4. Considerations for designers, manufacturers, suppliers and purchasers

4.1 Responsibilities

The OSH Act and the MSI Act set out broad duties for those who design, manufacture, import or supply plant or machinery to ensure they are safe. The OSH Regulations and the MSI Regulations also contain specific requirements for these people.

For non-mining workplaces, see Section 23 of the OSH Act and regulations 4.23 and 4.30 of the OSH Regulations. For mining workplaces see Section 14 of the MSI Act and regulations 6.3, 6.4 and 6.5 of the MSI Regulations.

Designers have a responsibility to assess and control the risks associated with the plant or machinery they design and provide safety information about them to manufacturers.

Manufacturers of machinery and plant have a responsibility to follow the designer's specifications precisely in order to ensure they are is as free from risks as the designer intended. Under some conditions, for example if the designer is outside Western Australia, the manufacturer in Western Australia takes on the designer's responsibility to make sure the risks associated with the design are assessed and controlled.

For non-mining workplaces, see Section 23 of the OSH Act and regulations 4.24, 4.30A and 4.31 of the OSH Regulations. For mining workplaces, see Section 14 of the MSI Act and regulations 6.6, 6.7 and 6.8 of the MSI Regulations.

The manufacturer also has a responsibility to provide particular kinds of safety information to users of the machinery or plant.

For non-mining workplaces, see Section 23 of the OSH Act and regulation 4.31 of the OSH Regulations. For mining workplaces, see section 14 of the MSI Act and regulations 6.9, 6.10 and 6.11 of the MSI Regulations.

People who import machinery and plant into Western Australia take on the responsibility of the designer and manufacturer to ensure the risks associated with the plant are assessed and controlled, and provide the required safety information to users.

Suppliers of machinery and plant are responsible for making sure the risks to safety and health from the plant they supply are eliminated or minimised. Suppliers who also import the plant they supply take on the importer's responsibility to ensure the whole risk management process is carried out.

For non-mining workplaces, see Section 23 of the OSH Act and regulation 4.33 of the OSH Regulations. For mining workplaces, see Section 14 of the MSI Act and regulations 6.12 and 6.13 of the MSI Regulations.

The general duties of a supplier apply to hirers and leasers of plant for use at a workplace. In between hirings and leasings, the supplier must ensure the plant is inspected and maintained to reduce, as far as practicable, any risk of injury or harm. They must also provide safety information to people hiring or leasing the plant.

For non-mining workplaces, see Section 23 of the OSH Act and regulation 4.35 of the OSH Regulations. For mining workplaces, see Section 14 of the MSI Act and regulation 6.14 of the MSI Regulations.

4.2 Designing to eliminate or reduce machinery and plant hazards

Considering ways to eliminate or reduce hazards in the engineering design of machinery and plant can eliminate many risks to safety and health. Similarly, consideration of design during manufacture and purchasing can eliminate or significantly reduce the chances that people using the machinery or plant will be harmed.

Design-related hazards may relate to the characteristics of the plant itself, the application and associated work practices, as well as the working environment in which it will be operated.

Common categories of hazards that should be considered in machinery design include:

- mechanical hazards — for example hazards created by the shape, relative location, mass and stability, kinetic energy and material strength;
- electrical hazards — factors include contact with or proximity to live parts, suitability of insulation, electrostatic phenomena, thermal radiation and consequences of overloads or short circuits;
- thermal hazards — for example contact with high temperature objects or materials;
- noise and vibration hazards;
- radiation hazards — both ionising and non-ionising;
- materials and substances hazards — such as hazards produced, used or emitted by machinery or from the construction materials;

For more information, see the Commission's guide, *Plant design: Making it safe: A guide for designers, manufacturers, importers, suppliers and installers of plant* and Resource Safety's fact sheet series on manual tasks in mining.

- ergonomic hazards — for example physiological or operational errors with inadequate matching of machinery and human characteristics. See Appendix 5 for more discussion on these hazards;
- maintenance related hazards — for example when guarding is removed or deactivated to allow for cleaning, maintenance or access to the area surrounding a machine;
- slips, trips and falls hazards — for example surface of floorings and means of access; and
- work environment hazards — for example the influence of environmental conditions such as temperature, weather or lighting.

4.3 Inherently safe design measures

Experience shows that protective measures built into the design are more likely to remain effective even where well designed safeguarding fails or is vulnerable to error or the failure to follow safe use information.

