Chapter 15

Machinery and equipment

The hazard

Machinery and equipment are involved in many of the accidents and ill health in our industries. Deaths and serious injuries are often associated with mobile plant e.g. forklifts [e.g. pinning of worker/operators between loads], working underneath vehicles.

Many safety hazards are associated with the movement of people, goods and vehicles into, around and out of workshops.

Of these "movement" accidents:

- About half involve lifting and moving goods, and
- About half involve slips, trips and falls and hitting stationary or moving plant and equipment.

"Non-movement" accidents usually arise from the use of machinery and electrical accidents are not uncommon. Injuries are caused by the parts that move or transmit power and the parts that do the work. The most common occupational diseases associated with equipment are dermatitis, deafness, asthma and back, hand, arm, shoulder and neck problems.

In any workshop, risks which are relevant should be assessed. Those likely to be of most concern include:

- Movement of people, goods and vehicles around the workshop, particularly in manual handling
- Machinery safeguarding
- Hazardous substances, particularly metalworking fluids, degreasing solvents, and dust or fumes from welding, brazing, coating and painting
- Noise
- Vibration.

Common problems with machinery and equipment include:

- Using the wrong equipment for the job
- Inadequate or poor guards – bad design so that the job is easier to do with the guards disabled or by-passed
- Failure to keep guards, safety devices, controls etc. properly maintained
- Inadequate or the wrong type of controls so that equipment can't be turned off quickly
- Failure to give the correct information, instruction and training to users of equipment
- Poorly designed equipment that requires the body to strain or adopt awkward postures
- Production targets or quick runs that lead to cutting of corners.

Prevention of injuries requires well designed equipment:

- Guarding that prevents access to dangerous parts
- Control of all electrical hazards – lock-out procedures and disable power sources, automatic cut-outs
- Easily accessible emergency stops
- Controls well marked, easy and safe reach
- Easy and safe access for adjustment, cleaning and maintenance – repairing or clearing malfunctions
- Proper leg room, knee clearance and foot rests
- Hand grips for small and large hands
- Work surface just below elbow height
- Removal of noise, dust and fumes
- Comfortable to operate
- Limit awkward postures and provide easy access to parts for cleaning, maintenance and repair.

The Regulations

The PCBU/employer obligations to control the risks from machinery and equipment include but are not limited to:

- Control of risks arising from installation or commissioning
- Preventing unauthorised alterations to or interference with plant
- Proper use of plant and controls
- Plant not in use
- Guarding
- Guarding and insulation from heat and cold
- Operational controls
- Emergency stops
- Warning devices
- Maintenance and inspection of plant

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There are extra obligations for the following:

- Powered mobile plant – general control of risk
- Powered mobile plant – specific control measures
- Industrial lift trucks
- Plant that lifts or suspends loads
- Plant not specifically designed to lift or suspend a person
- Industrial robots
- Lasers
- Pressure equipment
- Scaffolds
- Plant with presence-sensing safeguarding system-records

The Code contains practical advice on how to control the risks.

Machinery and equipment are often the source of other hazards e.g.:

- Noise
- Chemicals
- Fumes and dusts
- Diesel exhausts
- Hazardous manual handling.

Hierarchy of control

As with any hazard, the hierarchy of control must be used when controlling the risks associated with the use of machinery.

Elimination is the permanent solution to the problem and is often the most long-term cost-effective option. It is achieved by:

- Removing the machinery/equipment or the system of work associated with the machinery/equipment which presents the risk
- Purchase of raw materials in useable form – avoiding the need to cut/process materials using unsafe plant
- Initial design, planning, or purchase of plant to ensure hazards have been controlled.

Substitution can involve the replacement of plant or parts of plant with those which present no or a lower level of risk; it may be possible to use a physical (hand-held) process of lower risk to replace a process.

Isolation means removal of persons who may be exposed from the risk:

- Erection of barriers and enclosures
- Separation of people from the hazard by enforcement of distance
- Enclosure of a noisy machine with sound absorbing material
- Fitting of feed chutes to machines which are of a length which prevents body parts reaching the danger point
- Repositioning of plant to provide a safe distance
- Erection of barriers to prevent persons being struck by ejections from the plant.

Engineering control means measures to change the physical characteristics of a plant to eliminate or reduce risk:

- Machine guarding (fixed, interlocked or approved)
- Ventilation systems
- Automation
- Physical modification of tools or equipment

For any one piece of plant/machinery or equipment, a combination of control measures will be necessary.

Administrative measures and personal protective equipment are the last line of defence and must only be used in combination with any, or all of the above.

And always, no matter what, workers need to be trained and skilled for the job. Everyone needs to know how to use the equipment safely. This includes temporary, casual or someone filling-in. Inexperience and lack of information and training puts workers lives at risk – literally.

Case studies

Power press:

- The worker was changing the dies after having turned off the power. The worker had to put their hands in the trapping space but inadvertently presses the foot pedal. The stored energy in the fly wheel allows for one uncontrolled stroke which amputates the workers' fingers.
- The injury would have been prevented using isolation procedures which took account of all energy sources – actual and potential.

Vertical compression rollers:

- The worker feeds product into a set of vertical compression rollers. The workers' hands are frequently close to in-running nip points. The worker impulsively grabs a foreign body from the product which results in crushing and amputation injuries to the right hand.
- The hazards of in-running powered nip points are often not recognised. The injury would have been prevented by a fixed or interlocked guard that allowed reasonable access but stopped bodily contact while the roller was in motion.

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Case studies

Screw auger:

- An 18 year-old worker with six months experience was cleaning product from the base of a screw auger. The power was turned off. The worker puts hands inside auger casing through inspection opening. The machine was started by another employee from the control panel in an adjacent building resulting in fingers being amputated.
- This injury would have been prevented if the stop/start controls were positioned appropriately, i.e. where the workers have easy and emergency access to controls, during the design/installation of the machinery. Plant and isolation procedures must be positive and designed to fail to safe condition.

