Department of Industry
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Mine Safety

GUIDE | MUSCULOSKELETAL DISORDERS

Managing musculoskeletal disorders

A practical guide to preventing musculoskeletal disorders in the NSW mining industry

NSW MINE SAFETY ADVISORY COUNCIL

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NSW Mine Safety Advisory Council

The NSW Mine Safety Advisory Council is established under the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* to provide advice to the Minister for Resources and Energy on critical work health and safety (WHS) matters in mining.

MSAC has the strategic objective of achieving world-leading WHS through the development of changes in health and safety culture throughout the resources industry in NSW.

The council includes senior officials from some of the most respected bodies in the resources industry, including the CFMEU (Mining and Energy Division), Australian Workers Union, NSW Minerals Council and Cement Concrete and Aggregates Australia. An independent chairperson and two independent WHS experts are also members of the council.

Contents

1. Introduction

About this document

Three levels of guidance to prevent MSDs

This document provides three levels of technical guidance for the prevention of musculoskeletal disorders (MSD) in mining. These are:

- **level one:** generic process and approach consistent with regulatory requirements and best practice
- **level two:** mining-specific information
- **level three:** practical examples, case studies and tools (such as checklists).

Contents overview

A complete prevention resource

The document contains the following sections:

- about musculoskeletal disorders
- preventing musculoskeletal disorders
- participatory ergonomics
- checklists and worksheets
- guidance
- mining industry case studies
- resources.

Summary of the MSD risk management process

Six step prevention process

Preventing MSDs is a six-step process:

Gather information
Group tasks by operational area
Review the risk factors
Assess the risks associated with the task
Control the MSD risk
Monitor and review

Remember, each step in the risk management process is supported by:

- consultation
- training
- supervision and
- engagement.

2. About musculoskeletal disorders

This section contains information about:

- your legislative obligations
- the definition of musculoskeletal disorders
- general risk factors
- specific industry risk-factors
- how big of an issue are MSDs in the mining/extractives industry?

2.1 Your legislative obligations

The work health and safety (WHS) laws[1] contain principles and requirements for musculoskeletal disorder (MSD) prevention.

The WHS laws set out the principles and requirements that apply to MSD risk management in the workplace. These laws require a person conducting a business or undertaking (PCBU) to manage risks to health and safety relating to a musculoskeletal disorder associated with a hazardous manual task.

Duty holders have several responsibilities to manage risks under the Work Health and Safety Regulation 2011. These include, in so far as reasonably practicable:

- identifying hazards that could lead to risk
- eliminating risks to health and safety
- minimising risks so far as is reasonably practicable by implementing control measures as per the hierarchy of control
- maintaining control measures so that they remain effective
- reviewing, and if necessary revising, control measures.

The objective of these responsibilities is to create and maintain so far as is reasonably practicable a work environment that is without risks to health and safety. Consultation with workers, and in some cases with other duty holders, is an important part of this process.

Mine and petroleum site operators must prepare and implement a health control plan to manage risks to health associated with mining or petroleum operations. Duty managers can achieve an effective health control plan by:

- ensuring that the management of MSDs is part of an operator's health control plan
- consultation with workers and other stakeholders
- obtaining and providing information for the identification, assessment and control of risks
- using tailored risk assessments for hazardous manual tasks
- using a hierarchy of controls with a focus on higher order controls
- considering lower order control such as instruction, training and supervision **only after** higher order controls have been explored.

[1] 'WHS laws' means the Work Health and Safety Act 2011, Work Health and Safety Regulation 2011, Work Health and Safety (Mines and Petroleum Sites) Act 2013 and the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014.

Hazardous manual tasks code of practice

This code of practice provides guidance on managing the risk associated with hazardous manual tasks. You can download the Hazardous manual tasks code of practice in PDF or Word format on the Safe Work Australia website.

Codes of practice are admissible in court proceedings under the WHS Act and Regulations. Courts may accept codes of practice in evidence in relation to what is known about a hazard, risk or control. The courts may rely on the code in determining what is reasonably practicable in the circumstances that the respective code covers.

The hazardous manual tasks code of practice should also be read in conjunction with Safe Work Australia's Principles of good work design.

2.2 What is a musculoskeletal disorder (MSD)?

The term musculoskeletal disorders or MSDs do not refer to just one disorder. MSD is an umbrella-term for a variety of injuries and disorders including:

- sprains and strains of muscles, ligaments and tendons
    - for example, shoulder muscle strain leading to rotator cuff tear
- back injuries, including damage to the muscles, tendons, ligaments, spinal discs
    - for example, ruptured discs, nerves, sciatica, joints and bones
- joint injuries or degeneration, including injuries to the shoulder, elbow, wrist, hip, knee, ankle, hands and feet
- bone injuries, for example, fractures
- nerve injuries, for example, carpal tunnel syndrome of the wrist
- soft tissue hernias, for example, abdominal hernias
- muscular and vascular disorders as a result of hand-arm vibration (HAV).

Development of MSDs

There is no set timeframe for the development of a MSD. MSDs can happen suddenly or develop over time. They may:

- **occur suddenly** as a result of a single forceful action like pulling or moving an object, lifting a heavy object, actions causing overexertion or through a slip, trip or fall
- **develop over a longer period** as symptoms associated with minor tissue injuries (including nerve and vascular tissues) are ignored, eventually resulting in a more serious injury
    - injuries suffered by workers (for example, transport drivers, mechanics) doing repetitive work and/or work of a similar nature could also fall into this category
- **be a combination of both,** where tissue that is weakened by cumulative injury may become more vulnerable to an acute injury, even at much lower forces.

2.2 Hazardous manual task risk factors

Many factors contribute to MSDs

For a manual task to be considered as hazardous there needs to be specific risk factors present. Based on research conducted in Australia and overseas, the key MSDs risk factors in a mining and petroleum environment are:

- awkward postures
- bending and twisting
- manual handling/load
- forceful exertions
- repetitive actions

- duration of task
- heavy lifting
- vibration of hand/arm and whole body (including jolting and jarring)
- poor access to equipment
- slips, trips and falls
- working long hours without the opportunity for rest and recovery
- exerting force in a static position for extended periods
- problems with the work environment, for example, working in hot or cold weather, rain and unpredictable conditions
- high job demands and time pressure
- fatigue
- lack of job rotation.

2.3 Direct risk factors

Research has shown significant links between exposure to specific risk factors and the onset of a MSD. The relationship between MSDs and the risk factors of awkward posture, force, repetition and duration, and vibration has been demonstrated by strong evidence.

Awkward posture

Awkward postures are common in the mining and extractives industry due to the nature of the work environment, the equipment used and the confined areas where tasks are performed. Ensuring a good posture while working is crucial to minimising the risk of developing a MSD.

Force

Applying force, especially for body areas including the lower back, shoulders, wrists and hands, is strongly linked to the development of MSDs. Force on the lower back is common in the manual handling of loads. Manual task hazards in mining can be made worse by poor work and workplace design, including lack of adequate lighting, wet, muddy or unstable ground conditions, and limited or restricted space to move. These contributing factors are discussed in the next section.

Manual tasks involving forceful exertions combined with other risk factors, such as awkward posture or vibration, will significantly increase the risk. Moderate to maximum force to the hands and wrists are found when using hand tools, gripping objects, or loosening tight parts.

Manual handling tasks are compounded by significant environmental factors including lack of adequate lighting, wet, muddy and/or unstable ground conditions, and limited or restricted space.

Difficult loads, that is, when the load is unstable, unbalanced or difficult to grasp or hold, are an additional characteristic of hazardous manual tasks that can contribute to the development of a MSD.

Repetition and duration

Repetition exposure occurs when similar movements are required to be performed for one hour or more. This includes situations where similar actions are performed across a number of tasks during a shift and the same muscles and other soft tissue are being used constantly. Examples include the use of hand tools in maintenance and the handling of bolting equipment in bolting operations.

Duration is the length of time a task is performed. The longer the task is performed the higher the risk. Extended shifts should be taken into account for duration. Operating mining vehicles in an open cut mine is a very clear example of duration as a factor.

Vibration

Three categories of vibration should be considered:

- whole body vibration - steady state
- whole body vibration - jolts and jars (also known as transient mechanical shock)
- hand-arm vibration.

