ELEMENT 5 WORK EQUIPMENT - HAZARDS AND RISK CONTROL

Learning outcomes

On completion of this element, candidates should be able to demonstrate understanding of the content through the application of knowledge to familiar and unfamiliar situations. In particular they should be able to:

- Outline general requirements for work equipment
- Outline the hazards and control measures for hand-held tools, both powered and non-powered
- Describe the main mechanical and non-mechanical hazards of machinery
- Explain the main control measures for reducing risk from common construction machinery hazards.

5.1 THE SUPPLY OF MACHINERY

THE MACHINERY DIRECTIVE

The standards in the machinery directive define how essential safety requirements (ESR) are met. The European Committee for Standardisation (CEN) and the European Committee for Electrotechnical Standardisation (CENELEC) are responsible for producing standards, the British Standards Institute is the UK member on these committees. In the UK, the European Standards are transposed into BS EN standards, these are known as transposed harmonised standards.

From 1 Jan 1995 all relevant machinery put into use in the EU must bear the CE mark, this covers new machinery, imported items and modified machinery. It is illegal to supply new machinery in the EU without the CE Mark, it is the passport for the free movement of goods within the EU.

Supply of Machinery (Safety) Regs 2008

Relevant Machinery - This includes:-

“An assembly of linked parts, at least one of which moves, includes power circuits joined together for a specific application.”

“An assembly of machines.... which are arranged and controlled so that they function as a whole.”

“Interchangeable equipment modifying the function of a machine which is supplied with the purpose of being assembled with a machine... not a spare part or tool”

Supply of Machinery (Safety) Regulations - The Process

Step 1 Fulfil Essential Safety Requirements
Step 2 Prepare Technical File
Step 3 Prepare Declaration of Conformity
Step 4 Affix CE Mark

The designated responsible person within the organisation must ensure machinery:

- satisfies H&S requirements

- undergoes conformity assessment,
- has EU declaration and CE mark or declaration of incorporation
- is safe

There are general requirements which need to be met covering issues such as:-

- Markings
- Instructions for purchasers
- Specific requirements apply for specific hazards and specific machinery

Hazardous Machinery

Certain machines are judged high risk, these are listed in Schedule 4 of the regulations. Many are identical to those listed as dangerous machines in existing legislation. These require external verification that all essential safety requirements have been met.

Examples: circular saws, sawing machines, planning machines, band saws, portable chain-saws, presses, plastic moulding machines, machinery for working underground, household refuse trucks and vehicle servicing lifts.

5.2 TYPICAL CONSTRUCTION MACHINERY ACCIDENTS

Accidents occur for a variety of different reasons:-

- Poor design
- Human failing
- Carelessness
- Lack of Knowledge
- Incorrect tool
- Ignorance
- Poor maintenance
- Lack training or instruction

PILING OPERATION - CRUSH INJURIES

During a Secant Bored piling operation an operative sustained serious crush injuries to his legs when he was struck by part of the Piling equipment.

During the extraction of the Pile casing which also includes filling the with concrete, an Oscillator Unit (left of picture) is used to act as a clamp that encloses the top of the pile casing to prevent the casing descending back into the ground under its own weight.

However due to inadequate communication procedures between the team the pile casing was rotated with the Oscillator still clamped to it. This caused the Oscillator to unexpectedly rotate towards the Piling Rig.

The Injured person was standing between the piling rig and the Oscillator and was trapped by his legs between the tracks of the rig and one of the projecting arms of the oscillator.

Learning Opportunities

1. Never stand between items of site plant where there is any possibility of being trapped (crush zones)
2. Demarcate and exclude all persons from crush zones
3. Clear understanding of bespoke signalling arrangements
4. Ensure good line of sight between all persons involved in the operation
5. Ensure the operation is properly planned to provide a safe system of work
6. Be prepared to re-plan if the circumstances change

OVERHEAD TRAVELLING CRANE

A maintenance fitter and apprentice were sent to carry out routine maintenance on three cranes within the works. The crane track was 91 metres long approx and 12 metres above the ground. The bridge walkway was reached by a fixed ladder located at the rear of the drivers cab. When work was completed on the second crane, the tools were placed on the crane bridge and the apprentice was asked to drive the crane to where the third crane was parked. As the crane moved slowly along the fitter was crushed between a roof truss and a fixed part of the crane. The clearance between the crane and the roof trusses in this case was minimal.

The method for working on the cranes was developed through custom and practice, fitters were often required to ride on the walkways for maintenance purposes. It was common practice to crouch down and shout instructions to the driver, these were often misinterpreted.

Employees involved in maintenance were authorised crane operators and apprentices were allowed to use the crane under close supervision. Safe working practices had not been laid down but had merely evolved.

LADDER FATALITY

A maintenance engineer died in hospital after falling from a ladder which he had been using to change an indicator bulb on an overhead crane. There were no witnesses but a ladder was found next to his body.

Other maintenance engineers confirmed that the use of a ladder for such work was the norm. The ladder used was too short for the task and had no guard rails etc.

No risk assessments on any maintenance tasks had been carried out.

No formal training had been given on the use of ladders.

DUMPER TRUCK

As Brian, the works chippy walked along the wet and muddy site road carrying a length of 3 by 6, his foot slipped. The timber swung round his shoulder and was hit by a passing dumper truck. The timber was dragged from his shoulder leaving several massive splinters in his neck and back.

