Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**

Preparation of a health and hygiene management plan – guide

October 2018

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Government of Western Australia
Department of Mines, Industry Regulation and Safety

To: Registered Managers, Ventilation Officers, Registered Samplers

Dear Sir / Madam

RE: HEALTH AND HYGIENE MANAGEMENT PLANS IN SRS

One of the objects of the *Mines Safety and Inspection Act 1994 (MSIA)* is to 'secure the safety and health of persons engaged in mining operations'. Section 9 specifically places a duty on employers to have systems so that employees are not exposed to hazards.

A health and hygiene management plan (HHMP) provides a structured means of creating a register of agents that may impact the health of workers. It documents the risk from those agents, the controls that are used, and the verification and validation methods used to confirm the effectiveness of those controls. The HHMP complements other management plans, registers and reports that are submitted to the Department of Mines, Industry Regulation and Safety (DMIRS).

This communication is to advise that the Safety Regulation System (SRS) has recently been enhanced to cater for HHMPs. This functionality represents a significant improvement over the risk-based hygiene management plans (RBHMPs), and was developed with extensive stakeholder consultation.

Guidance on preparing an HHMP and how to submit that plan are available on the DMIRS web site and include:

- A 'Guide for the preparation of a health and hygiene management plan'
- Frequently Asked Questions (FAQs) on health and hygiene management
- Supporting help videos on submission of HHMP into SRS.

Required Action

To demonstrate compliance with MSIA, I require sites that do not have a current RBHMP to submit a HHMP as soon as practicable, and no later than 30 June 2019. Sites that have a current and accepted RBHMP are required to submit a HHMP prior to the expiry date of the current management plan.

Please do not hesitate to contact a Department inspector or officer should you wish to discuss these requirements.

Yours faithfully

Andrew Chaplyn
State mining engineer

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Introduction

All mining workplaces have some form of chemical, biological, radiation and physical hazard or human stressor that may cause injury, illness, or impair workers' health or wellbeing. These agents can include dusts, chemicals, radiation, noise, extremes of temperature, ergonomic, vibration, bacteriological, fungal and illumination hazards; and the stressors caused by shift work, remote locations and time away from home.

A health and hygiene management plan (HHMP) provides a systematic process for managing agents at all stages of the mining operation. It is an integral part of an organisation's safety management system and complements other major hazard management plans for the site (see Figure 1). It documents the agent, how hazards are controlled and what methods are used to verify that controls are effective.

The HHMP is more comprehensive than the dust and noise monitoring plan previously required by the Department of Mines, Industry Regulation and Safety (DMIRS). A HHMP sets out a holistic, risk-based approach to managing all health and hygiene hazards that adopts changing technology and current scientific knowledge, and encourages innovation. The HHMP should demonstrate an understanding of the mining operation's hazardous agents based on solid research and consultation with experts and workers. The HHMP provides objective guidance and instruction so that both the employer and workers understand the health risks in the workplace, what controls are in place and how the controls work. It documents the policies, procedures and reporting processes that will ultimately verify that the health of workers is not being adversely affected.

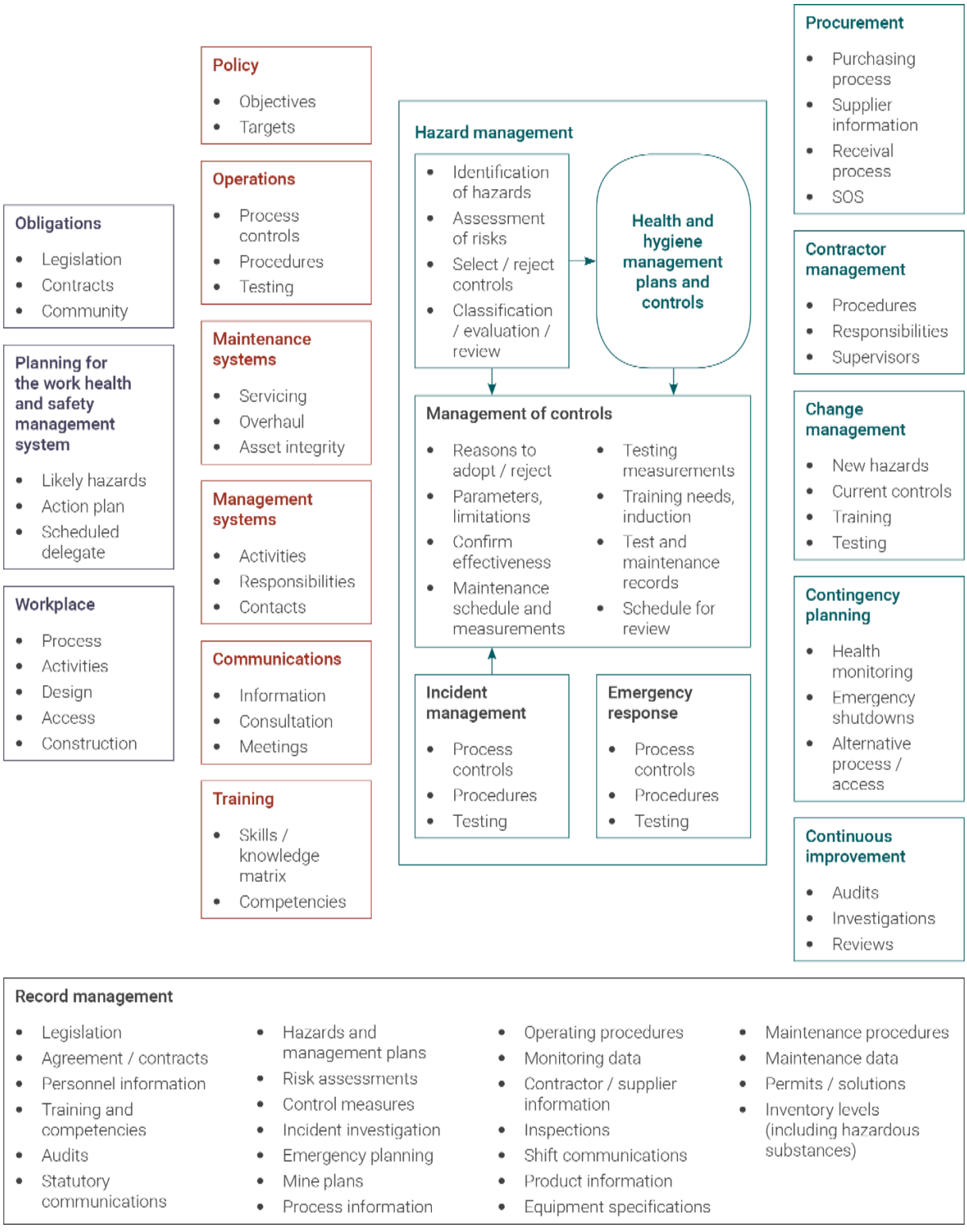

Figure 1 Site-based work health and safety management system

The management of health and hygiene hazards follows a well-established process. Figure 2 depicts the stages of this process. The first stage involves anticipating and identifying hazardous agents and assessing the risk that these present. In the second stage, roles are defined and controls and work systems are implemented to manage the hazard. In the final two stages, inspections, tests, monitoring and health assessments are conducted to confirm that the controls and work systems are effective and, if required, the controls and work systems are modified, or additional controls are implemented.