2.4 Contributing risk factors

Direct risk factors often have a contributing cause

To assess and control MSD risk factors it is important to find out why direct factors, i.e. those directly linked to a possible MSD outcome, are present. Poor job and workplace design and work organisation often significantly contribute to injury.

Relevant examples of this include:

- risks associated with shovelling coal off walkways next to conveyors, which can be traced to the less-than-adequate design of the system causing coal spillage
- the design of machinery and equipment with limited access for maintenance, which can be a contributing risk factor to awkward postures.

Other contributing risk factors can be related to the nature of equipment or work environment, such as mesh walkways that require shovelling to clear coal.

Direct risk factors in the mining and extractives industry will generally have a contributing factor, such as:

- organisational factors, including systems of work and work practices
- the nature and design of equipment and loads
- work environment issues.

However, it is important to look for other, less obvious risk factors in the risk assessment. The Hazardous manual tasks code of practice refers to these contributing risk factors as “sources of risk”.

2.5 Specific industry risk factors

There are a number of risks that may contribute to MSDs specifically in mining. These can include:

- less-than-adequate design of mining and quarrying equipment, including the provision of access for operation and maintenance
- difficult work environments, including
    - uneven, wet, muddy ground and road surfaces
    - vibration
    - limited access to and around equipment
    - poorly lit work areas
    - limited visibility from vehicle and machinery cabs
    - glare from the sun or artificial lighting
- characteristics and storage of tools and other equipment that are not fit-for-purpose
- work organisation and planning of systems of work that are not the most favourable, including rosters, shutdown deadlines and overtime.

2.6 Other risk factors

Ageing workforce

The main issues for older workers are:

- Lack of ability to undertake physically demanding or physiologically demanding work. There are several tasks that older, injured miners find significantly more physically demanding than younger, injury-free miners. These include:
    - manual tasks such as lifting, carrying, lowering
    - pushing, pulling, dragging for example cables, hoses or other loads
    - reaching forward, bending, twisting or stooping
    - prolonged work in an awkward or uncomfortable posture
    - shovelling
    - repetitive physical work.
- Increased risks of slips, trips and falls. Several factors relate to the loss of balance and an inability to recover from a slip. Specific risks include:
    - effects of ageing on vision as older workers have more difficulty in noting trip hazards unless illumination and contrast is increased
    - loss of strength and endurance in the lower legs
    - changes to sensory and motor function affecting balance
    - potential cumulative effects of injuries over time.
- Older workers will often have more falls than younger workers and their falls will often lead to more severe injuries.

Slips, trips and falls risk factors

In mining and extractives industry, the hostile environmental conditions and regular interaction with plant and equipment are major risk factors contributing to slips, trips and falls. Specific risk factors include working:

- at night or underground (limited visibility)
- in, on and around uneven and hazardous ground conditions
- with poor access to heavy vehicles for operators and maintainers.

Risk factors in underground mines include:

- very low levels of lighting
- wet, boggy, muddy and uneven ground conditions, especially for those conducting inspections
- restrictions in interacting with equipment and objects due to seam conditions, mine plan and ground conditions
- dirt and mud obscuring visual features of steps and platforms
- dirt and mud clogging footwear treads
- wet conditions restricting choices of footwear
- frequent changes in conditions due to shift and mine operations.

New workers

New workers in any hazardous job have an elevated risk of injury. This can occur when new workers:

- volunteer for or assist in tasks they are not familiar with
- do not understand the need to pace themselves with physically demanding tasks
- are not aware of MSD hazards, such as working beyond their physical capacity for prolonged periods
- are given low status, higher-risk jobs
- do not know exactly what to do and how
- do not know when to ask for assistance.

2.7 Other issues to consider

Jobs must suit individual workers, not the average worker

The mining and extractive sectors now have a more diverse workforce, with increased numbers of women, older workers and workers new to the industry.

Jobs and tasks need to accommodate the physical characteristics, skills and experience of individual workers rather than the abstract and unhelpful concept of the 'average worker'. For example:

- individuals will vary in the amount of force they can apply
- some tasks promote awkward postures due to workers' physical size differences
- less experienced or poorly trained workers may perform repetitive tasks more frequently due to errors, or if they are unfamiliar with the task
- lack of training and opportunity to work on different types of equipment
- systemic organisational problems limiting rest periods at work, rest periods outside of work and appropriate intervals between rest periods at work.

Work organisation

A range of factors can impact on how work is organised or how procedures are designed and applied. Some organisational factors may result in manual tasks being performed in ways that add to the risks of injury. For example:

- production and time pressures may increase the frequency at which repetitive tasks are performed or introduce the risk of slips, trips and falls
- under resourcing of workers may increase the duration of risk exposure
- overtime and inadequate scheduling may reduce recovery time between tasks
- maintenance tasks may need to be performed in the field, increasing the difficulty of the task due to lack of suitable handling equipment and climatic conditions.

Fit-for-purpose equipment is essential for the safe production of coal. In some sectors, for example underground coal, some equipment design has not significantly changed in the past five decades. It is possible to review the match between the equipment and the workers to determine if a better fit is possible using new technology.

Consultation with workers regarding health and safety

In many organisations planning, purchasing and design decisions are made by a range of people responsible for the commissioning, design, purchasing, installing, maintaining and operating equipment and buildings. Without the consulting with all stakeholders during the initial and ongoing design, many manual tasks can become unnecessarily challenging and repetitive. Workplace health and safety legislation requires that all stakeholders are consulted about their work with respect to health and safety. One of the most effective ways of involving stakeholders when planning change that may involve manual work is through participative risk assessments and design reviews.

2.8 MSD and workers' compensation claims

MSD is the most common source of workers' compensation claims. It causes many injured workers and significant losses in time and money. From an analysis of workers' compensation claim data, we can conclude that:

- MSD from mechanical vibration, muscular stress and falls on the same level contribute approximately 50% of all claims from the icare NSW WorkCover NSW data, and just over 46% of all claims from Coal Services
- in the 2011-2012 financial year, there was a total of 850 MSD-related claims, with coal mining accounting for 550 of these claims
- the average cost of a MSD claim is $11,000, with the total cost of MSD-related mining injuries costing the industry around $9.5million per year
- as outlined in a recent Health indices report (2013) undertaken by the Mine Safety Advisory Council (MSAC), only 47% of mines surveyed have a program to identify risks in MSD, with 23% of respondents self-identifying their approach to MSD as reactive.

3. Preventing musculoskeletal disorders

This section contains information on:

- preventing MSDs
- identifying hazardous tasks
- reviewing risk factors
- reviewing contributing risk factors
- reviewing other risk factors
- assessing tasks
- controlling the risk for musculoskeletal disorders.

3.1 Preventing MSDs

Preventing MSDs must be part of the WHS management system

MSDs need to be managed as an integral part of each organisation's WHS management strategy and system. Musculoskeletal disorders are a significant drain on resources including workers' compensation, sick pay, lost productivity, retraining and legal expenses. However, MSDs do represent an opportunity for savings because they are manageable and preventable.

WHS professionals and workers must undertake these steps to prevent MSDs.

- clear objectives
- management support
- consultation
- resources
- expert advice
- action plans.

Adopting a systematic strategic approach:

1. Set a broad objective: depending on the operation and needs of your company, your objectives could relate to legislative compliance, reducing the costs of workers' compensation, or MSD incidents, improving productivity, operational efficiency or a combination of these and other factors.
2. Appoint a management champion and a representative team to manage the process: this allocates responsibility for getting the job done and establishes a participative approach.
3. Allocate resources, including a budget.
4. Consider the need for expert help and training of key personnel: MSDs are complex and multi-factorial, occupational diseases often requiring specialised understanding.
5. Develop and implement an action plan including timeframes, targets and key performance indicators for MSD performance: ideally this will include lead indicators, not just lag.

Begin by reviewing the current situation

For many businesses the first steps will include:

- conducting a stocktake of what has been done/what is being done about MSD prevention and assessing its effectiveness

- reviewing the WHS management system to ensure that it effectively integrates MSD prevention, in particular assessing whether:
    - the current WHS policy needs a specific target or priority statement related to the control of MSD hazards
    - responsibility for MSD management and performance has been delegated correctly.
- determining whether the risk management process for MSDs meets legislative requirements.

