

BALE STACK STABILITY AND LOADING AND MOVING BALES

This WISH information document is aimed at health and safety improvements in the waste and recycling industry. The Health and Safety Executive 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 regarding health and safety

Contents

Introduction and scope

Linked WISH documents

Common accident features

Bale stack stability and storage

Loading and moving bales

Appendix 1. Factors potentially affecting bale stack stability

Introduction and scope

As the amount of waste being recycled in GB has increased over time, there has also been a consequential rise in the amounts of baled wastes being stacked, stored, moved and loaded at recycling plants/sites (commonly called MRFs – materials recovery facilities) and other similar facilities, such as MBT (mechanical biological treatment) plants. While not one of the most common accident causes at MRFs and other similar sites, this rise has unfortunately been accompanied by a series of serious and fatal accidents involving bale stack collapses/falling bales. Since 2010 WISH is aware of five fatal accidents at MRFs associated with stack collapses/falling bales. In addition to these fatalities, there have also been several similar accidents at MRFs resulting in serious and life-changing injuries, and fatal and other accidents involving bales have occurred outside of MRFs, or on the ‘fringes’ of the waste sector. Common factors in these incidents include bales being stacked too high, irregular shape of bales, badly stacked bales, stacks being struck by vehicles, bales falling during loading and movement of bales etc.

Linked WISH documents

This information sheet provides more detail and information on the overviews on bale stack storage and the loading and moving of bales given in two WISH guidance documents:

- WISH WASTE 13 'The safe design and operation of materials recovery facilities (MRFs)', available at: [WISH WASTE 13](#) – covers bale stack storage
- WISH WASTE 09 'Safe traffic management on waste and recycling sites', available at: [WISH WASTE 09](#) – covers bale loading activities

You should read the above two documents in conjunction with this information sheet.

Guidance on waste bale stacks is also available from the HSE (Health and Safety Executive) at: <https://www.hse.gov.uk/waste/safely-stacking-bales-of-waste.htm>. While not directly aimed at waste bales, useful information is also available in the HSE's guidance on the stacking of agricultural bales at: www.hse.gov.uk/pubns/indg125.pdf.

This information sheet primarily applies to MRFs and other types of recycling site and similar operations. It also applies to the storage, movement and loading of baled wastes on any type of site carrying-out waste baling, waste bale storage and/or waste bale loading activities under a waste management permit/licence, exemption etc.

Most waste bales are 'square' in shape. However, some are 'round', such as some RDF/SRF waste bales. The general advice given in this information sheet applies to all shapes of bales. However, for specific advice on the safe stacking of round bales see the HSE's guidance note on the stacking of agricultural bales as noted above.

Note – bale stacks and bale storage are also mentioned in the WISH guidance document WISH WASTE 28 'Reducing fire risk at waste management sites' (available at: [WISH WASTE 28](#)). However, this information sheet is concerned with the physical safety of bales rather than the fire risk they may pose, and fire risk is not directly considered in this sheet.

Common accident features

Most accidents involving persons being struck by bales and bale stacks at MRFs and other sites, including the fatal accidents mentioned above, occur in two ways:

- A pedestrian is walking by or standing next to a bale stack when the stack unexpectedly collapses striking the person. The pedestrian may simply be walking-by or may be conducting a task such as bale inspection etc. The stacked bales may be in a designated main storage area or stacked/stored temporarily, such as awaiting movement to a storage area or awaiting loading for offtake
- Mobile plant, such as a clamp truck, or another vehicle accidentally 'nudges' or strikes a bale stack causing it to collapse or a bale is accidentally dropped by mobile plant during bale loading, stack construction or movement of bales into/out of storage. The falling/dropped bale/s strikes a pedestrian in the area. As above, the pedestrian struck may be just walking-by or may be carrying out a task. Sometimes there is a 'domino' effect where the 'nudged' stack knocks-into the next stack etc which collapses or the dropped bale strikes another bale/stack causing it to fall

There are multiple factors which can affect bale stack stability (see appendix 1). Some of these factors can be unpredictable. Industry experience is that even well-constructed seemingly stable bale stacks can sometimes collapse unexpectedly (poorly constructed stacks which are too high etc are obviously more likely to collapse). Moving, loading and placing bales involves the use of clamp trucks or similar. These are operated by human beings who can and do make mistakes, no matter how well-trained and competent they may be. Both factors, that stacks can collapse and that plant operators may make mistakes, are well known in the waste and recycling industry and are foreseeable.