5.3. THE SELECTION OF WORK EQUIPMENT AND MACHINERY

a. LEGAL BASIS

Manufacturers and suppliers of new machinery have to meet certain standards as suppliers, the main legislation is the Supply of Machinery (Safety) Regulations 1992. These regulations require manufacturers and suppliers to ensure that machinery is safe when supplied and to have CE marking.

As an employer whose staff will be using the equipment, this is covered by the Provision and Use of Work Equipment Regulations 1998 (PUWER) apply which require the right kind of safe equipment to be used at work. They must also ensure that it can be used correctly; and that it is maintained in a safe condition. Equipment put into use before 1/1/95 will not have the CE marking but must still meet the provisions of PUWER.

If a new piece of equipment (including machinery) is purchased, the employer must check that all the supply legislation is met as well as that covering the use of the equipment.

b. Machinery

A machine is normally regarded as being a piece of equipment which has moving parts and, usually, some kind of drive unit. Examples include:

fork lift truck/ abrasive wheel / band-saw

c. Manufacturers and Employers Responsibilities

When an employer places an order for machinery they must specify that the equipment is safe. When it arrives it should be checked to ensure it bears the CE mark and has a Declaration of Conformity. A set of instructions in English on how the machine works or operates should be provided, then the employer must check it is safe to use.

The employer's check should consider:-

- Are there any exposed mechanical hazards? eg exposed gear wheels or blades?
- Can the machine operate with the guards removed?
- Are the controls clear and easy to understand?
- Can dust or fumes escape from the machine?
- Is it excessively noisy or is there excessive vibration?
- Are any exposed parts likely to be extremely hot or cold?
- Are there any live electrical parts which are exposed or easy to get at?
- Are there any special features, eg slow running speed, for use when setting?
- Are the manufacturers' instructions clear and comprehensive?

By producing an assembly line, through connecting several machines together, the employer becomes the supplier and must comply with some of the requirements of the supply law.

Do not assume just because the equipment has the CE mark that it is safe.

5.4 PROVISION AND USE OF WORK EQUIPMENT REGS 1998

Machinery and equipment are covered by the Provision and Use of Work Equipment Regulations 1998.

"any machinery, appliance, apparatus or tool for use at work"

This wide ranging definition quite literally covers the pen you use at work as well as any automated plant and machinery. The Regulations set some basic standards for all equipment used at work. They where amended in 1998 and now cover power presses, abrasive wheels, wood working machines and lifting equipment. (Although this is additionally covered by the Lifting Operations & Lifting Equipment Regulations 1998 (LOLER).)

Examples of work equipment: hammers, screw drivers, drilling machines, laboratory apparatus, hoists, fork lift truck, ladders and knives.

a. OVERVIEW OF THE REGULATIONS

SUITABILITY - All work equipment must be suitable for the task and the working conditions where it is being used. Consideration should be given to the equipment's design and use.

APPROPRIATE MAINTENANCE - This could range from fault reporting to planned preventative maintenance. Where it is carried out, records must be kept. It must also be carried out safely. All equipment must be maintained in a good condition and in safe working order.

INSPECTION – Equipment should be inspected if there could be significant risks from incorrect installation or deterioration. Records should be kept.

SPECIFIC RISKS - Where the risk is high e.g. using a band saw, the use and maintenance must be restricted to trained competent people.

INFORMATION, INSTRUCTION - For managers and employees, including the hazards, safe use and emergency procedures.

TRAINING - For employees and others e.g. casual workers, this may include training in the safe system of work or permit to work.

EU CONFORMANCE – See section 3.1

DANGEROUS MACHINERY - Access to moving parts, blades pulleys etc must be prevented. This will normally be achieved by guarding and safety devices.

DANGEROUS PARTS OF MACHINERY – The employer should follow a hierarchy of controls which begins with a fixed guard, if this is not possible other guards and protection devices should be used. In addition the provision of jig sticks, push rods may need to be used, with training, information and instruction for staff provided to ensure safe use.

The requirement to guard dangerous parts was amended in 2002 to avoid employers removing guards which the manufacturer has fitted, as the health and safety inspectors could only prosecute under "suitability" or "maintenance" not because the guards were not in place.

The employer must ensure that equipment complies with all essential safety requirements which where there when it was first supplied.

Where there is a risk of mechanical contact the hierarchy of controls must be used – the existing Regs have the same requirements but the EEC were concerned employers could rely on training at the bottom of the hierarchy rather than going down the hierarchy in stages.

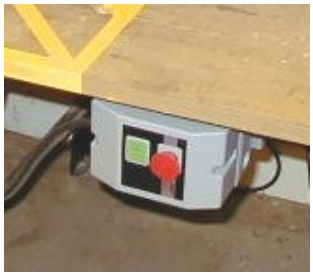
Where practicable fit a **Fixed** guard – if not possible then …
Other guards – if not possible …..then …
Jigs and push sticks
Training, information, instruction and supervision as necessary

This is a change of law but those using best practice would not have relied on the last option but would have guarded where possible, as such the impact may be minimal.

SPECIFIED HAZARDS e.g. OVER HEATING or EJECTION - appropriate precautions must be taken to minimise the effects should this occur.

HIGH / LOW TEMPERATURES - must be controlled to reduce risk of injury. The body of a machine or tool may get very hot.

