Dissipation of Residual Energy in Waste Handling Equipment
Industry Guidance

The following guidance is aimed at the operation of fixed machinery and plant used in the recovered paper industry

Background.

1. There have been a high number of serious accidents to employees in the recovered paper industry, including several fatalities involving baling machines.

2. HSE guidance *Recover Paper Safely (INDG 392*), identifies the requirement for safe systems of work when interacting with the equipment (e.g. accessing the bale chamber, clearing blockages).

3. Although the exact details of the safe system of work may vary, based on site characteristics (such as the nature of the application, throughput, and age of equipment) it should include:

- Physically isolating and locking off the baler and all ancillary equipment. This should involve locking off an electrical isolator, attaching a personal padlock or a sufficiently reliable key exchange system; and

- Following an established formal method of working e.g. written procedures, permit to work, etc.

4. The captive key system (also referred to as the key exchange system) is commonly used in the protection of baler systems and provides a high integrity of safeguarding. It is based on the premise that a single key cannot be in two places at once. Key interlock systems can be located on guard access panels, configured to ensure a predetermined sequence of events takes place, to result in physical disconnection and isolation of power source to the equipment, before operators can become exposed to dangerous parts.

5. Although the captive key/ isolator provides electrical disconnection from power source, there may still be risks from residual or stored energy.

Duties

6. Regulation 19 (1) of the Provision and Use of Work Equipment Regulations (1998) requires that every employer shall ensure that where appropriate, work equipment is provided with suitable means to isolate it from all its sources of energy.

7. The main aim of this regulation is to allow equipment to be made safe under particular circumstances e.g. during maintenance, when an unsafe condition develops or where a temporarily adverse environment would render the equipment unsafe.

Risks

8. For safety reasons, in some circumstances, sources of energy may need to be maintained when the equipment is stopped, for example when the power supply is helping to keep the equipment or parts of it safe.

9. Powered rams, mechanical springs, held in compression can release suddenly, causing impact or crush injury.

10. Removing hydraulic fluid, pneumatics or even the item causing the blockage can cause parts to move under gravity i.e. a platen or pre-compaction lid falling.

Controls

11. Consider the following hierarchy of controls for new and existing plant. Wherever practicable, risks should be controlled in the order given

12. Take hardware measures to control the risks. These include

- Installation of pilot operated check valves to hydraulic and pneumatic cylinders to protect against hose/pipe failure and prevent creep movement (leakage)
- Use of self-locking irreversible transmission with a mechanical drive
- Use of spring-applied brakes with motors fitted to mechanical drives
- Automatic mechanical scotches
- Fail-safe brake mechanism should hold the platen/ tooling in place, when not powered up or down.
- Other equally effective measures

13. Take software measures as part of the system of work.

14. Use pressure gauges, bleed off valves to monitor and dissipate fluid power circuits. Use chains and props to provide temporary support. A competent person should provide a written assessment, so as to confirm

- Adequate design strength of chocks
- Method for inserting chocks in the correct position

15. Parts of the machine (i.e. pre-compaction lid) may require supporting by temporary means to prevent gravity fall. This may include an anchor point attachment to the lid, and attaching a chain block/ turfer to the supporting structure.

16. Consider maintenance of the machine. Safety devices used must be regularly checked, properly adjusted and adequately maintained.

17. Manufacturers should provide the necessary information to allow the user to devise a safe system of work for interacting with the equipment. Information should include

i. Equipment details – technical support, drawings, information on the equipment provided (i.e. energy distribution).
ii. Access points – establish how access to a certain part of the equipment is to be achieved (identify any designated anchor points for safety harnesses.)

18. The Manufacturer, employer and person planning the work must assess the risks from residual energy. The equipment must be rendered so that the residual energy does not introduce additional risk.

19. In all circumstances consideration must be given to the 'human factor'. You should take a good look at how your own machines operates, the location of controls, the layout of plant and the tasks that are carried out. Make sure you not only consider the routine day-to-day tasks but those that occur during maintenance and when things go wrong. You should ask yourself "Where do people work and what do they do when they get there?" Remember, many accidents happen when things go wrong.

It is important to recognise that every human being is prone to human failure. This includes making errors and, in some circumstances, violating safety rules and procedures. You should never rely on an individual getting it right 100% of the time to prevent serious injury. The potential for people to make errors and to violate rules and procedures should be taken into account when undertaking risk assessments, designing safeguards and when preparing safe systems of work and procedures. (For further guidance see appendix 2. How safe are your arrangements?)