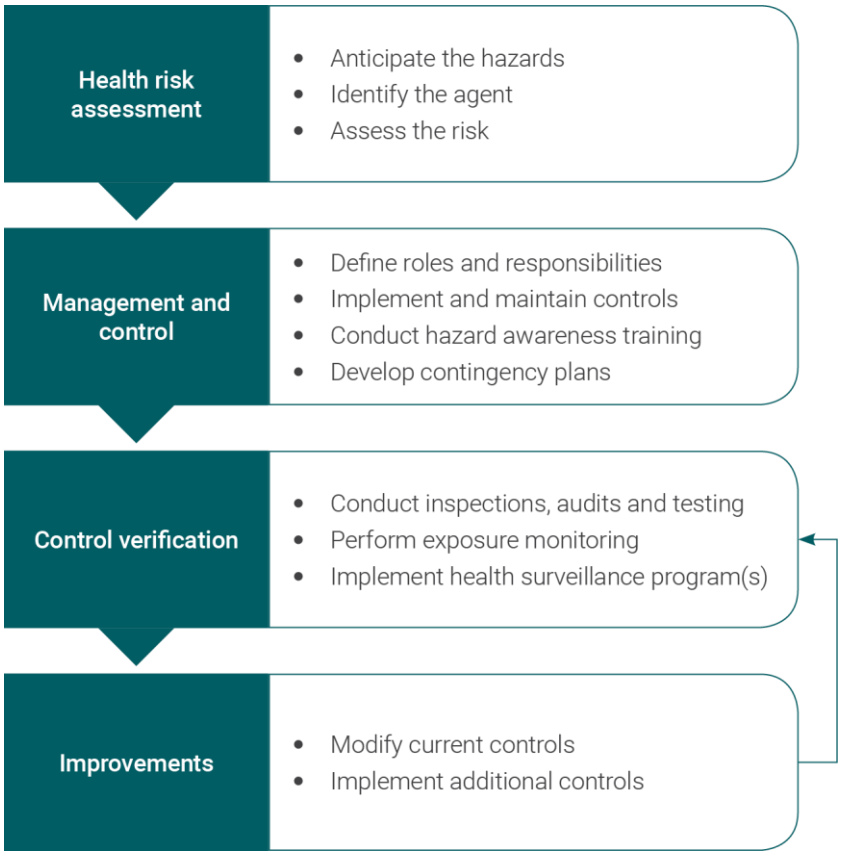

Figure 2 Stages in managing health and hygiene hazards

Why have a health and hygiene management plan?

The identification and management of hazards is a requirement of the *Mines Safety and Inspection Act 1994* (MSIA). Additional specific obligations are outlined by the Mines Safety and Inspection Regulations 1995 (MSIR). These include the requirements that:

- employers must, so as far as practicable, provide workplaces, systems of work, information and training so that employees are not exposed to hazards [MSIA s. 9]
- workers are not exposed to atmospheric contaminants (agents) above exposure limits *and* exposures are maintained to as low as practicable [MSIR r. 9.11]
- workers are not harmed by the adverse effects of extremes of heat or cold [MSIR r. 9.15]
- noise hazards have been identified, quantified, risk assessed and controls have been defined [MSIR rr. 7.1-11]. Regular noise measurements and hearing tests (audiometry) are used to demonstrate compliance with the requirements to keep noise exposure to as low as practicable and below defined levels
- hazardous substances have been identified [MSIR r. 7.25], an assessment of the risk from hazardous substances has been completed [MSIR r. 7.27] and the means by which exposure will be controlled has been detailed [MSIR r. 7.28]
- employers carry out health assessments if adverse health effects may be related to exposure, or if directed to by the State mining engineer [MSIR r. 3.27]
- employers conduct biological monitoring if accepted values may be exceeded, or if directed to by the State mining engineer [MSIR r. 3.28].

The HHMP complements the requirements of MSIR r. 3.13(1)(b) to prepare a project management plan (PMP) that identifies the operation's major risks and summarises the strategies to manage those risks.

The HHMP also describes the mining operation's policies and processes to reduce health hazards, lists the roles and responsibilities of relevant staff, outlines contingencies when measurements indicate imminent or increasing risk to health or wellbeing of staff, and provides an overview of the content and frequency of training. The HHMP may also include what hazard management techniques are in place in the event of an emergency, if these are not covered in an emergency response plan. As such, it is an important source of information for all mine workers and must be written in plain English so that it is meaningful for all internal stakeholders.

Regular inspections, audits, atmospheric monitoring, medical examinations and biological testing are used to demonstrate that controls and systems of work are effective with exposures maintained below standards and are as low as practicable such that workers are not adversely affected.

Some information gathered as part of a HHMP is submitted to DMIRS as required by MSIR rr. 9.5(d) and 9.6(b) (e.g. atmospheric sampling results). Other records must be maintained in accordance with good corporate governance provisions and be available for inspection or review.

Due to the specific nature of radiation hazards associated with mining of thorium or uranium ores, a separate radiation management plan that details controls and validation techniques is required [MSIR r.16.7] and is outside the scope of this document.

The requirements of the HHMP are consistent with the expectations contained within the model Work Health and Safety Regulations to develop and implement major hazard management plans.

Who has a role in a health and hygiene management plan?

The *registered manager* (RM) endorses the HHMP and, as the person responsible on a daily basis for the control of the mine [MSIA s. 33(3)], makes a commitment on behalf of the organisation to fulfil the HHMP and its associated obligations. The HHMP is submitted to DMIRS by the RM (or a responsible person appointed by the RM).

The appointed *ventilation officer* (VO) or *hygienist* collates the required information and arranges the production of the HHMP. The VO confirms that all information contained within the HHMP is correct, accurate and that all criteria have been met. The VO shall be satisfied that controls are adequate to prevent workers from being adversely exposed to agents in the workplace (as per MSIR rr. 9.5 and 9.6). The VO shall be satisfied that the verification and validation methods detailed in the HHMP (e.g. air monitoring, medical examinations, biological testing) are sufficiently robust to confirm that controls are suitable, effective and are implemented so as to reduce exposures to levels as low as practicable (this is likely to require consultation with medical or other personnel).

The *ventilation technician* (registered sampler) confirms that all samples are collected in accordance with approved or recognised methods, that samples are representative of exposure, and that sample results are submitted correctly and within a reasonable time after collection.

