ERGONOMICS
for the control of sprains & strains
IN MINING

A handbook compiled by Barbara McPhee

WORKSAFE AUSTRALIA
NATIONAL OCCUPATIONAL
HEALTH & SAFETY
COMMISSION

Joint Coal Board

ERGONOMICS FOR THE CONTROL OF SPRAINS AND STRAINS IN MINING

A handbook compiled by Barbara McPhee
A Project funded by Worksafe Australia and the Joint Coal Board

Contents

Acknowledgements

This Handbook is the result of work I undertook while conducting a demonstration ergonomics project in the NSW coal industry for the National Energy Research, Development and Demonstration Council (NERDDC) under the auspices of the Joint Coal Board. It is the synthesis of many pieces of information and ideas and I am grateful for the support of a number of people. I am particularly indebted to my husband Jim Knowles who provided honest and constructive comments on my original drafts. I also would like to thank Noel Pye of the Joint Coal Board for having the idea in the first place; and my colleagues at Worksafe Australia who have provided input or comments: Mike Elliott, who, with me, struggled valiantly with the format; Marissa O'Donnell for the illustrations; Rosalinda McGovern and Cheryl McDonald for some of the original photographs; and Cliff Carrasco and Sharonne Phillips for feedback on the text. Most importantly I would like to thank personnel in the coal mining industry for their support, interest and ideas.

Barbara McPhee

Worksafe Australia

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Introduction

Statistics and other sources of information indicate that large numbers of mining personnel suffer from, and sometimes make workers' compensation claims for, sprains and strains such as back, neck, knee and ankle injuries. Two of the most frequently occurring activities in mining which lead to these injuries are manual handling and rough rides. They are the subject of this Handbook.

The Handbook is for use by occupational health and safety personnel and others who have responsibility for the prevention of accidents and injuries in mining. Its aim is to assist these users in the identification and management of risks associated with manual handling and rough rides in mines. One approach to reducing or eliminating risks associated with these activities is ***ergonomics***.

The Manual Handling Section with the accompanying checklists has been based on the National Standard and Code of Practice for Manual Handling and other guides and should be used in conjunction with them and other references, some of which are listed in the Bibliography. This Section has been designed to be a practical guide in the application of ergonomics methods for the management of manual handling risks in mining. At each stage key questions are posed. These are followed by a list of factors which will need to be considered in order to answer the questions and to develop solutions.

The Seating Section and checklists are aimed more at assisting users in the development of solutions to identified problems. The checklists provide a method for systematic assessment of current seating and a guide to manufacturers, designers, purchasers and users on how better to design and select vehicle seating.

The checklist entitled 'Ergonomics of Mining Equipment' has been included to help users in identifying a wider range of ergonomics issues associated with the operation and maintenance of mining equipment. It has been compiled as an introduction to some of the more common problems found in mining vehicles - in both underground and open-cut operations.

The checklists should be used *after* Sections 1 and 2 have been read. They are a key element of the Handbook and have been designed to be used as tools at each stage of the problem solving.

What is Ergonomics?

Ergonomics is the design of equipment, processes and environments so that tasks and activities required of people are within their limitations but also make the best use of their capabilities.

In the workplace the application of ergonomics aims to promote health, efficiency and well being in workers. It focuses on *people* in order that they can work safely and efficiently. It also has to consider *processes, products, productivity and profits.*

Each hazard has its component risks which are the elements leading directly to injury or loss. Their investigation may take many forms but one which has proved effective in Australia is a four stage process:

Risk Identification

Risk Assessment

Risk Control

Monitoring and evaluation of controls (solutions)

Like other branches of occupational health and safety, ergonomics uses this process to examine the likelihood of risks in a job and how they might cause harm to a person. It also provides information on how risks might be minimised or eliminated.

Team lifts may be used where loads are difficult for one person to handle.

Manual handling

Hazard recognition

Manual handling is any activity requiring the use of force by a person to lift, lower, push, pull, carry or otherwise move, hold or restrain any animate or inanimate object. (WORKSAFE AUSTRALIA National Standard for Manual Handling, 1990)

Any manual handling activity constitutes a hazard for injury unless otherwise demonstrated. Therefore where it occurs steps should be taken to investigate the risks associated with the hazard and to reduce them.

Is manual handling a part of the work undertaken by employees of the mine?

If yes, then an appraisal of the likelihood of injury resulting from the work should be made.

As in ergonomics generally this investigation takes the following form:

Risk Identification

Risk Assessment

Risk Control

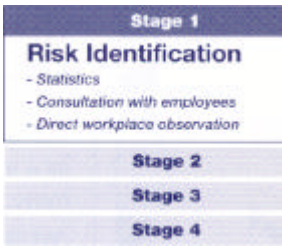
Monitoring and evaluation of controls (solutions)

Individuals risk injury when lifting very heavy objects - even when they do it correctly.

Stage

1

Risk Identification



The first step in controlling a risk is to identify that it exists either in the industry as a whole or at your mine and which jobs might be affected.

Which jobs or tasks are associated with the manual handling injuries?

Where are those jobs?

How often do injuries or losses occur?

How severe are the injuries or losses?

In determining which tasks or activities may be hazardous and need to be assessed the following sources of information could be used:

Power tools reduce work-loads but need to be used the preferred height (see P

 # Statistics and injury records

- workers' compensation
- mine injury and incident records
- accident reports held by bodies such as the Joint Coal Board (NSW), Mining Inspectorates, WorkCover Authority