3.2 Positive help: the participatory approach

Finding effective risk solutions

Using workers' knowledge, skills and experience can be a very useful method for developing effective participative processes. Engineers, designers and systems management personnel have successfully used participative techniques for many years. They now are proving to be an engaging and productive method for systematically identifying work health and safety risks and developing solutions. In particular, they allow issues to be aired with respect to the wider work system and therefore provide a perspective that may not be possible when people are working in isolation. They have the added advantage that they can be integrated into a company's risk management program. They can be carried out on tasks, locations, roles or processes but using job steps, tasks or activities is the most common approach.

The availability of relevant information and expertise is an essential factor in the effectiveness of the participative process. Technical knowledge is usually required at both the assessment level and for the development of suitable solutions (controls). Therefore a sufficient mix of skills, knowledge and experience in the assessment group is critical to a successful outcome.

Participatory ergonomics

Participatory ergonomics is a site-based program that uses the concept of workers as task experts. With the assistance of several site champions, the aim of the program is to identify 'gut busting' activities in the workplace, then use the hierarchy of controls to implement changes and reduce the hazardous manual component of the task.

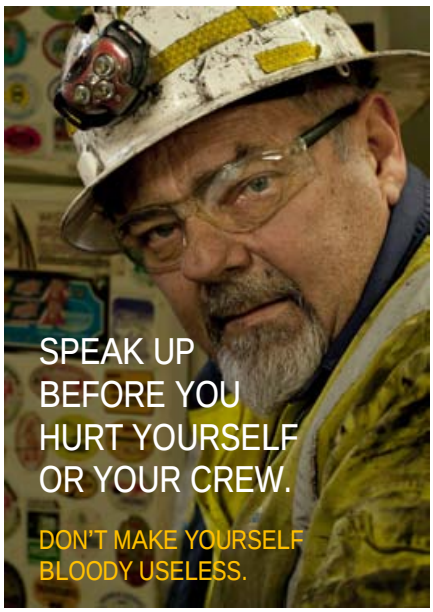
Wilson (1995) in his chapter on *Ergonomics and Participation* (p.1075) states:

> "…as well as an ergonomics management programme and training and awareness for as many as possible in the company, participative ergonomics also requires the active involvement of relevant job holders in task, job and workplace assessments and in the generation and testing of alternative solutions."

There have been several reviews of the effectiveness of participatory ergonomics (Cole et al, 2005, Rivlis et al, 2008) with the results being that participatory ergonomics is strongly supported worldwide and promoted by most jurisdictions. Examples of the participatory ergonomics approach in the mining industry include the Badger Mining project referred to in Torma-Krajewski et al (2006), the work by Robin Burgess-Limerick et al (2004), and the Ergonomics Task Force currently in place at Crinum Mine in Queensland (2010).

In 2014 the *Don't make yourself bloody useless* participatory ergonomics program was implemented for the NSW mining sector. The program, which is an initiative of the MSAC, has been developed and implemented by the department's Mining Industry Assistance Unit. The Participatory ergonomics guide teaches stakeholders to confidently facilitate their own participatory ergonomics workshops. For more information on the program, download the guide in PDF format.

A number of excellent participatory ergonomics initiatives have been developed since the implementation of this program. For more information on these initiatives please refer to mining industry case studies section within this document.



3.3 Good practice MSD prevention

A range of strategies

Minimising the risk of developing MSDs requires a range of strategies. These can include:

- using site or industry examples to show how risk factors cause injury or long-term disorders
- using participatory ergonomics to consult and interact with workers (including contractors) to identify, assess and control MSD hazards. This will also help meet regulatory requirements (for example, for consultation)
- providing additional training to supervisors, health and safety representatives, WHS committee members, safety and health representatives in coal mines and others with responsibilities for WHS to allow them to facilitate risk assessments of jobs or tasks and evaluate control measures
- using or developing easy-to-understand checklists, with pictures as prompts, for concepts such as posture and position, location and distance, and workplace layout. These checklists can also be used as part of the risk assessment training
- ensuring that the facilitator or trainer has an understanding of the causes of MSD, the requirements of regulation and supporting material such as the Hazards manual tasks code of practice. Also ensure that the root cause or reason behind the manual task is the focus of the risk assessment
- using surveys of MSD symptoms to identify jobs or tasks that may not have obvious risk factors. These surveys also help prioritise implementation
- modelling best practice solutions from innovation awards to show that control measures can be simple and cost-effective.

3.4 Summary of good practice

Prevent strategy flowchart

The process of MSD hazard identification, risk assessment and control is summarised in the flowchart below. The flowchart is provided to explain the prevention strategy approach described in this document.

Step	Action	Outcome
1	Gather information	A list of tasks most likely to be hazardous MSD tasks

Step	Action	Outcome
2	Group tasks by operational area	A list of jobs, occupations, operational areas most commonly associated with high or potentially high levels of MSD

Step	Action	Outcome
3	Review the risk factors	A list of tasks and/or jobs with identified associated risk factors

Step	Action	Outcome
4	Assess the risk associated with the tasks	A prioritised list of tasks/jobs to be controlled – this could be in the form of an MSD risk register

Step	Action	Outcome
5	Control the MSD risk	Control solutions and an associated implementation action plan

Step	Action	Outcome
6	Monitor and review	Auditable records showing that MSD risks are being effectively managed

Training, supervision, consultation

Step 1 Gather information

Objective

Consulting workers is essential in gathering information. The purpose of consultation with workers and/or their representatives where appropriate, is to identify potentially hazardous manual tasks for further investigation.

1.1 Source information on hazards

The best way to source information to help identify MSD hazards is to systematically examine available information about tasks with the potential to harm the musculoskeletal system. Common sources of such information include:

- injury records and trends
- incident and hazard reports
- issues raised by health and safety representatives, safety and health representatives in coal mines, WHS committee members, deputies, workers, permanent and intermittent contractors
- proactive surveys or consultants' reports
- WHS committee meeting minutes or reports
- industry reports or information on MSDs or ergonomics issues such as
    - ACARP reports
    - Coal health and Safety Trust reports
    - Safety Bulletins
- records of production or service difficulties causing additional manual tasks
- records of maintenance and service requests which mention physical difficulty in using equipment.

1.2 Consider bringing in consultants

If there is insufficient information, or insufficient resources at the site, it may be necessary to engage suitable consultants to observe the work processes and consult with workers or their representatives and WHS committee members about which tasks are hazardous.

1.3 Review the information

After you have consulted with workers, sourced information and, where necessary, engaged consultants, you should review the information you have gathered. In consultation with workers and contractors, make a list of:

- all manual tasks where an injury, pain or symptoms **that persist** have been reported
- manual tasks reported as **difficult to perform**, such as those that require more than one person to complete
- manual tasks associated with **interruptions or difficulties with work processes**, particularly the need to redo work
- tasks involving **equipment or hand tools** that are not working properly or that **are difficult to use**.

1.4 Identify other relevant task characteristics

You should also list task characteristics that may help identify MSD hazards. These tasks may include:

- new manual tasks or those to be altered in some way or which are being undertaken in a changed environment
- manual tasks that have not previously been examined for their potential as a hazard
- tasks which have led to reports of slips, trips and falls.

Outcome:

A list of tasks most likely to be hazardous manual tasks or cause MSD.

Good practice tips

Better analysis, better outcomes

It is good practice to examine and compare:

- specific equipment and/or infrequent tasks, including shutdowns, breakdowns or other infrequent tasks
- the numbers of incidents/injuries in particular locations that have a manual task and/or slip, trip and fall component
- the frequency and severity of injuries and how these have varied with the number of workers, particular groups of workers (new, older, contractors), the hours worked and the areas of work
- the number of injuries related to each job and/or operational area and how serious these injuries have been.

Step 2 Group tasks according to operational areas

Objective

Grouping tasks makes it easier for each operational area to determine their hazardous manual tasks and tasks with a risk of slip, trips and falls, as well as to see where more information is required.

2.1 Use outcomes of step 1 to identify MSD hazards

Each operational area should now have a list of known hazardous manual tasks, or slips, trips and falls hazards, and a number of tasks or jobs where the MSD risk factors and overall risk is not fully known.

If the site has identified a hazardous manual task, such as cable handling, changing conveyors and others, the next step is to review the current risk assessment to determine if the MSD risk factors are clearly documented.