CONTROLS - These must be easily identifiable, in full working order, easily accessible, clearly visible and work in an appropriate manner. Suitable controls for starting, stopping and controlling speed should be fitted. Emergency stops will also be needed for machines where other safeguards do not prevent the risk of needing to stop the machine in an emergency. Should be easily reached and actuated and including mushroom-headed buttons, bars, levers, kick-plates or pressure sensitive cables. These must be easily accessible.



ISOLATION - electrical plant must be able to be isolated from the power source to prevent it being turned on during maintenance. This may also apply to isolating pipelines.

STABLE - every piece of work equipment must be stable for use.

LIGHTING - adequate for the task and to use the equipment safely.

MARKINGS & WARNINGS - UNAMBIGUOUS following appropriate European or British standards.

CARRYING EMPLOYEES ON MOBILE EQUIPMENT – This should not be done unless the equipment is designed for this purpose.

ROLLING OVER OF MOBILE EQUIPMENT – Measures should be taken to reduce the risk of roll over which may be more of a risk in certain environments. Roll over protection must be fitted where necessary, i.e. cages, roll over bars.

OVERTURNING OF FORK LIFT TRUCKS – Measures to reduce the truck from over turning, additionally restraining systems may be needed to protect the driver. (i.e. seat belts)

SELF PROPELLED WORK EQUIPMENT – Measures should be taken to prevent unauthorised starting and to minimise collisions. All equipment should be fitted with a suitable and effective braking system.

REMOTE CONTROLLED SELF PROPELLED EQUIPMENT – This type of equipment should stop if it leaves its control range. It should include devices to ensure the risks of crushing and impact are controlled.

DRIVE SHAFTS – These convey power from mobile equipment to any equipment connected to it. Measures should be taken to ensure the operating mechanism does not become blocked, and that the shaft is safe guarded.

5.5. PRINCIPLES OF MACHINERY SAFEGUARDING

The fact that a company has not had an accident so far, is not an indication of its safety or compliance with statutory obligations, neither does it indicate how safe any moving/stationary part of a machine is!

DANGERS FROM MACHINERY

Injury can result from:

- Coming into contact with or being trapped between the machine and any other fixed machine/structure/material.
- Being struck by any material in motion or being ejected from a machine.
- Being struck by any part of the machine.
- Becoming entangled in the machine.

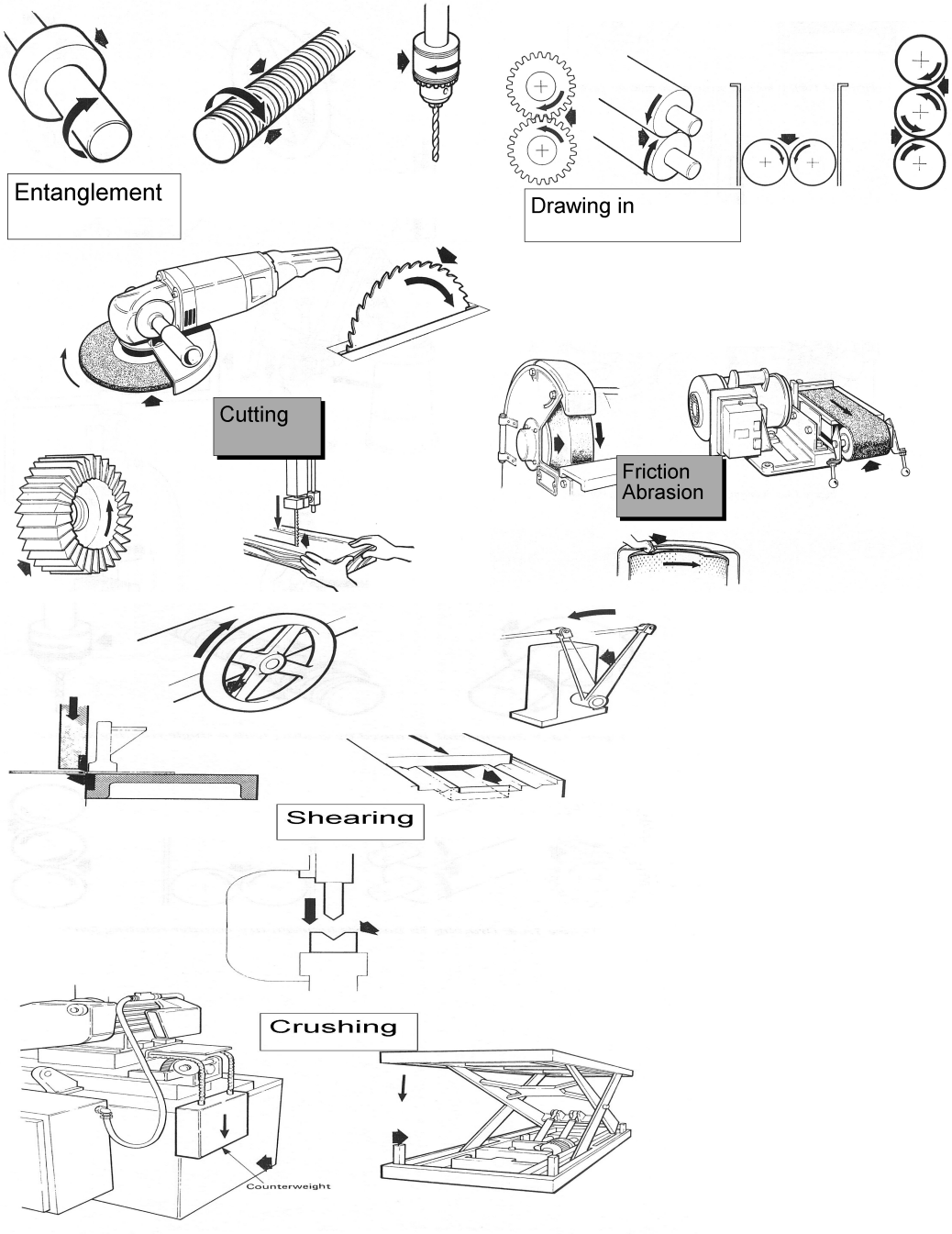
Mechanical Hazards : Entanglement, stabbing, impact, cutting, shearing, drawing in, crushing ejected particles, ejected liquids & abrasion.