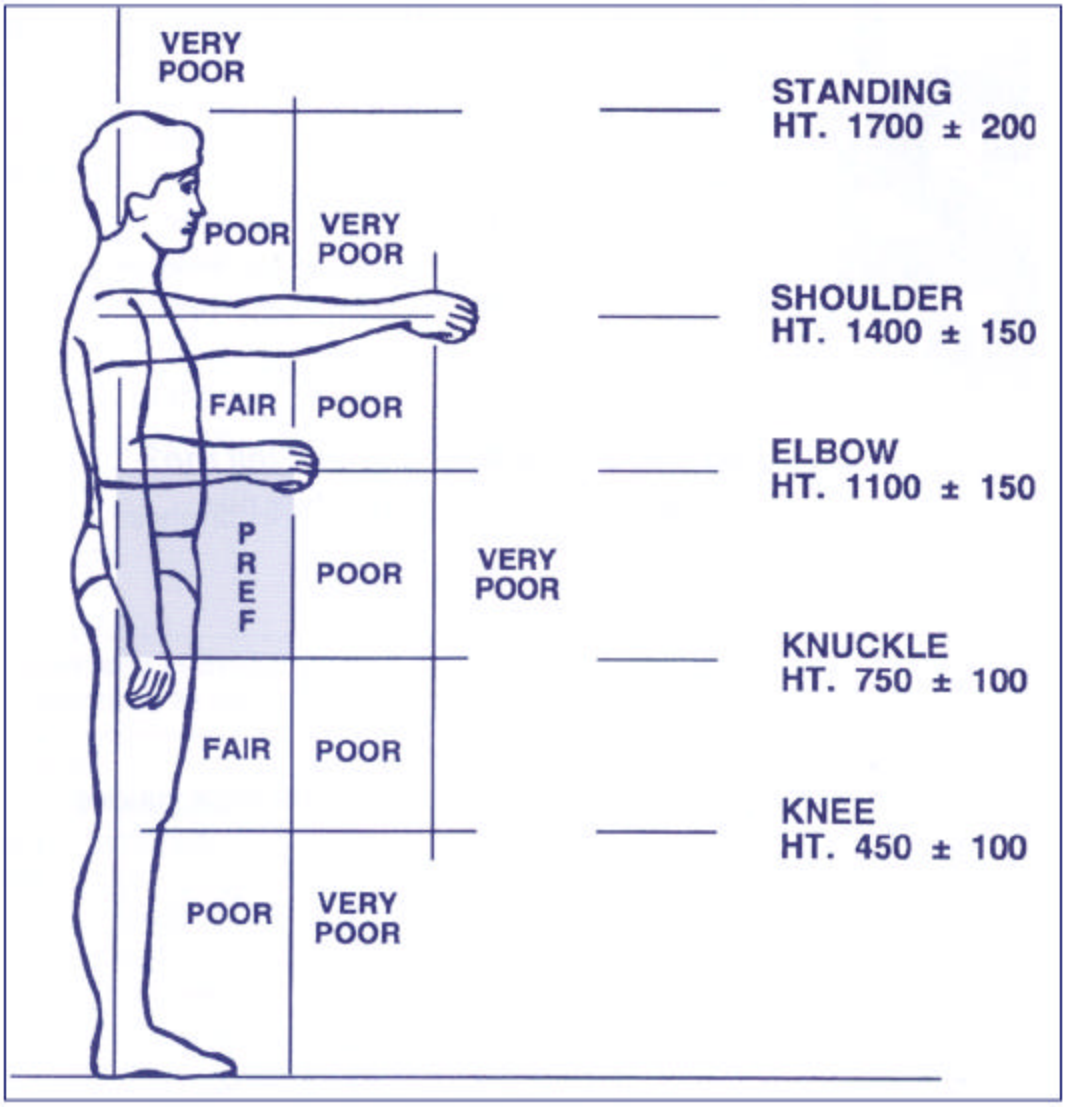
 # Consultation with employees

- formal supervisor/safety representative reporting
- informal discussions
- questionnaires

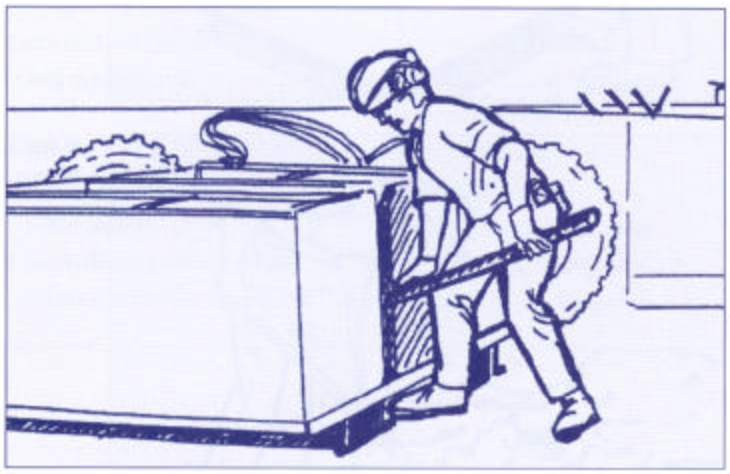
 # Direct observation (refer to Risk Assessment if you are not familiar with the general nature of the risks)

- area inspections
- walk-through surveys
- audits

Height ranges for lifting actions - after Pheasant and Stubbs (1991). Note the preferred height range.



Handling supplies can be made safer by improving the design of the supply trailers.



☞ *For more information on Risk Identification please refer to the Risk Identification Checklist on Page 22.*

Stage 2

Risk Assessment

When should a Risk Assessment be carried out?

Risk Assessment is necessary after possible sources of injury or loss associated with manual handling in the workplace have been identified.

Risk Assessment is particularly important whenever:

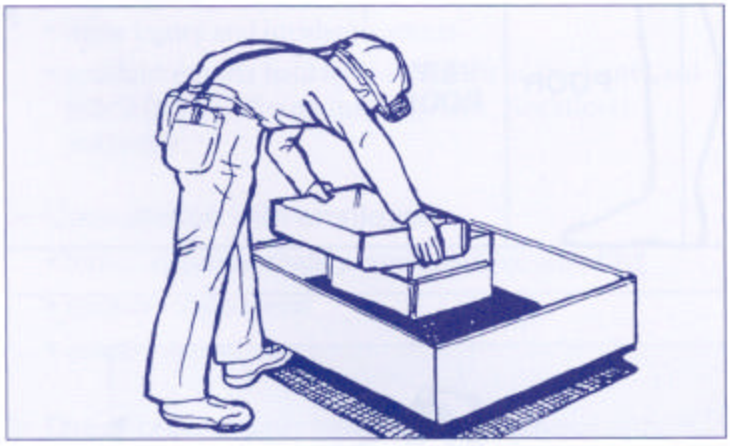
(a) a work process and/or practice causes an injury; or

(b) a work process and/or practice is introduced or modified.

What will a Risk Assessment tell me?

- which specific jobs/tasks or activities have risks associated with them
- the employees likely to be affected
- the nature of the risks identified
- how frequently the risks occur
- the severity of possible injuries or losses

Actions commonly associated with back injuries



Lifting at a distance from the body – unloading a supply trailer.

Bent and twisted back while lifting – shovelling.

The Risk Assessment will indicate the areas requiring Risk Control measures. It should be carried out in consultation with those who do the job.

Handling 60 litre drums is awkward and has an increased risk of injury.

It should indicate the following:

 # Frequency of the risk

- is the risk common?
- how many people might be exposed to it?
- how many people might be affected if exposed?

 # Severity of the risk

- nature of the injuries and losses associated with the risk
- cost of injuries/incidents or damage associated with the risk

 # Work and individual factors which might contribute to the risk

The task

- actions and movements
- working posture and position
- location of loads and distances moved
- duration and frequency of handling
- task organisation

The load

- weights and forces
- characteristics of loads and equipment

The work environment

- space, access and work-place layout
- hazards particular to the mining environment, for example, uneven floors, poor visibility, temperature, air quality, noise
- need for special clothing and equipment (personal protective equipment - PPE)

Work organisation

- workflow including flow and availability of materials
- adequate number of employees to complete the task within the required time particularly during peak load periods
- availability of assistance for handling heavy objects
- effective procedures for reporting and fixing unsafe equipment or environmental conditions
- effective selection, purchasing, instruction and maintenance programs for 1oads, equipment and mechanical handling devices
- availability and adequacy of general and specific training

Individual capability

- training for the task
- skills and experience
- physical capabilities
- age
- special needs including recurring disability

☞*For more information on Risk Assessment please refer to the Risk Assessment Checklist on Page 24.*

Stage

3

Risk Control

When and why should Risk Control measures be considered?

The NSW Occupational Health and Safety Act 1983, Manual Handling Regulation (1991) encompasses the National Standard and Code of Practice for Manual Handling which states:

'An employer shall ensure, as far as workable, that the risks associated with manual handling are controlled. Risk control shall be done in consultation with the employees who are required to carry out the manual handling and their representative(s) on health and safety issues.' (p41)

Similar Regulations exist in most other Australian states and territories. While they might not be *directly* applicable to mining in most states these Regulations can be and have been deemed to apply to the mining industry from time to time.

What can be done to eliminate or reduce the risk?