When a hazardous manual task or a task with known slip, trip or fall hazard is present and information on risk factors is available, it is possible to move to **step 5 – Control the MSD risk**.

If the task or job or area is not easily identified as being hazardous, then the information should be reviewed to see if MSD risk factors are documented. Other helpful information will include the area of the body where injuries have occurred and any hazard reports or information on root causes. Whenever possible, information that includes photographs, videos, or other prompts will make it easier for the risk assessment.

The more information available at this point on risk factors, the better prepared the team will be in undertaking the risk assessment.

Examples of operational groups

A number of jobs and tasks in mining have already been identified as having a high likelihood of a musculoskeletal disorder (Burgess-Limerick, Parker, McPhee). There are also jobs that have known exposure to multiple MSD risk factors, for example, whole body vibration (WBV) for extended shifts, along with long duration of sedentary work.

Parker (2005) has found that there were differences in loading and demands between the following operational groups in coal mining:

- deputies
- electrical workers
- mechanical workers and fitters
- professional and administrative staff
- operators and maintainers.

Some jobs in underground coal mining that were demanding on the heart include cable handling, ventilation tube work and shovelling. Shovelling had the highest demands, reaching 80% maximal heart rate (Parker 2005).

Examples of physiologically demanding tasks in mining/extractives include:

- most heavy vehicle maintenance or repair work in the field (if outside) or underground in summer
- electrical work and shot firing work in hot mines
- cable handling in most mines

- drillers offsiders in hot mines
- heavy manual tasks requiring the wearing of respiratory protection and other protective equipment.

Step 3 Review the risk factors

Objective

Reviewing risk factors means it is far easier to determine the root cause or source of MSD risk factors for jobs and tasks, including slips, trips and falls.

3.1 Group MSD information

Larger sites will usually benefit from grouping the MSD information collected in step 1 into the operational areas, for example, mining (production), processing and maintenance. It may also be possible to group tasks by phase of production, for example, shutdowns or planned maintenance, when higher risk activities are known to occur.

3.2 Look for links and trends

After grouping MSD information, look for trends in reporting injuries, hazard reports or other information that indicate MSD hazards. In many cases, hazardous manual tasks will be easily identified. For example, previous mining studies have documented a number of hazardous manual tasks including changing rollers on conveyors, cable handling, handling drill rods, airleg drilling and dozer operations.

Grouping tasks or MSD and slips, trips and falls hazards by operational areas will allow for planning of risk assessments. Some operational areas may have more hazardous manual tasks than others. Planning for risk assessments (steps 3 and 4) will include:

- determining if there are gaps in the information collected
- deciding if assessment of some hazardous tasks or jobs may require additional expertise
- allocating sufficient resources and representatives to participate in the risk assessments.

Step 4 Assess risks associated with tasks

Objective

Assessing risks associated with tasks means it is easier to identify the root cause or source of MSD risk factors for jobs and tasks, including slips, trips and falls.

4.1 Use the appropriate risk assessment checklist

Each operational area will have a list of tasks or jobs from step 3 requiring a risk assessment. The risk assessment should explore the root causes of the MSD risk factors, including asking why the manual task is being undertaken. This will assist with the next stage of developing controls.

As part of the risk assessment the team will need to choose the most appropriate tool or checklist for the relevant MSD and also slip, trips and falls risk factors. For example, undertaking a risk assessment of haul truck operations in an open cut mine would require a checklist or tool covering vibration, sedentary posture and vehicle design and access.

There are no specific tools that cover all the risk factors for MSD in mining. The examples listed below show what some mines have done to assess MSD risks relevant to their operational needs only.

There are some hot, heavy jobs or tasks where the risk may not be adequately assessed by some risk assessment tools. In mining/extractives these include:

- most heavy vehicle maintenance/repair work in the field (if outside) or underground when hot
- electrical and shot firing work in hot conditions
- cable handling in most mines.

These jobs or tasks may require a checklist or tool on physiological demands or modifying one to include additional questions.

Examples of MSD risk assessments

There are a number of tools available to assist in assessing the risks of hazardous manual tasks. Experience shows that implementing a number of risk assessment approaches is effective.

The following list is a guide only and the choice of tools to use is at the discretion of the relevant facilitator. Some of the risk assessment tools are reasonably complex. Quite often it is necessary to engage the skills and experience of a health or medical professional such as an ergonomist, physiotherapist, occupational therapist or WHS nurse to assist in the risk assessment process.

Below a list of relevant MSD risk assessments.

- Ovaka working posture analysis system
- Rapid upper limb assessment (RULA)
- Rapid entire body assessment (REBA)
- NIOSH lifting equation guidelines
- Borg rating of perceived exertion
- PErforM tool.

For more detailed information please refer to the section 2.4 of the Participatory ergonomics: train the work teams facilitator's guide.

Conducting a risk assessment utilising a participatory ergonomics approach

A participatory ergonomics approach to risk assessment allows a focus group to tackle a hazardous manual task using a systematic approach with a view to identifying solutions to the problem.

The availability of relevant information and expertise is essential to the effectiveness of the participatory process. In addition it provides a forum for constructive consultation, something that can be difficult to achieve in other processes. Fundamentally the participatory ergonomics approach needs to be realistic and provide achievable solutions. If done well, it will:

- provide a sense of ownership of ideas and responsibility for identifying the most appropriate solution
- provide a framework that worker use to solve problems
- present the worker the theory and application of ergonomics
- promote effective workplace communication (McPhee, 2005).

Step 5 Control the MSD risks

Objective

Controls should eliminate risks rather than relying on people to do the right thing. This means a lower risk to developing MSDs.

5.1 Develop controls based on the hierarchy of controls

The hierarchy of controls is a well-recognised framework for managing risks. It must be applied by all persons conducting a business or undertaking at a mine or petroleum site to manage health and safety.

Controlling the risk directly, by designing out the hazard (high order control), is generally more effective than lower order controls, which rely on physical barriers (for example, personal protective equipment), or administrative control measures (relying on appropriate and/or compliant worker behaviour).

For example, there is evidence that training in safe lifting techniques on its own is not an effective control for MSD. Manual task techniques training is therefore not an acceptable control measure on its own.

5.2 Eliminate the risk by eliminating the job or task

Based on the risk assessment findings, identify the hazardous manual tasks and the tasks where slips, trips and falls are a significant hazard.

After identifying these tasks, determine why the manual task is being performed and if the task could be eliminated. This same process should be undertaken for slips, trips and falls. Ask “is it possible to eliminate the slip, trip or fall hazard by eliminating the job or task performed?”

5.3 Reduce risk through engineering and design controls

Consider engineering or design control to reduce the risk of MSD. The control should deal with contributing risk factors causing the direct risk factor.

For example, if the

- design of access to a vehicle is causing the direct risk factor of awkward posture or slips, trips and falls, then designing suitable access is the recommended control
- risk factor is an awkward posture, then ensure that the control measure actually reduces or eliminates the awkward posture.

It is useful to focus on efficiency as well as risk reduction, as safer ways of working are often also more efficient.

A good source of equipment design and engineering controls for MSD risk factors such as manual tasks, whole body vibration, equipment access and egress can be found at the Earth moving equipment safety round table (EMERST).

5.4 Apply the principles

When implementing risk controls you should apply these principles:

- use the hierarchy of control
- trial solutions before making them permanent
- review controls after an initial testing period as they may need modification
- develop work procedures to ensure that the controls are understood and responsibilities are clear

- communicate the reasons for the change to workers and others
- train workers to use the controls
- supervise the reliable implementation of controls.

Better design

A key issue in reducing adverse MSD outcomes is better design. Safe Work Australia has produced a handbook on the Principles of good work design.

Step 6 Monitor and review

Objective

Monitoring and reviewing risk controls means that controls are implemented and effective in managing MSD risks.

6.1 Solicit observation and feedback

There are several ways to review the effectiveness of existing controls. These include:

- consulting with workers and supervisors regularly, especially those using the risk control measures
- observing work activities during walk-through surveys
- conducting audits and inspections
- monitoring hazard, incident and injury reports
- conducting surveys of MSD risks.

You should also review the availability of control measures:

- monitor equipment design changes available in industry that can potentially solve difficult MSD problems, for example, mechanized processes for bolting
- review mining innovation awards, industry-specific publications, trade shows, and updates from suppliers—EMERST contains information on effective design controls.

