

Sugar mill safety

A supplement to the
Sugar industry Code of Practice 2005

This Queensland code of practice was preserved as a code of practice under section 284 of the *Work Health and Safety Act 2011*.

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Foreword

This Sugar industry Code of Practice and its supplements are an approved code of practice under section 274 of the *Work Health and Safety Act 2011* (the WHS Act).

An approved code of practice is a practical guide to achieving the standards of health, safety and welfare required under the WHS Act and the *Work Health and Safety Regulation 2011* (the WHS Regulation).

From 1 July 2018 duty holders are required to comply either with an approved code of practice under the WHS Act or follow another method, such as a technical or an industry standard, if it provides an equivalent or higher standard of work health and safety to the standard required in the code.

A code of practice applies to anyone who has a duty of care in the circumstances described in the code. In most cases, following an approved code of practice would achieve compliance with the health and safety duties in the WHS Act, in relation to the subject matter of the code. Like regulations, codes of practice deal with particular issues and do not cover all hazards or risks which may arise. The health and safety duties require duty holders to consider all risks associated with work, not only those for which regulations and codes of practice exist.

Codes of practice are admissible in court proceedings under the WHS Act and the WHS Regulation. Courts may regard a code of practice as evidence of what is known about a hazard, risk or control and may rely on the code in determining what is reasonably practicable in the circumstances to which the code relates.

An inspector may refer to an approved code of practice when issuing an improvement or prohibition notice. This may include issuing an improvement notice for failure to comply with a code of practice where equivalent or higher standards of work health and safety have not been demonstrated.

1. Introduction

1.1 Who is this document intended for?

This document is a supplement to the *Sugar industry Code of Practice*, and forms part of that Code. It is intended to be used by persons with health and safety duties under the *Work Health and Safety Act 2011* (the WHS Act).

This document does not identify all hazards within a sugar milling environment and duty holders should implement risk management systems which identify hazards and reduce associated risks by implementing appropriate controls. The management system should also have a method of monitoring and review, particularly after changes are made, so that the controls implemented for particular hazards remain effective.

Many hazards are common within sections of a sugar mill, such as the use of confined spaces or plant. Hazards that are addressed by this document are considered to be typical in a sugar milling environment and should be assessed by operators as part of the risk management process.

A range of example risk assessments for sugar manufacturing operations have been included in Appendices 9.3 to 9.7 in order to provide mill operators with guidance on the types of systems which can be implemented for sugar specific hazards.

This document should assist sugar mill operators to develop a hazard register for the sugar mill, assess the risks associated with those hazards, and implement appropriate controls.

1.2 How this document is organised

This code has been organised into the major hazard areas including general workplace hazards; hazardous manual tasks; plant; substances; biological substances and work environment.

There is also a section on managing health and safety. Within the hazard specific sections the document is generally structured in a numbered format.

For example:

1 - The major heading i.e. Substances

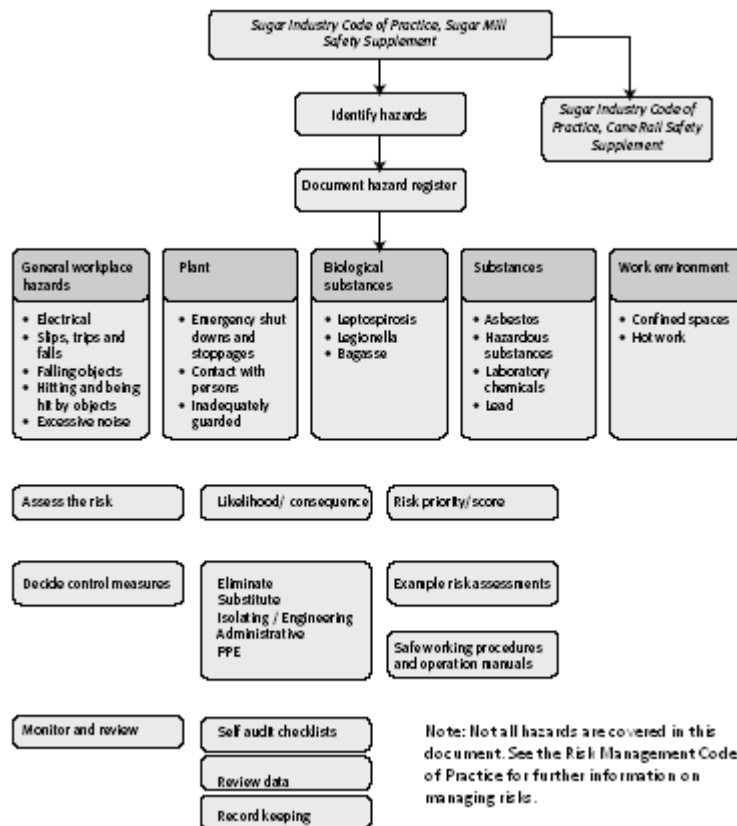
The specific hazard

(such as Hazardous chemicals)

Possible control measures for the specific hazard.

(an outline of the issues which should be considered as control measures for the specific hazard)

Figure 1 Hazard register and controls



2. Sugar manufacturing operations

A sugar mill is a large factory used to produce raw sugar and other products from sugar cane. Mills are made up of a range of industrial plant such as boilers, storage and processing vessels, crushing and hammer mills and a large range of maintenance equipment. Mills operate in two distinct modes, crushing and non-crushing, both of which introduce a range of specific and general hazards to persons conducting a business or undertaking (PCBU), workers and others. In essence, a sugar mill can be broken into the following processes (see Figure 2 for a diagram that shows the sugar milling process).

2.1 Cane handling

Cane handling describes the methods used to move cane billets into the milling section of the process. Billets are transported and stored using items such as:

- cane railway bins
- road transport systems (such as multi-lifts and semi trailers)
- in field transporters.

The cane billets are then transferred into the milling system by:

- trans-loaders (such as from road to rail)
- tipplers (tipping cane bins into carriers)
- direct tip into the carrier (by infield transporters and road transport).

Rail transfer methods use large hydraulic systems to push or pull rakes of bins into the tippler which tips them onto a 'carrier' (a moving floor conveyor). Most mills have storage yards for excess bins. Tipplers are a rotary device which hold the rail bin in place and turn it 180 degrees to empty its contents into the main conveyor (carrier).

2.2 Milling

The milling process involves the initial breakdown of cane into its primary fibres by a large hammer mill (shredder). Shredders consist of a number of large hammers (usually around 12 kilograms in weight) attached to a rotor by swing rods which are then driven at around 1200 revolutions per minute (rpm) by mechanical means (either by steam turbine or electric motor). The billets are shredded by smashing them between the hammers and the grid bar (a hard set of plates on one side of the shredder) breaking them into individual strands of fibre. This fibre is then processed through a series of crushing mills to extract juice. Mill rollers exert huge forces on the shredded cane which is fed through them via a vertical chute. The pressure between the rollers is large enough to break down the cell structure of the fibres so that the sucrose can be extracted within the juice. Juice contains a large amount of water which is removed or reduced in subsequent processes. The remaining fibre is then burned in a boiler to produce steam which drives most mill processes in a typical factory.

Extraction of as much of the sucrose as possible is a key element in milling. Mills use a number of methods to aid sugar extraction which include the application of hot water (around 95 degrees Celsius) to the fibre within the mill set, a series of crushing mill sets (the milling train) and reapplication of mixed juice and water (maceration) throughout the milling process.

2.3 Clarification/evaporation

The clarification/evaporation stage executes a number of functions such as:

- mixed juice incubation
- adjusting PH by addition of lime
- heating
- addition of flocculant (a product which assists contaminants to subside)
- addition of anti-scale chemicals
- removal of mud and heavy contaminants
- reduction of water levels in the juice.

Heating is completed using shell and tube heaters that are normally either cylindrical units with multiple passes for juice in tubes surrounded by steam (allowing thermal transfer between the two products) or multi-path plate and frame commercial units that are smaller than conventional heaters and are constructed from pressed SS sheets separated by gasket material.

Lime and flocculant are usually added to the juice as a slurry. A subsider then removes heavy contaminants from the juice. Subsiding, the process of allowing heavy materials to sink or fall to the bottom, usually removes the majority of dirt and the chemical mud formed from the reaction between the phosphate in the juice and the added lime from juice. The mud is then spread across a moving filter (a rotary drum filter) and 'washed' to leech out any remaining sucrose before removal from the factory. Mill mud is a nutrient rich product which is normally returned to the field.

The effert stage consists of a number of evaporators (large kettles) in series that boil the juice to reduce the water content. Effets are constructed in a particular pattern using multiple effert evaporation. Vapour produced from each vessel is used to boil the juice in the subsequent vessel at a lower pressure making maximum use of the energy initially put into the first vessel as low pressure steam. The latter effets in the set are operated at a vacuum in order to reduce the boiling point. The final product from the effert stage is usually known as 'liquor' or 'syrup' and is a dark gold coloured liquid.

Dependent on juice properties heating surfaces within the effets and contact heaters are prone to contaminant build up (scale) which reduces heating efficiencies and after a period needs to be removed. Most factories use a chemical process to remove scale build up, normally by boiling caustic soda in the vessels or other chemical means such as sulphamic acid or rarely EDTA. On some occasions manual cleaning is required and is completed by blasting with high pressure water or mechanical brushing.

2.4 The pan stage

The pan stage is a similar process to the effets in that a pan boils off additional water. The main function of the pan stage is to produce sugar crystal from the liquor. In order to increase the speed of this process the pan stage operates in a manner which utilises 'seed crystal' and a combination of products with varying levels of sugar content to produce a range of crystal sizes and hence qualities. The pan stage has many storage tanks such as receivers (tanks which receive product from the pans), crystallisers (a series of tanks and stirrers which cool the product from the pan stage resulting in additional crystal growth before fugal) and large transfer pipes and valves.

2.5 The fugal stage

A fugal is a large electric centrifuge which spins up to 1200 revolutions per minute (rpm) dependent on its function and stage of operation (while filling batch fugals only turn at around 50 rpm). There are two types of centrifuge in use within sugar mills, high grade

centrifuges (usually batch, but sometimes continuous) and low grade centrifuges which are continuous. Continuous fugals maintain a constant flow of product through them while batch fugals fill, operate and then discharge the final product. The fugal stage removes the remaining liquid product which surrounds the crystal, washes the crystal and delivers it into the final sugar system through a series of conveyors and a drier. The material removed during the centrifuge process is known as molasses and has a range of uses including sale as stock feed, fermentation for distillery production and as a component of cattle licks.

2.6 Final sugar

Finally, the sugar crystal is dried and moved to large storage bins awaiting transport to sugar terminals or other areas (such as refineries). Driers are large cylinders which are fluted and rotate to pass the crystal through at an even rate whilst dry air is applied via ducted fans or large air conditioners. Moisture levels and sucrose purity are important measures for sugar quality. Storage bins hold large amounts of raw sugar and the conveyor system supplying them can be directed into different bins dependent on the product type. Low moisture levels in final sugar product and atmospheric conditions can create a risk of sugar dust explosion. Sugar dust explosions are rare; however, they have caused significant damage and loss of life in sugar mills overseas.

2.7 Energy supply systems

Mills are usually powered by steam and subsidised by electrical devices, however in recent years a number of factories are moving to predominantly electric powered equipment. A standard sugar mill will still include equipment such as suspension or multiple fuel boilers, steam turbines, electrical generators and all of the associated distribution equipment for electric and steam power. A range of equipment is associated with steam and electric energy including transformers, high and low voltage distribution systems, protection devices such as circuit breakers, steam relief valves, expansion joints and water traps.