For a person to be struck by a falling bale/collapsing bale stack two conditions need to be met: the bale/s need to fall/collapse **AND** a pedestrian is in close enough proximity to be struck by the bale/s. Many of the controls listed in this information sheet are aimed at reducing the risk of a bale/s falling and/or a bale stack collapsing. These are risk reduction measures which do not eliminate the risk completely – that is not to say that these controls should not be followed. However, if there is no one in the area to be struck then the worst scenario is likely to be property damage rather than injury.

Your risk assessment/s should focus on **BOTH** reducing the risk of a bale falling and/or a bale stack collapse occurring **AND** excluding pedestrians from the hazardous area.

Bale stack stability and storage

Bale storage areas

Bales should only be stored in designated storage areas. These areas should be recorded in a site's storage plan, including any designated temporary stacking/storage areas. This plan can be a stand-alone or part of one of the site's management plans, such as a 'fire prevention/mitigation plan'. Wherever your plan is recorded, in addition to recording storage areas, it should also include issues such as storage height, how bales are stored (layout, adequate fire breaks etc), how stock levels are managed, safe capacities for storage and other relevant issues. Bale storage, including designated temporary storage:

- Should be on firm and level ground with good drainage
- Located away from pedestrian routes/walkways etc, unless the pedestrian route is physically protected such as by a suitably high and robust wall capable of restraining a collapsing stack of bales
- Away from vehicle routes, unless the bale storage area is physically protected such as by suitably robust traffic barriers
- Only pedestrians performing essential tasks should be allowed into bale storage areas – all other pedestrians should be excluded from bale storage areas
- The safe capacity of bale storage areas should not be exceeded. Your site storage plan should state what the safe capacity/ies is/are and detail how you will achieve this such as by the management of waste inputs and offtake - even to the point, as required, of ceasing to accept wastes until safe storage can be achieved
- Some waste bales can degrade/deteriorate over time, which can lead to instability in storage. Your storage plan should include such issues. For example, stating maximum storage times and operating storage on a 'FIFO' (first-in-first-out) basis
- Bales should not be stored outside of designated storage areas, both designated 'main' storage and designated temporary storage areas, even when stacked/stored on a short-term basis such as awaiting loading for offtake

Industry experience – the commodity prices for recyclates can vary, both in the short and long term. When prices are low there may be a temptation to hold waste recyclates on site in the hope/expectation that prices will rise. Provided that a site's safe storage capacity is not exceeded, such 'market-playing' may be acceptable. However, such 'commercial' considerations should not result in a site's safe storage capacity being exceeded or ad-hoc and similar storage being resorted to outside of designated safe storage areas.

Bale stack height and stability

Various factors can affect bale stack stability. A summary of these factors is given in appendix 1 of this information sheet. You should, as relevant, include these factors in your risk assessment/s for bale storage. WISH WASTE 13 'The safe design and operation of materials recovery facilities' states that "*Generally, baled storage should be no more than 4 metres high or four bales high whichever is the lower. If bales are not regular in shape storage should be less than this for stability reasons – workers have been fatality injured by collapsing bale stacks*". This '4 metres/4 bales whichever is the lower' is a maximum and is only appropriate for bales which are regular in shape (flat, level sides with little or no bulging etc). For bales which are irregular in shape and/or exhibit other factor/s which may affect stability (see appendix 1), a lower storage height is more appropriate.