Each year there are an estimated 16,000 accidents involving machinery.

Accidents that occur through lack of, or inadequate, guards are with very few exceptions, serious, resulting in crushed or amputated limbs and on many occasions, death. Over 50% could have been avoided if the existing standards were implemented.

The standards in the UK regarding safeguarding of machinery: British Standard BS 5304 - BSI's Code of Practice on the "Safeguarding of Machinery", they have been updated on a number of occasions and are now covered by BSEN 12100 – Safety of Machinery. Mechanical hazards include cutting, abrasions, stabbing, shearing, ejection of fluid, impact, crushing, drawing in, entanglement and slips and trips!

Typical Mechanical Hazards



5.6 TYPES OF SAFEGUARDS

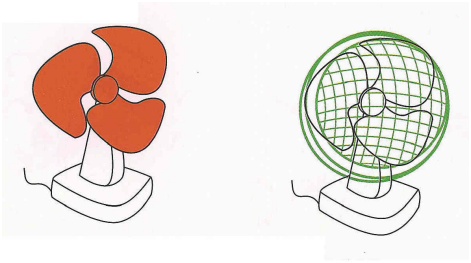
Any guarding fixed to a machine must not introduce further hazards such as trapping points, sharp edges or access problems. The guard must be made from suitable material, strong enough for the task and environmental conditions. It must also be able to withstand day to day use and possible misuse and interference.

General requirements for guarding:

- Strength, stiffness, durability
- Effects on the machine will it make it difficult to use?
- Visibility
- Will it create or more hazards (eg noise or trapping points)

SAFEGUARD - A guard or device designed to protect persons from danger.

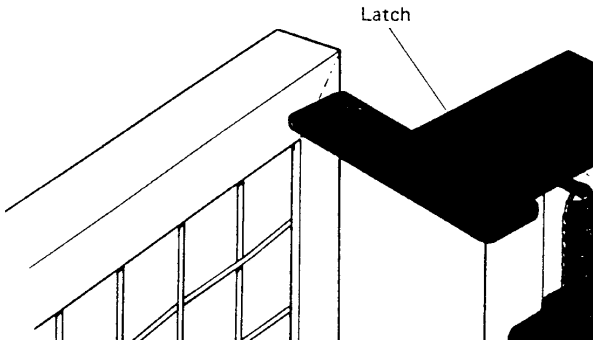
FIXED - A guard which has no moving parts, it prevents access to the danger and is in place all the time. It should not be easily removable. e.g. Cage around pulley & metal case around video recorder. Many will need a special tool to remove them. Large fixed guards may make it difficult to maintain the machine or may restrict visibility to the user. (A distance guard is usually a form of fixed guard – there to keep people and parts of their body away from the danger area shown in the photo here)



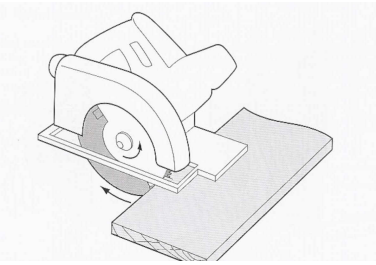
Above a fixed distance guard.

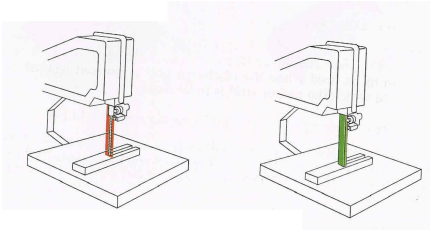
INTERLOCKING - A guard which has a movable part connected to the machinery so that the machine cannot be started if the guard is not in place. It allows easy access but in some cases can be easily overridden. e.g. microwave or lift door. The interlock can be mechanical, electronic or hydraulic. The machine **should** not allow access until it has stopped.

Diagram of interlock latch.



AUTOMATIC - A guard which is dependant upon the machinery, when the machine is switched on the guard comes down and then automatically the machine process will begin. e.g. power press or guillotine. As the operator starts the process the guard comes into place pushing the person out of the danger zone, the machine process will then continue until the end.

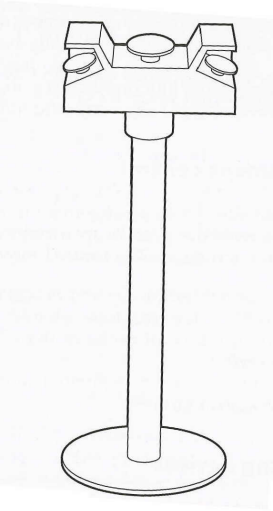




ADJUSTABLE/SELF ADJUSTING - The guard can be moved and adjusted depending on the material being worked upon. The aim is to have the smallest part of the blade exposed. e.g. circular saw, bacon slicer and drill. There are also self adjusting guards which as you move the equipment are sprung loaded to cover as much as possible of the blade.