Risk Control is the process of eliminating or reducing identified and assessed risk factors.

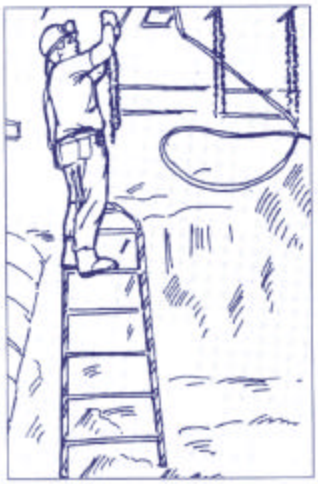
Control solutions for manual handling

For each risk factor identified consider doing one or a combination of the following to control the risks:

- ***the task***
  - improve task layout
  - improve accessibility to equipment
  - improve maintenance of equipment
  - use the body more efficiently
  - improve the work routine
  - use team handling
- ***the load***
  - make it lighter and/or easier to push or pull
  - make it smaller or easier to manage
  - make it easier to grasp/carry
  - make it more stable
  - make it safer to hold
- ***the work environment***
  - reduce space constraints
  - improve access
  - prepare floor to best possible condition
  - optimise work heights
  - optimise thermal environment
  - improve lighting in critical areas
  - reduce unacceptable noise
  - take account of special clothing and equipment

Training and experience in safer handling may reduce risks when other controls are unavailable.

- ***work organisation***
  - minimise manual handling including rehandling
  - ensure adequate numbers of workers to do the work safely
  - ensure sufficient time to do work safely
  - minimise handling when workers are tired such as at the end of the shift or when overtime is being worked
  - use equipment which is appropriate to the task
- ***individual capability***
  - provide adequate and appropriate training for workers undertaking the task
  - make the best use of skills and experience
  - take account of varying physical capabilities
  - take account of the effects of increasing age
  - take account of individual limitations including recurrent disability



Work above the shoulders can be made easier with a light, well designed ladder.

Risk Control is best accomplished by a combination of:

- elimination of the job or job redesign
- mechanical handling equipment
- provision of suitable training

In particular try to minimise the effects of a changing work environment.

Often in mining ***reducing loads and improving handling training*** will need to be considered first while more effective long-term solutions are found.

The solution should be considered in relation to the actual or potential size and cost of the problem.

Will the controls (solutions) work?

- effectiveness/impact on the problem
- availability; (including long-term implications)
- cost

Where is information on solutions found?

Sources of information

- the workers who do the job including supervisors and managers
- manufacturers and suppliers of equipment
- consultants
- experts in particular areas of engineering, mining, ergonomics, health and safety etc.

☞ *For more information and a guide to recording possible Risk Control options please refer to the Risk Control Checklist and Risk Control form on Pages 26-29.*

Stage

Monitoring and evaluation of controls

Evaluation of solutions is important if the benefits - or the lack of them - are to be determined.

Was the solution successful?

Are there residual problems?

Different forms of evaluation can be used according to the needs and limitations of each situation. They need not be complicated. *It may be as simple as asking a range of users what they think.*

When might more formal evaluations be required?

- when usable information is to be fed back to manufacturers and suppliers
- if the solution is critical in terms of injury control
- where costs of injuries are unacceptable and the effectiveness of the control needs to be demonstrated
- where information is needed for the record or is required by law

Examples of different methods

- informal feedback or discussions with those applying solution
- informal or structured interviews
- photographs or videos ('before and after')
- checklists
- questionnaires

What should be considered in the evaluation?

- did the solution solve the problem?
- was it a total or partial success?
- was the solution used as planned?
- what, if any, aspects did not work?
- did any aspects work better than was expected?
- was the solution acceptable to the workers involved/did they use it. If not, why not?
- does it need modification to make it work better?
- if it needs modification do the workers/users or others have any ideas on how it might work better?

Rough rides

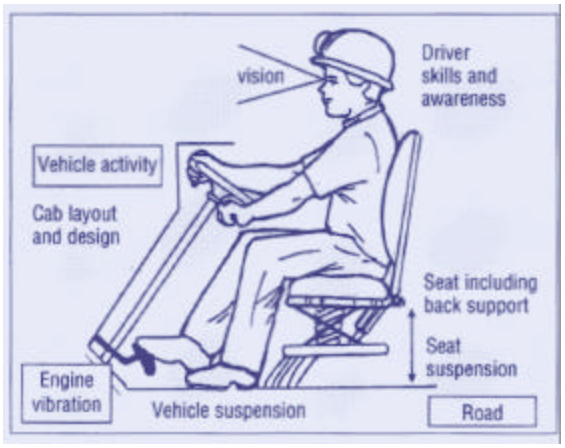
Discomfort while driving, operating and riding

In the Australian mining industry dissatisfaction, discomfort and sometimes injuries are resulting from rough rides in a range of vehicles. Rough rides are experienced by passengers and drivers in both underground and open-cut mining. They are a hazard for sprains and strains in those exposed especially for neck and back pain.
The single component of the hazard is ***vibration*** of different magnitudes, frequencies and directions. Usually the two major combinations are referred to as:

- vibration
- jolts and jars

Sources of vibration are the engine, road and vehicle activity (See diagram at right). The British Standard (BS6841, 1987) is a useful guide to the measurement of exposure for whole body vibration (WBV). It is considered more reasonable for general evaluations than the current Australian standard.

Sources and ways of reducing vehicle vibration



In mining, risks from rough rides appear to occur for seven main reasons:

- poor visibility
- condition of the roads
- lack of adequate suspension in vehicles
- lack of appropriate seat suspension
- poor cab design, layout and position
- poor seat design and
- inadequate driver skills and awareness.

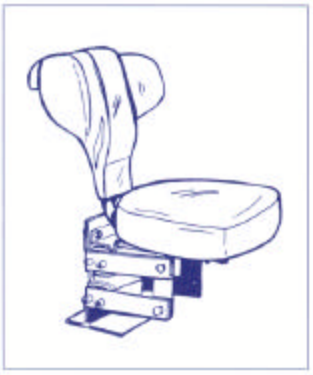
Each of these problems exists at both under-ground and open-cut mines to a different degree depending on:

- the availability of suitable seats and seat suspension systems and their correct installation
- the types of vehicles used
- policies and procedures on equipment and road maintenance, and driver training
- general mining conditions
- availability and cost of solutions.

In finding solutions to the problems a systematic approach to identifying and assessing each issue must be taken and each solution should be evaluated.
Seating and seat suspension are two areas which can be improved quickly even when the overall issue of rough rides cannot be addressed in full immediately.

Mining vehicle seating evaluation

Ergonomics in seat design



A mining operator's seat — designed using ergonomics guidelines and operator feedback.

Optimum seat design should:

- provide adequate support for the person while working or riding;
- not place any unnecessary stress on any part of the body; and
- encourage optimum posture allowing for comfort and efficiency and minimal muscle fatigue.

There are three major anatomical/physiological factors which need to be considered in sitting posture:

- the posture of the spine, in particular the configuration of and pressure within the spinal discs;
- the type and amount of muscle work required to maintain work postures (static and active) and individual fatigue levels;
- compression of the tissues (most particularly the blood vessels and nerves) at the back of the thigh and behind the knee.

People vary markedly in size and this range must be allowed for in the dimensional specifications of chairs and seats. To accommodate 95% of the target user population some adjustability can be incorporated into the design, for example, seat height, backrest angle, fore/aft adjustments.