Example of an Isolation & Lockout procedure.

The Basic Principles
Before any plant is inspected, repaired, maintained or cleaned, it **MUST** be shut down and its energy source locked out as part of an isolation procedure to ensure the safety of all those doing the work.

The aim is to:

- Isolate all forms of potential hazardous energy to ensure that an accidental release of hazardous energy does not occur.
- Control all other hazards to those doing the work
- Ensure that entry to a restricted area is tightly controlled

The basic principle is comprised of five separate steps:

1. LOCK
2. ISOLATE
3. TAG
4. TEST
5. CHECK

The success of the basic principles depends on two key factors:

- through training of all workers in isolation procedures; and
- the disciplined exercise of individual responsibility in always following the procedures

This establishes the minimum requirements for the lockout of energy isolating devices whenever cleaning, maintenance or servicing is done on machines or equipment. It shall be used to ensure that the machine or equipment is stopped, isolated from all potential hazardous energy sources and locked out before employees perform any cleaning, maintenance or servicing where the unexpected energisation or start-up of the machine, equipment or the release of stored/residual energy could cause injury.

Stored/residual energy within a machine or piece of fixed plant can result from any component that is controlled/operated by either Hydraulic or Pneumatic pressure systems or a component that can move or travel under its own inertia or by gravity. A machine that is stopped from operating either by the normal control circuit or via an emergency stop, could exhibit either of the items listed above.

Physical Isolation of process equipment should be carried out before entry is gained to the equipment. This procedure may take the form of locking off an electrical isolator, chaining off a spindle valve, etc. to allow personnel working on the equipment to attach a personal or departmental padlock. Isolation of the equipment upstream & downstream may be required; to ensure the equipment being worked on does not include risk from powered movement, residual energy or uncontrolled movement. It is not acceptable for safety interlocks to be used for isolation purposes.

Sequence of Lockout. – (See appendix 1.1 flowchart)

1) Notify all affected employees that cleaning, servicing or maintenance is required on a machine or equipment and that the machine or equipment must be shut down and locked out to perform the task.

2) The authorised employee shall identify the type and magnitude of the energy that the machine or equipment utilises, shall understand the hazards of the energy, and shall know the methods to control the energy.

3) If the machine or equipment is operating, shut it down by the normal stopping procedure.

4) De-activate the energy isolating device(s) so that the machine or equipment is isolated from the energy source(s).

5) Stored or residual energy (such as in springs, raised machine components, rotating flywheels, shredder drums, hydraulic, air or gas systems etc) must be dissipated or restrained by methods such as; Blocking, bleeding pressure systems or repositioning components etc.

6) Lock out the energy isolating device(s) with assigned muti-hasps and individual lock(s).

7) Ensure that the equipment is disconnected from the energy source(s) by first checking that no personnel are around the machine or equipment, then verify the isolation of the equipment by operating the start button or other normal operating controls or by testing to make certain the equipment will not operate. **CAUTION**: return the operating controls to neutral or "off" position after verifying the isolation of equipment.

THE MACHINE IS NOW LOCKED OUT.

When the cleaning, maintenance or servicing has been completed and the machine or equipment is ready to return to normal operating condition, the following steps shall be taken. (See appendix 1.2 flowchart)

1) Check the machine or equipment and the immediate area around the machine or equipment to ensure that non-essential items have been removed and that the machine or equipment components are operationally intact.

2) Check the work area to ensure that all employees have been safely positioned or removed from the area.

3) Verify that the controls are in neutral.

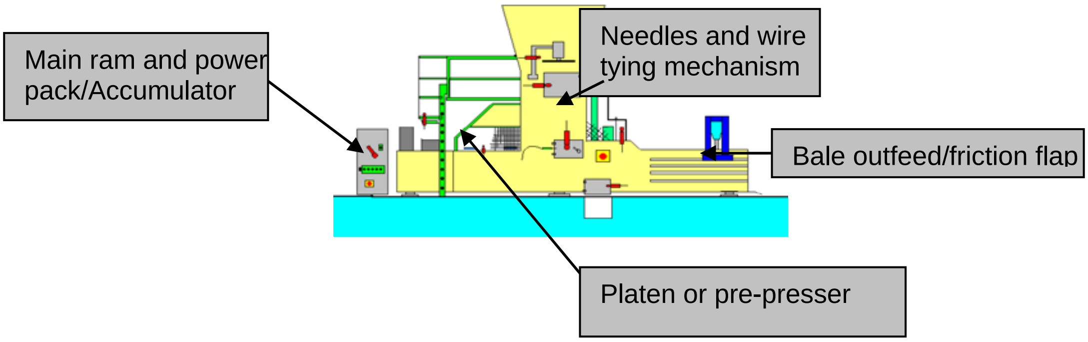
4) Remove the lockout devices and re-energise the machine or equipment. NOTE: the removal of some forms of blocking may require re-energisation of the machine before safe removal.