An approved *noise officer* (NO) confirms that all noise and vibration information contained within the HHMP is correct and accurate. The NO shall be satisfied that controls are adequate to prevent workers from being exposed to excessive noise and vibration and that exposure is as low as practicable. The NO shall be satisfied that the verification and validation methods detailed in the HHMP (e.g. hearing tests, dosimetry, audiometric testing) are sufficiently robust to confirm that controls are suitable, effective and are implemented so as to reduce worker exposures to levels as low as practicable. The NO is also responsible for producing the noise report and noise control plan for the operation. The HHMP does not replace this obligation.

Other subject matter experts such as nurses, doctors, ergonomists, psychologists, and health and safety practitioners all have a role to ensure that information contained within the HHMP is

correct and accurate, that controls are adequate to prevent harm, and that the verification and validation methods are suitable.

Key personnel including the mine geologist, mine superintendent, process plant superintendent, village manager, lab manager, airstrip coordinator and others, all have a role in providing accurate and timely information about the agents and their controls under their area of responsibility. They should also advise the VO of any changes to their areas of operation that could change the risk profile to workers.

Mines inspectors or mines safety officers will conduct inquiries to ascertain that controls are adequate to prevent personnel from being exposed to agents. Inspectors also evaluate the verification and validation methods detailed in the HHMP to ensure they are sufficiently robust to confirm that controls are suitable, effective and have been appropriately communicated to the workforce.

When is a health and hygiene management plan required?

All mining operations, including processing plants, supporting infrastructure (e.g. ports, camps), rehabilitation areas and exploration sites are required to identify hazards, assess the risks posed by the hazards, implement controls and document the methods by which the effectiveness of those controls are assessed. Accordingly, all sites are required to have an HHMP or equivalent plan that fulfils the expectations outlined in this guide.

In addition to the Project Management Plan (PMP), a HHMP is submitted:

- prior to operations commencing (as the hazards must be identified and controls implemented prior to operations)
- whenever a significant change occurs to operations that may alter the risk profile.

The HHMP is reviewed and submitted:

- five yearly, if the risk profile or control strategies have not changed significantly.

To demonstrate ongoing management and compliance, a summary report with key highlights and actions is submitted to DMIRS annually.

The requirement to manage hazards equally applies to exploration activities and a suitable HHMP is required for these activities.

An exemption from submitting a formal HHMP (and annual updates) may be requested for particular operations; for example, very small operations that have been exempted from requiring a ventilation officer by the district inspector. In these cases, the PMP must adequately describe the hazards, controls and control validation methods for the operation.

Health and hygiene management plan requirements

The HHMP covers all the activities at an operation. It should provide the following information:

- an overview of the operation and the processes that occur at the site(s)
- the chemical, physical, biological agents and human stressors associated with the site
- an assessment of the risk posed by the agents (including the method of determining risk)
- the controls in place to reduce or mitigate the risk posed by the agents
- techniques used to verify that controls are working
- proposed improvements to the controls, and methods of their verification and validation.

Step 1 Describe the operation

The HHMP must include an overview of the operation such that the location, scale of operation and principal activities are clear. As an example, the following should be included, the:

- principal function of the site, e.g. quarry, processing, rail or port
- principal minerals being extracted/handled and secondary agents that may be present in the orebody/deposit; e.g. arsenic, fibrous minerals.
- site's location, and its potential to impact on or by neighbours
- the workplace environment and climatic conditions expected and what impact they are likely to have on exposure
- key operational activities and their relationships to one another (a schematic flowchart can be used to assist)
- size of the operation; e.g. area, distances, mine depth, production rates, number of workers
- status of the operation; e.g. a proposed new operation, a re-opening of suspended activities, an expansion of existing facilities, or continuation of normal activities
- ancillary or support activities that occur at the operation; e.g. power stations, water treatment, village and messing, airport, offices, laboratory, workshops, warehouses, medical centre
- activities that occur nearby or are related to the operation; e.g. rehabilitation works, exploration, bore fields, railways, ports or overland conveyers.

Step 2 Identify hazards

The first step in the risk management process is to identify the hazards and the controls associated with each area of the operation; for example, during:

- exploration
- mining
- hauling
- processing and stockpiling
- transport of product
- tailings management
- people interaction
- ancillary and support services

In addition to the specific information requirements below, each area of the operation should identify:

- engineering controls fitted to plant and equipment to minimise exposure to agents
- administrative controls implemented to minimise exposure to agents
- personal protective equipment (PPE) provided to minimise exposure to hazards.

Exploration

Where exploration activities occur, or the principal activity is exploration, the following additional information should be provided:

- the shire(s) in which exploration activities are likely to occur. Other details such as tenement(s) or distance from known landmarks may also be provided
- the expected duration of exploration and any critical dates; e.g. commencement of drilling program
- a basic description of the exploration techniques; e.g. RC drilling, diamond drilling, trenching.

Mining operations

Where mining activities occur, then the following information should be provided:

- a basic description of the geology for the mining and quarrying operations
- a basic description of the mining or quarrying techniques
- the agents that are likely to occur or may be encountered when mining ore and managing wastes, including:
  - harmful or flammable gases or dusts
  - chemicals and reagents
  - mined material likely to become chemically unstable or spontaneously combust
  - extremes of temperature and humidity

- noise and vibration.

Hauling

Where hauling activities occur, the following information should be provided:

- a basic description of the haulage activities (e.g. description of the fleet, including age, number, models), general description of location and condition of haul roads
- the agents that occur or may be encountered during hauling activities, including:
  - noise and vibration
  - ergonomic/manual handling.

Processing and stockpiling

Where stockpiling or processing activities occur, then the following information should be provided:

- a basic description of stockpiling and processing techniques including temperature and pressure if not completed at ambient conditions
- agents that occur or maybe encountered when processing or stockpiling, including:
  - harmful or flammable gasses or dusts
  - material likely to become chemically unstable or spontaneously combust
  - extremes of temperature and humidity
  - noise and vibration
  - chemicals (such as catalysts) added to enable the processing (including contaminants in process water)
  - intermediate hazardous materials generated during the process
  - ergonomics/manual handling hazards associated with the normal operation of the plant.

Tailings management

Tailings facilities often contain toxic or harmful agents, can be extremely acidic or caustic and can function at elevated temperatures. A basic description of the tailings facilities and harmful agents present should be provided and include:

- chemical agents present
- pH (acidity or alkalinity) of contents
- temperature of discharge material (if elevated significantly above ambient)
- controls to prevent exposure during the various stages in the lifecycle of the tailings dam facility; e.g. construction, operation, decommissioning.