TRIP DEVICE - A means whereby any approach by a person beyond the safe limit of working machinery causes the device to activate and stop the machinery or reverse its motion, thus preventing or minimising injury at the danger point. These can be in the form of light beams, pressure pads or probes. A trip device is not a guard as it is not a physical barrier.

TWO-HANDED CONTROL DEVICE - A device which requires both hands to operate the machinery controls, thus affording a measure of protection from danger only to the machine operator. These are not ergonomically sound as some require the operator to press a button with each hand and at the same time operate a foot pedal.



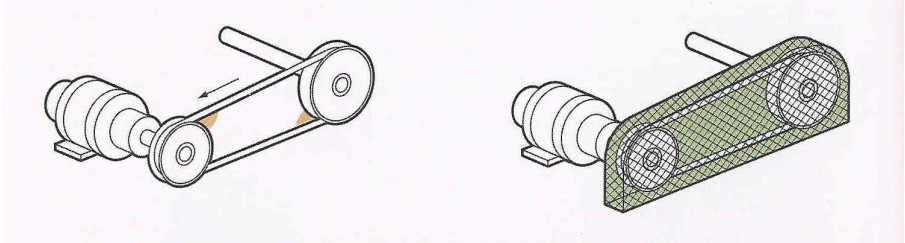
FAILURE TO SAFE (FAIL SAFE) - Any failure or interruption of power supply to a safeguard will result in the prompt stopping, or where appropriate the stopping and reversal before injury can occur.

Other controls include:-

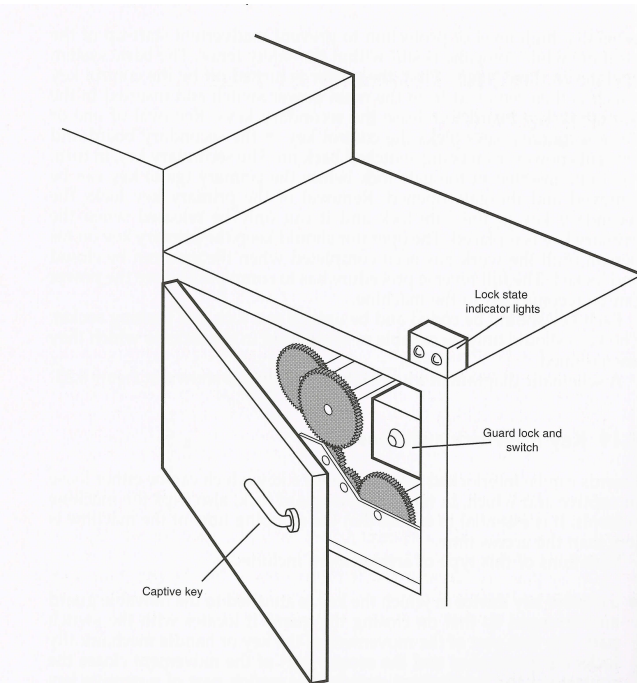
- Hold to run devices / Deadman's handles – where the handle or button must be depressed, once pressure is removed power is removed as well.
- Emergency stop buttons or wires
- Time delays
- Training
- No loose fitting clothing
- PPE i.e. eye protection, ear defenders and signage
- Supervision
- Good lighting and clear space