Lockout procedures

Lockout/isolation procedures prevent the risk of machinery and equipment being inadvertently started during maintenance, breakdowns, cleaning etc. People are often injured when plant operators are unaware that someone else is working on the machinery.

Lockout and isolation procedures are essential to de-power and de-energise energy sources.

Essential features of any isolation procedure are:

- There must be no duplicate keys
- Every person must have an assigned padlock
- Roles and responsibilities must be defined
- Tagging out is a warning identifying who to contact. It is not a lock or a form of isolation.
- Each worker involved in the maintenance, cleaning or repair of the plant should have a lock, tag and key for each isolation point. A set of master keys should be kept in a secure location and should only be used in an emergency.
- During development of the procedure everyone must be consulted - machine operators, maintenance, cleaners, supervisors, HSRs etc.

Steps to isolating plant

Isolation procedures need to be developed in consultation with workers. Each procedure will involve the following steps:

1. Identify all energy sources

All energy sources and their controls must be identified and recorded including electricity, steam, pressurised fluids and circuits, e.g. air, water, hydraulic oil, stored energy (in batteries, capacitors, springs, flywheels etc.), gravity, radiation.

2. Step by step plant shutdown

The procedure for shutting down the plant in the correct order should be determined and recorded.

3. Isolate all the energy sources

Such as multiple control stations, local isolators, independent energy sources and single/multiple point isolation. Ensure the operator and all associated workers are aware of what work is being conducted.

4. The machinery should be designed with clearly marked identifiable isolation points

It is important to remember that:

- Emergency stopping devices are not isolation points and must not be used for isolating machinery.
- Electrical isolators may only isolate control circuits. This is not an adequate level of isolation.
- Shutting down machinery/plant may require single or multiple energy sources to be shutdown,
- Sometimes in a certain order.

5. Isolate all energy sources

There may be multiple control stations or independent electricity sources. Some machinery will require electrical circuits, connecting equipment and circuit protection devices to be de-energised.

6. De-energise stored energy sources

Energy may still be stored, even after energy sources have been isolated. Stored energy includes static, kinetic (e.g. rotational motion) and potential (e.g. due to the plant's position).

Stored energy can be:

- Released by earthing to the ground, allowing the machine to complete its motion (particularly after breakdown).
- Contained by preventing movement through blocking, wedging or propping the part. Ensure blocks, wedges or props are designed for this task and can only be removed by a deliberate release action. Consider any negative pressure used to activate some types of plant.

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7. Lockout isolation points

When locking out equipment, PCBU/employers must ensure:

There is one lock fitted for each person performing maintenance or non-production tasks. If there is more than one isolation point, each person will require sufficient locks to lock out each isolation point.

There is a lock for each worker attached to isolation points that need to be isolated by more than one worker. This should be identified in the isolation procedure:

- Locks are kept on until the work is finished or the work is passed on to another worker.
- Multiple locks at each point are avoided by using a lock box.
- There is only one key for each lock, apart from a master key that should be given to a responsible person and stored in a secure location for emergencies only. If someone has multiple locks assigned to them, they can hold one key for all locks.

8. Lockout isolation points – out of service locks

Make sure a supervisor or nominated person has been allocated with out of service locks and there is a system to fit locks to jobs that run over one shift or day:

- Machinery/plant has been tagged with the appropriate tag
- Tagging is not an isolation procedure, it is a warning of who to contact
- Personal danger tags (red and white) warn that someone is working on the machinery. These tags should only be attached after the machinery has been locked out and must be in clearly visible areas
- Out of service tags (yellow and black) are used when machinery is out of operation. If these tags are placed on machinery with isolated energy sources, they should only be done when it is locked in the safe (off) position.

9. Confirm isolation – Confirm all isolation steps have been carried out effectively and ensure that:

- No errors have been made (e.g. correct isolators have been selected).
- Isolators are in safe position
- All stored energy is dissipated or restrained
- Locks are attached to each isolation point for each worker performing work
- There is confirmation that all steps have been undertaken.

10. Test for zero energy

Test that isolation of energy sources has been successful. Testing should be done using appropriate equipment and by someone who is suitably qualified and understands the machinery, energy sources, energy principles and isolation procedures.

11. Changing shifts or crews

If work is being taken over by the next shift or another crew, a handover must occur. This involves discussing the stage the work is at and changing over locks and personal danger tags.

Removing another worker's locks and tags. The only worker who should remove personal danger locks and tags is the person who put them in place. If the worker cannot remove the lock and tag, ensure that:

- A senior person is accountable for the lock and tag
- The situation is assessed to be safe before removing the lock and tag
- The removal is validated and signed off by two or more people
- Removal is only done by an approved process. Removal by another method must be accompanied by signed and dated documentation.

12. Reactivate isolated plant

Isolation procedures should include tasks for reactivating the machinery/plant.

Reactivating procedures must ensure that:

- Everyone has finished their work and is aware of the start-up
- All workers are a safe distance away from any hazardous area
- Blocks, wedges and props used to prevent parts from moving are safely removed (this will release energy)
- Guarding is replaced
- Locks and tags have been removed by the workers who placed them
- Sensory guarding is reactivated and tested to ensure it is functional
- Emergency devices are reactivated and tested (e.g. stop buttons and pedals)
- Everyone understands the method and order energy will be restored to each isolated point.

Resources

Engineering workshops: This refers to UK law but the detail and principles apply – for example section on CNC machine safety:
http://www.hse.gov.uk/pubns/priced/hsg129.pdf