Industry experience – at least two of the larger waste and recycling companies have attempted to quantify safe bale storage heights, such as by performing structural engineering calculations on various types of waste bale. However, because of the variables involved the outcomes of such research were not practical to apply at an operational level. As a result, and based on other practical operational experience, some waste and recycling companies have simply put in place a rule that bales should not be stacked more than 3 bales high as a practical way of reducing risk, which is operationally feasible, and capable of easier monitoring and enforcement.

Most waste bale stacks are 'towers' where bales are stacked directly on top of each other. Alternative stacking methods can be used and may enhance stack stability, although there are often operational issues associated with such alternative methods. The two most commonly considered alternative methods being pyramidal stacking and interlocked stacking. Interlocked (interlaced) stacking involves bales being stacked like bricks in a wall, overlapping with each other. Pyramidal stacking involves stacking bales in a pyramid shape, as shown in the diagram below.

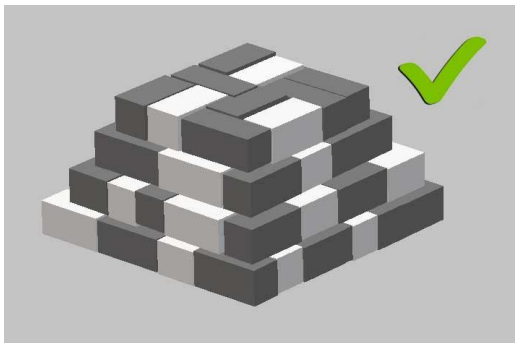


Diagram of pyramidal stacking of bales. Note that the bales in this diagram are also interlocked – they overlap with each other

Both above alternative methods can enhance stack stability but are not in common use at MRFs etc because of the operational challenges they can pose. For example, pyramidal stacking usually requires longer-reach mobile plant to be used to place and remove bales. Some MRFs use 'partial' pyramidal stacking. For example, 'tiering' bales at the ends of bale storage stacks leaving one or more vertical faces for ease of placement/removal of bales. However, this method only assists stability at the face/s where tiering is used.

Bale stack construction, inspection, and maintenance

Bale stacks are typically constructed using a forklift or similar equipped with a clamp attachment (a 'clamp truck'). Forklift truck etc plant training does not usually include the use of clamp attachments and additional training will be required (this also applies to the use of clamp trucks during the movement and loading of bales). During bale stack construction:

- Bales should be placed carefully and considerately with bales being placed accurately on top of each other with no 'overhanging' or other misplacement or misalignment
- Clamp truck operators should be instructed in the methods to use when stacking bales and the rules applied such as on maximum stack height and stack arrangement
- Clamp truck operators should be instructed to report any issues during construction, such as badly made bales, splitting bales etc, and to stop construction and report any issues to their manager/supervisor before continuing
- Pedestrians should be excluded from the area during stack construction, even those performing essential duties
- Some MRFs and similar have more than one baler, sometimes producing different sized bales. Different size bales should not be mixed in stacks
- Different types of waste bale should not be mixed in stacks. For example, stacking paper and metals bales together. There is already a wide range of variables affecting bale stack stability (see appendix 1) without adding another variable

Once constructed bale stacks should be inspected routinely. The frequency of inspection is a matter for risk assessment based on factors such as the length of time bales are stored for. Inspection is usually possible from the relative safety of a clamp truck cab (which should have FOP – falling object protection - fitted) or similar mobile plant rather than by a pedestrian. Any leaning stacks, over-height stacks, overhanging bales, degrading bales, split bales etc should be reported and the relevant stack dismantled (and any damaged etc bales split and re-baled) and the stack remade safely. During such dismantling and remaking of stacks all pedestrians should be excluded from the area, even those performing essential duties.

Waste Industry Safety and Health Forum

The results of inspections should be recorded and any trends identified. For example, if a specific waste type of bale is causing more issues than another type. Remedial actions from monitoring might include reducing bale stack height for specific waste type bales, reducing storage retention time for waste type bales that degrade quicker than others etc.