Examples of Machinery Guarding

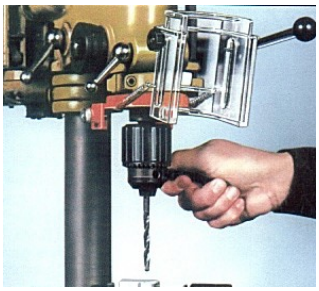
Fixed Guards

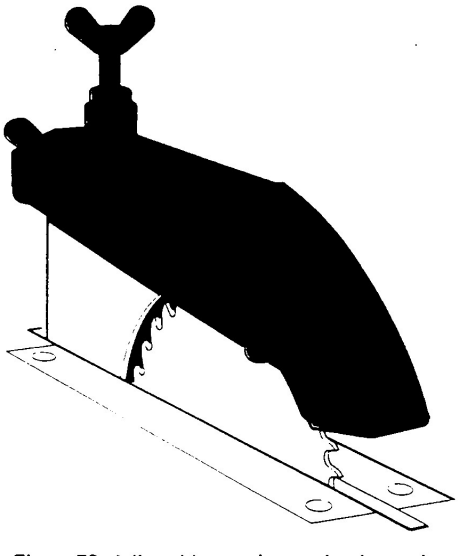


Interlocking Guards



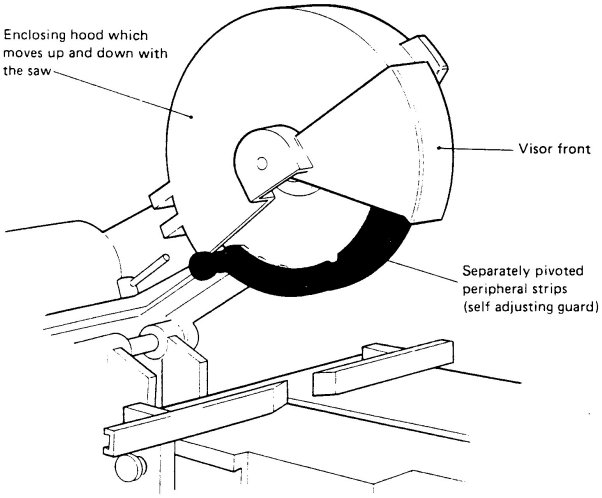
Adjustable

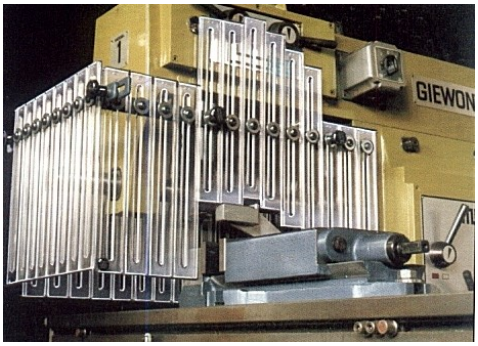




Slots in the
line of cut

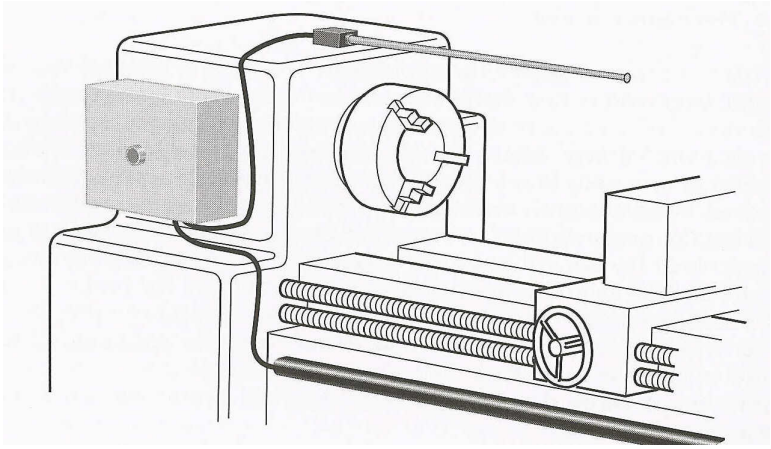
Self Adjusting

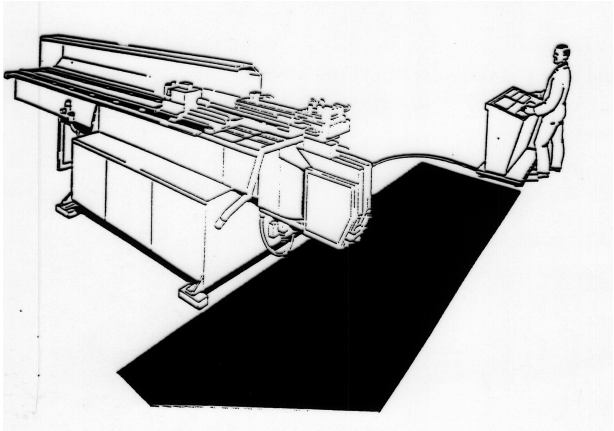




Automatic Guard

Trip devices





5.7 CONSTRUCTION SPECIFIC EQUIPMENT – HAND TOOLS

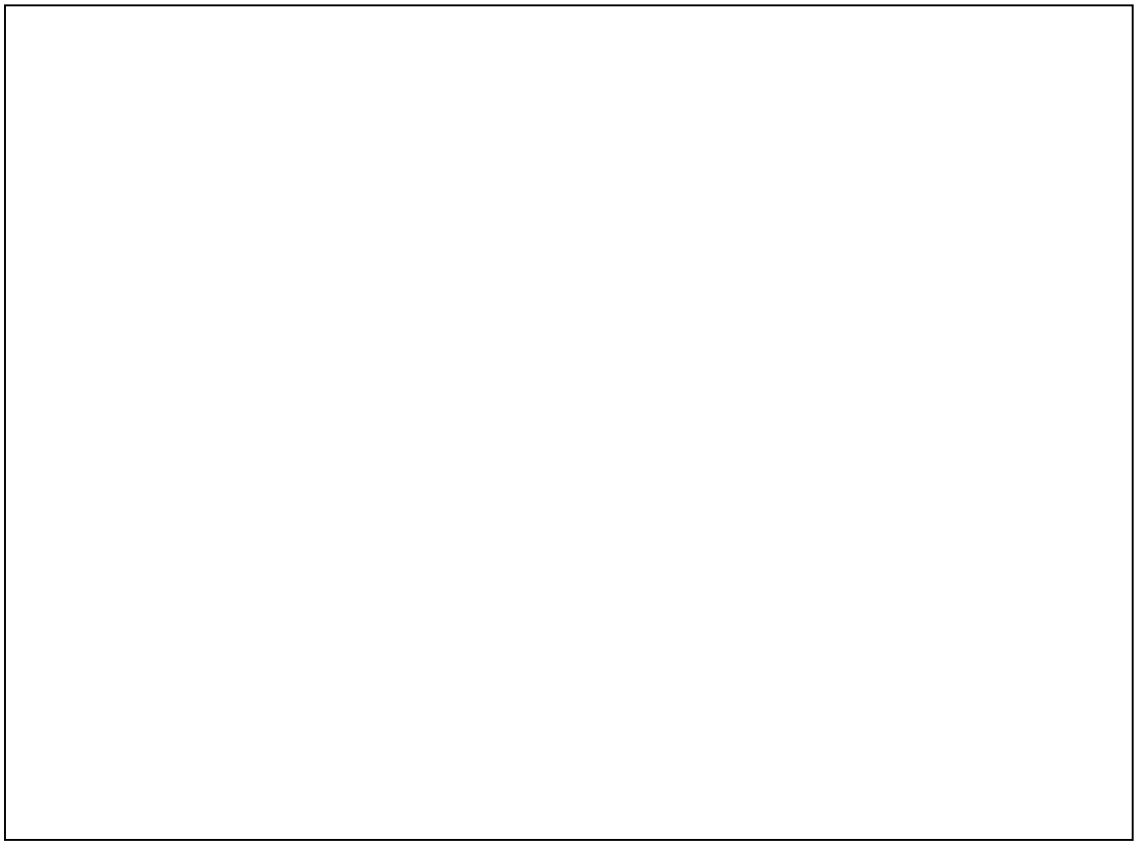
There are a variety of non powered hand tools used on site which can be hazardous they may be defective, create dust or ejected particles, have manual handing or ergonomic problems or present the risk of cutting, shearing or abrasion to the hands or body.