5) Run up and test machine or equipment and operate all the stop and emergency stop controls in turn, ensuring that they all function in the correct manner.

6) Notify affected employees, that the cleaning, servicing or maintenance is completed and the machine or equipment is ready for use.

All locations should produce site-specific instructions for lockout, which will be applicable for the equipment used in that location.

Examples of stored energy within a typical existing horizontal baling machine,
(Information kindly supplied by Persona and Biffa Waste Services)



- The **Platen** or **pre-presser** can store energy. If the baler is stopped when the pre-presser is not in its fully rear or fully front position there will be a risk of continued movement, if the doors at the pre-presser are opened. The doors should only be opened when the pre-presser is in its fully rear or fully front position.

- The **main ram** can store energy. If the main ram is stopped in its front position energy will be stored from the expanding bale. Release the pressure by driving the main ram backwards before maintenance is done on the hydraulic unit, main ram or pre-presser. You do this normally from the control panel in manual mode. When the baler stops in automatic mode it stops in its rear position.

- The **friction flap** can store energy. The friction flap and its hydraulic cylinders can sore energy from the expanding bale. Open / release the friction flap before maintenance is done on the friction flap. You do this normally from the control panel in manual mode.

- The **needles** can store energy. A hydraulic motor drives up and down the needles. A brake stops the hydraulic motor if the hydraulic system does not work. On some machines, these needles operate horizontally; there is a reduction in risk with this type.

- The **accumulator** store energy. Release the pressure from the accumulator before maintenance is done on the hydraulic system. The valve under the accumulator releases the pressure. Only older models have an accumulator.

Remember to ISOLATE and LOCKOUT before undertaking any maintenance or cleaning

Appendix 1.1 Before Completing Maintenance or Blockage Removal

Physical isolation of the equipment **must** be carried out before entry to the equipment is attempted.

1) Notify all affected employees that cleaning, servicing or maintenance is required, and that the machine **MUST** be shut down; **ISOLATED** and **LOCKED-OFF**

2) Authorised person to identify all energy sources and hazards and know the methods to control the energy

3) Switch Off All Relevant Machinery

Baling Press Isolation

Turn Off
- Hogger/Shredder
- Baler
- Conveyor

Sorting Floor Isolation

Turn Off
- All sorting floor conveyors

Dissipate or Restrain Stored or Residual Energy

i.e. springs, raised machine components; flywheels, shredder drums, hydraulic, air or gas systems etc...

Consider All Forms of Power

Machinery should be Isolated such that residual energy cannot be discharged and that uncontrolled movement does not occur when power is disconnected

4) Remove Key from Control Panel

Minimum of 2 People. 1 operator and 1 authorised person.

ONE LOCK EACH

5) Switch off power at the main control panel

6) Isolate the switch with a unique padlock

7) Remove key and keep on person

8) Inform supervisor & all other parties of the situation

9) Wait until run down time of machinery has completed

* **10)** Check machine area is clear of personnel then test by 'trying' to re-activate the plant

11) Follow blockage removal procedure / SSoW

Locking Off Machinery *

This is the most effective way of preventing machinery becoming operational. It effectiveness lies in the "one key per lock, one lock per person"

NOTE*

If there is only one key per lock, the key must be held by the person carrying out the work

CAUTION*

Return the operating controls to neutral or 'off' position after checking the isolation of equipment

Appendix 1.2 After Completing Maintenance or Blockage Removal

1) Check the machine or equipment and the immediate area to ensure non-essential items have been removed and components are operationally intact.

2) * Check the work area to ensure all personnel have been safely removed from the area

CAUTION*
Persons in AREA.

There may still be a potential risk that persons are present in the work area. Check area and inform supervisor and all interested parties that the machinery is to be switched on

3) Verify that the controls are in neutral

4) ***Unlock and Remove Padlock**

NOTE*
The person who puts the lock on is responsible for removing it. Under NO circumstances should a personal lock be removed by another person, unless authorised in writing.