Ancillary and support services

Identify ancillary and support services such as laboratories, water treatment plants, power stations, boiler houses, workshops, warehouses, offices, villages, messing, airstrip, railways, roadworks, bore fields, overland conveyers and recreation facilities such as swimming pools, and describe:

- the storage, decanting, use, handling, controls and disposal methods of chemicals and hazardous substances
- biological hazards

- areas of excessive noise or vibration
- areas with insufficient illumination to perform work safely or move from one area to another.

Information should also be provided on controls implemented to prevent contamination of "clean areas" such as mess rooms, offices and accommodation.

Step 3 Assess the risk

Define risk and risk acceptability

Understanding and defining risk is fundamental to a successful HHMP. Many companies have internal policies and procedures for determining and quantifying risk. Alternatively, Australian Standard AS/ISO 31000 *Risk Management – Principles and Guidelines* provides information on this matter.

When considering the risk posed by agents, exposure rather than presence of an agent needs to be considered. Presence of a material does not necessarily imply exposure or elevated risk. The risk is related to the dose delivered to a worker. In turn, the dose is determined by the length of time the worker is exposed to the agent, and its concentration. In this section, exposure represents the potential for a dose to be delivered by the agent (via inhalation, absorption through the skin, ingestion or otherwise acquired), and is determined by the actual concentration of the agent in comparison to the agent's occupational exposure level. Additional understanding of the agent is required as small quantities over a long time (chronic exposure) may be as, or more, harmful that a single large dose (acute exposure).

> Risk is related to the dose delivered to the worker which is based upon how long the worker is exposed and the concentrations to which they are exposed.

A qualitative risk assessment is acceptable.

The parameters used to determine risk must be defined within the HHMP, generally through a risk assessment matrix. A statement of what is acceptable and unacceptable levels of risk must also be provided within the HHMP. Figure 3 shows how a qualitative risk assessment approach may be applied to workplace agents.

Likelihood / exposure		Consequence				
		Probably not carcinogenic to humans (IARC-Cat4) or causes minor irritation	Not classifiable as carcinogenic to humans (IARC-Cat3) or causes irritation, headache, nausea, shortness of breath, erythema Temporary hearing loss (threshold shift)	Possibly carcinogenic to humans (Cat2b) or causes temporary incapacitation, or dermatitis, dizziness, poor coordination Permanent hearing loss/ impairment	Probably carcinogenic to humans (Cat2a) Permanent incapacitation/ sensitisation, liver or kidney damage. Significant permanent hearing loss/ impairment	Carcinogenic to humans (Cat1), reproductive effects, death Deafness
		Insignificant	Minor	Moderate	Major	Catastrophic
Always < 10 % of Exp Std (ES)	Very unlikely to occur	Low	Low	Low	Medium	Medium
Consistently < 50 % of ES and 0 % of all samples above OEL	Unlikely to occur	Low	Low	Medium	Medium	High
Consistently < 50 % of ES and < 5 % of all samples above ES	Possibly could occur	Low	Medium	Medium	High	Unacceptable
Consistently 50-100% of ES or > 5 % of all samples above ES	Probably will occur	Medium	High	High	Unacceptable	Unacceptable
Consistently > 100 % of ES	Almost certain to occur	Medium	High	Unacceptable	Unacceptable	Unacceptable

- Exposure that is low risk is permitted subject to controls being fully implemented.
- Exposure that is medium risk is permitted subject to existing controls fully implemented and other reasonably practicable controls being implemented.
- Exposure that is high risk is generally not permitted unless further controls are implemented, that workers are made specifically aware of the risks, and that senior management has agreed to expose workers to that risk.
- Exposure that is unacceptable risk is unconditionally not permitted. Significant improvements in controls to reduce risk are required before proceeding.

Figure 3 Risk matrix and risk acceptability

Assess the health risk for each similar exposure groups (SEG)

In order to determine the potential health risk for each SEG, historical sampling data, health surveillance statistics, incidents that had an adverse impact on worker health, workforce feedback and industry information may be used. This information should be reviewed and considered when completing the risk assessment. Based on the identified agents, existing controls, and available information, a risk assessment is completed for each SEG utilising the risk assessment methodology deemed appropriate for the mining operations.

The most likely reasonable consequence of exposure to agents rather than the worst case scenario should be used in the assessment.

Generally when minimal information is available, a higher risk rating is assigned and efforts to better assess the hazard form part of the actions contained in the HHMP.

The risk assessment should also consider the consequences if controls fail or are not implemented correctly. For example, if controls are predominantly lower order (i.e. PPE and administrative), and the failure of the control could result in an elevated dose or serious health outcome, then the risk rating is likely to be higher.

Health risk assessment (HRA)

Collate information for each SEG, such as the occupations, worker numbers, shift lengths and patterns, hazards, existing controls and the risk assessment.

Based on the criteria of risk acceptability defined by the mining operation, determine if additional controls are required. If additional controls are identified, an action plan for implementation should be developed, including allocation of responsibility for completing the required action and an expected implementation date.

This information should be documented and forms the basis of what is often called a health risk assessment (HRA). The HRA can either be an appendix within the HHMP or a stand-alone document. The commitments made in the HRA will be assessed by DMIRS to determine an organisation's ability to manage its workplace agents.

An example of a HRA is provide in Table 1.

Table 1 Example of a health risk assessment (HRA)

SEG	Occupation	*Occ. code*	Last year	This year	Hazards	*Agent code*	Controls	Risk	Further controls	By who	By when
SEG 1 – Site management and office	Registered manager Administrative officer Safety officer TOTAL	150000 149000 142000	1 1 0 2	1 1 1 3	Inhalable dust Respirable dust Silica	INH RES SIL	Training and education Boot scrubbers at office entrance Daily office clean	Low	Remove carpet from offices	AB	Q3
SEG 2 – Surface mining	Excavator operator Truck driver Water truck driver Blast hole driller Shot firer TOTAL	349000 361000 362000 311000 321000	1 1 1 2 1 6	2 6 1 1 1 11	Inhalable dust Respirable dust Silica Noise Vibration	INH RES SIL - -	Training and education Daily cab clean Water truck to keep roads and loaded material wet P1 dust masks used when out of cab within 10 m of operating equipment Class 4 Hearing protection	Medium	Conduct two yearly dust training Conduct hearing tests	CD	Q1 Q3
SEG 3 – Processing plant	Process operator Load operator Laboratory technician TOTAL	411000 421000 441000	2 2 1 5	2 2 1 5	Inhalable dust Respirable dust Silica Noise Acid	INH RES SIL - HSO	Training and education Daily cab clean Water truck to keep roads and loaded material wet P1 dust masks used when out of cab within 10 m of operating equipment Class 4 Hearing protection Monthly check of lab ventilation system	Medium	Conduct two yearly dust training Conduct hearing tests	CD	Q1 Q3
SEG 4 – Maintenance	Fitter Mechanic NOC TOTAL	630000 830000	1 1 2	2 2 4	Inhalable dust Respirable dust Silica Noise Asbestos Solvents/hydrocarbons Welding fume	INH RES SIL - ASB IPA WLD	Training and education Clean vehicle prior to entry in workshop P1 dust masks used when out of cab within 10 m of operating P2 welding fume masks to be used when welding No power tools when removing unknown gaskets Class 4 hearing protection Class 5 when doing arc air gouging or boilermaker duties Monthly check of welding bay ventilation system Parts washer to be used – monthly check, nitrile gloves when handling solvents, refuelling outside only	Medium	Conduct two yearly dust training Conduct hearing tests	EF	Q1 Q3