Adjustments should be easy to achieve for any user in the seated position. For practical purposes some dimensions, for example, seat depth, backrest size, have to be fixed and compromises have to be made.

Visibility, cab and seat design, clothing and equipment all affect driver posture and comfort.

As far as possible these compromises should not disadvantage one group in favour of another.

Therefore a seat should be:

- stable and safe to operate or work from, or ride in;
- be correctly dimensioned and shaped in the seat and the backrest;
- able to be adjusted in some way so that the height above the floor is correct for the user;
- covered and padded so as to minimise discomfort from sitting on a hard impermeable surface; and
- designed in such a way as to minimise interference to trunk, head and limb movement and vision.

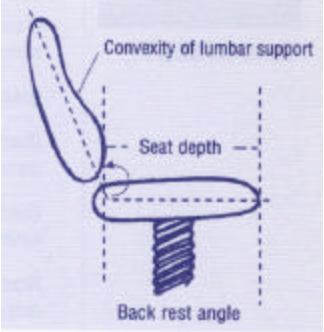
Driver and passenger seat design and selection

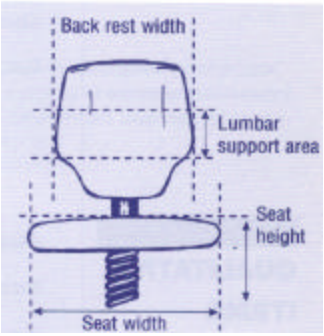
As a guide to driver and passenger seat design or selection the following dimensions may be useful. They do not take into account problems such as lack of leg, arm or head room but represent the 'optimum' for about 95% of the population in terms of the seat itself.

They have been derived from a number of sources which are listed in the Bibliography.

Where space limitations require the seat to be smaller than optimum some allowances should be made for the difficulties imposed on the user. Consideration should be given to improving the cab design in areas where it is deficient.

The need to wear personal protective and other equipment such as self rescuers, helmets and batteries should be taken into consideration and may require design compromises.





Key dimensions for a driver's seat.

VEHICLE OPERATOR/DRIVER SEATS

Operators of mining vehicles have a range of conditions to contend with and often have less well designed cabs and seats than their road transport counterparts. Inadequately sized cabs in inappropriate locations on the vehicle with poorly designed displays and controls compound the stresses placed on operators.

An added problem in underground mines is that many vehicles may not have suspension systems of any kind. Under these conditions operators are often subjected to vibration levels beyond current international standards for an eight hour day.

In addition, visibility is often poor, roads and vehicles are poorly maintained and drivers are inadequately trained.

All these aspects of an operator's job contribute to stresses which can make vehicle operation unnecessarily tiring at best and hazardous to health and safety at worse.

Effective seat depth	Between 380mm and 480mm.
Effective seat width	Minimum 450mm.
Seat angle	Backward tilt 5 to 10 degrees.
Height adjustment range	Between 370mm and 500mm.
Seat fore/aft range	300mm of travel to accommodate tall and short users.
Seat swivel	15 to 45 degrees either side of the midline, where appropriate.
Seat shape	Depending on vehicle type, make and model, the need for lateral stability and for frequent and ready access, the seat may be flat or slightly dished (only minimal dishing is desirable: max 25mm in transverse direction and 40mm lengthwise).

BACKREST

Backrest vertical dimension	Between 200mm and 250mm top to bottom (lumbar support area).
Backrest width	Between 360mm and 400rnm.
Backrest horizontal concavity	Approx 400mm radius (in curvature plan view at level of support area).
Backrest vertical convexity	Approx 250mm radius (lumbar support area).
Backrest angle adjustment	Between 95 and 120 degrees (if appropriate) to the horizontal.
Backrest height above seat	Approx 200mm to 250mm (position of mid lumbar support above seat).
Backrest flexibility	Should allow limited movement in three directions to suit minor changes in upper body posture. Where the operator has to twist to see to the side or behind, some swivel in the seat (as least 15 to 20 degrees in each direction) is required.

QUALITATIVE ITEMS

Seat height adjustment	Easily and quickly achieved from the seat position.
Seat fore/aft adjustment	Easily and quickly achieved from the seat position.
Backrest angle	Easily and quickly achieved from the seat position.
Seat cushion	Seat cushion should effectively distribute pressure but not 'bottom out' with heavy users.
Backrest cushion	Backrest cushion should effectively distribute pressure and protect the user from local pressure due to the frame.
Seat & backrest covers	Easily changed or repaired. Should be maintained in good condition.
Front edge of the seat	Well rounded to avoid pressure on the underside of operator's thighs (approx 60mm radius).
Sides of the seat	Designed to avoid pressure on underside of operator's thighs.

SAFETY & STABILITY

Edges	Smoothed or rounded so as not to catch clothing or equipment. Surfaces should be free of sharp edges which could snag clothing or cause discomfort or injury.
Attachment of seat assembly to the vehicle	Secure and not able to be inadvertently removed or displaced under normal operating conditions.
Seat suspension	Sufficient to prevent major jolts and jars being transferred through the operator's body and to minimise the effects of vibration in a range of operator body weights.
Components	Corrosion resistant.
Fittings and controls	Smoothed, rounded or shaped to avoid personal injury and damage to clothing.
Controls & moving parts	Able to be operated without risk of trapping fingers and designed so that they cannot be inadvertently removed.
Operating instructions	Clear and permanently displayed near the seat.
Construction	Robust. The seat should feel solid and safe to the user.
Design and materials	Appropriate to conditions generally experienced in mining.

PASSENGER SEATS

While passengers are often seated for shorter periods than drivers there are a number of reasons why rough rides for passengers can be harmful and should be avoided:

- passengers often cannot see or anticipate bumps and rough areas;
- passenger seats in mining vehicles usually face sideways and passengers have no way of bracing or reducing the impact of rough rides;
- most seat design is inadequate; and
- some transport vehicles do not have suspension.

Poorly designed passenger seating creates unnecessary discomfort and risk of injury.

SEAT

Effective seat depth	Between 380mm and 480mm.
Effective seat width	Minimum 450mm for each person.
Seat angle	Backward tilt 10 to 15 degrees.
Seat shape	For ready access and to accommodate the maximum number of people. A bench seat should be flat and tilted backwards sljghtly.

BACKREST

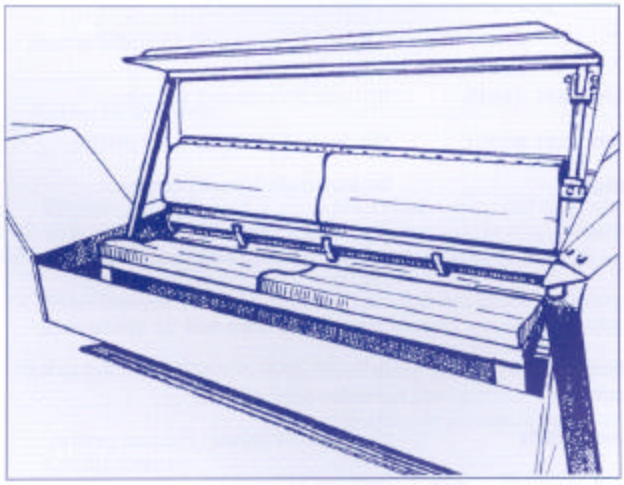
Backrest vertical dimension	Between 200mm and 250mm top to bottorn (lumbar support area).
Backrest width	Minimum of 360mm for each person.
Backrest vertical angle	Between 110 and 120 degrees to the horizontal (20 to 30 degrees backwards from the vertical).
Backrest height	200mm to 250mm above compressed seat (position of mid lumbar support area above seat).
Seat cushion	Seat cushion should effectively distribute pressure but not ‘bottom out' with heavy users.