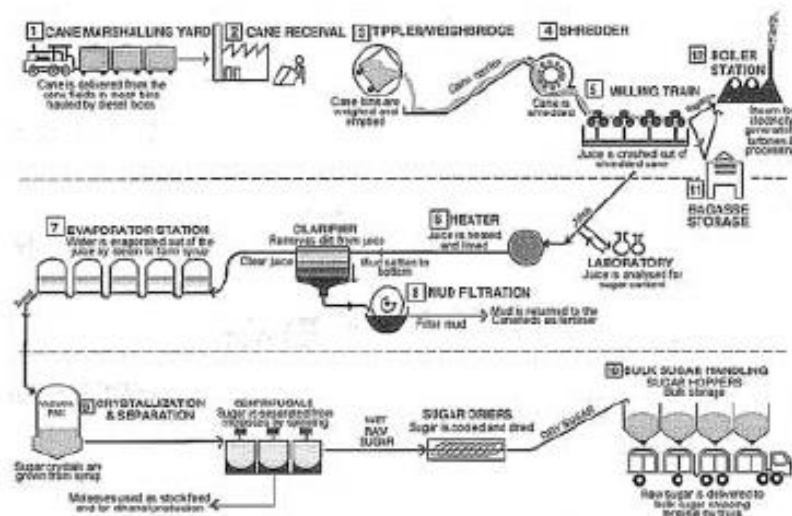
Mills also have extensive air distribution systems supplying general and instrument air.

2.8 Associated operations

A range of facilities associated with sugar production are located on site including:

- laboratory and associated processes
- packaging lines
- engineering workshops covering areas such as rolling stock repair, general engineering and fabrication, and electrical
- administration areas
- molasses storage and distribution systems
- water supply and effluent systems
- mud, ash, bagasse and other by-product handling and storage.

Figure 2 The sugar milling process



1. Cane marshalling yard
2. Cane receiving
3. Weight bridge tippler and empty bin return system
4. Shredder
5. Milling train
6. Juice heater
7. Evaporator station
8. Filtration
9. Crystallisation and separation
10. Bulk sugar handling
11. Bagasse storage bin
12. Boiler station

3. Managing health and safety

As outlined previously, the intent of this document is to identify industry specific hazards, suggest possible controls, and provide examples on the risk management process which mill operators could adopt to assess and control risks specific to their operation. It is expected that mill operators would develop a risk register as outlined in the *How to manage work health and safety risks Code of Practice*, assess the risks in their operation, implement controls and monitor and review the systems implemented to control those risks.

When managing health and safety in sugar mills, operators should consider the following issues as key components of the management system:

- risk registers
- risk management
- consultation
- training
- emergency procedures.

Further details on these issues are provided in the following sections, and in the *Sugar industry Code of Practice*.

3.1 Risk registers

The *How to manage work health and safety risks Code of Practice* recommends the development of a risk register for all hazards at a workplace. Hazards can be classified under the following areas:

- (a) biological hazards
- (b) energy and electricity
- (c) hazardous manual tasks
- (d) plant
- (e) hazardous chemicals
- (f) work environment.

A number of hazards typical to the sugar milling process have been classified into these areas in the following sections and a range of possible controls suggested for each hazard. There is also a section on general workplace hazards and possible control measures. As each mill operates differently it is necessary for each mill to assess the risk of identified hazards so that the most appropriate controls can be implemented within that operation. A number of example risk assessments have been included in the appendices to provide guidance on this process.

3.2 Emergency procedures

A number of emergency situations may arise within sugar milling operations including but not limited to:

- fire and or explosion
- rescue from heights
- rescue from confined spaces
- chemical spills
- natural disasters
- bomb threats.

Mill operators should ensure that appropriate, adequate and effective emergency response procedures are planned, distributed, understood and rehearsed so that in the event of an accident or emergency, people are prepared.

In some instances hazards which create emergency situations such as natural disasters cannot be controlled. However, the hazards associated with these events can be managed. Sugar mill operators should implement processes which enable:

- (a) the notification of incidents to emergency services
- (b) identification of the location of the incident site by emergency and other services and the provision of clear instructions and information
- (c) the provision of basic first aid
- (d) a first response system for dealing with emergency situations
- (e) a method of instigating and controlling a site evacuation.

These procedures should be implemented in a manner which allows the emergency system to successfully operate regardless of the status of the factory (e.g. when the mill is operational, non-operational, on continuous shift roster or on a five day roster). Consideration should also be given to other operational factors such as the general availability of personnel because of sick leave and annual leave.

3.3 Housekeeping

Housekeeping is an important part of maintaining a system aimed to reduce or eliminate risk in the workplace. Workers, supervisors and managers all have roles to play in maintaining the required housekeeping standards in their work area and in all their activities. Training designed to encourage awareness of the importance of housekeeping, using systems set up at each site, should be included in induction programs. Additional training may be provided as appropriate.

Key methods for maintaining good housekeeping include:

- allocate responsibility for housekeeping for particular areas to teams or individuals
- regular housekeeping inspections and records
- process for corrective action for identified hazards based on risk management practices
- barricading areas where spills have created a health and safety hazard. The barricade should be of a standard which will contain the spill and restrict access to the area.

3.4 Workplace inspections

Regular workplace inspections can play a significant prevention role by identifying health and safety issues before they result in injury or damage at the workplace. Inspection programs should be undertaken by all mill personnel at various times. Workplace inspections are a key element in monitoring the health and safety standards of contractor activities

Copies of inspection reports should be available for review and discussed at workplace health and safety committees meetings. A documented process should be used to control hazards identified during workplace inspections which is based on the risk management process. Inspections should be conducted in conjunction with a representative of the area which is being inspected to enable discussion and resolution of minor issues as they are identified.

The frequency of inspections will depend on the nature and circumstances of the area being inspected. Issues such as the level of risk and extent of control that the mill has over the

workplace (e.g. remote locations) will influence the frequency of inspections. The mill operator should establish an inspection schedule allocating responsibility to appropriate persons for completion of the inspections.

3.5 Safety signs

Safety signs are a recognised method of identifying hazards within a workplace and consist of signs, symbolic signs, markings and colour. Signs have a range of applications but should be considered an administrative control only. This section covers the issues associated with the identification of hazards by means of signage with an aim to ensure known hazards are identified by means of signs, markings or colour and that all personnel are familiar with the meaning of safety signs and markings.

The use of appropriate signage will be determined from the risk assessment process. Signage should only be used in conjunction with other control measures. Mill operators should be aware of the language capabilities of employees and signage in other languages or symbols only may be required.

Hazards which can be identified by signage include:

- physical hazards should be identified by means of colour,
- confined spaces should be marked as required by AS 2865 *Confined spaces*
- underground services (pipes and cables) should be marked by means of the appropriate marking tape in accordance with AS/NZS 3000 *Electrical installations (known as the Australian/New Zealand Wiring Rules)*
- pipes, conduits and ducts should be identified in accordance with AS 1345 *Identification of the contents of pipes, conduits and ducts*.

Safety signs in accordance with AS 1319 *Safety signs for the occupational environment* should be installed where required.

4. General workplace hazards

4.1 Electrical

The *Electrical Safety Act 2002* (ES Act) and *Electrical Safety Regulation 2013* (ES Regulation) prescribe ways to control the risks associated with electricity for duty holders.

The ES Act outlines general electrical safety duties. The ES Regulation states the allowable distance for working near a live electrical part. The following Electrical Safety Codes of Practice give practical advice on safe systems of work and exclusion zones.

- *Working Near Overhead and Underground Electric Lines*
- *Works*
- *Managing Electrical Risks in the Workplace*
- *Electrical Equipment Rural Industry*

Typical electrical risks within a sugar milling environment include:

- operation of plant around electrical lines and parts
- electrical work
- use electrical equipment
- failure of electrical equipment.

Overhead powerlines

Contact with overhead power lines can cause death. Even if you don't touch the power lines you are still in danger, as electricity can arc or jump gaps. Working near overhead electrical power lines is therefore a very dangerous activity unless the appropriate precautions are taken. The ES Regulation states that workers and equipment (e.g. hand held or powered tools or mobile work platforms) must stay outside the defined exclusion zones around overhead power lines.

An exclusion zone is a safety envelope which surrounds the power line and is designed to keep people out of harm's way and away from the risk of sustaining electrical injuries. It is against the law to go inside your exclusion zone. You can, however, reduce your exclusion zone size by becoming an authorised or instructed person, but the exclusion zone itself is not eliminated unless the power lines are de-energised and/or isolated. These exclusion zones operate for the use of plant and equipment (including elevating work platforms).

The actual size of an exclusion zone depends upon the voltage of the lines, the competence/training level of the worker, and the way that the worker is accessing the work area. All the exclusion zone distances are listed in Appendix B of the *Electrical safety Code of Practice – Working near overhead and underground electric lines* and in Schedule 2 of the ES Regulation.

For low voltage power lines (anything under 1000 volts) along a road, or a service line connecting a property to the power lines on a road, the exclusion zone is generally three metres. A smaller exclusion zone may be possible, but only after consultation with the local electricity supplier (e.g. Essential Energy, Ergon Energy or Energex), and following the requirements of the electrical safety legislation, which may include the use of an authorised person, instructed person trained and accredited worker or safety observer.

Exclusion zone distances for high voltage lines vary somewhat, but for high voltage lines attached to either wooden or concrete power poles, the exclusion zone is also generally three metres. Where power lines are on steel towers or large easements, the local electricity

supplier should be contacted. Please check with your local electricity authority prior to working near powerlines.

If you expect that your work may cause a person and/or equipment part to come closer than the exclusion zone of overhead power lines, you must ensure a risk assessment is conducted and control measures are consistent with the risk assessment and any requirements of the electrical entity who is responsible for the line.

You are not allowed to start work near the overhead power lines without meeting this requirement. Therefore it is critical that you assess the work requirements prior to arriving to do the work and take the necessary steps to minimise the risks involved with work near overhead power lines.

4.1.1 Control measures for electricity

Mill operators should ensure that safe systems of work are in place which enables the organisation to comply with the ES Act and the ES Regulation. This may include:

- training
- work procedures
- authorised and instructed persons
- auditing.

There are a number of devices available that either assist in preventing contact with power lines or reduce the degree of risk in the event of contact. Such devices include:

- Ensuring work does not encroach into the exclusion zone - all work is to be conducted outside the exclusion zone.
- When using items of plant near powerlines (e.g. elevating work platforms) ensure there is a safety observer (or spotter) who's job is to watch the worker and their equipment and warn them if they begin to get close to their exclusion zone around the powerlines, and to keep people away from the area at ground level where falling items (e.g. branches etc.) may land.
- Ensuring all injuries, electric shocks and near misses are reported to the person conducting a business or undertaking (PCBU). The PCBU is required to notify the local electricity supplier of certain electrical events.
- The use of 'tiger tails' on power lines which act as a visual aid that assists in preventing contact by highlighting the location of the power line. Only low voltage lines (under 1000 volts) can be continuously covered with tiger tails, which leaves the higher lines on power poles (usually at least 11,000 volts) exposed. **NOTE:** tiger tails do not insulate the wires and therefore the 'exclusion zone' must be maintained.
- Limiting or warning devices to assist in preventing objects entering the exclusion zone. If a limiting or warning device is used, the system should be designed to 'fail safe' or should at least meet category four reliability in accordance with AS 4024 *Safety of Machinery* or EN ISO 13849-1 *Safety of Machinery – Safety Related Parts of Control Systems*, and
- Allowing for sway and sag of the overhead lines (sway is usually caused by wind and sag occurs when the temperature of the line fluctuates).