Issues to be considered in hand tool selection

- Is it suitable for the job, user and environment
- Quality – the Argos special may not be suitable!
- Handles – shape, roughness, surface
- Cleanliness
- Cutting edges - sharp
- Repair and storage – some hand tools get damaged not in use but in storage or transportation.

A hazard is the condition with the potential to cause harm, the risk is the likelihood of injury and the possible severity, for the following tools list down the possible hazards, risks and typical precautions which could be taken to reduce the risk of injury.

- Screwdrivers
- Hammers
- Chisels
- Pliers
- Files
- Knives
- Punches
- Spanners & Wrenches.



Self Retracting Knife

5.8 POWERED HAND TOOLS

The main power tools to consider are: pneumatic drills, pneumatic chisels, electric drills, disc cutters, sanders, cartridge and pneumatic nail guns and chain saws. An awareness of the key hazards, associated risks and typical safe guards and safety precautions is required. Many of the hazards and risks may be similar.

Remember powered tools and machinery may present a range of hazards physical, mechanical, ergonomic, chemical and biological.

Mechanical hazards are all associated with the movement of components or parts i.e. rotating blades or reciprocating belts.

Non mechanical hazards incorporate all the other hazards which may be encountered:-

- Electricity-power and static
- Noise
- Vibration
- High/low temperature
- Pneumatic
- Compressed air
- Fire / Internal combustion
- Radiation
- Hazardous substances.

It is important to consider a range of issues when assessing the risks namely:

- Electrically operated tools
  - ✓ Voltage
  - ✓ Plugs
- Power hand tools
  - ✓ Chuck keys
- Petrol engines
  - ✓ Fumes & dust
  - ✓ Noise
- Persons at risk
- Severity of possible injury
- Probability of injury
- Need for access

- Duration of exposure
- Reliability of safeguards
- Operating procedures

One the following pages note down the specific hazards, risks and typical precautions for the following equipment

1. Pneumatic drill/Jack Hammer

The only energy involved in making a drill like this pound up and down is supplied from an air hose. The hose, which has to be made of especially thick plastic, carries high-pressure air (typically 10 times higher pressure than the air around us) from a separate air-compressor unit powered by a diesel engine.

A construction worker using a pneumatic drill. Note the air hose coming from the left-hand side of the drill, which is supplied by the large yellow portable air compressor on the right. Picture courtesy of Atlas Copco.

The air compressor is a bit like a giant bicycle pump that never stops blowing air. When the worker presses down on the handle, air pumps from the compressor into the jackhammer through a valve on one side. Inside the hammer, there's a circuit of air tubes, a heavy piledriver, and a drill bit at the bottom. First, the high-pressure air flows one way round the circuit, forcing the piledriver down so it pounds into the drill bit, smashing it into the ground. A valve inside the tube network then flips over, causing the air to circulate in the opposite direction. Now the piledriver moves back upward, so the drill bit relaxes from the ground. A short time later, the valve flips over again and the whole process repeats. The upshot is that the piledriver smashes down on the drill bit over 25 times each second, so the drill pounds up and down in the ground around 1500 times a minute.

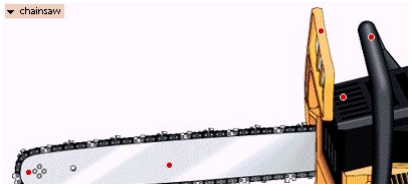
Jackhammers, and the air compressors that power them, come in all different shapes and sizes. The drill bits on the end are interchangeable too. There are wide chisels, narrow chisels, and tools called moil points for fine work. A skilled drill operator can loosen chunks of road in just 10-20 seconds, making light work of what our ancestors—with their antler picks—would have found truly backbreaking work!