Inherently safe design measures reflect the 'hierarchy of control' principle, referred to in Section 2.3 of this code. They are a first step in the design process.

Examples where the reliance on safeguards for maintenance work might be eliminated include:

- locating the oil filters and grease nipples on the opposite side of a machine to hot parts; and
- locating lubrication points away from moving parts.

Where required, additional information on inherently safe design may be found in Australian Standard, *AS 4024.1202 Safety of machinery: Part 1202: General principles - Technical principles.*

Note the term 'safeguarding' is used here specifically to refer to technical measures such as machinery guards and safety devices.

Geometrical and physical factors

Aspects to consider could include:

- the visibility of working areas from the control position;
- shape and proximity (or gaps) between mechanical components;
- reducing sharp edges;
- enabling effective working positions and accessibility of controls; and
- limiting forces or emissions.

Technical information

Technical insight may be developed from standards, codes and calculations and address stress limitations, materials and properties, emission values, and component reliability.

Stability aspects

Design of sufficient stability may take into account factors such as:

- geometry of the base;
- weight distribution;
- dynamic forces;
- vibration;
- oscillations;
- the nature of the support surface; and
- external forces.

Maintenance

Important maintainability aspects include:

- accessibility;
- ease of handling; and
- reducing the number of tools and equipment required.

Ergonomic principles

Consideration of ergonomic principles, or the machine-operator interface, can reduce exposure to physical risks, for example amputations and physiological or mental strain, and reduce the likelihood of errors in all aspects of machinery use.

Typical ergonomic elements include:

- the nature of postures and movements;
- the ease of physical operation;
- the effects of noise or temperature;
- the lighting environment;
- the clarity and location of manual controls; and
- the design of dials, markings and displays to best fit the characteristics of human perception and cognition.

An important application of ergonomics is the use of anthropometric (human body) measurements in machinery design. This type of information is important in determining the dimensions of access openings for maintenance and repairs, the space requirements for operators, and the safety distances and gaps to prevent contact of parts of the body with danger zones.

Ergonomic design principles are discussed further in Appendix 5.

Types of energy

Energies that may be considered in this design aspect include electrical, hydraulic and pneumatic.

Design specifications should take into account:

- means of limiting energy to maximum ratings;
- controlling surges or rises;
- the effects of leakage or component failures;
- the effects of harmful external conditions; and
- deactivation for adjustment or maintenance.

Control systems

Control systems can assist in reducing the consequences of hazardous machine functioning such as unintended start up, uncontrolled speed changes or failure of protective devices.

Reliability of safety functions

This aspect of design includes consideration of:

- the reliability of all machinery components;
- use of safety failure modes of components;
- duplication or redundancy of safety related parts; and
- automatic monitoring of fault conditions.

In the case of safety related parts of control systems, the designs need to be independently validated.

Where required, additional information on reducing the likelihood of failure through good design principles, and on typical failure modes, may be found in Australian Standard, *AS 4024.1502 Safety of machinery: Part 1502: Design of safety related parts of control systems - Validation.*

4.4 Considering the life cycle during design

The ‘life cycle’ of the machinery or plant should be considered during the design phase, and design features introduced to control unacceptable risks that may occur at different stages in its life. This should be done by eliminating hazards at source where practicable.

The life cycle phases for machinery and plant are:

- manufacture — examples of controlling or eliminating hazards at source include:
  - the replacement of spoked gears with gears with a solid disc to eliminate a shear hazard; or
  - building a housing around obvious hazards rather than relying on fitting guards later;
- transport — for example, a machine, such as a metal lathe, that could be delivered fully assembled would be much heavier on the headstock end than the tailstock end. In this example, the designer might foresee the potential for the lathe to slip out of its lifting slings and incorporate lifting eyes to ensure the slings are located in positions that enable the lathe to be lifted horizontally;
- installation — to minimise hazards during installation, a large machine might be designed so that it is supplied in modules that can be placed in position by a crane. This avoids the need for installers to work at height or manually handle heavy items;
- commissioning — to avoid problems with inadvertent energising of various areas of machinery or plant, test points for instruments and alarms might be built into the machinery or plant;

See also Appendix 5 Ergonomics design principles.