The exclusion zones for Queensland Rail power lines and those of some power authorities may differ. It is the responsibility of the person conducting a business or undertaking or person in control of the workplace to check with the person in control of the overhead electric line.

4.2 Slips trips and falls

Slips trips and falls are a cause of injury in most large workplaces and can be caused by poor design, damage and in particular, poor levels of, or incorrectly placed lighting.

Sugar manufacturing has some particular processes which may affect the risk of slips trips and falls for example, reactions between concrete and sugar products (sugar dust, molasses, or massecuite) which can damage floors and walkways.

Varying weather conditions can also create slippery conditions in sugar mills.

4.2.1 Possible control measures for slips, trips and falls

A range of control measures could be used to reduce the risks associated with slips, trips and falls, for example:

- regular housekeeping inspections
- maintenance (e.g. repair of leaking pipes, joints and vessels)
- adequate lighting
- barricading – short and long term
- loss of sugar product reduction programs (e.g. example dust, molasses, liquor and juice leaks)
- regular floor repairs
- replacement of flooring in susceptible areas with non concrete materials
- identification of hazards with appropriate markings.

4.3 Falling objects

Under the WHS Regulation, a PCBU must manage risks to health and safety associated with an object falling on a person if the falling object is reasonably likely to injure the person.

Sugar mills are multi-level installations and have some structures which can be higher than 60 metres like chimney stacks. Operators should consider a range of issues when assessing the risk of injury from falling objects, including:

- the type of work being conducted
- what equipment is being used
- the number of people using the area below
- whether special provisions are required for specific work (e.g. hot work)
- how far an object might fall and what the object might be
- the consequences of being struck.

4.3.1 Possible control measures for falling objects

The following are examples of control measures that may be used to prevent or minimise exposure to the risk of being hit by falling objects:

- establishing exclusion zones to prevent unauthorised persons from accessing high risk areas (this can be done by using barricading)
- using catch nets or platforms
- using lanyards
- specifying pathways for workers and others
- using head protection (e.g. helmets).

Note: Helmets are a personal protective control measure only and guidance should be sought from the appropriate Australian Standard as to what level of protection they offer from falling objects.

4.4 Hitting and being hit by moving objects

Hitting and being hit by moving objects is a major hazard at sugar mills. This can be caused by:

- cluttered workplaces
- workers colliding with moving plant or equipment (e.g. rolling stock in a mill yard)
- lack of warning signs fitted at intersections
- doors opening into walkways
- plant not maintained in safe condition (e.g. unguarded or inadequately guarded machinery which generates flying objects such as splinters, metal fragments and dust)
- lack of appropriate personal protective equipment such as safety glasses to protect eyes from splinters of wood, metal, concrete or sparks
- lack of warning devices on moving plant and vehicles such as forklifts.

4.4.1 Possible control measures for hitting and being hit by moving objects

Mills which utilise cane railway delivery systems have large storage and delivery areas for both empty and full bins around the factory.

The risk of injury from persons walking through rolling stock is eliminated if access is provided to work areas without the need to walk through bins in mill yards.

Preventing or minimising exposure to the risk of being hit by moving objects can be achieved through separation, for example:

- overhead walkways
- yard fencing
- underpasses
- exclusion zones.

Other possible control measures that can be used to minimise or prevent the risk of injury from hitting or being hit by moving objects include:

- providing training
- ensuring site rules are prepared and followed
- wearing high visibility garments
- ensuring machines are guarded to prevent flying objects from being produced, and if this cannot be achieved, then barriers installed to prevent them flying into the general work area
- fitting reversing lights and beepers to mobile vehicles
- clearing a designated walkway so that people and mobile plant/equipment are kept separate
- install mirrors and other warning devices at intersections.

5. Plant

The WHS Act places health and safety duties on PCBUs who design, manufacture, import, supply, install, construct or commission plant. The duties include ensuring that adequate information is given to certain people about the plant.

The *Managing risks of plant in the workplace Code of Practice* gives practical advice on ways to manage exposure to risks related to plant use including its safe design, manufacture and installation. It outlines the duties of persons involved with plant and provides information on risks and their control.

The major hazards associated with plant involve being caught between, struck by or against plant. There is a large range of plant within sugar milling operations and this section identifies some plant hazards. This section also details some of the major control measures regarding plant which may be implemented to control risk.

5.1 Emergency shut downs and stoppages

Routine shut-downs and start-ups should usually be scheduled and planned so that the appropriate preparation can be made and precautions taken to minimise risk of injury to workers and damage to mill equipment. Examples of routine shut-downs include, but are not restricted to:

- routine planned maintenance
- wet weather shut-down
- maintenance day activities
- weekend shut-down if five/six day cycle.

Unscheduled shut-downs, as the name implies, usually require an emergency stop for immediate repair. They occur at any time while the factory is in normal production. There are two types of unscheduled shut-downs within sugar milling operations:

- type 1 – those that can occur from time to time as a consequence of for example, choked feed chutes and motors tripped on overload
- type 2 – those that are not expected to occur and are the result of a failure, for example, conveyor belt breakage or mechanical failure in an item of plant.

Other types of unscheduled shutdown due to failure that can occur at sugar mills include:

- water tubes failing in a boiler
- ruptured steam/hot juice pipes
- steam driven plant failure
- loss of external electricity supply
- motors or pumps failing
- hydraulic driven plant failures
- electrically driven plant failures.

Routine shut-downs and subsequent start-ups processes should be documented in standard work procedures. These procedures can be made available in a number of ways such as paper based, as in a folder system or, on-line and printable from a maintenance management system.

Where modifications are planned as part of a scheduled shut-down, safe work procedures should be provided to ensure the appropriate person is fully aware of the modifications to be undertaken and the safe work practices to be used. This is particularly important while

energy supply systems in the plant are live, for example, boilers, generators and air compressors. Operators should be instructed in any new procedures needed to operate and/or maintain modified equipment. Each safe work procedure should be signed off by a supervisor or the person in control of the work.

5.1.1 Possible control measures for emergency shutdowns and stoppages

For unscheduled and emergency shut-downs and start-ups, the supervisor and/or operator should conduct a risk assessment and take appropriate actions to minimise risks of injury to workers. Where appropriate, a safe work procedure (if not already available) and safe work permit should be issued for the repair of the particular plant including all the necessary precautions and hazard control measures arising from the risk assessment.

Following an emergency shut-down, if standard work procedures exist for the plant requiring repair, then these should apply. Where no standard work procedures exist for the repair of the plant and significant risks are identified, then safe work procedures should be developed and implemented prior to commencement of the task (e.g. via a safe work permit).

The process should include an appropriate safety inspection prior to start-up, to ensure that any incomplete work or hazards, resulting from the shut-down, are identified and risks eliminated or emergency shutdown minimised. Each safe work procedure should be signed off by a supervisor or the person in control of the work on completion of the job.

Management should ensure that all persons involved in shut-down and start-up activities are trained and competent to perform their respective duties.

5.2 Isolation and lockout

Isolation is used to eliminate or minimise the risks associated with energy sources whenever work involving removal, break-in, replacement, repair or other similar activity is performed by persons, or for the safe isolation of equipment to minimise potential damage. In the majority of cases lock out is the preferred method.

Hazards which can be controlled by isolation include:

- hazardous chemicals (e.g. caustic soda or milk of lime)
- hot materials (e.g. steam, hot juice, masses of hot material and other process streams)
- energy sources (e.g. electrical, mechanical, heat, pneumatic or hydraulic).

In large mills where workers perform a range of different tasks it may be necessary to maintain and provide written isolation procedures, particularly:

- when plant is suspected of being in a hazardous condition (e.g. malfunctioning, broken or damaged) and inspection and repair/replacement is required
- following an incident when it is necessary to isolate plant
- for routine inspection
- for any entry into plant by workers
- when it is desirable to prevent the use, including unlawful use of plant.

Isolation procedures can be item specific or generic such as procedures to:

- replace or repair valves, pumps or pipe sections
- replace fugate screens
- shredder hammer replacement.

An assessment of the risks should be conducted before any work involving removal or repair of plant, breaking into lines and systems or any other task that may involve exposure of workers to hazards from energy sources, is commenced.

Where significant risks have been identified, safe work procedures (such as a permit to work system¹) should be prepared with specific details for:

- Identified hazards such as energy sources (e.g. gravity, moving loads or steam).
- Type of lockout and other isolation devices to be used (e.g. locks – keys, multi-lock or code-lock, danger tags, out of service tags, mechanical devices – bars, clamps, chains, or removal of component, valve bleeding and other control measures).
- Stored energy should not be used to effect isolation (e.g. pneumatic valves which fail safe without a mechanical isolator). The use of manual isolation valves is recommended where possible.
- Application and removal of isolation and lockout devices (test-run machines before isolation).
- Identification of lockout points and zones of isolation systems.
- Dual drives.
- Nomination of trained and authorised personnel for isolation procedures for each work area (e.g. an isolation coordinator).
- Process and authority for over-riding any interlocks already in place.
- Regular testing of isolation systems and circuits, and
- Electrical items to be isolated from all sources of electrical power prior to the commencement of any work on the equipment.

5.2.1 Possible control measures – isolation and lockout

The following controls can be used to prevent or minimise the risk of injury from energy sources when using plant:

- Before commencing work on plant, all isolations and lock outs should be tested by competent persons.
- Where equipment is isolated regularly (i.e. during routine replacement or maintenance, isolation procedures) or standard work procedures could be developed and used as required. If it is not possible to isolate the electricity supply, control measures should be implemented to prevent energising of the plant (e.g. through the use of a permit-to-work system).
- Training in relation to isolation procedures should be conducted to ensure competency of workers who are required to comply with those procedures. Isolation procedures should be periodically reviewed, particularly when plant is modified or replaced, or new plant is introduced to the system. Records of training and procedure reviews should be kept, and
- The isolation and lockout system should be regularly audited to ensure they operate effectively.

5.3 Work with mobile plant

Sugar mills utilise a range of mobile plant including forklifts, bob cats, end loaders, mobile cranes and general heavy vehicles. Mobile plant operation has a range of hazards, including:

- contact with persons
- operator error
- contact with electrical parts

¹ See *Section 9 Work environment* for information on safe work permits.

- roll over.

Injuries can occur by being struck by machinery, equipment or their by-products (e.g. metal fragments, conveyor belts, mobile plant and cane bins).

5.3.1 Possible control measures for plant contact with persons

The following control measures may be used to prevent or minimise exposure to the risk of injury or death by moving plant:

- using specific signage
- adequate work space or exclusion zones around machines
- training for operators
- regular maintenance
- good housekeeping standards
- provision and use of appropriate personal protective equipment
- the plant is not cleaned, maintained or repaired while it is operating, unless risks from moving parts are controlled
- guarding to prevent the operator coming into contact with moving parts.

Where guarding of moving parts does not prevent the risk of entanglement, persons should not operate or pass in close proximity to the plant unless a barricade or safe system of work has been implemented to prevent or minimise the risk.

5.4 Machine guarding

The types of guard and their suitability for particular applications include:

Fixed guards

They have no moving parts and offer protection only when properly fixed in position. Where necessary for access, fixed guards should be easy to remove and replace but only be able to be opened or removed with a tool.