2. Nailing Gun

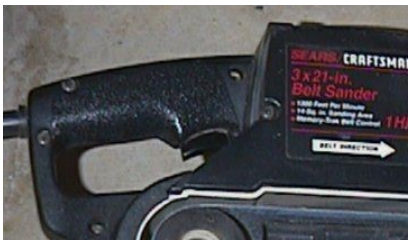
3. Electric Drill

4. Disc Cutter

5. Chain Saw



6. Hand Held Sander



5.9. SPECIFIC MACHINERY

1. Office photocopier

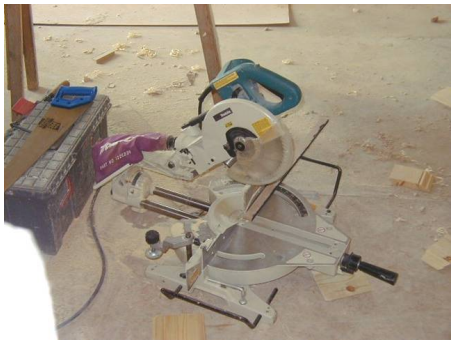
2. Office – large scale shredder

5.10 Workshop Machinery

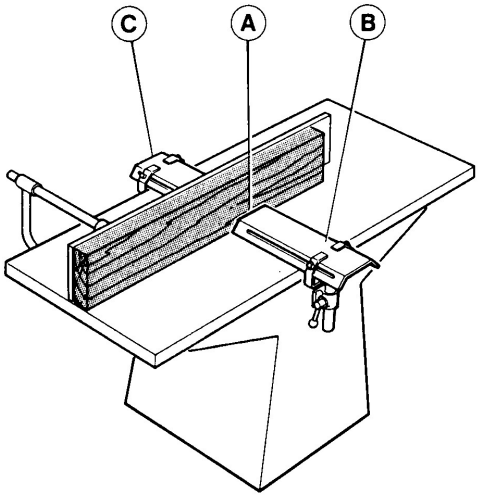
1. Bench top grinder

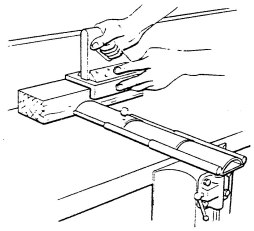
2. Pedestal drill

3. Bench mounted circular saw

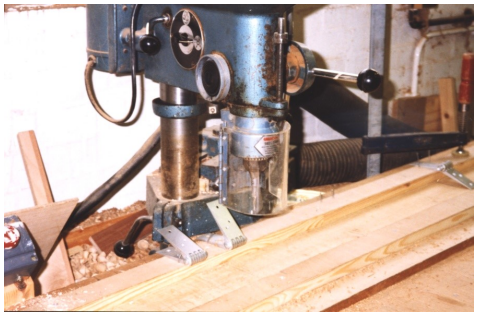


4. Hand fed planer & guards





5. Spindle moulding machine



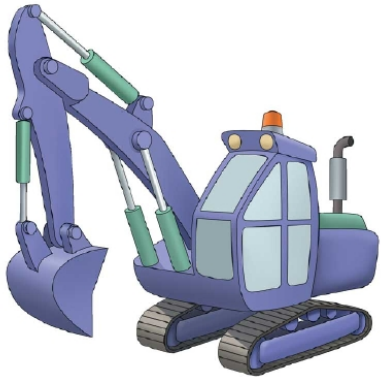
6. Bench top grinder

5.11 Site Machinery

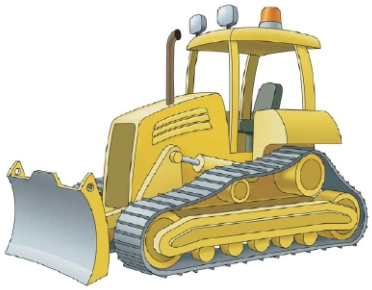
1. Cement mixer

2. Plate compactor

3. Excavator



4. Bull dozer



5. Road marking Equipment

6. Electrical generator

5.12 MAINTENANCE WORK

Maintenance work encompasses a range of different activities including the maintenance of machinery, cleaning of confined spaces, repairs to buildings and general maintenance of outside areas. Rather than deal specifically with each aspect of maintenance the general hazards and principles of control are considered below.

PRINCIPLE HAZARDS

PHYSICAL

Mechanical - Trapping, Entanglement, Contact, Ejection, Shearing, In-running nips & Unexpected start-up, Abrasions and Cutting.

Electrical - From coming into contact with live electricity – Electrocution or electric shock

Pressure- The unexpected release of stored pressure & explosion.

Other - Extremes of Temperature, Noise & Vibration, Naked Flames - Fire & Explosion.

CHEMICAL

Gases, Fogs, Mists, Fumes, Dust etc that are harmful to health.
Confined spaces and lack of oxygen.

ERGONOMIC

MH - Awkward Lifting/Pulling/Pushing/Carrying positions.

Access issues - Obstructions, Floor openings, Sloping surfaces, Work at height & Confined spaces.

BIOLOGICAL

Places/machines where the engineer may disturb old, often decaying, debris.

PRECAUTIONS (both general and specific)

- Safe Systems of Work/Permits to Work
- Defined Competent Person for high risk operations
- Method Statements for contractors - how they intend to carry out the task
- Supervision/Enforcement of Contractor Rules
- Limit access where maintenance is being carried out and barriers to protect workforce
- Training and Supervision
- Information and Instruction
- Signs, marking and labelling
- P.P.E - gloves, face masks, safety shoes
- Lock Off Procedures for pipelines and electrical energy (isolation)
- Adequate ventilation and lighting
- Provide safe access e.g. ladders & scaffold.
- Allow hot surfaces to cool prior to work or work nearby
- Suitable tools to complete the task