6.2 Perform regular record-keeping:

Keep records of hazard identification, risk assessment and control processes to help meet regulatory requirements and ensure that MSD risks in performing manual task issues are being managed.

Records will also help to:

- keep track of what has been done and what is planned
- retain information on why you changed the task
- prevent relapses of old, ‘unsafe’ procedures.

4. Checklists and worksheet

This section contains a:

- checklist for assessing the risk of MSDs while using mining equipment
- checklist for hand tool selection and use
- checklist for purchasing large mining equipment
- example of a manual handling action plan worksheet

Checklist: assessing the risk of MSD when using mining equipment

This checklist can be used to:

- Conduct pre-purchase or onsite review of equipment risks.
- Assist workers to consider equipment risks in risk assessments.
- Assist in training.

□ Is there safe and easy access to the machine by the operator?

□ Are steps, stairs, ladders, walkways and access platforms provided where necessary and are they safe to use under all foreseeable conditions (i.e. risks of slips, trips and falls are minimised)?

□ Are there handrails and handholds installed where necessary?

□ Are doorways wide and high enough?

□ Does the equipment allow for safe and efficient operation?

□ Can the operator see and hear?

□ Can the operator understand and act appropriately when given information?

□ Can the operator manipulate controls easily and without confusion?

□ Can the operator work in reasonable comfort without unnecessary or excessive physical and/or mental stress or fatigue?

□ If operators are working extended shifts, has this been considered in the risk assessment?

□ Are breaks adequate for recovery from the demands of the task?

□ Do the environmental conditions in the cab allow for comfort, communication and adequate protection from noise, vibration, dust and other risks to health?

□ Can the cab be kept at a reasonable temperature for sedentary work (20-25 C) and is adequate heating, cooling or air conditioning provided where necessary?

□ Can the operator communicate easily and without misunderstanding people outside the cab?

□ Can doors and windows be closed and are seals adequate to prevent the ingress of unwanted, distracting or excessive noise, dust, fumes or other environmental contaminants?

□ Is the whole-body vibration reduced to an acceptable level? Does it meet the Australian Standard for WBV (AS2670 – 2001: *Evaluation of human exposure to whole-body vibration*)?
NB: Measurement of WBV, interpretation of results and management often requires specialised skills, competencies and familiarity with mining conditions and practices

□ Are operators aware of all features on the vehicle, how to use them optimally and why it is important that they do?

□ Is there suitable competency training available for operators and maintenance personnel?

When considering specific hazard areas such as whole-body vibration, it is important to recognise that the training should include training in the site vibration management plan and policy dealing with seat replacement

□ Are operators trained in techniques to reduce the risk of injury from vibration?

□ Is there easy access to machine parts or areas requiring attention, and are there suitable tools readily available in maintenance and servicing of equipment?

□ Can the equipment be towed readily to the workshop to avoid field servicing whenever possible?

□ Are the demands of maintenance tasks within the capability of all maintenance personnel?

□ Maintenance does not require undue force, awkward posture or dangerous practices?

Checklist: hand tool selection and use

Hand tool selection	Hand tool use
Hand tools should be selected if they: ☐ Can be held in a neutral wrist or handshake position ☐ Allow the hand to retain a comfortable grip span ☐ Can be used by the worker in one hand ☐ Are well balanced (the heaviest part of the tool should be behind the wrist) ☐ Are suitable for use by either hand ☐ Provide a good grip surface ☐ Prevent a worker from adopting a pinch grip with high force or for prolonged periods	Minimise the level of muscular effort needed to use hand tools, particularly of the shoulder and wrist, by: ☐ Using power tools where possible ☐ Suspending heavy tools where they are used repetitively and in the same place ☐ Counterbalancing heavy tools that are used repetitively and need to be kept away from the body ☐ Using trigger locks where the grip has to be sustained for more than 30 seconds ☐ Holding the work piece in place with jigs or fixtures ☐ Selecting tools that produce the least amount of vibration ☐ Reducing impact shocks ☐ Limiting torque or kick back reactions

Checklist: purchasing large mining equipment

Questions for operational areas

Before purchasing any fit-for-purpose equipment, ask:

- What is the age range of the users or operators?
- How big and how strong are they?
- What are they expected to do with the machine? What is the nature of the work?
- Where will they be working and under what environmental conditions? For example, in high humidity, heat, toxicity of dust, or other conditions.
- When do they do the work? What time of day, seasons or weather?
- Has the end-user been involved during the whole process?

Questions for the original equipment manufacturer or supplier

These questions will assist in determining the key components of the equipment that must be addressed in the purchase. For example, certain environmental conditions will require very good internal seals for dust minimisation and high humidity may require additional measures to reduce humidity inside the cab.

- What is their experience in supplying similar machines with these users and environments?
- Are they compliant with the EMESRT design principles (for open cut and extractives)?

Criteria for safe purchasing and evaluation of heavy equipment

Questions 1 to 3 discuss criteria for the safe purchasing of heavy equipment. They also cover evaluating equipment by a suitable team of safety and health, purchasing and engineering/maintenance personnel when it arrives on site.

1. Is there safe and easy access to the machine by the operator that meets relevant standards?

- Are steps, stairs, ladders, walkways and access platforms provided where necessary?
    - Are they safe to use under all foreseeable conditions?
    - Are the risk of slips, trips and falls are minimised?
- Are there handrails and handholds where necessary?
- Are doorways wide and high enough?

2. Does the equipment allow safe and efficient operation?

- Can the operator see and hear?
- Can the operator understand and act appropriately when given information?
- Can the operator manipulate controls easily and without confusion?
- Can the operator work in reasonable comfort without unnecessary or excessive physical and/or mental stress or fatigue?
- If operators are working extended shifts, has this been considered in the risk assessment?
    - Are breaks sufficient for a proper recovery to reduce the risk of the task?

3. Do environmental conditions in the cab allow for comfort, communication and adequate protection from noise, vibration, dust and other risks to health that meet relevant standards?

- Can the cab be kept at a reasonable temperature for sedentary work (20-25°C)
    - Is adequate heating, cooling or air conditioning provided where necessary?

- Can the operator communicate easily and without misunderstanding with people outside the cab?
- Can doors and windows be closed and are seals adequate to prevent the ingress of unwanted, distracting or excessive noise, dust, fumes or other environmental contaminants?
- Is whole-body vibration reduced to an acceptable level?
    - Does it meet the Australian Standard for WBV?

Training and competency

Questions 4 and 5 assist with determining operator and maintenance training and competency. They also cover risk assessments for operators and maintenance workers interacting with the equipment.

4. Are operators aware of all features on the vehicle, the best way to use them and why it is important that they do use them in this way?

- Can the supplier of OEM offer training for operators or training personnel?

5. Is there suitable competency training available for operators and maintenance personnel?

NB: When considering specific hazard areas such as whole body vibration, it is important to recognise that the training should include training in the mine health control plan and/or policy dealing with seat change outs and early warning signs of potential seat degrade.

Questions on risk assessments and serviceability issues

6. Is there easy access to machine parts or areas requiring attention, and are there suitable tools readily available for maintenance and servicing of equipment?

- Can the equipment be towed readily to the workshop to avoid field servicing whenever possible?

7. Are the demands of maintenance tasks within the capabilities of all maintenance personnel?

- Can maintenance be completed without undue force, awkward postures or dangerous practices?

If the answers to questions 1 to 7 are yes, then the machine can be said to be well-designed from an ergonomic point of view.

Reference: Barbara McPhee, Usability Standards for Large Vehicles, Ergonomics Australia

Manual handling action plan

Complete the action plan for all tasks that achieve completed risk assessment and control worksheets. Attach references to other documents such as drawings, detailed plans and work procedures. Outline how you will involve workers and what action will be taken to improve management of the risk.

Work location/department: _____

Task description	Control measures	Approved by	Implementation date	Person responsible	Evaluation date	Progress

Developed by _____ Date _____

5. Additional guidance

This section contains additional guidance on:

- Vibration
- Musculoskeletal training
- Roles and responsibilities
- MSD lead indicators

5.1 Vibration

Whole body vibration

Further information on managing the risk of whole body vibration (WBV) can be found in the Coal Services guide Bad vibrations. Although the information in *Bad vibrations* is predominantly for the coal sector, metalliferous mines and extractives will find it useful.