Interlocking guards

These are moveable, with the moving part interconnected with a control system. Interconnections are usually electrical, mechanical, hydraulic or pneumatic. The interlock prevents the machinery from operating unless the guard is closed.

Automatic guards

These automatically move into position as the machine or cycle is started. These are only suitable on slow moving machines.

Distance guards

These prevent access to hazardous areas through a barrier or fence.

Trip guards (presence sensing devices)

These stop a machine when a person gets into a position where they are liable to be injured. A photo-electric curtain is an example of this type of guard.

5.4.1 Possible control measures - machine guarding

Management should conduct a separate risk assessment for each item of plant and any associated system of work used with that machine. The risk assessment should prioritise the

risks so that effort can be directed to eliminating or controlling risks that have a high potential to cause harm.

Fixed guards should be used where access is not necessary for operation, inspection, and maintenance or cleaning.

Where a risk assessment indicates a significant risk to workers required to work in close proximity to or interact with plant (e.g. power presses), interlocking guarding should be fitted that would prevent starting or operating the machine if the guard is removed. The system should be designed so that it is difficult to tamper with or bypass the interlock.

Interlocks should be fitted to all items of plant that may present a hazard if removed or changed (e.g. openings on tanks under high pressure or high temperature, exposed blades on disintegrators or a cutter grinder). Such interlocks should prevent the plant from operating whenever the cover, door, lid or inspection hatch is removed or opened.

Where guarding is considered insufficient or easy to tamper with, the erection of barriers or fences should be considered. If an interlock system is malfunctioning and there is a need to operate the plant, a risk assessment may indicate that a barrier or fence may be a suitable short-term alternative.

If appropriate, presence sensing devices may be fitted to prevent the plant from starting or operating.

Safe work procedures should be prepared, issued and signed off when access to hazardous parts of plant is required. The procedures should identify the circumstances where access to guarded parts is safe. This will prevent the need to tamper with guarding or interlocks. During the period when a guard is removed to enable access, appropriate lockout and tagout procedures should be used.

The risks associated with plant that is remotely started and/or operated should be assessed and appropriate controls implemented. Controls may include:

- signposting
- flashing lights timed to operate prior to the plant activation
- presence sensing devices
- barriers or guards
- audible alarms
- local isolation switches.

Machine guarding and interlocks should be inspected and maintained at regular intervals. Records of inspection and maintenance should be kept.

Elimination of a hazard should be considered when designing new plant or when replacing or modifying existing plant.

For guidance on reliability requirements for interlocks and safety circuitry, including pressure sensing device please refer to AS/NZS 4024 *Safety of Machinery* and AS 61508 *Functional safety of electrical/electronic/programmable electronic safety-related systems set*.

6. Biological substances

6.1 Legionella

The *Guide to Legionella control in cooling water systems, including cooling towers*, provides guidance on controlling the growth of Legionella in cooling water systems associated specifically with evaporative condensers and cooling towers in both industrial and air-conditioning situations.

Cooling towers are used extensively in the sugar milling industry and the presence of Legionella bacteria can cause serious infection in humans, called Legionellosis, which can take two forms: Legionnaires' disease and Pontiac fever.

Legionnaires' disease is an infection that causes a type of pneumonia (lung infection) that can be severe and even life threatening. Pontiac fever is a milder form of respiratory illness.

Legionella is one form of microbial contamination and it should be noted that other microbes can contaminate air-conditioning units and cooling towers. Other microbes can result in other health problems such as respiratory sensitisation and building related illness.

Legionella can contaminate and multiply in cooling towers if a combination of conditions occurs for example:

- the water temperature ranges from 25 to 45 degrees
- nutrient levels are high
- there is an accumulation of organic materials, sediments and other micro-organisms.

AS/NZS 3666 (SET) *Air-handling and water systems of buildings (set)*, and its supporting document AS SAA.HB32 *Control of microbial growth in air-handling and water systems of buildings*, specify minimum requirements for design, installation, commissioning, operation and maintenance of air-handling and water systems in buildings to assist in the control of micro-organisms, including Legionella bacteria.

6.1.1 Possible control measures for Legionella

To reduce contamination of cooling towers, mill operators should consider:

- equipment design, installation, operation and maintenance in order to minimise microbial multiplication
- minimising nutrient accumulation
- monitoring and treating microbial levels
- water treatment.

For more control measures refer to the *Guide to Legionella control in cooling water systems, including cooling towers*.

6.2 Bagasse

Bagasse, a by-product of the milling process, is normally used as fuel in suspension boilers in sugar mills which in turn produces the steam necessary to operate factory processes.

Bagasse is a natural, fibrous material which occurs in respirable and inspirable sizes.

Bagasse is a nuisance dust which is difficult to control, particularly in the form of bagacillo, a dry dust separated from the larger fibres by cyclones and screens, used to mix with material subsided from juice to create mill mud.

Atmospheric contaminants encountered in sugar milling operations such as Bagasse fibres, sugar dust and dirt are classed as irritants. Health risks associated with bagasse, include the development of bagassosis, an allergic reaction of the lung tissue in the presence of **Thermoactinomyces Sacchari** spores. Research has indicated that bagasse does not cause bagassosis. However, if bagasse is stored in damp conditions, **T. sacchari** bacteria can propagate. The spores of this bacterium can give rise to bagassosis in workers.

6.2.1 Possible control measures for bagasse

A number of control measures should be considered for controlling and minimising levels of bagasse dust, they include:

- high standards of housekeeping
- covered conveyors and transfer points
- local exhaust ventilation
- provision of personal protective equipment
- training and supervision.

Reclamation or de-baling of stored bagasse can generate significant levels of airborne dust and spores containing **T. sacchari** and control measures appropriate for these types of operation include:

- involving the minimum number of workers
- conducting the activities only when weather conditions are suitable
- providing air conditioned cabins on machinery used for these activities
- providing suitable P2 class respirators (minimum) and goggles to workers who are exposed.

A review of the risks associated with stored bagasse may require additional control measures such as:

- health checks of workers normally involved in activities generating levels of atmospheric contaminants
- identification of sources of dusts
- assessment of measures to minimise the generation of dusts
- site inspections to assess housekeeping standards
- suitability and use of personal protective equipment provided.

7. Substances

Many substances may present hazards at sugar mills. But if the hazards are known and understood, appropriate precautions can be taken so that they can be used safely.

7.1 Asbestos

Asbestos is a known carcinogen. Inhaling asbestos fibres can cause diseases such as mesothelioma, lung cancer and asbestosis. There is a long latency period between exposure to asbestos fibres and the onset of disease, for example, the latency period of asbestosis is generally between 15 and 25 years.

Asbestos poses a risk to people's health when asbestos fibres become airborne and can be inhaled.

The WHS Regulation has requirements dealing with preventing or minimising the risks from exposure to asbestos fibres.

Ban on using asbestos

Work involving asbestos or asbestos containing material (ACM) is prohibited except in very limited circumstances; for example, handling or using asbestos or ACM for the purpose of obtaining samples or removal or disposal in accordance with the regulation is permitted. For more information on work involving asbestos and the circumstances in which it is permitted, refer to Part 8.1 (Prohibitions and authorised conduct) of the WHS Regulation and the *How to manage and control asbestos in the workplace Code of Practice*.

Prohibited activities involving asbestos

The WHS Regulation prohibits the use of certain equipment on asbestos or ACM as they can cause unacceptable levels of asbestos fibres to become airborne; for example, a worker must not use high-pressure water spray or compressed air on asbestos or ACM. For more information about limitations on the use of equipment on asbestos, refer to Part 8.5, division 3 of the WHS Regulation.

Managing asbestos at the workplace

Part 8.3 of the WHS Regulation has requirements regarding the management of asbestos at workplaces. This includes requirements for:

- identifying asbestos at the workplace
- indicating the presence and location of asbestos at the workplace
- asbestos registers and asbestos management plans for certain workplaces.

Chapter 8 of the WHS Regulation also sets out requirements for:

- asbestos-related work, including training and health monitoring for workers
- demolition and refurbishment of structures or plant built or installed before 31 December 2003.

More information about managing asbestos can be found in the *How to manage and control asbestos in the workplace Code of Practice*.

Asbestos removal work

Chapter 8 of the WHS Regulation sets out requirements for removal of asbestos or ACM at workplaces. These include:

- requirements for licensed asbestos removal work, including who may apply for a Class A or Class B licence to carry out licensed asbestos removal work

- training for workers carrying out asbestos removal work, including licensed asbestos removal work
- requirements for asbestos removal supervisors
- asbestos removal control plans
- notifying Workplace Health and Safety Queensland before starting licensed asbestos removal work
- informing other relevant people before licensed asbestos removal work is carried out, for example, workers and others at the workplace
- signage, restricting access and decontamination facilities for asbestos removal areas
- clearance inspections and clearance certificates after licensed asbestos removal work has been carried out
- additional requirements for asbestos removal work requiring a Class A asbestos removal work licence (friable asbestos removal)
- requirements for health monitoring.

More information about removing asbestos or ACM can be found in the *How to safely remove asbestos Code of Practice*.

7.2 Hazardous chemicals (incorporating hazardous substances and dangerous goods)

Under the WHS Act certain persons have duties regarding hazardous chemicals. The WHS Regulation provides information on the requirements for safety data sheets (SDS), controlling exposure, monitoring, health surveillance, keeping registers and records and training.

The *Labelling of workplace hazardous chemicals Code of Practice*, the *Managing the risks of hazardous chemicals in the workplace Code of Practice* and the *Preparation of safety data sheets for hazardous chemicals Code of Practice* give practical advice on ways to manage specific risks that arise when hazardous chemicals are used at workplaces.

Hazardous chemicals found within a sugar milling environment include:

- petroleum products
- caustic soda (sodium hydroxide)
- hydrochloric, phosphoric, sulphuric and sulphamic acids
- formaldehyde
- lime (calcium hydroxide).

Sugar mill operators should identify high risk activities involving these chemicals and implement control measures which minimise the risk of exposure. For example, activities or issues such as:

- unloading and bulk transfer
- process or plant failure
- operator error.

7.2.1 Possible control measures for hazardous chemicals

The main risk associated with hazardous chemicals is the potential for exposure to site personnel and other persons. Exposure can occur by breathing in the chemical, through skin contact where a chemical is absorbed through the skin or ingestion when eating with contaminated hands.

Hazardous chemicals within sugar milling operations have methods of risk reduction prescribed by a regulation which include:

- ensuring a safety data sheet is readily available to anyone likely to be exposed to the hazardous chemical
- a hazardous chemicals register containing a list of all hazardous chemical on site plus a current copy of a safety data sheet for each chemical is maintained
- labelling and storage comply with the appropriate standards and codes
- a risk assessment is completed and risks minimised for each hazardous chemical
- workers are aware of the control measures to be implemented
- appropriate PPE in accordance with the risk assessment is available and used as intended
- adequate training is provided in the use of the hazardous chemical and the recommended PPE
- monitoring or health surveillance is conducted if required
- records are maintained for the specified time.

Safety Data Sheets provide important information on hazardous chemicals including:

- the ingredients of a product
- the health effects and first aid instructions
- precautions for use
- safe handling and storage information.

Specific control measures should be developed such as:

- isolating high risk areas with barriers and signage (e.g. under the effert stage while caustic boiling)
- detailed and documented operating procedures
- training
- emergency response
- provision of, and training with, appropriate PPE
- provision of eye wash and safety shower facilities adjacent to the site but isolated from likely engulfment
- access to safety data sheets and emergency procedures at the site.

