided.

Ruffling etc area – rufflers, spikers, aerators, and similar devices are often located at the top of an inclined load conveyor or at the entrance to the feed chute of a baler. The hazards presented will vary and should be assessed. Typical hazards include rotating parts, short-run conveyors and their nip-points, 'teeth', and similar elements etc. Whatever the hazards, adequate safeguarding needs to be provided and access for cleaning, blockage clearing etc needs to be considered (see section below on access). Other considerations may include:

- Some devices can continue to move under their own inertia for a time after power has been isolated. For example, a shredder may continue to spin even after the power supply has been isolated. This type of 'retained energy' issue needs to be included in isolation and lock-off procedures. In addition, timers or motion sensors on interlock systems may also be required. For example, a motion sensor on a trapped key (Castel key) system which will not allow a guard to be opened until the device has 'spun-down' and stopped
- Some dangerous parts on rufflers etc may have been deemed to be 'safe by position' by the machine's designer on the rationale that the device is at the top of a long feed conveyor and/or feed chute. Careful consideration needs to be given to this approach, such as access by workers by walking-up/climbing the feed conveyor
- Some devices are capable of being moved out of the way of the baler feed, such as by hydraulic systems, to allow their use with some waste types and not with others. The design of guarding provided needs to take account of such movement to ensure that gaps in guarding do not occur when the device is moved

Left to right: inadequately guarded rear of baler ram (crawl access at the side possible), example view rear ram area (hinged guards open), baler wire needle area with large mesh guard fitted, bale ejection area with interlocked sliding guard over needles and bale wire-tie mechanism

Baling channel/tunnel (bale output area) – The width/size of the opening (throat) at bale discharge areas can be adjusted on many balers, depending on the density of feed material. Although these are not rapidly moving parts, the adjustment throat is under extremely high closure force, sufficient to crush bone - trap points at baling channels/tunnels need to be adequately guarded. Access to baling channel areas also needs to be prevented while baling is being undertaken. Isolation and lock-off procedures should include access for cleaning, blockage clearance, removal of split bales etc.

Pre-compaction plate – these are usually enclosed in the same structure as the baling chamber. However, some pre-compaction plates have external moving parts such as moving arms, spindles etc. Typically, fixed guards are fitted at these points, although some balers have interlocked guards if access to external moving parts is required frequently.

Feed opening (feed chute, hopper or similar) – while feed openings, chutes etc do not pose their own machinery hazards directly, they may allow access to machinery hazards. See section below on safe access for detail.

Whatever safeguarding approach is taken, guards and similar need to be suitable robust and designed to the required standards. You may need to seek competent advice.

Emergency stop provision

Emergency stops should be provided at control panels and at access points such as hatches. Emergency stops should be tested as part of routine daily/weekly checks. Emergency stop provision at loading conveyors to feed chutes needs careful attention, in particular floor-loaded conveyors where there is the risk of a person falling or otherwise getting onto the conveyor.

Many conveyors are fitted with pull-wire (sometimes called tripwires) emergency stop systems running along the sides of the conveyor or suspended pull-cords at regular intervals. For hopper fed load conveyors to balers where the height and design of the hopper protects against climbing access side mounted pull-wires or similar may be adequate, subject to risk assessment. However, for floor mounted load conveyors to balers overhead pull-wire arrays should be fitted. These should be designed so that a person lying prone of the conveyor can reach them (workers may slip or trip on wastes in the area and fall onto the conveyor or be struck by mobile plant pushing them onto the conveyor sustaining injury which makes them unable to climb off quickly).

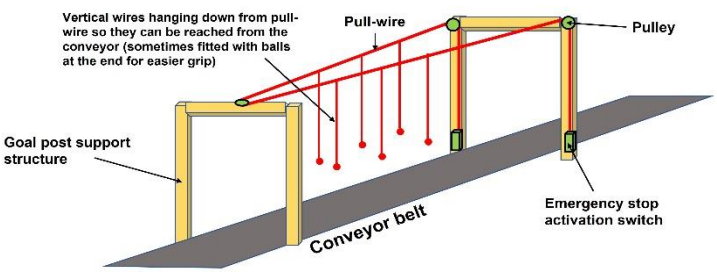
Overhead pull-wire arrays also need to be designed and maintained to minimise any ‘drag’ or friction in the system which may result in a failure to activate. For example, by the use of free-running pulleys where the wire changes direction, avoiding sharp changes of direction and reducing any changes of direction to a minimum.

Some load conveyors are fitted with sensing systems: workers wear a belt with a transceiver, RFT (radio frequency tagging) etc device or have them sewn into their PPE. A sensor hoop over the conveyor detects if a device passes through it and stops the machine. While this type of system can be a useful back-up they must not be relied on as a primary safeguard or control (battery failure, or persons not wearing the RFT/transceiver, and other faults can render the systems defective) – adequate emergency stop provision is still required

Safe access and blockage clearance

If practical, any need for routine interventions at a height should be eliminated, such as by the use of automatic or remote oiling and greasing points. If not practical, safe access needs to be provided where maintenance, cleaning, blockage clearance and similar tasks 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 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 baler feed chute may provide access to the chute and via the chute to the baler compaction chamber or to rufflers, shredders etc located at or near to the top of the feed chute. Examples of the approaches which can be taken are provided in the bullet points below.



Left to right: Floor mounted load conveyor fitted with a pull-wire emergency stop array (red wires supported on blue goal posts), simplified diagram of a pull-wire array with vertical wires hanging down from the pull-wire so that a person prone on the conveyor can reach them, typical pull-wire activation switch

- Body access prevention bars (commonly called ‘jailers bars’) can be used at access hatches and doors. For example at an access platform provided to allow blockages to be cleared at the top of a feed chute to a baler. These allow the use of reach tools (poles and similar) through the gaps in the jailors bars while preventing body access
- Alternatively, fencing can be provided at access platforms which is higher than would normally be required for fall prevention to deter climbing over fencing
- Fixed access systems such as access stairs and platforms can be safeguarded by perimeter/machine fencing with locked gates, or for frequent access interlocked such as being incorporated into a Castel key system
- Vertical access ladders to platforms can be fitted with hinged plates to prevent their unauthorised use. Where frequent access is required, hinged plates can be fitted with interlocks as a support to isolation and lock-off procedures

Note – access by walking-up or climbing load and other conveyors is not a safe practice and should be avoided (see case study above).

For infrequent/rare interventions where fixed access is not practical, when working at height a safety harness should be used and this should be secured to a suitable anchorage via a lanyard. Consideration needs to be given to the environment that anchorage points are installed, which may lead to their deterioration (i.e. humid and dusty environments). Removeable or temporary anchorage points should be used in these circumstances.

The aim should be to provide safe access free from fall hazards while not compromising machinery safety standards.

Tip – installing mirrors and/or CCTV over feed hoppers and similar can assist workers to assess blockages etc in advance and be better prepared for tasks requiring access.

Left to right: jailers bars provided at an access hatch to the top of a feed chute to a baler, example of fixed access to the top of a tall feed chute (note – hatch shown is also fitted with jailers bars), diagram of hinged plate over a vertical access ladder, mirror mounted above a feed hopper, increasing use of CCTV at recycling plants can allow workers to assess problems before access

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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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