QUALITATIVE ITEMS

Backrest cushion	Backrest cushion should effectively distribute pressure and protect the user from local pressure due to the frame.
Seat and backrest cover	Easily changed or repaired. Should be maintained in good condition.
Front edge of the seat	Well rounded to avoid pressure on the underside of passengers' thighs (approx 60mm radius).
Sides of the seat	Designed to avoid pressure on underside of passengers' thighs.

SAFETY & STABILITY

Edges	Smoothed or rounded so as not to catch clothing or equipment. Surfaces should be free of sharp edges which could snag clothing or cause discomfort or injury.
Attachment of seat assembly to the vehicle	Secure and not able to be inadvertently removed or displaced under normal operating conditions.
Seat suspension	Sufficient to prevent major jolts and jars being transferred through the passengers' bodies and to minimise the effects of vibration in a range of passenger body weights.
Fittings and attachments	Smoothed, rounded or shaped to avoid personal injury and damage to clothing.
Components	Corrosion resistant.
Construction	Robust. The seat should feel solid and safe to the user.
Design and materials	Appropriate to conditions generally experienced in mining.
Front edge of the seat	Turned down so there is no undue pressure on the underside of the passengers' thighs.



A simple design for a comfortable and practical passenger seat using ergonomics guidelines.

Glossary of terms

Awkward is where the posture or action required for the task creates some discomfort or is unable to be maintained

Constrained is where the posture is forced, cramped, restrained or unnatural, confined or restricted

Job - specific set of ongoing tasks to be performed by an individual

Task - set of human actions that contribute to a specific functional objective and ultimately to the output goal of a system

Sprain/strain - traumatic or cumulative injury resulting in damage to and inflammation of joints and adjacent muscles. It is usually accompanied by pain and stiffness. Swelling and loss of function of the area involved may also result

Hazard - anything that has potential to cause harm to a person

Risk - factor that contributes to the occurrence of injury or loss from a hazard

Workable - practicable or reasonably practicable having regard to:
(a) severity of the hazard/risk
(b) state of knowledge about the hazard/risk and its controls
(c) availability and suitability of controls
(d) cost of controls

Optimum/optimal - best or most favourable

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Manual handling and seating checklists

The following checklists are a guide to surveying different aspects of ergonomics in mining in order to reduce risks of sprains and strains.

They are suitable for photocopying if you wish to reuse them.

If they prove to be unsuitable for your particular application, you can adapt or redesign them. Keep what you want, discard what you do not and add anything you feel is appropriate.

The manual handling checklists are designed to help at each level of the hazard control process, that is

Risk Identification

Risk Assessment

Risk Control

As well there is a Risk Control form to assist with recording the implementation of solutions.

The seating checklists provide a method for systematic recording of seating dimensions and qualities.

Some features are more important than others but ultimately user comfort, safety and function are the aims. Further information and assistance may be required where unavoidable compromises have to be made.

1st Stage

Risk Identification checklist

Mine:	
Area:	
Task(s):	
Assessor:	
Date:	
Time:	

Instructions:

Tick boxes where applicable.

Spaces allow you to write further information where required.

If you identify jobs where possible risks exist use the **Risk Assessment Checklist** to further examine those jobs.

POINTS TO CONSIDER

What do the statistics and injury records tell you about claims for back, neck or other strains or sprains?

Mining industry workers' compensation claims

How many claims?

_____

How serious?

_____

_____

How costly in terms of workers' compensation and other direct measures?

_____

_____

Individual mine injury and incident records:

How frequent or common are the injuries?

_____

_____

What are the estimated workers' compensation costs and the overall losses of manpower and production associated with the injuries?

_____

_____

Is there associated waste of product, supplies and time?

_____

_____

Accident reports held by bodies such as the Joint Coal Board, Mining Inspectorates:

How do the statistics at your mine compare with others in the industry?

_____

_____

Are there any obvious patterns in reported lost time injuries by mine, area, type of mining operation?

_____

_____

When you talk to employees do you consistently hear complaints about difficult manual handling problems? _____YES ☐ NO ☐

Do supervisors and/or safety representatives report difficult manual handling situations?

When you undertake area inspections, surveys, audits do you observe:

- movements performed frequently or prolonged awkward postures?_ YES ☐ NO ☐
- difficult tasks or loads?_____ YES ☐ NO ☐
- difficult work environments? _____ YES ☐ NO ☐
- work organisation difficulties? _____ YES ☐ NO ☐
- personal factors? _____ YES ☐ NO ☐

If you are unsure of the types of factors which might need to be considered, please refer to the Risk Assessment Checklist.

Depending on the range and nature of the risks identified you may choose to draw up a priority list in terms of the severity and costs of the problem. This will help you to be systematic in your approach to seeking support for Risk Assessment and the development and implementation of controls.

Risk Assessment checklist

Mine:

Area:

Task(s):

Assessor:

Date: **Time:**

Instructions:
Tick boxes where applicable.
Spaces allow you to write further information where required.
A "**Yes**" answer for any question means that some form of risk control is required.

Risk Assessments should be carried out in consultation with the people who do the work being assessed.

For each risk identified at your mine the following factors should be considered:

1. Nature of the risk identified

Are any of the following work or individual factors evident when you undertake area inspections, surveys or audits?

Movements performed frequently or prolonged postures:

- bending with the hands below mid thigh height _____ YES ☐ NO ☐
- reaching or handling above the shoulders _____ YES ☐ NO ☐
- reaching forwards _____ YES ☐ NO ☐
- bent and twisted, or bent postures _____ YES ☐ NO ☐
- other awkward or cramped postures _____ YES ☐ NO ☐

See illustrations on pages 6 – 11

Difficult tasks or loads:

- frequent or prolonged manual handling _____ YES ☐ NO ☐
- handling heavy weights i.e. more than 16kg _____ YES ☐ NO ☐
- application of large forces e.g. pushing, pulling, holding especially when it is not expected _____ YES ☐ NO ☐
- handling of awkward or difficult loads, for example, awkward grips, sharp edges, unbalanced, slippery or bulky loads _____ YES ☐ NO ☐

Difficult work environments:

- confined spaces (restricted access or workspace) _____ YES ☐ NO ☐
- poor visibility _____ YES ☐ NO ☐
- cold, hot or wet conditions _____ YES ☐ NO ☐
- particularly unsafe floor/ground conditions _____ YES ☐ NO ☐

Work organisation difficulties:

- need for speed, accuracy or both _____ YES ☐ NO ☐
- peaks or sudden increases in workload _____ YES ☐ NO ☐
- extended working hours (e.g. overtime, 12 hour shifts) _____ YES ☐ NO ☐
- shortage of personnel _____ YES ☐ NO ☐

Personal factors:

- new employees or those returning from extended time (more than 2 weeks) away from work _____ YES ☐ NO ☐
- older workers or those with recurrent disabilities _____ YES ☐ NO ☐
- restrictions imposed by personal protective equipment _____ YES ☐ NO ☐
- inadequate skills or experience _____ YES ☐ NO ☐
- inadequate training _____ YES ☐ NO ☐

2. Frequency of the risk

How common is the risk factor at your mine?