7.3 Laboratory chemicals

Laboratory staff may have a more frequent exposure to a larger range of hazardous chemicals in smaller quantities. It is important to minimise the risk of exposure so as to reduce the possibility of acute and chronic health effects over the long term.

Handling, mixing and transferring hazardous chemicals such as hydrochloric and sulphuric acids, sodium hydroxide and flammable liquids including ethanol are some of the activities which are undertaken in sugar mill laboratories. Users of chemicals should also be aware of any by products or chemical reactions which may take place which could create additional hazards during laboratory processes.

7.3.1 Possible control measures for laboratory chemicals

Specific control measures should be implemented for each separate activity involving a hazardous chemical in mill laboratories. The most appropriate control measures will depend on the particular circumstances of use and the hazardous chemical however typical control measures should include:

- detailed analytical procedures
- training in the standard procedures to be followed
- emergency response training and access to speciality first aid treatment
- provision of, and training with, the recommended personal protective equipment for each activity
- provision of eye wash and safety shower facilities adjacent to the site but isolated from likely engulfment
- easy access to safety data sheet, information and emergency procedures in the laboratory
- adequate labelling of all containers of hazardous chemicals
- use of automatic pipettes
- adequate ventilation
- a high standard of hygiene
- disposal systems for used personal protective equipment
- separate laundering of laboratory coats, hand towels, etc.
- use of fume cupboards that comply with AS/NZS 2243.8 *Safety in laboratories – Fume cupboards*.

7.4 Lead

The WHS Regulation sets out the requirements for workplaces where lead is used. These include requirements on obtaining safety data sheets, labelling containers, keeping registers, keeping records, conducting risk assessments, notifying of lead risk work, controlling exposure, conducting monitoring and health surveillance, and providing training.

All sugar factory laboratories use lead in the form of dry lead acetate and 'wet lead', which require specific control measures to ensure workplace health and safety. Lead can be absorbed by inhaling lead dust, fume or mist and by ingesting lead that has contaminated hands, food or cigarettes.

Early symptoms of lead poisoning may include headache, loss of appetite, abdominal pain, constipation, nausea, fatigue, loss of weight and irritability. Continued exposure can cause anaemia, kidney damage, and nerve and brain damage.

7.4.1 Possible control measures

The WHS Regulation places health and safety duties on various duty holders in relation to the provision of adequate information about the safe use of chemicals used at a workplace.

In certain situations, PCBUs must arrange and pay for health monitoring. This health monitoring must be done by, or under the supervision of, registered medical practitioner with experience in health monitoring. Health monitoring, which includes biological monitoring, can assist in minimising the risk to health from lead exposure by:

- confirming that the absorbed dose of a substance is below the acceptable level
- detecting adverse health effects at an early stage so that the worker can be protected from further injury, either by control of the process or by removal from exposure
- evaluating the effectiveness of control measures.

The primary technique for monitoring the working environment is usually to determine the concentrations of an airborne contaminant and then compare the result with the relevant exposure standard specified in the *Workplace Exposure Standards for Airborne*

Contaminants. However, if lead dust or fume can be ingested or inhaled, biological monitoring techniques should also be used (e.g. in lead risk work, biological monitoring would measure the blood lead level of individual workers). Biological monitoring has the specific advantage that it can take account of issues that dictate an individual's response to particular hazardous chemicals. Some of these factors include size, fitness, personal hygiene, work practices, smoking and nutritional status.

Health monitoring should not be used as an alternative to proper implementation and maintenance of control measures designed to prevent exposure. For more information on health monitoring techniques required for hazardous chemicals (e.g. Respiratory function tests), see Schedule 14 of the WHS Regulation.

In circumstances where a risk assessment determines the job not to be a lead risk work, the PCBU must conduct a risk assessment within five years after the last assessment. The risk assessment must be conducted sooner if there is a significant change in the way a lead process is done at the workplace or if there is a significant change in the amount of lead, or the amount of lead contained in a thing at the workplace.

Provided that the risk assessment has been conducted at prescribed intervals and appropriate control measures are adhered to, then the status as a lead process rather than lead risk work can be maintained. It is recommended that all new laboratory workers have baseline and mid-season samples to identify those workers whose absorption of lead is significant.

Appropriate control measures include:

- labelling all containers in which any lead compound is stored
- avoiding generating dust when handling dry lead acetate
- when transferring to smaller containers:
 - use personal protective equipment (face shield, P2 dust respirator and gloves)
 - transfer in a well ventilated area free of strong air currents
- high standards of personal hygiene
- not allowing drinking from laboratory taps
- training and supervision to ensure that the correct procedures are followed
- maintaining appropriate emergency response treatments
- providing automatic dispensers for wet lead.

7.5 Welding and cutting fumes

The fumes and gases arising from welding and cutting processes may contain a number of hazardous chemicals. The welding/cutting arc can cause reactions which produce oxides of nitrogen, carbon monoxide and other gaseous contaminants. The intense ultraviolet radiation emitted from some arcs may also give rise to significant quantities of ozone.

The composition of the fume depends upon:

- consumables – electrodes or filler metals, heating or shielding gases and fluxes
- material – chemical composition of material being cut or welded and of any protective coating (e.g. galvanising) or primer paint (e.g. lead-based paints)
- operating conditions (e.g. temperature and rod current).

The amount of fume generated depends on:

- process and thermal conditions – amperage, voltage, gas and arc temperatures and heat input which may also vary with the welding position and degree of enclosure and the degree of skill of the welder

- consumables
- materials
- duration of welding or cutting.

The *Welding processes Code of Practice* and the *Technical Note 7 – Health and safety in welding* produced by the *Welding Technology Institute of Australia* should be consulted for detailed information on fume generation and control.

7.5.1 Possible control measures for welding and cutting fumes

When assessing the risks associated with a particular welding or cutting process, consideration should be given to airborne concentrations of toxic metals, such as chromium and nickel that may be generated from the parent metal or electrode. In addition to complying with the individual exposure standards for specific contaminants, the fume concentration in the breathing zone (which is inside a welder's helmet when a helmet is worn) should not exceed five mg/m³ TWA (time weighted average).

When selecting control measures, routine tasks should be identified so that generic procedures can be developed and documented for future use. Within sugar milling operations repetitive tasks include:

- roller arcing
- welding and cutting in dedicated workshop areas
- railway maintenance.

Special consideration is also required for specific tasks such as:

- hot work in confined space
- welding in open spaces
- tasks involving stainless steel, galvanised steel, etc.

An example of a safe work procedure for roller arching is provided in Appendix 9.3.

A workplace where airborne contaminants hazardous to the health of workers are generated should:

- have air quality acceptable to the standard specified in AS 1668.2 *The use of ventilation and air conditioning in buildings – Part 2: Mechanical ventilation in buildings* when mechanical ventilation is introduced
- have exhaust appliance systems which prevent or minimise the risks from exposure to those airborne contaminants.

Ventilation systems can be of two types. When the airborne contaminants comprise of low to moderately toxic materials generated only in small amounts, general forced dilution ventilation, either as supplied air or as extracted air systems complying with AS 1668.2, can be employed.

Where airborne contaminants are generated in moderate to large quantities or comprise of toxic or very toxic materials, a local exhaust ventilation system should be used for which AS 1668.2 may be used for initial guidance. In either case, the exhaust appliance in use must be capable of reducing the level of airborne contaminants such that an involved worker's exposure is not more than the relevant exposure specified in the *Workplace Exposure Standards for Airborne Contaminants*. Air-conditioning systems are not considered suitable for control of atmospheric contaminants.

7.6 Methane gas

The WHS Regulation requires the elimination of ignition sources in hazardous areas. Flammable or combustible gases, vapours, dusts and mists may be generated or evolve within a dangerous goods storage and handling environment. These can form explosive mixtures with air in certain proportions.

Under the ES Regulation, electrical installation work must be done in accordance with the wiring rules². The wiring rules define hazardous areas as areas where an explosive atmosphere is present or may be present. For further information refer to the Electrical Safety Office.

Methane gas (CH₄) is a colourless, odourless gas that forms when organic matter decomposes under oxygen poor conditions (anaerobic – without oxygen). High concentrations of methane gas can lead to a lack of oxygen in the air.

Within a sugar milling environment methane or 'fermentation' gas can be produced as a result of fermentation of certain materials within the factory (e.g. mixed juice, liquor, molasses and mesquite). Methane can also result from fermentation of fibre products such as cush material (fibre separated from mixed juice prior to processing) or bagasse deposits mixed with water such as in mill boots, juice pits and within the cush-cush system. Mill operators should ensure that areas where these materials may remain following a shut down or mill closure are cleaned out before there is a risk of fermentation, thus avoiding methane build up.

If methane gas occurs in a confined space it can be explosive; the explosive range is between five percent and 15 percent methane in air and high concentrations of methane gas in the air can also be flammable.

Operators should be aware of possible methane gas deposits after extended close downs in areas such as:

- molasses pipes
- hollow mill rollers
- between wear plates on pressure feeder chutes
- juice pipes
- pans
- effets
- mill boots
- juice pits
- rotary filter boots
- heaters
- a range of tanks such as subsidors, mixed juice, incubators and flash tanks.

7.6.1 Possible control measures for methane gas

Documented procedures should be in place to identify or control potential explosive atmospheres prior to entry by personnel or work from outside the vessel or pipe (particularly for hot work). Mill operators should consider the hierarchy of controls in dealing with potential risks from methane gas explosion, including:

- training of personnel
- engineering controls (e.g. ventilation or flame proof equipment)

² AS/NZS 3000 *Electrical installations (known as the Australian/New Zealand wiring rules)*.

- sign posting and marking of areas where flammable atmospheres may exist to exclude ignition sources by a safe distance
- work procedures
- safe work permit systems for identified high risk processes (e.g. hot work permit systems including monitoring for flammable atmospheres in areas identified to be at risk).

7.6.2 Monitoring for methane gas before permitting entry to potentially flammable atmospheres

Monitoring for methane gas is required prior to an entry permit being issued for hot work or any other work that could possibly introduce an ignition source into an area where methane gas may be in the flammable range.

A PCBU must ensure, so far as is reasonably practicable, that while work is being carried out in a confined space, the concentration of methane gas in the atmosphere of the space is less than five percent of its Lower Explosive Limit (LEL).

If it is not reasonably practicable to limit the atmospheric concentration of methane gas in a confined space to less than five percent of its LEL and the atmospheric concentration of the methane gas in the space is equal to or greater than five percent, but less than 10 percent of its LEL, the PCBU must ensure that any worker is immediately removed from the space unless a suitably calibrated, continuous-monitoring flammable gas detector is used in the space.

However; if the concentration of methane gas in the space is equal to or greater than 10 percent of its LEL, the PCBU must ensure that any worker is immediately removed from the space.

7.7 Sugar dust

Under the ES Regulation, electrical installation work must be done in accordance with the wiring rules³ and that it is inspected by an accredited auditor before connection to supply. The wiring rules define hazardous areas as areas where an explosive atmosphere is present or may be present. For further information refer to the Electrical Safety Office.

The exposure standard for inspirable sugar dust which should be observed provides for an allowable time-weighted average (TWA) airborne concentration for sugar dust of 10 mg/m³. This value is a standard value for all inspirable dusts containing no asbestos and less than one percent crystalline silica. Inspirable dust refers to particles where the equivalent aerodynamic diameter is greater than 10µm.