Step 4 Verification and validation of controls

Verifying that controls are functioning as intended is a critical aspect of risk management. Many techniques are available to verify that controls are effective. These can include:

- atmospheric sampling
- biological monitoring
- noise dosimetry
- audiometric testing
- medical examinations
- ventilation system measurements (e.g. capture velocities)
- audits and inspections
- workforce questionnaires
- workplace examinations/inspections.

To confirm that controls are suitable, the verification and validation techniques proposed should be assigned against each SEG on a quarterly basis with a comparison to the previous year's activities. For the most part, some techniques should occur regularly, such as biological monitoring of workers who routinely handle a chemical). However, others, such as hearing tests, may only need to be conducted every three to five years.

It is desirable to include the test or examination methods to be used and the skills or qualifications of workers conducting the testing, audits or examinations as evidence that recognised techniques and competent workers have been used in the validation/verification process.

Any significant changes should be highlighted and justification provided in the HHMP.

Determining number of samples

Sampling can be done for a number of reasons, including:

- identifying if a hazard exists during a task or process
- identifying if a new control is effective
- identifying workers at risk of excessive exposure
- verifying that controls are sufficient and continue to function as intended.

Different sampling strategies and sample numbers are required depending on the intended purpose.

Sampling for the identification of agents

If sampling is conducted to identify if an agent is present in the workplace, or to test the effectiveness of a new control, then samples must be collected from those likely to receive the highest exposure, or the "maximum risk employee". Sufficient valid samples must be collected to ensure that worst case results are obtained (refer Table 1).

If all worst case sample results are below 50 per cent of the exposure standard (often referred to as an action level) for that agent, then it can be assumed with some confidence that the

controls are effective and the sampling strategy can progress to verification of control effectiveness sampling.

If one or more results are above the action level, then further controls are advised and subsequent testing of worst case scenarios is required. Once sample results for maximum risk employees under typical worst case situations are consistently below the exposure standard, and ideally below the action level, then the sampling strategy can progress to a control validation sampling strategy with targeted samples included to assess subsequent improvements.

If one or more results are above the exposure standard, a legislative breach exists and additional controls must be implemented. Sampling is required until controls are sufficient to reduce exposures consistently below the exposure standard and ideally below the action level. It should be noted that sampling is not a control, only a method of assessing the effectiveness of implemented controls.

Control validation sampling

Once intensive sampling of maximum risk employees has established that controls are sufficient, then the sampling strategy can evolve to one of validating the effectiveness of controls that apply to a group of employees.

Collecting sufficient samples that are representative of an exposure group is often a compromise as it is rarely practicable, or even possible, to continuously monitor every worker. By applying sound sampling statistical techniques, a high degree of confidence can be achieved for a testing program.

The primary objective of any sampling program is to ensure that the workers with the highest risks are monitored.

The minimum number of samples that must be collected randomly from each SEG each period is given in Table 2.

These workers should always be monitored. However, in some cases it may not be possible to identify those in a homogenous or similar exposure group exposed to the highest risk.

Table 2 sets out the minimum number of samples that must be collected randomly from a homogenous group (i.e. SEG) in each evaluation period (year). This is to ensure a balance between the burden of sampling and collecting sufficient samples so that at least some of the higher exposures are collected. The sampling should be distributed as evenly as possible across the year (on a quarter-by-quarter basis). If an activity is seasonal or as part of a campaign, the sampling program should reflect the timing of the event and a notation in the HHMP is recommended to justify the sampling program. Collecting the required samples during the evaluation period will ensure that at least one sample will be from the upper 20 per cent of the sample group (i.e. the highest risk workers) with 95 per cent confidence.

Table 2 Required sample size to include the top 20 % from a homogenous population (with 95 % confidence)

Size of group (N)	**<6**	**7-8**	**9-11**	**12-14**	**15-18**	**19-26**	**27-43**	**44-50**	**>51**
Minimum # of measured employees (n)	n=N	6	7	8	9	10	11	12	14

Step 5 Document hazards, risks, controls and improvements

The final stage of the HHMP is to summarise the findings of the hazard identification and risk assessment process, the validation/sampling program and improvements identified that will result in reduced risk to the workforce (Table 3).

Define SEGs

It is recognised that it is rarely practicable (or warranted) to assess the risk from an agent for every worker at a facility or mining operation. For expediency, workers with similar exposure profiles may be organised into similar exposure groups (SEGs).

The following steps should be followed to define SEGs:

- group workers based on duties, hazards to which they are exposed, the duration and concentration of exposure and controls in place to manage hazards
- define the agents that each SEG is exposed to
- for atmospheric agents, identify the applicable contaminant code as this will be required when submitting results to DMIRS
- check that every worker (employees and contractors) is a member of at least one SEG
  - identify the applicable occupation codes as this will be required when submitting results to DMIRS
- determine the number of workers in each SEG (note that a worker may be in more than one SEG)

It is expected that the hazards, key occupations and the number of workers in each SEG for the applicable year and the previous year(s) are clearly presented in the HHMP, health risk assessment and annual updates.

Sample collection, interpretation of results and storage of records

Valid samples

The presence alone of a hazardous agent does not automatically imply an undesirable risk. A critical aspect of determining risk, and verifying that controls are effective, is to accurately determine employee exposure. This often involves taking valid, quantitative and representative samples and interpreting the results using experience and professional judgement.

To ensure that only valid samples are reported to DMIRS (which are subsequently used to determine compliance, or for epidemiological studies), a number of requirements must be satisfied. These include a requirement to:

- follow approved sampling techniques (using calibrated equipment and for representative exposure periods)
- analyse samples using recognised and, where appropriate, approved methods

use only competent workers to collect and interpret samples, i.e. registered samplers or certified noise officers.