The requirements above in this section apply equally to temporary designated stacking/storage areas such as separate loading areas and temporary stacking/storage of bales near balers awaiting movement to main storage.

Discussion – as noted above, inspection of bale stacks can usually be conducted from the relative safety of a clamp truck or similar mobile plant cab. The same approach can often be applied to other ‘essential’ tasks. For example, instead of having a pedestrian cleaner on the ground in bale stack storage areas, the use of a ‘scraper’ attachment on a forklift truck to clear storage areas of detritus, blown litter etc may be practical. The aim should be to eliminate pedestrians from bale stack areas wherever reasonably practical, or at least reduce the time that pedestrians need to be in the area to as low as is practical – if there are no pedestrians in the area then they cannot be struck by a falling bale/stack.

Loading and moving bales

Bales are produced at MRFs using a baler. Once bales have been ejected from the baler they are moved to their designated storage area, typically using a clamp truck or similar. At some MRFs bales are temporarily stacked/stored near to the baler awaiting movement to main storage. When bales are ready for offtake, they are loaded onto a lorry or into a container to be taken off site. At most MRFs loading takes place at or immediately adjacent to a main designated bale storage area. However, at some MRFs bales are moved to a loading area for temporary stacking/storage prior to loading. Typically, loading can either be direct onto a curtain sided or similar lorry using a clamp truck etc or via a loading ramp into the rear of a lorry or into a container, again typically using a clamp truck.

When moving bales, including from baler area to storage and storage to loading area etc:

- Pedestrians should be excluded from the area/route of movement, even those performing essential duties
- Generally, only one bale should be moved at a time. If the bales are well compacted, regular in shape with flat level sides it may, subject to a specific risk assessment, be acceptable to move two bales at a time, provided the clamp truck operator's vision is not impeded and that the practice is within the safe capacity of the plant/attachment being used. This includes both bales being moved two-bales high and two-bales side-by-side (such as the use of a wide range clamp attachment fitted with 'batwings'). However, should a bale fall during movement, or significant instability is observed the practice should cease and the site revert to moving one bale at a time. Moving more than two bales at a time is hazardous and should not be attempted or permitted

When loading bales:

- If a separate loading area is used and/or loading takes place adjacent to but not in a storage area, the same requirements as for storage areas apply. Loading areas should be on level, firm ground etc (see section above on storage areas, stack stability etc). Bales should not be loaded from impromptu or ad-hoc areas, on access and other roads with vehicle movements, on cambers, on the public highway etc
- Pedestrians should be excluded from the area during loading (this includes lorry drivers who should either go to a safe area/safe distance away from loading or remain in their cab). If pedestrians need to enter the loading area, such as to take photographs of bales for quality/regulatory reasons etc, then loading should cease and not recommence until the pedestrian/s leaves the area

Waste Industry Safety and Health Forum

- Loading should take place away from other vehicle movements, both lorries and mobile plant. At some sites this may mean temporarily blocking vehicle/plant access to the area while loading takes place
- For curtain sided etc lorries, tasks such as fixing load straps, closing curtains etc may need to be performed. In these cases, loading should cease until the task has been completed and the driver/pedestrian has left the area and/or the driver has returned to their cab. You should consider whether such tasks can be performed after loading has been completed rather than allowing them during 'pauses' in the loading process
- Drivers should never stand on the bed of their lorry during loading – this is an extremely hazardous practice which has resulted in multiple serious and fatal accidents. Drivers should go to a safe area during loading or remain in their cabs
- When loading via a ramp, the ramp should be attached to the lorry securely to prevent any movement during loading. Ramps should be fitted with guide rails/sides to stop clamp trucks and similar coming-off the ramp, and ramps should be included in routine inspections such as under PUWER (Provision and Use of Work Equipment Regulations) to ensure they are undamaged and safe to use
- Generally, only one bale should be loaded at a time. If the bales are well compacted, regular in shape with flat level sides it may, subject to a specific risk assessment, be acceptable to load two bales at a time, provided that the clamp truck operator's vision is not impeded and the safe capacity of the plant/attachment being used is not exceeded. This includes both bales being loaded two-bales high and two-bales side-by-side (such as the use of a wide range clamp attachment fitted with 'batwings'). However, should a bale fall during loading, or significant instability is observed the practice should cease and the site revert to loading one bale at a time. Loading more than two bales at a time is hazardous and should not be attempted or permitted