Under certain conditions, sugar dust can also be explosive. The conditions that must be fulfilled simultaneously for a sugar dust explosion to occur are:

- at least nine percent by volume (at atmospheric pressure) of oxygen
- a sugar dust concentration greater than 20 g/m³
- a minimum ignition energy of 30 mJ
- for an electrostatic spark ignition – a minimum field strength of 20 kV/cm.

³ AS/NZS 3000 *Electrical installations* (known as the Australian/New Zealand wiring rules).

7.7.1 Possible control measures for sugar dust

Sugar mill operators should evaluate areas where combustible dusts are or may be present as detailed in *AS/NZS 60079.10.2 Explosive atmospheres - Classification of areas - Explosive dust atmospheres*. *AS 2243.8 Safety in laboratories – Part 8: Fume cupboards*. In general, operations which involve handling, production or storage of sugar which create sugar dust should utilise equipment which is designed, operated and maintained so that releases of dust are minimised. Further guidance is also provided in *AS/NZS 2381.2 Electrical equipment for explosive atmospheres – Selection, installation and maintenance*.

Control measures which should be considered include eliminating the likelihood of:

- an explosive dust/air mixture and combustible dust layers
- any source of ignition.

If elimination of these hazards cannot be achieved then other control measures should be implemented which reduce the risk of the occurrence of an explosive atmosphere or ignition source. For example:

- the use of appropriately rated equipment for operation within a combustible dust atmosphere (for example Zone 20, 21 or 22)
- dust containment to reduce the 'at risk' area, such as identifying sources of release
- dust reduction processes to maintain dust levels under the explosive point
- minimising occurrences which may disturb dust layers creating dust clouds or removal of dust layers through good housekeeping practices
- elimination of other sources of ignition such as hot work, smoking and naked flames
- segregation of equipment
- other associated control conditions (e.g. automatic disconnection of power supply and alarm initiations).

Under no circumstances should battery chargers or low pressure sodium vapour discharge lamps be installed in hazardous locations.

8. Work environment

8.1 Safe working in confined spaces

The WHS Regulation outlines the requirements for confined spaces. The WHS Regulation is supported by the *Confined spaces Code of Practice*.

Within sugar milling operations a range of plant is installed which meets the definition for a confined space under the regulation. For further information see AS 2865 *Confined spaces*.

Types of equipment that may be a confined space can include:

- air conditioning ducts
- bagasse bins
- boilers
- clarifiers
- pans and evaporators
- filter drums
- pipes
- pits
- sugar bins
- trenches
- sugar dryers
- tanks.

A safe work permit system must be used to ensure that all risks associated with entry into a confined space are assessed and those risks are minimised or, where possible, eliminated. The issuer of safe work permits must be trained in confined space entry procedures and risk assessment techniques.

Some of the hazards associated with confined spaces include:

- oxygen deficient or enriched atmosphere
- flammable atmosphere
- toxic atmosphere
- external hazards that may affect those in the confined space
- residual hazardous chemicals
- surfaces
- engulfment
- electric shock
- temperature extremes
- access and egress
- visibility
- noise
- psychological factors
- mechanical equipment.

8.1.1 Possible control measures for work in confined spaces

Required tasks

The issuer should explain the hazards and the control measures to the recipients, prior to the commencement of the work and ensure that the potential risks, control measures to be

used, and the safe work procedures are all thoroughly understood by the recipients. The recipients should acknowledge their understanding of the details of the safe work permit in writing before work commences.

Procedures are required that address all hazards likely to be encountered before a safe work permit is completed and person(s) are permitted to enter the confined space. Issues to be considered include:

- identification of the authorised person
- risk assessment
- isolation procedures
- atmospheric testing and the need for air purging
- portable electrical equipment
- lighting and ventilation
- access and egress
- requirement for a stand-by person and identification
- emergency equipment, rescue procedures and first aid
- signs and barriers to prevent unauthorised access
- education and training of all persons working in or involved with confined space entry
- the work to be performed in the confined space
- work being performed outside the confined space
- whether other hazardous conditions apply (hot work, working at heights or excavation)
- potential for hazardous conditions to result from the work activities.

All existing confined spaces and the hazards associated with working in those confined spaces must be identified at each workplace. A confined space can also be created during the manufacture of plant, equipment and or machinery such as building a tank.

No safe work permit should be issued until all controls are implemented and the persons entering the confined space are briefed about the conditions of entry.

The work in the confined space is to be carried out as specified in the permit and all the required controls and procedures must be followed.

If the work activities are likely to generate harmful fumes or deplete oxygen levels then it will be necessary to implement controls that will minimise the risks associated with these hazards.

The name of each person entering a confined space must be recorded and a system implemented to account for each person involved using appropriate procedures to control entry/egress.

A stand-by person must be provided if a risk assessment indicates a risk to health and safety, such as an unsafe atmosphere or engulfment.

If a stand-by person is required by the risk assessment they must complete the duties specified in the standard and not leave the position while any person remains in the confined space. In the event of an injury or collapse of the person in the confined space, the stand-by person's primary role is to summon help and if possible, provide assistance (e.g. first aid or resuscitation). The observer must not enter the confined space until it is deemed to be safe by a qualified, authorised person.

At the completion of the work, all persons involved in the work must be confirmed as having left the confined space, the confined space shall be closed, the relevant persons notified and

the permit signed off and returned to the issuer and closed (an example of a safe work procedure, plugging a boiler tube, is included in Appendix 9.4).

8.2 Hot work

Before commencing hot work (welding, thermal or oxygen cutting, heating, and other fire-producing or spark-producing operations that may increase the risk of fire or explosion) mill operators should ensure any risks associated with the hot work are properly assessed. This is so work may be carried out safely and not produce sources of ignition in areas where flammable gases or dusts may be present.

Consideration should also be given to hot work in areas which contain flammable liquids or build up of flammable solids such as cane trash (around the tippler) or in other areas where there is a risk of fire or explosion (sugar dust or bagacillo risk).

8.2.1 Possible control measures for hot work

A safe work permit should be issued prior to the commencement of any hot work which outlines the process to be followed, including any isolation and other controls. Persons authorised to issue safe work permits should be trained in the identification of specific hot work hazards, risk assessment and the selection of appropriate control measures to minimise or eliminate the risks.

Consideration should be given to:

- the removal of flammable or explosive materials before work commences
- the reduction in the flammability of materials (wetting down)
- isolating plant
- residues of flammable materials
- testing for flammable and fermentation gases (e.g. methane)
- special precautions (e.g. using a lookout)
- personal protective equipment
- suitable tools, equipment and materials to be used for the work
- emergency procedures
- the location of the fire fighting equipment.

If flammable materials are present, a suitably trained and qualified observer should be in attendance for the duration of the hot work.

Persons carrying out hot work should be qualified and trained for the task (e.g. welding or fire extinguisher use). This training should be documented.

Where flammable gases may be present, testing of the atmosphere prior to the work and at regular intervals should be carried out.

8.3 Safe work permit systems

Safe working permit systems enable mill operators to enhance safety procedures and this section provides information on the requirements associated with safe work permit systems including:

- the authority to issue safe work permits
- the situations where a permit is required
- things to be considered prior to the issue of a permit

- the conduct of the work in accordance with the permit
- the closure of the permit.

There are many advantages to using a permit to work system as it:

- Ensures appropriate people are authorised to carry out designated work. This designated work may be for specific work or any work in a specific area.
- Makes it clear to people carrying out the work the exact identity, nature and extent of the job and the hazards involved. It also outlines any limitations on the extent of the work and the time during which the job may be carried out.
- Specifies the precautions which need to be taken, including safe isolation from potential risks such as electricity and hazardous chemicals.
- Ensures the person in direct charge of the plant or in charge of the area where the plant is located, is aware of all the work being done under the permit to work system.
- Provides a system of continuous control and also a record showing the nature of the work and the precautions needed which is checked by a competent person or people.
- Provides for the suitable display of permits.
- Provides a procedure for times when work has to be suspended.
- Provides for cross referencing of permits for work activities that may interact or affect one another.
- Provides a formal handover procedure for use when the permit is issued for a period longer than one shift, and
- Provides a formal hand back procedure to ensure that part of the plant affected by the work is in a safe condition and ready for reinstatement.

Before a safe work permit is issued, a risk assessment should be conducted and documented with the permit. Each mill should develop a register of tasks requiring a safe work permit within its operations.

Any task on the register or other tasks considered at the time to pose a significant risk, should not be performed without a safe work permit being issued and adequate controls implemented.

The issuer of the work permit should be properly trained in hazard identification, risk assessment and risk control techniques. Their responsibilities and authority should be clearly defined, training reviewed and documented periodically.

Before issuing a safe work permit, the issuer and recipient should consider all potential hazards such as material hazards, pressure, temperature, fumes, electrical power, mechanical energy, hazardous areas, height, radioactive sources, explosive materials, restricted space or field vision, and others.

The work permit should clearly specify the precautions and risk control measures which need to be employed, such as:

- isolation
- decontamination
- working in confined spaces
- hot work
- working at heights
- excavation and building work
- work on high voltage equipment
- personal protective equipment
- provision to notify relevant persons when work commences and when work is completed

- any other special precautions.

The issuer of a safe work permit should ensure that the recipient(s) are competent to perform the work. Once a work permit has been issued, the work should be carried out as specified in the safe work permit. At completion, the permit should be returned to the issuer and closed.

9. Appendices

9.1 Dictionary

Confined space means an enclosed or partially enclosed space that:

- is not designed or intended primarily to be occupied by a person; and
- is, or is designed or intended to be, at normal atmospheric pressure while any person is in the space; and
- is or is likely to be a risk to health and safety from:
 - an atmosphere that does not have a safe oxygen level; or
 - contaminants, including airborne gases, vapours and dusts, that may cause injury from fire or explosion; or
 - harmful concentrations of any airborne contaminants; or
 - engulfment,
- but does not include a mine shaft or the workings of a mine.

Consequence: the most probable results of an incident due to the hazard under consideration.

Demolition work: work to demolish or dismantle a structure, or part of a structure that is loadbearing or otherwise related to the physical integrity of the structure, but does not include:

- the dismantling of formwork, falsework, or other structures designed or used to provide support, access or containment during construction work; or
- the removal of power, light or telecommunication poles.

Exposure: the frequency of occurrences of the hazard.

Hazard: means a situation or thing that has the potential to harm a person.

Hot work: welding, thermal or oxygen cutting, heating, and other fire-producing or spark producing operations that may increase the risk of fire or explosion.

Interlocking guard: a guard which has a moveable part that is interconnected with the power or control system of the plant item so that, until the guard is in place, the interlock prevents the machine from operating. Interconnections can be electrical, mechanical, hydraulic or pneumatic.

$L_{Aeq,8h}$: the eight-hour equivalent continuous A-weighted sound pressure level in decibels (dB(A)) referenced to 20 micropascals, determined in accordance with AS/NZS 1269.1:2005 (Occupational noise management—Measurement and assessment of noise immission and exposure).

$L_{C,peak}$: the C-weighted peak sound pressure level in decibels (dB(C)) referenced to 20 micropascals, determined in accordance with AS/NZS 1269.1:2005 (Occupational noise management—Measurement and assessment of noise immission and exposure).

Probability: the likelihood that once the hazard - event occurs, the complete incident-sequence of events will follow with the timing and coincidence to result in the incident and consequences

Risk: the possibility that harm (death, injury or illness) might occur when exposed to a hazard.

Risk management: the identification of hazards, the assessment of the risks associated with those hazards and the implementation of methods to eliminate or control the risks.