_____

How many workers might be exposed to the risk?

_____

How many employees have suffered or are likely to suffer an injury if exposed to the risk?

_____

3. Severity of the risk

What is the nature of the injuries and losses associated with the risk?
e.g back injury, shoulder strain

_____

What are the costs of injuries/incidents or damage associated with the risk?

_____

 # Assessing the possible cost impact of identified risks:

- injury to workers and numbers of workers who might be affected

_____

- workers' compensation cost

_____

- slowed production, disruption to work

_____

- damage to equipment and supplies, waste

_____

Where the Risk Assessment indicates an increased risk there will be a need to control that risk in some way. The range and nature of the risks identified and assessed will indicate to you which ones should and can be controlled immediately, which can be dealt with in the medium term and what approaches and solutions need to be developed over the long term.

Risk Control checklist

Mine:

Area:

Task(s):

Assessor:

Date: **Time:**

Instructions:
Tick boxes where applicable.
A "**Yes**" answer to a question indicates the types of control which might be appropriate.

Controls (solutions) should be developed in consultation with the people who will use them.

There are several different approaches to reducing risks of handling injuries.

1. Eliminating or minimising manual materials handling (mmh) by:

Eliminating the task

- is the task necessary? _____ YES ☐ NO ☐
- can another method be used? _____ YES ☐ NO ☐

Mechanisation or the provision of machines or aids to do the task

- are there aids or machines which could do the task? _____ YES ☐ NO ☐
- can the aid be made/designed? _____ YES ☐ NO ☐

Eliminating or minimising rehandling

- can handling be reduced by reorganizing, planning, designing? ____ YES ☐ NO ☐

Increasing the weights of materials which can then be transported in bulk

- can frequently used items be more effectively transported in bulk to their point of use? _____ YES ☐ NO ☐

2. Reducing physical loads associated with mmh by:

Decreasing the weight of the object being handled

- can weight be decreased? _____ YES ☐ NO ☐

Changing the method of handling

- can handling methods be improved? _____ YES ☐ NO ☐

Reducing push/pull forces

- can resistance forces be decreased? _____ YES ☐ NO ☐

Using well designed containers

- can the load be transferred into easy to carry/transport containers? YES ☐ NO ☐

3. Minimising stressful postures by:

 # Minimising bending particularly below knee level

- can the loads be raised off the floor? _____ YES ☐ NO ☐
- can supplies and equipment be stored at waist level? _____ YES ☐ NO ☐

 # Minimising twisting particularly in conjunction with bending

- can loads be placed in a more convenient position? _____ YES ☐ NO ☐
- can access to loads be improved? _____ YES ☐ NO ☐

 # Minimising above shoulder work

- to provide better access to high work can hoists or ladders be better designed or more effectively used? _____ YES ☐ NO ☐
- can the work be lowered? _____ YES ☐ NO ☐

 # Bringing work closer to the body

- can loads be placed in a more convenient position? _____ YES ☐ NO ☐
- can access to loads be improved? _____ YES ☐ NO ☐

 # Providing sufficient access, space and clearance for work to be undertaken safely

- can mobile equipment such as supply trailers be parked in more convenient positions? _____ YES ☐ NO ☐
- can access and space be improved? _____ YES ☐ NO ☐

4. Reducing fatigue through work reorganisation by:

 # Rescheduling tasks to allow for more consistent effort and fewer periods of high and low demand

- is the sequence of activities efficient? _____ YES ☐ NO ☐

 # Planning the frequency and length of natural work breaks between tasks so they are appropriate for the mental and physical effort expended

- is consideration given to balanced work/rest schedules? _____ YES ☐ NO ☐
- are there adequate numbers of people available to undertake the work? _____ YES ☐ NO ☐

5. Raising awareness and improving knowledge and skills by:

 # Training and education

- are workers sufficiently well trained in manual handling and identification and control of risks associated with these tasks? _____ YES ☐ NO ☐

 # Seeking advice from and feeding back information to the people who do the work

- are people undertaking the manual handling tasks regularly consulted with regard to the risks and difficulties associated with their work? ___ YES ☐ NO ☐
- are workers encouraged to put forward ideas on how jobs might be made safer and/or more efficient? _____ YES ☐ NO ☐

The Risk Control form on the next page provides a guide to recording the implementation of solutions.

Risk Control checklist

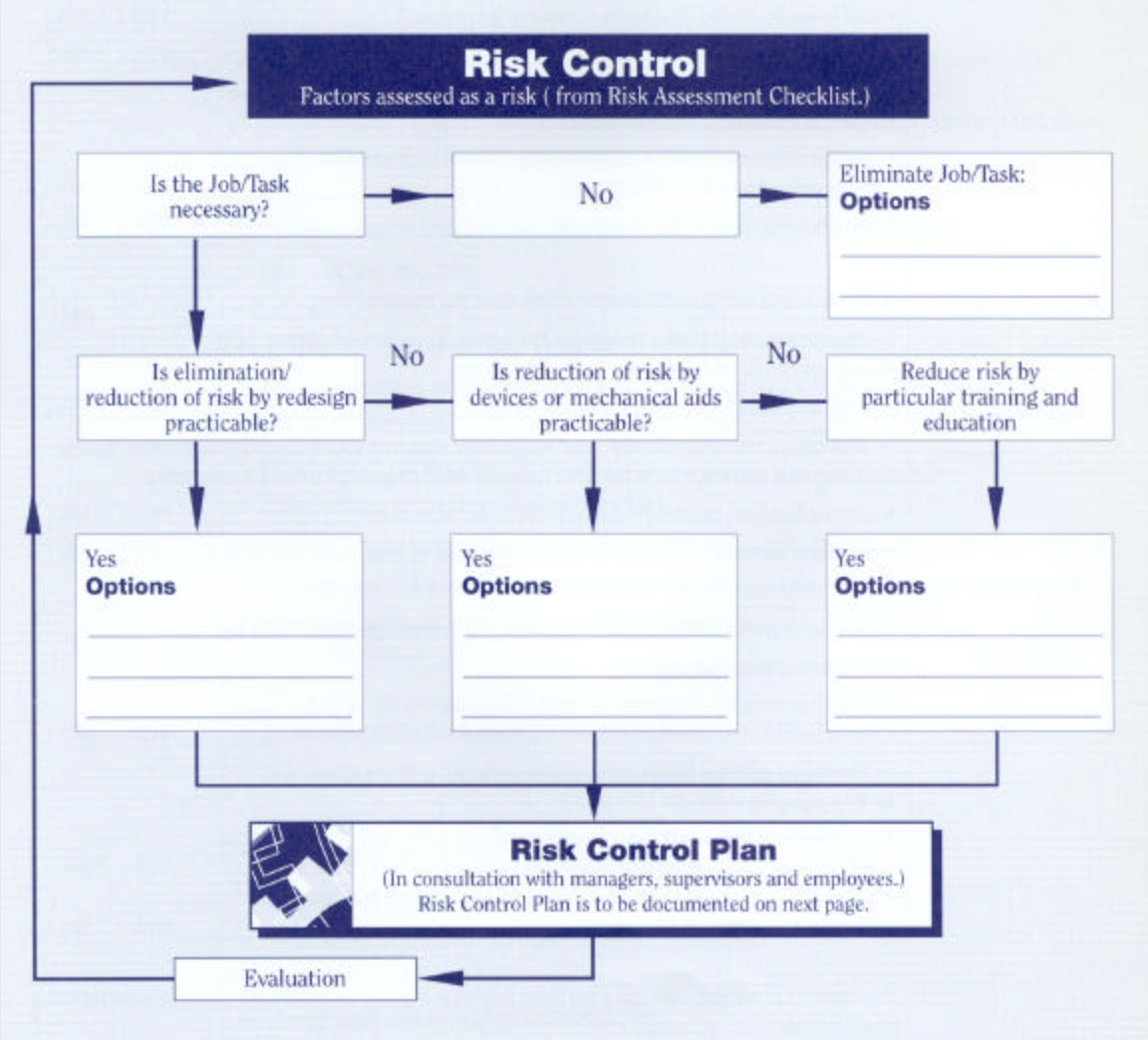
Mine:

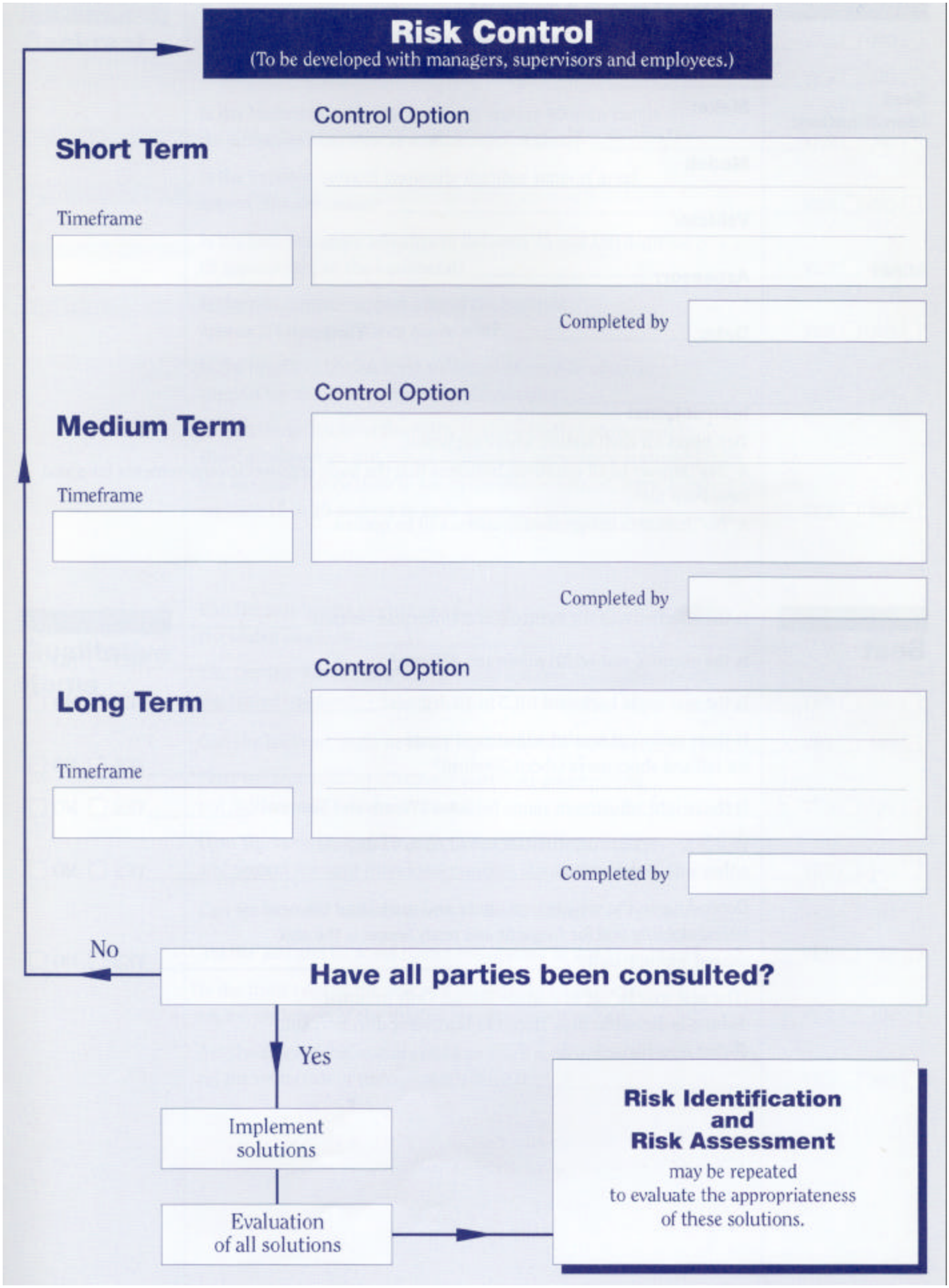
Area:

Task(s):

Assessor:

Date:




Risk Control
(To be developed with managers, supervisors and employees.)
Control Option
Short Term
Timeframe
Completed by
Control Option
Medium Term
Timeframe
Completed by
Control Option
Long Term
Timeframe
Completed by
No
Have all parties been consulted?
Yes
Implement solutions
Evaluation of all solutions
Risk Identification and Risk Assessment
may be repeated to evaluate the appropriateness of these solutions.

Vehicle operator/ Driver seating checklist

Seat Identification:

Make:

Model:

Vehicle:

Mine:

Assessor:

Date: **Time:**

Instructions:

Tick boxes for each feature where applicable.

A "**Yes**" answer to all questions indicates that the basic ergonomic requirements for a seat have been met.

A "**No**" indicates design modifications will be needed.

Seat

Is the effective seat depth between 380mm and 480mm? _____ YES ☐ NO ☐

Is the effective seat width minimum 450mm? _____ YES ☐ NO ☐

Is the seat angle backward tilt 5 to 10 degrees? _____ YES ☐ NO ☐

Is there sufficient fore/aft adjustment range for tall and short users (about 300mm) _____ YES ☐ NO ☐

Is the height adjustment range between 370mm and 500mm? _____ YES ☐ NO ☐

Where appropriate can the seat swivel 15 to 45 degrees either side of the midline? _____ YES ☐ NO ☐

Depending on the vehicle type, make and model and the need for lateral stability and for frequent and ready access is the seat shaped appropriately? _____ YES ☐ NO ☐

(The seat may be flat or slightly dished. Only minimal dishing is desirable: max 25mm in transverse direction and 40mm lengthwise.)