NOTE*
The removal of some forms of blocking may require re-starting of the machine before safe removal

Turn Power On

Replace Key in the control Panel

Switch Equipment On

Start up Relevant Equipment
Following correct start up procedures

Test all the stop and emergency stop controls, ensuring that all function correctly

Notify all employees, that the work is completed and the equipment is ready to use

Fill out Isolation Sheet
To record the isolation

End of Shift*
Keys should be handed over at the end of the shift if isolation of machinery is still effective. The on coming shift MUST apply their personal locks before continuing

* Isolation & Lock-Off Procedures, CPI

Appendix 2. How safe are *your* arrangements?

Everyone knows that machinery must be safeguarded to prevent access to the dangerous part or to stop the movement of the dangerous part before any part of a person enters the danger zone. Despite this machines continue to kill and inflict serious injuries. Accidents happen when guards or safety devices are disturbed, removed, overridden or defeated or when people go inside guard enclosures for carrying out tasks such as setting, adjustment, cleaning, clearing blockages or running maintenance.

So what are *you* doing to make sure accidents will not happen at your machines? You may have provided a safe system of work and you may have trained relevant employees in that system of work. But that alone will not guarantee success. Human beings are prone making errors and they will violate rules especially if they are working under pressure or if they perceive that their supervisors or managers do not think the rules are important. They are likely to have this perception if supervisors do not always enforce the rules, if managers never check how well the rules are being followed and if supervisors or managers do not intervene every time they see a rule being broken. Employees are also more likely to violate rules if the rules are impractical or if they were not involved and consulted properly when the rules were written.

Here are some questions for you to ask yourself about the tasks your employees perform at machines.

Checklist	**YES**	**NO**
1) Have you identified all operational and maintenance tasks that *could potentially* involve working inside guard enclosures, disturbing guards or overriding or defeating safety devices?		
2) In identifying these tasks have you looked at the way they are performed on *by everyone?*		
3) Do they include tasks that are carried out infrequently?		
4) In identifying these tasks did you observe work activities and look out for situations in which the working environment, plant layout and access make the job awkward and would be easier to perform from inside the guard, by removing the guard or defeating the safety device?		
5) Do these tasks really need to be performed at all?		
6) Do they need to be done that way?		
7) Can layout and access be improved to remove the need for disturbing guards or working inside enclosures?		
8) Can hardware, controls, adjustment devices, web and sheet feeding systems etc be modified to allow the job to be done safely from outside the guard enclosure?		
9) Have you carried out a detailed risk assessment for each task?		
10) Did the people who actually undertake the tasks participate in the risk assessment?		
11) In assessing the risks did you break the task down into its component steps?		
12) In assessing the risks associated with each task step have you systematically evaluated the potential for human errors including slips, lapses of memory, rule-based mistakes and knowledge-based mistakes and the potential for rules and procedures being violated?		
13) Have you examined past incident and accident reports for the tasks under consideration to identify human errors and rule violations?		
14) Can the hardware, controls, adjustment devices, feed systems be modified to eliminate or minimise the risk of human error and reduce the likelihood of rules and procedures being violated?		
15) Can they be modified or additional safeguards provided, to make the arrangements error-tolerant so that human errors, if made, do not result in serious outcomes?		
16) Where appropriate, are there formal safe working procedures to be followed by those who perform the tasks?		
17) Do they identify the hazards and deal properly with the risks?		
18) Are they in a format that is standard (i.e. common) across the site?		
19) Have they been written according to sound human factors principles (see pages 26 to 31 of HSE publication "Reducing Error and Influencing Behaviour" (HSG 48))?		

20) Were they written by, or with the full involvement of, the people who perform the tasks?		
21) Do the employees who are required to follow the procedures value them?		
22) What is their perception of the importance that managers place on complying with the procedures compared with their perception of the importance managers' place on achieving productivity?		
23) How do senior managers, managers and supervisors communicate to the workforce the importance they attach to rules and procedures being followed properly at all times?		
24) Do managers and supervisors always observe the rules and follow the procedures themselves?		
25) Do they always intervene if they see a procedure not being followed, or not being followed properly?		
26) How well are people trained in the procedures?		
27) Do managers and supervisors monitor/check that important safety rules and working procedures are complied with?		
28) Do they report the results of monitoring checks to senior managers?		
29) Do senior managers ask for the results?		
30) How are the results analysed and used to review and improve performance?		