Safe work permit: a procedure to ensure the risks associated with specific high risk tasks are documented, addressed, controlled or minimised.

Safe work procedure: a document to communicate to employees and contractors, the safest way of controlling identified hazards associated with a particular task.

9.2 Further information

9.2.1 Workplace Health and Safety Queensland and the Electrical Safety Office

Further information is available from www.worksafe.qld.gov.au or by contacting 1300 362 128.

Legislation

- *Work Health and Safety Act 2011*
- *Work Health and Safety Regulation 2011*
- *Electrical Safety Act 2002*
- *Electrical Safety Regulation 2013*

Codes of Practice

- Confined spaces Code of Practice
- Electrical safety Code of Practice - Electrical equipment rural industry
- Electrical safety Code of Practice - Working near overhead and underground electric lines
- Electrical safety Code of Practice - Works
- Electrical safety Code of Practice - Managing electrical risks in the workplace
- First aid in the workplace Code of Practice
- Hazardous manual tasks Code of Practice
- How to manage and control asbestos in the workplace Code of Practice
- How to manage work health and safety risks Code of Practice
- How to safely remove asbestos Code of Practice
- Labelling of workplace hazardous chemicals Code of Practice
- Managing noise and preventing hearing loss at work Code of Practice
- Managing risks of hazardous chemicals in the workplace Code of Practice
- Managing risks of plant in the workplace Code of Practice
- Managing the risks of falls at workplaces Code of Practice
- Managing the work environment and facilities Code of Practice
- Mobile crane Code of Practice
- Rural plant Code of Practice
- Safe design and operation of tractors Code of Practice
- Scaffolding Code of Practice
- Spray painting and powder coating Code of Practice
- Welding processes Code of Practice
- Work health and safety consultation, co-operation and co-ordination Code of Practice

Other OIR Publications

- “Guide to machinery and equipment safety” (2015)
- “Guide to Legionella control in cooling water systems, including cooling towers” (2018)

9.2.2 Standards Australia

www.standards.com.au

- AS 1210 Pressure Vessels
- AS/NZS 1269 Occupational Noise Management – Overview and general requirements
- AS 1319 Safety signs for the occupational environment
- AS 1345 Identification of the contents of pipes, conduits and ducts
- AS/NZS 1596 The storage and handling of LP gas
- AS 1657 Fixed platforms, walkways, stairways and ladders – Design, construction and installation
- AS/NZS 1668 (SET) The use of ventilation and air-conditioning in buildings set
- AS/NZS 1680.0 Interior lighting – safe movement
- AS/NZS 1715 Selection, use and maintenance of respiratory protective devices
- AS 1940 The storage and handling of flammable and combustible liquids
- AS 2030.2 The verification, filling, inspection, testing and maintenance of cylinders for the storage and transport of compressed gases – Part 2: Cylinders for compressed dissolved acetylene
- AS/NZS 2243.8 Safety in laboratories – Part 8: Fume cupboards
- AS/NZS 2293.1 Emergency escape lighting and exit signs for buildings – Part 1: System design, installation and operation
- AS/NZS 2381.2 Electrical equipment for explosive atmospheres – Selection, installation and maintenance – Part 2: Flameproof enclosure ‘D’
- AS 2670.1 Evaluation of human exposure to whole body vibration – Part 1: General requirements
- AS 2865 Confined spaces
- AS/NZS 3000 Electrical installations (known as the Australian/New Zealand wiring rules)
- AS/NZS 3666 (SET) Air handling and water systems of buildings set
- AS 3853.1 Health and safety in welding and allied processes – Sampling of airborne particles and gases in the operator’s breathing zone – Part 1: Sampling of airborne particles
- AS 3780 The storage and handling of corrosive substances
- AS 3745 Planning for emergencies in facilities
- AS/NZS 4024 Safety of Machinery
- AS 4332 The storage and handling of gases in cylinders
- AS/NZS ISO 31000 Risk Management – Principles and guidelines
- AS/NZS 4804 Occupational health and safety management systems – General guidelines on principles, systems and supporting techniques
- AS/NZS ISO 60079.10.2 Explosive atmospheres – Part 10.2: Classification of areas – Explosive dust and atmospheres
- AS 61508 Functional safety of electrical/electronic/programmable electronic safety-related systems
- AS IEC 61672.1 Electroacoustics – Sound level meters – Part 1: Specifications
- AS IEC 61672.2 Electroacoustics – Sound level meters – Part 2: Pattern evaluation tests

9.2.3 Safe Work Australia

- Hazardous Chemicals Information System (HCIS)
- National Standard for Licensing Persons Performing High Risk Work

- “Guidance note for the protection of workers from the ultraviolet radiation in sunlight”. ASSC (2008).
- Workplace Exposure Standards for Airborne Contaminants
- “Guidance on the Interpretation of Workplace Exposure Standards for Airborne Contaminants” (2013)

9.2.4 Other

- Welding Technology Institute of Australia, Technical Note No 7, Health and Safety in Welding, NSW, 2013.

9.3 Example only – Safe working procedure for roller arcing

SAFE WORK PROCEDURE – Example only				
DEPARTMENT: Engwara Mining		SECTION: CURRENT		PAGE 1 OF 3
TASK/JOB: Roller arcing (Shutdown and re-assembly)				
REASON FOR SWP:		SWP APPROVED BY: DATE:		REF:
DATE OF REVIEW:		OUTCOME: REVISE SWP <input type="checkbox"/> REVERSE RISK ASSESSMENT <input type="checkbox"/>		ISSUE:
BY WKO:		PERSONNEL REQ:		OTHER JOB REQ:
SAFETY EQUIP:		HAZARDS:		HAZARD CONTROLS:
TOOLS:		HAZARDOUS MATERIALS:		OTHER INFO:
A. Welding machine	1. Working helmet	1. 1 person	1. 1 person	1. 1 person
B. Hot rods and bats	2. Working gloves	1. 1 person	1. 1 person	1. 1 person
C. Hot lead wire	3. Hot lead wire	1. 1 person	1. 1 person	1. 1 person
D. Power hoses (hot)	4. Protective goggles	1. 1 person	1. 1 person	1. 1 person
E. Electric fan (HD)	5. Turn back	1. 1 person	1. 1 person	1. 1 person
F. Water hoses (cold)	6. Emergency stop	1. 1 person	1. 1 person	1. 1 person
G. First aid kit	7. First aid kit	1. 1 person	1. 1 person	1. 1 person
H. First aid kit	8. First aid kit	1. 1 person	1. 1 person	1. 1 person
I. First aid kit	9. First aid kit	1. 1 person	1. 1 person	1. 1 person
J. First aid kit	10. First aid kit	1. 1 person	1. 1 person	1. 1 person
K. First aid kit	11. First aid kit	1. 1 person	1. 1 person	1. 1 person
L. First aid kit	12. First aid kit	1. 1 person	1. 1 person	1. 1 person

SAFE WORK PROCEDURE – Example only				
DEPARTMENT: Engwara Mining		SECTION: CURRENT		PAGE 2 OF 3
TASK/JOB: Roller arcing (Shutdown and re-assembly)				
REASON FOR SWP:		SWP APPROVED BY: DATE:		REF:
DATE OF REVIEW:		OUTCOME: REVISE SWP <input type="checkbox"/> REVERSE RISK ASSESSMENT <input type="checkbox"/>		ISSUE:
BY WKO:		PERSONNEL REQ:		OTHER JOB REQ:
SAFETY EQUIP:		HAZARDS:		HAZARD CONTROLS:
TOOLS:		HAZARDOUS MATERIALS:		OTHER INFO:
1. Open up mill	1. 1 person	1. 1 person	1. 1 person	1. 1 person
2. Lock and tag out above	2. 1 person	2. 1 person	2. 1 person	2. 1 person
3. Check for power and run out leads completely	3. 1 person	3. 1 person	3. 1 person	3. 1 person
4. Set up crane	4. 1 person	4. 1 person	4. 1 person	4. 1 person
5. Set up crane	5. 1 person	5. 1 person	5. 1 person	5. 1 person
6. Set up crane	6. 1 person	6. 1 person	6. 1 person	6. 1 person
7. Set up crane	7. 1 person	7. 1 person	7. 1 person	7. 1 person
8. Set up crane	8. 1 person	8. 1 person	8. 1 person	8. 1 person
9. Set up crane	9. 1 person	9. 1 person	9. 1 person	9. 1 person
10. Set up crane	10. 1 person	10. 1 person	10. 1 person	10. 1 person

SAFE WORK PROCEDURE – Example only

DEPARTMENT: Sugarcane mgmt		SECTION: CURRENT		PAGE: 3 OF 3	
TASK/JOB: Roller rolling (Shutdown and re-assembly)		DATE: _____		ISSUE: _____	
REASON FOR SMP:		SMP APPROVED BY: _____		REVIEW RISK ASSESSMENT <input type="checkbox"/>	
DATE OF REVIEW:		OUTCOME: REVIEW SMP <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		HAZARD/CONTROLS	
BY WHO:		HAZARDS		OTHER INFO	
SPECIFIC JOB STEPS		A to F	1 TO 7	Approach with care	
11	Spotting can commence	A,B,C,D,E	1 TO 7	Break contact and check wipe	
12	When finished spotting roller, and (re-rolling) before etc. can start the roller the C.I. does not enter eyes	F	4	Use popgrip, can ahead of the roller when re-rolling (PPE: H.C.I. dust to the eyes with any lubrication)	This will cut down the risk of C.I. dust to the eyes
					Use rubber gloves when not at roller to check each roller or removal of equipment or every two hours. Eye checks for TIA
13	TIA to clean and roll up equipment after spotting is completed				Trademan to check
14	Cross bars that are not permanently fixed are to be removed and stored against the nearest column				Trademan to check

9.4 Example only – Safe working procedure – Plugging a boiler tube

SAFE WORK PROCEDURE – Example only						
DEPARTMENT: Engineering	SECTION: Boiler Station		CURRENT		PAGE: 1 OF 3	
TASK: Plugging Boiler Tube	SWP APPROVED BY: [Signature]		DATE: [Date]		DATE IN USE: [Date]	
DATE OF REVIEW: [Date]	BY WHO: [Name]	PERSONNEL: RSD	OTHER JOB RISK	PREPARED BY: [Name]		
TOOLS REQUIRED		SAFETY EQUIP		PERSONNEL RSD		
A. Lock	1	Isolation Equipment	Plmr	If a permit is required, it must be completed.		
B. Squares	2	Shovels	Blkr mahr			
C. Drum cover spanner	3	Hot water bottle	SWW			
D. Main cooler fan	4	Safety pad for fan	Welder			
E. 7.5 & 8.5 turner	5	Work stand	Engineer			
F. Jig equipment	6	Overalls Long sleeves				
G. Working procedure and equipment	7	or long sleeve shirt and long pants				
H. Tap wheel	8	Shim stainless steel				
I. Tube plug	9	Confined space entry permit				
J. Door plate 13	10	Hot work permit				
K. Barrels 127	11	Cooling vent				
L. Four plates (max 1M)	12					
M						
N						
O						
P						
Q						
R						
S						