Backrest

Is the backrest vertical dimension (lumbar support area) between 200mm and 250mm top to bottom? _____ YES ☐ NO ☐

Is the backrest width between 360mm and 400mm? _____ YES ☐ NO ☐

Is the backrest horizontal concavity approx 400mm radius (in curvature plan view at level of support area)? _____ YES ☐ NO ☐

Is the backrest vertical convexity (lumbar support area) approx 250mm radius? _____ YES ☐ NO ☐

Is the backrest angle adjustment between 95 and 120 degrees (if appropriate) to the horizontal? _____ YES ☐ NO ☐

Is the mid lumbar support area of the backrest approx 200mm to 250mm above seat? _____ YES ☐ NO ☐

Is the height of the backrest sufficient to provide adequate support for the driver with rapid deceleration? _____ YES ☐ NO ☐

Is there some backrest flexibility to allow limited movement in three directions to suit minor changes in upper body posture? Where the operator has to twist to see to the side or behind, some swivel in the seat (at least 15 to 20 degrees in each direction) is required. _____ YES ☐ NO ☐

Qualitative items

Can the seat height adjustment be easily and quickly achieved from the seated position? _____ YES ☐ NO ☐

Can the seat fore/aft position be easily and quickly adjusted from the seated position? _____ YES ☐ NO ☐

Can the backrest angle be easily adjusted while seated? _____ YES ☐ NO ☐

Does the seat cushion effectively distribute pressure and not 'bottom out' with heavy users? _____ YES ☐ NO ☐

Does the backrest cushion effectively distribute pressure and protect the user from local pressure due to the frame? _____ YES ☐ NO ☐

Can the seat and backrest covers be easily changed or repaired? ____ YES ☐ NO ☐

Are the seat and backrest covers maintained in good condition? ____ YES ☐ NO ☐

Is the front edge of the seat well rounded to avoid pressure on the underside of the thighs? (approx 60mm radius) _____ YES ☐ NO ☐

Are the sides of the seat designed so there is no undue pressure on the underside of the operator's thighs? _____ YES ☐ NO ☐

Safety & stability

Is the attachment of seat assembly to the vehicle secure and not able to be inadvertently removed or displaced under normal operating conditions? _____ YES ☐ NO ☐

Is the seat suspension sufficient to prevent major jolts and jars being transferred through the operator's body and to minimise the effects of vibration in a range of operator body weights? _____YES ☐ NO ☐

Are surfaces free of sharp edges which could snag clothing or cause discomfort or injury? All edges should be curved or rounded. YES ☐ NO ☐

Are fittings and controls smoothed, rounded or shaped to avoid personal injury and damage to clothing? _____ YES ☐ NO ☐

Are all metal parts corrosion resistant or treated with a corrosion resistant finish? _____ YES ☐ NO ☐

Are the controls and moving parts able to be operated without risk of trapping fingers and designed so that they cannot be inadvertently removed? YES ☐ NO ☐

Are the operating instructions clear and permanently displayed near the seat? _____ YES ☐ NO ☐

Is the construction robust? The seat should feel solid and safe to the user. _____ YES ☐ NO ☐

Are the seat design and the materials used appropriate to conditions generally experienced in mines? _____ YES ☐ NO ☐

COMMENTS:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Passenger seating

Seat Identification:

Make:

Model:

Vehicle:

Mine:

Assessor:

Date: **Time:**

Instructions:

Tick boxes for each feature where applicable.

A "**Yes**" answer to all questions indicates that the basic ergonomic requirements for a seat have been met.

A "**No**" indicates design modifications will be needed.

Seat

Is the effective seat depth between 380mm and 480mm? _____ YES ☐ NO ☐

Is the effective seat width minimum 450mm? _____ YES ☐ NO ☐

Is the seat angle backward tilt 10 to 15 degrees? _____ YES ☐ NO ☐

Is the seat shape designed for ready access and to accommodate the maximum number of people comfortably? A bench seat should be flat and tilted backwards 10 to 15 degrees _____ YES ☐ NO ☐

Backrest

Is the backrest vertical dimension (lumbar support area) between 200mm and 250mm top to bottom? _____ YES ☐ NO ☐

Is the backrest width a minimum of 360mm for each person? _____ YES ☐ NO ☐

Is the backrest vertical angle between 110 and 120 degrees to the horizontal (20 to 30 degrees backwards from the vertical)? _____ YES ☐ NO ☐

Is the backrest height 200mm to 250mm above compressed seat (position of mid lumbar support area above seat)? _____ YES ☐ NO ☐

Qualitative items

Does the seat cushion effectively distribute pressure and not 'bottom out' with heavy users? _____ YES ☐ NO ☐

Does the backrest cushion effectively distribute pressure and protect the user from local pressure due to the frame? _____ YES ☐ NO ☐

Can the seat and backrest covers be easily changed or repaired? ____ YES ☐ NO ☐

Are the seat and backrest covers maintained in good condition? ____ YES ☐ NO ☐

Is the front edge of the seat turned down so there is no undue pressure on the underside of the passengers' thighs (approx 60mm radius)? __ YES ☐ NO ☐

Are the sides of the seat designed so there is no undue pressure on the underside of the passengers' thighs? _____ YES ☐ NO ☐

Safety & stability

Is the attachment of seat assembly to the vehicle secure and not able to be inadvertently removed or displaced under normal operating conditions? _____ YES ☐ NO ☐

Is the vehicle/seat suspension sufficient to prevent major jolts and jars being transferred through the passengers' bodies and to minimise the effects of vibration in a range of passenger body weights? _____ YES ☐ NO ☐

Are surfaces free of sharp edges which could snag clothing or cause discomfort or injury? All edges should be curved or rounded. YES ☐ NO ☐

Are fittings and attachments smoothed, rounded or shaped to avoid personal injury and damage to clothing? _____ YES ☐ NO ☐

Are all metal parts corrosion resistant or treated with a corrosion resistant finish? _____ YES ☐ NO ☐

Are traveling safety instructions clear and permanently displayed in the passenger cab? _____ YES ☐ NO ☐

Is the seat construction robust? It should feel solid and safe to the user. _____ YES ☐ NO ☐

Are the seat design and the materials used appropriate to conditions generally experienced in mines? _____ YES ☐ NO ☐

COMMENTS:

_____

_____

_____

_____

_____

_____

POINTS TO CONSIDER

Ergonomics of mining equipment

Mine:			
Machine/equipment:			
Make and model:			
Assessor:			
Date:		**Time:**	

This list *has been included to help users in identifying a wider range of ergonomics issues associated with the operation and maintenance of mining equipment. It has been compiled as an introduction to some of the more common problems found in mining vehicles for both underground and open-cut operations.*

Q1. Does the equipment allow safe and efficient operation by the operator?

While using the equipment can the operator:

(i) See and hear?

Consider:

- sight lines to the front, sides and rear;
- vision within the cab and/or operation area;
- illumination of the field of operation;
- readability and placement of dials and information displays;
- impediments to hearing such as noise, distance;
- need to see or hear visual and auditory cues or signals from the work environment; and
- communication between workers.

(ii) Understand and act appropriately when given information?

Consider:

- type and amount of information needed;
- need to readily understand displayed information;
- communication of other information such as through auditory signals;
- reaction times;
- accuracy and appropriateness of actions; and
- disincentives for safe operation.

(iii) Manipulate controls easily and without confusion?

Consider:

- arrangement of controls in relation to the operator;
- range, direction and type of movements required;
- strength and accuracy required;
- discrimination between controls;

- standardization of layouts especially for critical controls; and
- compatibility with user's expectations.

(iv) Work without unnecessary or excessive physical and/or mental stress or fatigue?

Consider:

- mental fatigue induced by stressful working conditions;
- eye fatigue because of the difficulty of seeing; and
- physical fatigue and strain induced by need for excessive physical exertion and/or awkward postures.

(v) Get into and out of the vehicle quickly, easily and safely?

Q2. In routine maintenance and servicing of equipment is there easy access to machine parts or areas requiring attention, and are suitable tools readily available? Does maintenance require undue force, awkward postures or dangerous practices?

Q3. Is suitable proficiency training available for operators of all machines and vehicles? Are operators aware of all features on the vehicle, how to use them optimally and why it is important that they do?

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