Equipment operators are exposed to WBV in both sitting (most equipment operation in mining and extractives) and standing (for example, jumbo operators in underground metalliferous) operations.

Common operational groups include drivers, operators and passengers in a variety of vehicles such as bulldozers, dump or haul trucks, graders loaders, personnel and equipment transport and load-haul-dump (LHD) machines used in surface and underground operations. Rides in most of these vehicles will usually incur jolts and jars, as well as steady state vibration.

Main sources of harmful vibration

There are three main sources of harmful vibration in vehicles and machines:

- rough road and poor work surface conditions
- vehicle activity, for example, ripping versus pushing material in a dozer
- engine vibration (to a lesser extent).

Factors that increase or decrease driver exposure

There are many factors that can either increase or decrease the exposure for the driver. These include:

- road construction and maintenance (grading etc.)
- vehicle type and design
- age and condition of the vehicle
- maintenance of vehicle suspension systems
- seat design, suspension and maintenance
- cab layout, design and orientation
- vehicle or machine speed, driver skills and awareness
- lighting and visibility
- task design and work organisation.

Methods of risk assessment and control

The hazard of WBV needs to be managed by using an appropriate method of risk assessment and controls. WBV guidance may be addressed by measuring and analysing exposure to vibration, comparison with original equipment manufacturers (OEM) and ISO/ASNZ standards, equipment design and seating, and training to minimise exposure. For more information see the Bad vibrations guide, which includes a checklist to manage sources of vibration.

Sample controls for WBV

Road maintenance controls can include:

- planned, systematic road maintenance programs
- dedicated vehicles and drivers for road maintenance
- effective communication of road conditions, for example, signposting or markers
- prompt repair of poor road conditions.

For more information please refer to MDG 1009 Managing road vehicle operating areas in underground coal mines.

Vehicle and seat design controls can include:

- vehicle suspension appropriate for loads—no bottoming out
- good seat design and suspension
- improved visibility from cab, especially at night, for example through headlights
- forward-facing passenger seating
- fully adjustable seating.

Operator training and awareness controls can include:

- raising awareness of the harmful effects of vibration
- driver competency training
- regular breaks out of cab.

Speed controls can include:

- enforcing speed limits
- appointing competent, safe drivers
- introducing speed limits for vehicles in specific situations.

Vehicle maintenance controls can include:

- planned maintenance of vehicle and seat suspensions
- specialist maintenance for vehicle and seating suspension systems

Miscellaneous controls can include:

- ensuring adequate shot firing standards
- equipment exposure limits
- equipment change out and swap arrangements.

Jolting and jarring (transient mechanical shock)

WBV includes exposure to high amplitude and infrequent mechanical shocks. These can appear on incident reports as jolting and jarring, seats bottoming out and workers reporting rough rides, that is, jolting and jarring while a vehicle is in motion.

Although rough rides may be less common in the metalliferous underground sector, other factors can increase its prevalence. This includes the state of the decline, driver speed and the appropriate seat design and adjustment by workers.

Hand–arm vibration

Hand-arm vibration (HAV) is transmitted as a result of work processes or tasks that involve workers' hands and arms. Common sources of HAV in mining and extractives are from:

- hand-held power tools
    - mainly those used in maintenance for process plants, fixed plant, some mobile equipment
- hand-guided powered equipment
    - mainly hand-held drills, airleg drills or drill rigs
- powered machines where vibration is transmitted via body to hands
    - for example, operating jumbos without vibration dampening.

HAV risk factors

The main HAV risk factors to review include:

- Length of exposure—the longer the worker is exposed to the vibration, that is, uses the vibration causing equipment, the more likely the worker will suffer a negative outcome.
- Vibration level of the equipment, usually measured in m/s^2. Common mining vibration levels range from a low value of 2 m/s^2 for some lower vibration rattle guns to close to 6 m/s^2 for low level rock drills (OPERC 2007). In a South African metalliferous mining evaluation rock drills had weighted vibration levels in excess of 20 m/s^2.

5.2 MSD training

MSD training should be given in a number of situations. Training is an administrative control and workers should be trained in the safe methods of work and use of mechanical aids. The evidence shows that lifting training is not an effective risk control strategy and should never be relied on for the management of hazardous manual tasks.

To implement an effective manual task risk management program, workers must be able to identify hazardous manual tasks and be aware of the aspects of manual tasks that increase injury risks.

Training should be provided when:

- a worker is inducted into a job with manual tasks
- a new manual task is introduced
- a manual task is being redesigned
- new equipment requiring a manual task is introduced.

Who needs training

Most people in the workplace need MSD training. Training should be provided to:

- workers undertaking manual tasks
- health and safety representatives
- managers and supervisors
- those selecting/purchasing equipment used in manual tasks
- those designing manual tasks or systems of work, or the layout of a workplace where manual tasks will be carried out
- those involved in identifying, assessing and controlling MSD hazards
- those involved in monitoring, reviewing and evaluating risk control measures

Teaching people specific lifting techniques to overcome lifting problems has mixed success in reducing the risk of injury. Sometimes techniques can be helpful in specific situations but some techniques place extra demands on muscles and joints, which is slower and physiologically more demanding (McPhee, 2005) For more information please refer to page 18 of the Participatory ergonomics facilitators guide.

Training and manual tasks

The type of training should relate to the manual tasks. The type of information, instruction and training required will depend on the manual tasks being considered and the hazards and risk associated with these tasks. However, training should always provide information on:

- general risk assessment principles
- task-specific safe methods of manual tasks
- safe use of items and systems of work.

Training objectives

Training objectives must be practical. Workers trained in manual tasks should be able to demonstrate how to:

- use risk control measures such as mechanical aids and safe systems of work
- undertake basic assessment of their tasks to recognise MSD hazards
- reduce the risks from hazards (by techniques including getting assistance when required)
- select and use the appropriate techniques
- perform tasks safely
- report any hazardous aspects of manual tasks
- consult with supervisors and others in solving MSD problems.

Purchasers and designers

Purchasers and designers should be trained in:

- how to identify MSD hazards or design factors that could contribute to the risk of MSD
- how MSD can be prevented through appropriate design.

Workers

Workers involved in risk management should be trained in:

- factors that cause MSD and slips, trips and falls
- how to identify jobs and workers at risk
- how to undertake hazard identifications and risk assessments in consultation with other workers and employees
- facilitating risk controls in conjunction with others
- effective measures to control the risk of MSD and slips, trips and falls
- evaluating controls to reduce risk.

Training records

Employers should record attendance details of training sessions, including:

- a description of each training session
- the date and location of the session
- details of the training provider
- details of the participants.

For more specific training content and application refer to WorkCover Queensland's video No sprains, big gains, which contains appropriate information on training for the area of manual handling.

5.3 MSD lead indicators

Lead indicators measure the effectiveness of strategies to prevent MSD injuries. Potential lead indicators that may be adapted for use in managing the risk of MSD include:

- the number (percentage) of hazard reports on MSD factors that identify possible higher order controls
- MSD symptom surveys conducted annually
- the purchase of all new equipment that includes consideration of ergonomics and MSD factors
- awarding of contracts that include risk management commitments from the contractor regarding manual tasks and slips, trips and falls
- training in manual tasks and slips, trips and falls hazards and risk assessments,
- reviews of manual tasks and slips, trips, falls risk assessments completed annually or more frequently as a result of new information
- toolbox talks on risk factors for MSD in each area at 80% of planned sessions
- percentage (number) of completed hazardous task risk assessments including engineering or elimination controls
- number or percentage of manual tasks hazard reports closed out with higher order (elimination/engineering) controls
- successful close outs (percentage) of committee health and safety items related to elimination or engineering controls of manual tasks/slips, trips and falls
- proportion (80%+) of near slips or trips of overall incidents involving slips, trips and falls
- the number or percentage of MSD solutions submitted for awards, recognition and/or that were submitted for a clinical trial.

6. Mining industry case studies

6.1 Cone crusher liner change out

Company

Hy-tec Yarrabee Road quarry, Cooperabung (2015)

Issue

Workers were attaching a hitting spanner while changing the liners on a cedrapids MVP380X cone crusher. In order to attach the spanner, they would have to hit it with a 13 kg sledgehammer and it would often take up to two hours to loosen the nut. The workers were required to stand on a 15 cm rim attached to the crusher, suspended about 4.5 m above the ground while swinging the sledgehammer.