- use — consideration should be given to how an operator will safely operate the machinery or plant. For example:
  - if the operator is to be seated, this could involve ergonomic considerations such as the type of seating and the ease with which controls can be reached and operated; or
  - if it is a large machine, which the operator has to move around, consideration might be given to providing a portable emergency stop button;
- maintenance — considerations should include providing ready access to areas identified during design requiring regular maintenance, such as cleaning, lubrication and adjustment. Other considerations for maintenance include:
  - routine adjustments should be designed to be carried out with the machine stopped but without the need for removal of safeguards or dismantling of machine components;
  - where frequent access is required, interlocked guards should be used;
  - self-lubrication or central lubrication of parts should be considered if access is difficult; and
  - positive lock-off devices should be provided to prevent unintentional restarting of machinery, particularly after a machine has shut down unintentionally;
- storage — considerations should include how to store a machine so that it does not present hazards in storage or when started after a period of inactivity. It might also include procedures for safe breakdown for storage; and
- disposal — hazards to people breaking down machines for scrap should be considered. For instance, considering hazards associated with potential energy, such as springs and pressure devices, and hazardous substances that are part of the machine or plant, for example PCBs and asbestos.

4.5 Basic rules for guard design

In circumstances where intrinsic safety is not achieved through the design, machinery guarding will be required to eliminate any remaining hazards.

The primary function of a guard is to provide a physical barrier between a worker and the dangerous parts of machinery or plant. When selecting controls such as guards, careful attention to design and layout at the outset can eliminate many of the risks to safety and health and avoid later problems.

See Section 2.3 of this code and, for non-mining workplaces, regulations 4.37 and 4.29(i) of the OSH Regulations and, for mining workplaces, regulation 6.2 of the MSI Regulations.

Basic rules for guard design

Avoid second best when designing a guard.

Some of the basic rules for guard design are:

- ensuring materials used are of suitable strength and good quality;
- recognising that simply having any sort of guard may not be enough. Poorly designed or inappropriate guarding is known to contribute to injuries. Ideally, a guard should be custom-designed for the machine and the work process;
- considering carefully the environment in which the guard is used and the needs of operators and maintenance workers; and
- if a guard is used from another machine, checking carefully to ensure that it:
  - is not defective;
  - fits the target machine;
  - is of suitable strength and quality for the new application; and
  - achieves the aim of controlling the risk.

Guarding of operational and non-operational parts

When considering the need for guarding, consider operational and non-operational parts of the machine.

Start with obvious operational parts such as:

- rolls, for example calendars and flour mills;
- saws, for example circular and band saws;
- drills and drill chucks;
- cutters in metal working machines, including the blades of guillotines and the tools of power presses; and
- beaters.

Then consider non-operational parts such as:

- chains and sprockets;
- belts and pulleys;
- gears including rack and pinion sets;
- shafts, plain or threaded; and
- flywheels.

Consider other safety and health issues

In determining the most appropriate guard design for the hazard, risk and machine, other issues or risks should be considered. This is part of the holistic risk management process - see Section 2.4 of this code.

Guarding can also play a useful role in dust and noise reduction. In many cases, issues of wear, heat and ventilation affect operating efficiency and may have consequences for safety and health.

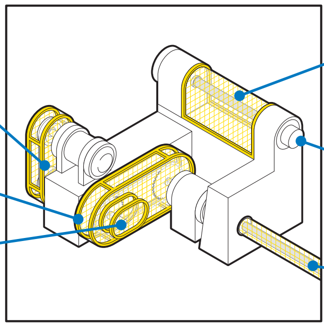

Illustration 23. Machine guards. Yellow = guarding.

Where required, additional information may be found in relevant Australian and Australia/New Zealand Standards. See Appendix 3 for more details.

Selection of material for guards

The selection of material from which guards can be constructed is determined by four main considerations. These are:

- strength and durability, for example use of non-metallic materials in corrosive environments;
- effects on machine reliability, for example a solid guard may cause the machine to overheat;
- visibility, for example there may be operational and safety reasons for needing a clear view of the danger area; and
- the control of other hazards, for example the use of a material that will not permit the ejection of molten metal.

4.6 Servicing considerations

During the design of guards, safe procedures for their removal for repair, clearing jams and breakdowns should be considered.

Servicing matters to consider include:

- following documented safe work procedures, including the manufacturers' instructions;
- proximity to hot or sharp parts;
- cool down or warm up periods;
- lock-out provisions or permission for guard removal;
- sufficient room to perform tasks without risk of injury or strain;
- stored energy in the machine or materials being processed;
- any additional hazards arising from maintenance procedures, for example testing while machine is unguarded (a 'dry run'), working at heights and use of solvents; and
- maintaining or updating service records.