Table 3 Example HRA and action plan

SEG	Occupation	Occupation code	Last year	This year	Hazards	Agent code	Controls	Risk	Verification							Exceeds	Comments or improvements
									Method	Q1	Q2	Q3	Q4	this year	Previous year		
SEG 1 – Site management and office	Registered manager Administrative officer Safety officer TOTAL	150000 149000 142000	1 1 0 2	1 1 1 3	Inhalable dust Respirable dust Silica	INH RES SIL	Training and education Boot scrubbers at office entrance Daily office clean Carpet removed from offices	Low	Inhalable dust Respirable dust Si02 Audit	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	4 4 4 4	4 4 4 4	0 0 0 n/a	No significant change to worker numbers or hazards
SEG 2 – Surface mining	Excavator operator Truck driver Water truck driver Blast hole driller Shot firer TOTAL	349000 361000 362000 311000 321000	1 1 1 1 1 5	2 6 2 2 1 13	Inhalable dust Respirable dust Silica Noise Vibration	INH RES SIL - -	Training and education Daily cab clean Water truck to keep roads and loaded material wet P1 dust masks used when out of cab within 10 m of operating equipment Class 4 hearing protection	Medium	Inhalable dust Respirable dust Si02 Noise dosimetry Audit	2 2 2 2 1 3	2 2 2 2 0 3	2 2 2 2 1 3	2 2 2 20 3	8 8 8 8 2 12	4 4 4 4 0 4	0 0 2 0 0 n/a	Change from day shift only to 24 hour operation Whole body vibration identified as possible hazard for blast hole driller Previous three monthly audits insufficient changing to monthly (one per quarter, to be night shift).
SEG 3 – Processing plant	Process operator Load operator Laboratory technician TOTAL	411000 421000 441000	2 2 1 5	2 2 1 5	Inhalable dust Respirable dust Silica Noise Acid	INH RES SIL - HSO	Training and education Daily cab clean Water truck to keep roads and loaded material wet P1 dust masks used when out of cab within 10 m of operating equipment Class 4 hearing protection Monthly check of lab ventilation system	Medium	Inhalable dust Respirable dust Si02 Noise dosimetry Vent inspection Audit	1 1 1 1 3 3	1 1 1 1 3 3	1 1 1 1 3 3	1 1 1 1 3 3	4 4 4 4 12 12	4 4 4 0 4 12	0 0 0 2 n/a n/a	No significant change to workers numbers or hazards Change laboratory ventilation inspection to monthly as three monthly inadequate to identify filter blockages or fan corrosion from acid
SEG 4 – Maintenance	Fitter Mechanic NOC TOTAL	630000 830000	1 1 2	2 2 4	Inhalable dust Respirable dust Silica Noise Asbestos Solvents/hydrocarbons Welding fume	INH RES SIL - ASB IPA WLD	Training and education Clean vehicle prior to entry in workshop P1 dust masks used when out of cab within 10 m of operating P2 welding fume masks to be used when welding No power tools when removing unknown gaskets Class 4 hearing protection Class 5 when doing arc air gouging or boilermaker duties Monthly check of welding bay ventilation system Parts washer to be used – monthly check, nitrile gloves when handling solvents, refuelling outside only	Medium	Inhalable dust Respirable dust Si02 Welding fume Noise dosimetry Audit	1 1 1 1 1 1	1 1 1 1 1 0	1 1 1 1 1 1	1 1 1 1 1 0	4 4 4 4 4 2	4 4 4 4 4 2	0 0 0 1 1 n/a	Change from day shift only to 24 hour operation Existing sampling frequency adequate based on previous year's data

Occupation, contaminant and sample method codes are contained in the SRS health and hygiene index www.dmp.wa.gov.au/Documents/Safety/MSH_G_SRSHealthHygieneCodeIndex.pdf

Interpretation of results

Interpreting atmospheric testing results

Air monitoring results are often compared to standards published in the NOHSC *Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment (or its equivalent),* or MSIR rr. 9.11(2) and (3) when assessing results.

This approach is often an oversimplification of the required process, as MSIR r. 9.11 requires levels to be maintained at levels below the applicable exposure standard AND as low as practicable.

The reasoning behind the requirement for exposure to be as low as practicable is detailed in the *Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment* published by the National Occupational Health and Safety Commission (NOHSC). In summary:

- Levels published by NOHSC are based on scientific knowledge at the time of the review. For this reason, the levels published may not always align with other international jurisdictions or the most current knowledge.
- Levels have been set to protect the majority of the workforce from ill health or undue discomfort. They are not a “no-effect” level. Some susceptible individuals may experience adverse effects at levels lower than those published.
- Because of individual susceptibility, the levels should never be interpreted as a fine line between “safe” or “unsafe” working conditions.
- For a few substances, usually the more potent carcinogens or where there is very limited information, it is not possible to assign an appropriate exposure standard. For these substances, exposure should be controlled to the lowest practicable level.

For the above reasons, an action level may be set at a level lower than the legislative standard, usually at 50 per cent of the exposure standard or in line with current international standards. The intention is that should the action level be exceeded, “action” is taken to prevent future exposures that may exceed the exposure standard and to demonstrate that levels are as low as reasonably practicable.

If sufficient samples have been collected on the members of a SEG, the exposure results will approximate a log-normal distribution (Figure 4, left). The log-normal distribution arises because results can never be less than zero (a lot of results will be at or near the limit of detection of the method but, infrequently, high results will occur.

This makes determining the average exposure for the group more complex.

For a normal distribution (Figure 4, right), the mean, mode and median are the same. The mean is simply calculated by adding all the results and dividing by the number of results (i.e. $\bar{x} = \frac{\sum x_i}{n}$) and the standard deviation (the spread of results from the mean) of a sample group is calculated by

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

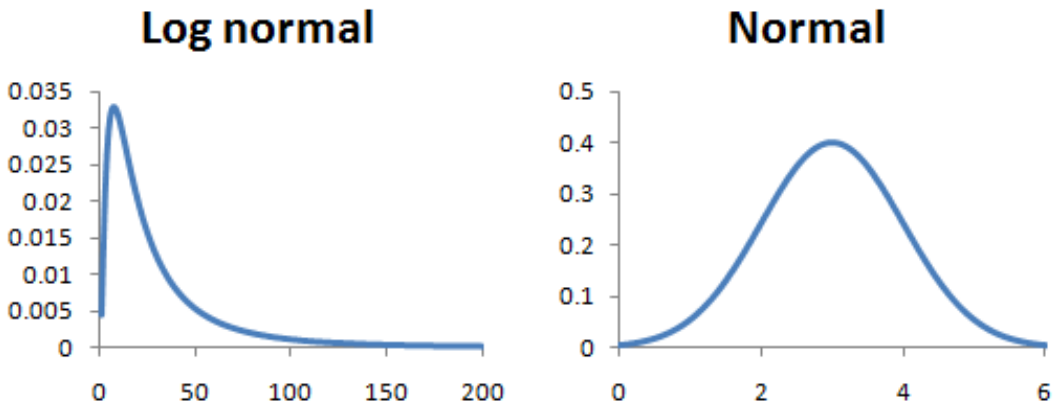

Figure 4 A log normal distribution (left) compared to a normal distribution (right)

In a log-normal distribution, the mean, mode and median are not the same. This means determining the average for a log-normal distribution involves a more complex calculation to determine the geometric mean (*gm*) and geometric standard deviation (*gsd*) than for a normal distribution.