Discussion – 'bale trimming' is conducted at some sites. Bale trimming is the removal of 'non-target' materials from the outer faces of bales. For example, pulling-out pieces of plastic from the outer faces of a bale of paper. The aim is to make bales more 'visually attractive' to customers. This is a cosmetic exercise which does not materially affect the quality of bales. MRFs conduct sampling exercises – selected bales are split and their contents quantified to assess quality. Bale trimming places pedestrians in close proximity to bales. If trimming is conducted on your site, you should consider if it is really required - providing customers with sampling results is a more accurate method of assessing quality. If you decide trimming is really needed, you should consider trimming before bales are stacked and/or dismantling stacks before trimming. During trimming all traffic should be excluded from the area.

Appendix 1. Factors potentially affecting stack stability

Bale stack stability can be affected by a range of factors. Some of the main potential factors are listed in the table below. You should take account of these factors, as relevant to your operation, in your risk assessment/s associated with bale storage.

Stack height	Generally, the higher the bale stack the greater the likelihood of instability may be
Type of waste	Type of waste in the bales can have an effect. For example, waste metals bales are typically more 'rigid' with flatter, regularly shaped faces, whereas plastics and paper/board bales can tend to have 'bulging' faces and such bales may be more irregularly shaped
Homogeneity of waste	How homogenous wastes are can have an effect. For example, large cardboard tube carpet rolls included in general card bales, or larger plastic containers in general plastic packaging waste etc, resulting in irregularly shaped bales and/or bales of uneven density which may increase the risk of toppling when stacked
Compaction	Larger more powerful balers tend to form more compacted, 'rigid' and evenly shaped bales than smaller less powerful balers
Bale wire tying effectiveness	Larger balers tend to have automatic wire tying mechanisms which bind the bale together, some smaller balers do not, and bale wires are fastened manually, which may result in looser tying and a 'looser', potentially irregularly shaped, bale. Bale wires can also break and/or 'undo', which may result in bales 'expanding' in one area leading to irregularity of shape
Dimensions/shape of bales	Generally, the wider, longer, and flatter bales are the more stable they are likely to be when stacked, although a large, flatter but irregularly shaped bale may be less stable than a smaller evenly shaped and flat-sided bale. In general, irregularly shaped bales tend to be less stable when stacked than regularly shaped bales
Quality of stack construction	Most bales are stacked as 'towers' (one on top of the other). Bales need to be aligned with each other rather than 'overhanging' (or misaligned in another way) to promote stability
Moisture	Some wastes absorb water, such as paper and card. If bales are left outside rainwater may enter a bale causing it to expand, resulting in greater irregularity in shape and potential instability

Waste Industry Safety and Health Forum

Ground conditions	Uneven, sloping. 'soft' etc ground conditions may result in stack instability. However, as most waste and recycling site environmental permits proscribe ground conditions at bale storage areas this is typically not an issue – provided that the bales are being stored in line with the site's storage plan/s
Potential vehicle and similar strikes	The factors listed above relate to the 'intrinsic' stability of a stack. However, no matter how stable a stack is if it is struck by a vehicle (such as a lorry, mobile plant etc) it may become unstable
Bale age/time left in storage	Some waste bales can degrade/deteriorate over time. Such degradation can result in bales becoming irregular in shape, bulging between bale wires etc resulting in potential instability

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 person using this document.

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.