SAFE WORK PROCEDURE – Example only						
DEPARTMENT: Engineering	SECTION: Boiler Station		CURRENT		PAGE: 2 OF 3	
TASK: Plugging Boiler Tube	SWP APPROVED BY: [Signature]		DATE: [Date]		DATE IN USE: [Date]	
DATE OF REVIEW: [Date]	BY WHO: [Name]	PERSONNEL: RSD	OTHER JOB RISK	PREPARED BY: [Name]		
SPECIFIC JOB STEPS		HAZARDS		HAZARD CONTROLS		
1. Isolate stop valve.	MLO	Stem	Effective isolation.			
2. Open front gate and ID damper to cool boiler cover.	B					
3. Blow cover hot water from boiler until empty.	B					
4. Fill boiler with water from outside storage tanks until full flow.	B					
5. Remove inspection door from drum at boiler top.	MLO					
6. Blow down boiler until water level is 100mm below top of drum.	MLO					
7. If forward is to continue out hot work permit is to be completed.	ANK					
8. Install plate on top hopper.	ANK					
9. Place on plate, fit wheel and rate position.	ANK	Hot water scalding out hot water for steam and boiler explosion.	Effective isolation. Shut down boiler from ID Bin. Working for lock on ID Bin.			
10. Plug boiler cover using jigs and squares.	MLO					
11. Blow down boiler until water level is 100mm below top of drum.	MLO					
12. Blow down boiler until water level is 100mm below top of drum.	MLO					
13. Blow down boiler until water level is 100mm below top of drum.	MLO					
14. Blow down boiler until water level is 100mm below top of drum.	MLO					
15. Blow down boiler until water level is 100mm below top of drum.	MLO					
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77. Blow down boiler until water level is 100mm below top of drum.	MLO					
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83. Blow down boiler until water level is 100mm below top of drum.	MLO					
84. Blow down boiler until water level is 100mm below top of drum.	MLO					
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88. Blow down boiler until water level is 100mm below top of drum.	MLO					
89. Blow down boiler until water level is 100mm below top of drum.	MLO					
90. Blow down boiler until water level is 100mm below top of drum.	MLO					
91. Blow down boiler until water level is 100mm below top of drum.	MLO					
92. Blow down boiler until water level is 100mm below top of drum.	MLO					
93. Blow down boiler until water level is 100mm below top of drum.	MLO					
94. Blow down boiler until water level is 100mm below top of drum.	MLO					
95. Blow down boiler until water level is 100mm below top of drum.	MLO					
96. Blow down boiler until water level is 100mm below top of drum.	MLO					
97. Blow down boiler until water level is 100mm below top of drum.	MLO					
98. Blow down boiler until water level is 100mm below top of drum.	MLO					
99. Blow down boiler until water level is 100mm below top of drum.	MLO					
100. Blow down boiler until water level is 100mm below top of drum.	MLO					

SAFE WORK PROCEDURE – Example only

DEPARTMENT: Engineering		SECTION: Maintenance	CURRENT	PAGE: 3 OF 3
TASK/JOB: Plugging boiler tubes		DATE	REVISION	ISSUE
REASON FOR STOP:		STOP APPROVED BY:	REVISION ASSESSMENT	MEL
DATE OF REVIEW:		BY WHC:	HAZARDOUS	HAZARD CONTROLS
SPECIFIC JOB STEPS		OUTCOME - RISK RAMP	HAZARDS	OTHER INFO
NO.	DESCRIPTION	RTO	FOUR	HAZARD CONTROLS
13	Installation of cover end of top cover.	G		
14	Remove baffles as necessary to plug cover.	B	3.0/0/0/1	
15	Clear tube area to be plugged and vent tube.	H	5.0/0/0/1	Cold water. Two man job.
16	Measure and machine plug. Drive plug with 7/8" driver into the vertical section.	FA 1	5.0/0/0/1	
17	Seat wedge plug to both ends of tube.	G	6.0/0/1	Wet conditional electrocution
18	Install baffles, remove all gear from covers.	GMP	GMP	Wetdown plants to vent off
19	Spot pat coats to keep air cushion in top cover.	B	B	
20	Remove lead to GORPA.	GMP	GMP	
21	Check and tighten and remove from refractory and liner plants.	B	B	
22	Close inspection and grade cover.	B	B	
23	Remove insulation.	TMB	TMB	CHECK FOR OTHER WORKING ELECTRODE
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9.5 Example only – Excavation and/or trenching work risk assessment

Details of work to be undertaken																			
Range of possible work methods which could be used																			
Method (a)																			
Method (b)																			
Method (c)																			
Method (d)																			
Hazards present				Is there a risk								Level of risk							
				No				Yes				No				Yes			
Work method	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d			
Excavation																			
(a) shoring/battering																			
(b) underground services																			
(c) access into trench																			
(d) seepage																			
Physical agents																			
(a) thermal extremes																			
(b) noise																			
(c) engulfment																			
(d) moving equipment																			
(e) introduction of water etc																			
(f) electrocution																			
(g) explosion of fire																			
(h) manual handling hazards																			
(i) slips, trips, falls																			
From the above information, which is the best method to use																			
Procedure for emergency and rescue																			

9.5.1 Example: Excavation and trenching work checklist

What area is to be excavated?			
What method is to be used (for example a backhoe)			
Proposed depth of excavation/ trench			
Is the excavation deeper than 1.5 metres? Trenches deeper than 1.5 metres have extra shoring requirements	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
Does the excavation require shoring/ battering?	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
If shoring required, adequate supply of suitable supporting material delivered to site prior to trenching commencing	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
All underground services located, marked and precautions taken to avoid them	Yes <input type="checkbox"/>	No <input type="checkbox"/>	
All shoring must be erected by a competent person			
All barricades around excavation/ trench must be placed 1 metre from edge. All barricades must be tagged with barricade tag. All materials and equipment must be placed no closer than 600 mm from the side of the excavation.			
Special Precautions required? for example Telstra, plumber, electrician			
Where applicable – please tick as completed			
Tools & equipment checked	Yes <input type="checkbox"/> No <input type="checkbox"/>	Isolation procedures applied	Yes <input type="checkbox"/> No <input type="checkbox"/>
Area signposted & barricaded/ tagged	Yes <input type="checkbox"/> No <input type="checkbox"/>	Additional permits completed	Yes <input type="checkbox"/> No <input type="checkbox"/>
Fences required	Yes <input type="checkbox"/> No <input type="checkbox"/>	Trenching does not undermine adjacent structures	Yes <input type="checkbox"/> No <input type="checkbox"/>
Warning lights required	Yes <input type="checkbox"/> No <input type="checkbox"/>	Controls for heavy plant operating in adjacent area	Yes <input type="checkbox"/> No <input type="checkbox"/>
Signs required	Yes <input type="checkbox"/> No <input type="checkbox"/>	Others in work area notified	Yes <input type="checkbox"/> No <input type="checkbox"/>
Access into trench required	Yes <input type="checkbox"/> No <input type="checkbox"/>	Emergency procedures in place	Yes <input type="checkbox"/> No <input type="checkbox"/>
Adequate access into the trench	Yes <input type="checkbox"/> No <input type="checkbox"/>	Ventilation checked	Yes <input type="checkbox"/> No <input type="checkbox"/>
Trenches checked for water seepage	Yes <input type="checkbox"/> No <input type="checkbox"/>	Motorised equipment not in trench	Yes <input type="checkbox"/> No <input type="checkbox"/>
Proceed with caution. If pipes or cables are encountered stop work and ask for further clearances and instructions			
Working in an excavation requires an excavation/ trenching permit.			
Return this permit to the Maintenance Planner/Supervisor/Safety Officer			

9.6 Example only – Work permits

What plant, machinery or equipment is being worked on	
Location	
Description of task	
Name of competent person issuing the safe work permit	
Safe work permit issued to (team or individuals)	
Does the task involve DECONTAMINATION ISOLATION HOT WORK CONFINED SPACE WORKING AT HEIGHTS HOTWORK EXCAVATION & BUILDING WORK HIGH VOLTAGE EQUIPMENT OTHER PROCEDURE (SPECIFY) PERSONAL PROTECTIVE EQUIPMENT (Special Occasions) Please tick the required check boxes when the relative checks for these procedures involved have been completed	
Approval to commence work	_____ Competent person Date / / Time
Each person working on the task must sign on and off	
Sign on	
Sign off	
Sign on	
Sign off	
Sign on	
Sign off	
Task completed	_____ Competent person Date / / Time

9.7 Example only – Safe work permit – Shredder hammers

Work permit no.		Work instruction no.		Plant description							
Risk assessment rating:		Date:		Job description:							
HAZARDS											
Body / general		Environmental		Safety equipment		PPE required		General and environmental requirements			
A	People below	N	UV-arc flashes	1	Isolation / tags /locks	14	Hearing protection	27	Prove isolation	40	Pre briefing carried out
B	Coughing, pinch points	O	Burns-chemical /thermal	2	Danger signs	15	Gloves-chemical, cotton, thermal etc.	28	Manbox	41	Others not ok, area notified
C	Fall objects	P	Sustained posture	3	Tags /lock barricades	16	Lv gloves	29	Suitable tools	42	Rescue procedures
D	Sharp objects	Q	Repetitive movement	4	2 way radios	17	Overalls	30	Crane	43	Fork lift
E	Slip /trip /fall	R	Manual handling	5	Safety harness	18	Rubber boots	31	Lifting device	44	Scaldding
F	Moving machinery	S	Projectiles /flying particles	6	Electrical protection, e.g. residual current	19	Goggles	32	Elevated work platform	45	Equipment inspection
G	Pressurised liquid /gases	T	Heavy vibration, e.g. wedge gun /pick hammer, etc.	7	Fire hose extinguisher /blanket	20	Face shield	33	Flas tag lights	46	Blood/crash system
H	Heat stress	U	Hot/cold surfaces	8	Safety shower	21	High visibility vest	34	Housekeeping	47	Operator certified
I	Inhalation	V	Electrical shock	9	Eye wash	22	Respirators	35	Power tools	48	Handrails
J	Hoise	W	Heavy lift	10	Check scalling	23		36	Team lift	49	
K	Mobile plant	X	Engulfment	11	Working screens	24		37	Hole covers	50	Banding
L	Poor visibility	Y	Combustible materials	12		25		38	Lighting	51	Waste bin
M	Fall potential	Z		13		26		39	Air supply	52	Spillage clean up/work permit

Job/steps	Hazards	Risk score	Control measures	Risk score
1 Isolate shredder	E,	1	L, 27	
2 Open access door / point	B	6	15; cotton	
3 Wash down	E, M	5	3, 19 or 20	
4 Arrange loads and get new hammers	R, F,	5	34, 38, 43, 47	
5 Lock roller in position	B	4	1	
6 Remove row of hammers with air gun	F, Q, I, F	4	14, 15, 35, 34	
7 Install new hammers	F, Q, I, F	4	14, 15, 35	
8 Unhook roller and rotate to next row manually. Re pair 5-8.	B,	6	**Use rotation of personnel to minimize contact/work exposure	
9 On complete check all electrical removed, close and lock access door to be isolable				

Prepared by : J Smith Date : 01 / 04 / 04 Reviewed by : B Blagge Date out : 01 / 04

Additional Permits required	Isolation list (Record all points required to be locked)		Lock box	OR Personal Lock only
	Plant description	Number		
Confined space	Main steam line - shredder	Done	Plant description	Done
Excavation	Main camber drive			
Hot work	Kicker drive			
Working at heights	Feed roller drives			
Hazardous materials	Install bolting pit on shredder roller and lag for each rotation.			
Fire systems				
Contractors				
High voltage				
Work instruction				
Tagging study				

Prepared by : _____ Date : _____ / _____ / _____ Reviewed by : _____ Date : _____ / _____ / _____