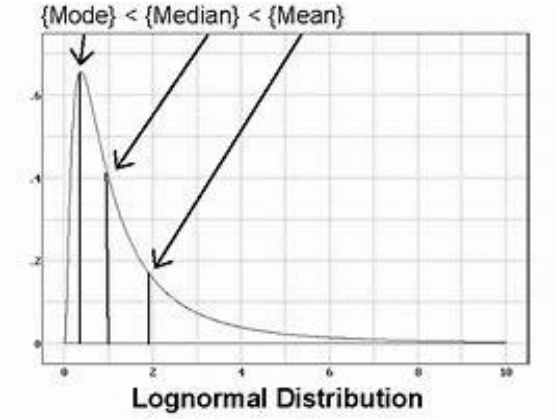

Figure 5 A log normal distribution showing mode, median and mean

The terms geometric mean (GM) and geometric standard deviation (GSD) are used to describe the mean and standard deviation of a log-normal distribution.

Let $y = ln(x)$

Then the $gm = \exp\left(\frac{\sum y_i}{n}\right)$

And $gsd = exp\sqrt{\frac{\sum(y_i - \bar{y})^2}{(n-1)}}$

Many statistical packages will calculate these values after inputting the individual sample results.

Because a large number of the results will be at or near zero the temptation is to believe that the controls are adequate. Similarly it is incorrect to dismiss samples that are 200-300 per cent greater than the average as “outliers” when these results are entirely predictable if the concentrations of an agent are (as happens in virtually all occasions) log-normally distributed.

Most samples collected to determine the concentration of agents in the workplace will be log-normally distributed.

To correctly assess if the SEG exposures are compliant with an exposure standard then the critical aspect is the upper tail of the exposure profile rather than the mean (average).

The value of the 95th percentile is often termed a “decision statistic”.

- If the 95th percentile figure is below the exposure standard then it can be assumed that the exposure is generally “acceptable or controlled”.
- If the 95th percentile figure is above the exposure standard, then concentrations are deemed as “unacceptable or not controlled”.

The 95th percentile can be calculated by $\hat{X}_{0.95} = gm \times gsd^{1.645}$

Many statistical packages will calculate this figure after inputting the individual sample results.

A HHMP or annual report should include key (and appropriate) statistics to support conclusions regarding the effectiveness of controls.

For example:

Within an SEG, workers are exposed to welding fume. The SEG consists of eight welder/fitters. Accordingly, a minimum of six random samples are required to be confident that at least one will be in the upper 20 per cent of exposures.

The results are:

Sample	Xi (mg/m3)	Ln of Xi
1	0.84	-0.174
2	0.55	-0.598
3	0.99	-0.010
4	3.55	1.267
5	4.77	1.562

Sample	Xi (mg/m3)	Ln of Xi
6	0.78	-0.248
	$\overline{X} = 1.91$	gm = 1.35
	s = 1.78	gsd = 2.43
		95th percentile = 5.83

While all samples are below the exposure standard (of 5 mg/m3), the 95th percentile estimate is above the exposure standard. As such, further controls are required because the exposure is not adequately controlled.

Interpreting biological testing results

Health monitoring is a systematic method of identifying changes in a worker’s health because of exposure to certain agents. There are different types of health monitoring techniques, such as interview questions, medical examinations and biological (invasive or non-invasive) monitoring.

Choosing the most appropriate health monitoring method will depend on the type of agent involved, the method of exposure, the level of exposure, and if it is possible to use a proactive method to predict ill health rather than to identify disease. In many cases, more than one method can be used.

Biological monitoring complements other methods of surveillance (such as questionnaires and examinations) and can use techniques that may involve testing exhaled breath, blood, urine, saliva or hair.

- The techniques used are dependent on many factors such as the agent to be assessed, the duration from exposure to testing, detection limits and reproducibility of testing, and workforce acceptance.
- A biological index/standard may mandate a specific testing regime.

- It is important to understand the limitations of each monitoring method and results as the level of a hazardous chemical or its metabolites in the body does not necessarily correlate with workplace exposure, symptoms or damage to health. For example, diet, home environment or lifestyle factors may affect results.

Interpreting biological testing results for the workforce is made by comparison to levels and guidance as specified under the MSIA and MSIR and the SafeWork Australia Guides, *Hazardous Chemical Requiring Health Monitoring* and *Health Monitoring for Exposure to Hazardous Chemicals Guide for Medical Practitioners (or its equivalent).*

Caution must be exercised to ensure that the correct standards are being used as different levels may exist for the same substance, but differ depending on gender, reproductive capacity or genetic/health susceptibility.

Biological monitoring results also tend to approximate a log-normal distribution. As such the same statistical methods as air monitoring are used to determine compliance.

A HHMP or annual report should include key (and appropriate) statistics to support conclusions regarding the effectiveness of controls.

Interpreting testing results – general

Those involved with interpreting results must be familiar with:

- MSIR; specifically:
  - Part 3 Division 4 (Health Surveillance)
  - Part 7 Division 3 (Hazardous Substances); and
  - Part 9 (Ventilation and Control of Dust and Atmospheric Contaminants)
- NOHSC, Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment; specifically, understanding the limitations and adjustments that are required to correctly interpret results.
- NOHSC, Hazardous Chemicals Requiring Health Monitoring; specifically, understanding the limitations and adjustments that are required to correctly interpret results.
- In accordance with good industrial hygiene practice, encourage organisations to set action levels below the legislative standards. These are commonly set at 50 per cent of the exposure standard.
- Statistical methods to support conclusions and recommendations.

Mining operations are *required* to:

- Complete either a declaration or an exceedance report for any result greater than the (shift adjusted) exposure standard. This report follows the PEEPO method whereby the people, equipment, environmental, process and organisational factors that contributed to the exceedance are identified.

PEEPO
- people
- equipment
- environmental
- process
- organisational

- The report must be sufficiently comprehensive to identify the location and circumstances that lead to the result, whether the result is unusual or typical, and what actions are to be taken to prevent a recurrence. A template for both the exceedance declaration and PEEPO investigation is provided in SRS in the health and hygiene sample submission module.
- Define the criteria used to interpret results as acceptable or requiring action in the HHMP.

Mining operations are *encouraged* to:

- lodge all valid monitoring results, not just those below a particular level or that meet minimum sample number commitments, as industry-wide data is used in epidemiological studies and exposure standard reviews
- submit an exceedance report when results are above an action level, or when levels are not as low as reasonably practicable. The SRS health and hygiene module allows discretionary reports to be submitted.