Solution

During a participatory ergonomics program participants completed a PEfrorM risk assessment, which identifies the risk involved when completing a task (see figure 1). The assessment involves workers considering the hierarchy of controls when looking at options to eliminate the risk. After consultation with their workmates, the company decided to install a platform and re-engineer the cone nuts.

Platform: Hy-tec engaged a local engineering company and trialled a number of platform prototypes before the final decision was made. The company decided to install a modular circular platform that fits on top of the cone crusher.

New configuration: the quarry team discussed a number of possible solutions and decided to change the nut so a power tool could be used. The team engaged a local engineering company that identified the main challenge of redesigning the nut: that it could affect the integrity of the cone crusher. After some trials and testing the cone nut was divided into two halves held together by a 12 bolt configuration.

Benefits

The new bolt design has eliminated the hazardous manual task and the risk of falling from heights. In the short-term, the workers are taking less time to change the liners, increasing production time. And in the longer-term, the new design will reduce exposure to injury and the subsequent cost of workers' compensations claims.

6.2 Augur unblocking system

Company

Westlime quarry, Parkes (2015)

Issue

The mine's augur was blocked or chocked from small mill balls of lime or increased moisture in the product. Unblocking involved working at heights with an elevated work platform. In addition the operator would be required to use a heavy hose to unblock the augur or, if this was unsuccessful, use a needle gun that would require prolonged exposure to vibration.

Solution

The company decided to install a reverse switch on the augur control board. Now when a blockage occurs, the operator switches the augur in reverse for about five seconds and changes the switch. About 90% of the time, this procedure will clear the blockage. If the augur remains blocked, the operator can open an air-activated door and run the auger in reverse until emptied and the blockage is clear. .

Benefits

The reverse switch has eliminated the manual task and risk from working at heights. Significant savings have also been incurred due to the augur's extended operating hours. The previous method of clearing the augur involved about four to six hours of work depending on the size of the blockage.

Figure 6.2.2: reverse-switch auger

6.3 Tensioning system for roof bolting

Year

2015

Issue

Roof bolting is a challenging task and involves a number of risks, namely an increased risk of developing a MSD. Historically, tensioning systems involved many risks including:

- working off a ladder without maintaining three points of contact
- handling a heavy object while working at the top of a ladder
- twisting while handling a heavy object
- lifting and recovering a heavy object overhead.

Solution

With the help of suppliers, the roof bolting rods have been adapted to include an extension rod. These extension rods remove the risk of working off a ladder, as the job can be completed from the ground of the mine.

Benefits

The new tensioning system removes the use of the ladders, the need to lift heavy objects overhead and any twisting movement that was usually part of the task. It has reduced the risk of injury, is cost-effective to implement and has increased productivity by reducing the time involved in bolt tensioning.

6.4 Control of slips, trips and falls (underground coal)

Company

Ulan coal mine, Ulan

Issue

Ulan has the longest longwall in Australia (400 m wide and 2.9 m high) and is known as The Fat Face. The primary MSD issues and manual task hazard identified included slips, trips and falls on the longwall, resulting in sprains and strains of workers' ankles and knees.

Risk assessment

The risk of a slip, trip or fall was rated as high.

Risk control measures

Several control measures were identified in the risk-assessment. These included:

- adjusting the base lift control parameters to suit different mining conditions
- installing an anti-slip checker plate with anti-slip paint
- introducing a retention chain.

Implementation

Ulan Coal authorised an initial trial of high-visibility anti-slip checker plates in the mine. The trial was successful. Reports of sore knees and feet from the longwall crews ceased, even after 4000 m of cutting during an eight hour shift.

Implementation was highly cost-effective. The costs involved were:

- Trial cost, per person: **$200**
- Full install of the checker plates, per plate: **$160**
- Total costs for 400 m longwall: **$32,000**

Figure 6.4.1: before the trial

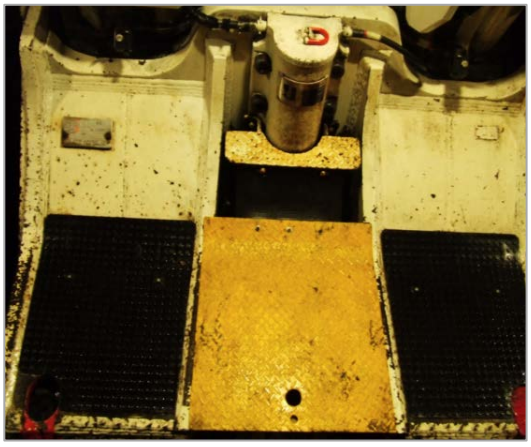


Figure 6.4.2: after the trial

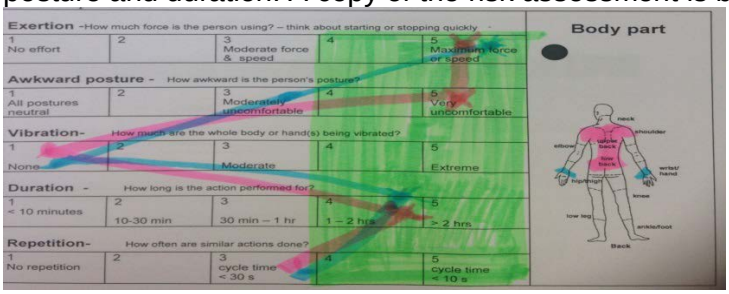
6.5 Developing a business case

Safe and healthy work is not just the law; it also makes business sense and has clear financial and non-financial benefits. When developing a business case for your work health and safety initiative, the most successful business cases tend to be more detailed and comprehensive. The business case should include a risk management approach to support its overall objectives.

As a minimum, you should include the following information in your business case:

- the name of the task
- a photo, if possible
- a description of the problem
- the frequency and severity of the injuries caused by the task
- the cost of workers' compensation claims associated with the task, if any
- the data and a brief summary of what it suggests, if any
- a hazardous manual task risk assessment and details about its conclusions
- the proposed control method and its
    - cost
    - benefits
    - potential implementation
    - associated items that might be required

Example of a business case

Information required	Details
Name	Changing a jaw liner
Problem	Replacing jaw liners requires workers to adopt a cramped and awkward position while they apply force to hand tools. This is because they have to loosen the jaw liner bolts and then redo the. It can take about one hour to undo them and one hour to redo them up.
Frequency and severity of injuries	No injuries are currently recorded but workers who undertake the risk are exposing themselves to an accumulation of small injuries. Over time, these injuries can result in a musculoskeletal disorder.
Data, if any	No data concerning the task or any related injuries has been recorded.
Hazardous manual task risk assessment	A PErforM risk assessment has been undertaken. The risk assessment has revealed that workers are in the high risk category for exertion, posture and duration. A copy of the risk assessment is below. 

Proposed control	The hazardous manual task risk factors involved in changing the jaw liners can be eliminated by the purchase of a power tool, such as a 1300 ft-lbs air impact wrench.
Cost	Cost of the impact wrench is $650 and includes a stubby socket on the wrench to fit into tight spaces.
Potential benefits	The time to change the jaw liner has been reduced from two hours to ten minutes. More importantly, it has reduced exposure to a prolonged awkward posture and eliminated the need for excessive force or exertion. Due to a reduction in downtime there is an opportunity to increase production. This potential increased production and income equates to approximately $35,000 per year.
Implementation of the control	All workers who regularly undertake the changing of the jaw liner will be involved in training on the tool prior to use. Additionally, all workers will be involved in the development of a procedure on the task and the use of the air impact wrench. A monitoring and evaluation period will also occur approximately three months after implementation.

7. Resources

This section contains information on:

- glossary of terms
- examples of the hierarchy of control
- lessons using participatory ergonomics
- resources for risk management
- references and further reading

7.1 Glossary of terms

This glossary contains terms used in this guide. The meanings are, so far as possible, commonly understood in work health and safety applications or in mining operations.