Reporting results

The HHMP should detail how results are to be reported, including, how:

- results will be reported to the workers who were tested
- the VO will report exceedances to the registered manager (MSIR r. 9.6 (e)(ii)) and how that will be confirmed
- exceedances will be reported to the workers who were tested
- sample results will be entered into SRS
- and when exceedances will be investigated, what information will be reported and how findings are reported into SRS and to those who were exposed.

Storage of records

Due to the long latency period for some diseases to become apparent in exposed workers (often 30+ years), robust record storage systems are required.

- The HHMP should define where results, sampling sheets, test certificates and the like are to be stored.
- It should be noted that some information may be considered “medical record data” and be subject to greater privacy requirements than normal records.

Appendix A SRS sample submission guide

Health and hygiene management plan review checklist

General overview

☐ Company name provided ☐ Sites covered by the plan defined ☐ Location address provided
☐ Contact person and details for queries provided

Status of the operation

☐ Proposed new operation ☐ Re-opening of suspended activities ☐ Expansion of existing facilities
☐ Continuation of normal activities ☐ Significant change of operations
☐ Introduction of new equipment or process

Management plan

☐ New (no existing plan has been submitted) ☐ Update (previously submitted plan exists)

Key operation activities

Including support activities and the relationships to one another described (a schematic flowchart can be used)

☐ Quarry / open pit mining
☐ Underground mining
☐ Mineral processing
☐ Offices
☐ Laboratory
☐ Workshops
☐ Warehouses
☐ Medical centre
☐ Village and messing
☐ Power station
☐ Water treatment
☐ Bore fields
☐ Overland conveyers
☐ Rehabilitation works
☐ Exploration
☐ Railways
☐ Port
☐ Other (specify) _____

Other

☐ Total number of workers (include contractors) typically employed is defined (exclude shut down crews)
☐ Principal minerals being extracted/handled defined
☐ Climatic conditions, neighbours or other factors that may impact contaminant exposures described

Hazards identified

The following hazards are identified within the HHMP.

Dust or fume

- Inhalable dust
- Respirable dust
- Silica
- Asbestos
- Diesel particulate
- Welding fume
- Lead
- Nickel
- Arsenic
- Mercury
- Other harmful dusts/fume

Gases or vapours

- Hydrogen cyanide (HCN)
- Ammonia (NH_3)
- Sulphur oxides (SO_x)
- Oxides of nitrogen (NOx)
- Carbon monoxide (CO)
- Carbon dioxide (CO_2)
- Methane (CH_4)
- Chlorine (CL)
- Sulphuric acid (H_2SO_4)
- Toluene
- Xylene
- Sodium hydroxide (NaOH)
- Other harmful gases/vapours

- Mined material likely to become chemically unstable or spontaneously combust
- Extremes of temperature and humidity
- Noise
- Chemicals added to enable the processing (including contaminants in process water)
- Intermediate hazardous materials generated during the process
- Potable water
- Biological hazards
- Sewage treatment
- Food handling
- Blood/urine
- Wildlife/livestock handling
- Radiation
  - UV/sunlight
  - Electro-magnetic
  - Gauges (note radiation from uranium/thorium) to be covered in radiation management plan)
- Illumination
- Ergonomics or manual handling
  - Repetitive or sustained force
  - High or sudden force
  - Repetitive movement
  - Sustained or awkward posture
  - Exposure to vibration (whole body, hand-arm)
  - Repeated use of ladders

Similar exposure groups

☐ SEGs defined
☐ SEGs – suitable number for diversity of operation
☐ Number of persons defined for each SEG
☐ Hazards defined for each SEG
☐ Controls defined for each SEG
Controls are predominantly: ☐ Elimination ☐ Engineering ☐ Elimination ☐ PPE

Risk assessment

☐ Risk assessment tool defined and provides defined criteria
☐ Risk acceptability criteria defined and applicable to the size of the operation
☐ Risk rating defined for each SEG

Validation of controls

☐ Validation
Validation methods for controls are defined for each hazard. Validation techniques include:
☐ Atmospheric sampling ☐ Biological monitoring ☐ Medical examinations ☐ Noise dosimetry
☐ Audiometric testing ☐ Ventilation system measurements, e.g. capture velocities
☐ Audit and inspections ☐ Questionnaires
☐ Statistically significant samples proposed for each SEG; i.e. no warnings in SRS
☐ Where non-statistically significant samples proposed, suitable justification provided
☐ Suitable statistics proposed to interpret sample results
☐ Geometric mean ☐ Geometric standard deviation
☐ 95th percentile of SEG population compared to exposure standards

Results

☐ Process to ensure management is aware of results/findings defined
☐ Process to ensure workforce is aware of results/findings defined
☐ Process to ensure results are suitably stored defined
☐ Process to ensure results are reported to the Department defined

Occupation, contaminant and sample method codes are contained in the SRS health and hygiene index www.dmp.wa.gov.au/Documents/Safety/MSH_G_SRSHealthHygieneCodeIndex.pdf

Appendix B Common causative agents and associated diseases and health conditions

The table below details agents commonly found at mining operations and their associated occupational diseases and health conditions.

Table 4 Occupational diseases and health conditions

Causative agent	Occupational diseases	Other associated health conditions
Noise	Hearing loss	Reduced ability to communicate Sense of social isolation Mental health disturbances Dementia
Gases	Asphyxiation Chemical sensitivity, asthma Systemic diseases of central nervous system (CNS), kidneys, liver Cancer	Odour sensitivity Short-term respiratory discomfort Nausea and headaches
Particulates – dusts and fumes	Short-term and chronic lung disease (pneumoconiosis) Dermatitis Cancer	Physical eye damage Chronic sneezing Chronic benign, irritating cough Wheeziness
Organic solvents	Dermatitis Chemical Sensitivity, asthma Systemic diseases of CNS, kidneys, liver Cancers of CNS, kidneys, liver	Burning skin Lacrimation (watery eyes) Nausea Headaches
Heavy metals as dusts, fumes or contaminated drinking water	Hearing loss Reproductive abnormalities Systemic diseases of CNS, kidneys, liver Cancers of CNS, kidneys, liver	Hearing threshold shifts Joint pains in predisposed people
Vibration (whole-body and hand-arm)	White-finger Musculoskeletal disorders Reproductive abnormalities	Mental health disturbances
Extreme temperatures	Cold and heat stress disorders Heat stress Death	White-finger
Biological agents	Acute gastrointestinal disorders Arbovirus diseases – Ross River virus,	Dermatitis Rash, headaches, lethargy
Ergonomic or manual handling factors such as repetitive or sustained forces, high or sudden force, repetitive movements, sustained or awkward posture, repeated use of ladders	Muscular skeletal injuries, sprain, strains, reduced mobility	Arthritis Occupational overuse syndrome