Term	Definition
Environmental conditions	In mining, this refers to the environment in which workers undertake work. Environmental conditions include the following factors: • lack of lighting generally and at night • muddy, wet and unstable ground • heat and humidity • high noise levels and confined access. Conditions are often exacerbated in underground mines.
Ergonomics	The design and evaluation of tasks, jobs, environments and systems to make them compatible with the needs, abilities and limitations of people.
Good practice	The European Agency for Safety and Health at Work lists the criteria of good practice as follows: • implemented following a proper assessment of the hazards and risks • improve working conditions and promote health, safety and efficiency • prevent identified risks at their source • be identifiable as the action reducing the risk • achieve identifiable permanent benefit • meet relevant legislative requirements and, preferably, exceed minimum standards • include a participatory approach between employers and workers.
Hazard (in the context of MSDs)	Any danger, risk or situation potentially causing or contributing to the development of MSDs. The danger, risk or situation occurs when performing manual tasks or when exposed to conditions causing slips, trips and falls. It may include the type of work performed, the environmental conditions, and the way the work is performed, including the use or handling of items.

Hazardous manual task	These tasks have any of the following characteristics: • repetitive or sustained application of force • sustained or awkward posture • repetitive movement • application of high force • exposure to vibration • manual tasks involving the handling of unstable loads or loads which are difficult to grasp or hold.
Force	The amount of muscular effort required to perform a movement or a task. Forceful muscular exertions overload muscles, tendons, joints and discs and are associated with the onset of most MSDs.
Manual tasks	Activities requiring a person to use their body (musculoskeletal system), including work involving • lifting • lowering • pushing • pulling • carrying • moving • holding or • restraining a person, animal or item. Manual tasks also include tasks with repetitive actions, sustained postures and may involve concurrent exposure to vibration.
Mines (in the context of MSDs)	Coal mines, metalliferous mines, extractives or petroleum sites.
Musculoskeletal disorder (MSD)	An injury or disease of the musculoskeletal system caused by manual tasks in the workplace, whether suddenly or over a prolonged period.
Physiologically demanding jobs	Jobs that increase reliance demand on the circulatory (heart) and respiratory (lungs) systems, causing increased heart rate, blood pressure or respiratory issues. These jobs can involve repetitive overhead work, significant periods of climbing, heavy work using the arms when squatting, heavy work wearing restrictive personal protective equipment, particularly respiratory, or working in heat and/or humidity.
Posture	Sustained posture is where part of the body is kept in the same position for a prolonged period of time. Awkward postures are where any part of the body is kept in the same position for a prolonged period of time. Postures that are both awkward and sustained are particularly hazardous.
Sprain/strain	Traumatic or cumulative injury damaging and inflaming joints and adjacent muscles. It is usually accompanied by pain and stiffness, often resulting in swelling and loss of function of the areas involved.
Task	A set of human actions contributing to a specific functional objective and ultimately to the output goal of a system.
Vibration	Whole body vibration (WBV) occurs when vibration is transmitted through

	the whole body, usually via a supporting surface, such as a seat or the floor in heavy vehicles or machinery. This may result in lower back pain, degeneration of the lumbar vertebrae and disc herniation. Hand-arm vibration occurs when vibration is transferred through a vibrating tool, steering wheel or controls in heavy machinery to the hand and arm. This can disrupt blood circulation in the hand and forearm and damage nerves and tendons. Localised vibration contributes to 'vibration-induced white finger' and 'carpal tunnel syndrome'. This occurs through the gripping force needed to hold the vibrating tools—the tighter the grip, the more vibration is absorbed—and the repetitive shock loads of some tools.
Work organisation	The way work is organised and how procedures are administered.

7.2 Hierarchy of control

The hierarchy of control is a system to minimise, manage and ultimately eliminate hazards. You can find examples of controls in mining in the table below.

Hierarchy of control		Examples of controls in mining
Level	**Type**	
Level 1	Elimination	• Automate of the manual task. • Remote control inspection with camera and/or mobile phone or tablet.
Level 2	Substitution	• Replace heavy items with lighter objects, smaller objects and/or objects with better handling characteristics (such as handles, less awkward size and shape). This may involve making arrangements with suppliers, packaging departments and delivery providers. • Upgrade to better quality tools with improved efficiency to reduce force required to perform task.
	Isolation	• Isolate vibrating plant from the user, for example, improved machine and vehicle suspension.
	Engineering	• Redesign the workplace/cab layout, for example, more cab space to reduce awkward postures, adjustable benches or seating in maintenance workshops. • Introduce mechanical lifting aids to eliminate manual handling. • Use damping materials around tool handles to absorb vibration and reduce impact on workers. Damping materials can also be used in floors and around vibrating machinery to reduce exposure to whole body vibration.
Level 3	Administration	• Consult workers about sharing tasks that require prolonged fixed postures or heavy, demanding work. • Arrange workflows to avoid peak physical and mental demands towards the end of the shift.
	Personal protective equipment (PPE)	Wear full lace-up supportive footwear for tasks requiring prolonged standing and walking in underground environments.

7.3 Resources for MSD risk management

Guidance and checklists

- **Reducing Musculoskeletal Risk in Open Cut Coal Mining**
  - Burgess-Limerick, R et al 2004, *Reducing Musculoskeletal Risk in Open Cut Coal Mining* ACARP project C11058 [report], Brisbane, QLD, available at acarp.com.au/search.aspx?&qS=C11058

- **Reducing injury risks associated with underground coal mining equipment**
  - Burgess-Limerick, R 2007a, *Reducing injury risks associated with underground coal mining equipment* ACARP project C14016 Appendix A [report], Brisbane, QLD, available at burgess-limerick.com/site/Home_files/C18012appendixA.pdf

- **MAQOHSC Manual Handling Hazard Audit Tool**
  - Mining & Quarrying Occupational Health and Safety Committee 2008, *MAQOHSC Manual Handling Hazard Audit Tool* [checklist], Government of South Australia, Adelaide, SA, available at maqohsc.sa.gov.au/_upload_docs/20080129031123.MiningAuditTool.pdf

- **Ergonomics for the Control of Sprains and Strains in Mining**
  - McPhee, B 1993, *Ergonomics for the Control of Sprains and Strains in Mining* [handbook], the Joint Coal Board Health and Safety Trust and WorkSafe Australia, Sydney, NSW, available at safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/30/ErgonomicsForControlSprainsStrainsMining_1993_PDF.pdf

- **Practical Ergonomics**
  - McPhee, B 2007 *Practical Ergonomics* [handbook], Coal Services Health and Safety Trust, Sydney, NSW, available at hstrust.com.au/MessageForceWebsite/Sites/326/Files/McPhee_20371_PRAC_ERGHBOOK_Final.pdf

  - **Manual Tasks Code of Practice**Workplace Health and Safety Queensland (WHSQ) 2000, *Manual Tasks Code of Practice 2000*, [code of practice], Queensland Government, Brisbane, QLD.

Slips, trips and falls

- **Guide to preventing slips, trips and falls**
  - Workplace Health and Safety Queensland (WHSQ) 2017, *Guide to preventing slips, trips and falls* [webpage], Queensland Government, Brisbane, QLD, available at worksafe.qld.gov.au/injury-prevention-safety/workplace-hazards/slips-trips-and-falls

Vibration

- **Hand-arm vibration at work**
  - Health and Safety Executive (HSE) 2015, *Hand-arm vibration at work* [webpage], UK government, London, available at hse.gov.uk/vibration/hav/

  - **Bad Vibrations: A Handbook on Whole-Body Vibration Exposure in Mining**McPhee, B, Foster, G, & Long, A 2009, *Bad Vibrations: A Handbook on Whole-Body Vibration Exposure in Mining* [handbook], 2nd edition, Coal Services Health and Safety Trust, Sydney, NSW available at hstrust.com.au/ManualHandlingandVibration.aspx

Good practice control measures

- **MIRMgate**
  - Minerals Industry Risk Management Gateway (MIRM) 2017, MIRMgate portal [webpage], University of Queensland, Brisbane, available at mirmgate.com

7.4 References and further reading

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Burgess-Limerick, R, Straker, L, Pollock, C, Dennis, G, Leveritt, S & Johnson, S 2007, 'Implementation of the Participative Ergonomics for Manual Tasks (PErforM) Program at Four Australian Underground Coal Mines' [journal article], *International Journal of Industrial Ergonomics*, London, UK, 37(2): 145-155.

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