Department of Industry
Resources & Energy

Mine Safety

MINING DESIGN GUIDELINE | MDG 1009

Managing vehicles and operating areas in underground coal mines

Published by NSW Department of Industry Skills & Regional Development

MDG 1009 Managing road and vehicle operating areas in underground coal mines

First published April 1999 as MDG 1009 Guideline for the operational use of free steered vehicles in underground coal mines

Republished October 2015

More information:

Cover photo: Allan Shoesmith, Centennial Mandalong

www.resourceandenergy.nsw.gov.au/safety

PUB15/418

Foreword

This mining design guideline (MDG 1009) for *Managing road and vehicle operating areas in underground coalmines* is a guidance document issued by NSW Department of Industry, Division of Resources & Energy, Mine Safety (NSW Mine Safety), to carry out its function under section 152 of the *NSW Work Health and Safety (WHS) Act 2011* 'to provide advice and information on work health and safety to duty-holders under this Act and to the community'. This function extends to duty holders under the *Work Health and Safety (Mines) Act 2013* and the *Work Health and Safety (Mines) Regulation 2014.*

Guidance issued by NSW Mine Safety provides instruction to duty holders on how to comply with the NSW WHS legislation in ways that may reflect current best practice. However, guidance may not cover all legislative requirements and risks in the workplace, so duty holders should also consider other relevant codes of practice and guidance material depending on their circumstances.

Guidance can be admitted in court proceedings, but it is not enabled by the legislation to be automatically eligible technically for admission as are codes. Codes of practice also have an elevated status by legislation for the court to consider them first for what is known about a hazard, risk or control and the code may be relied on for determining what is reasonably practicable in the circumstances to which the code relates.

An inspector may refer to guidance documents when issuing an improvement or prohibition notice, along with any relevant code of practice.

This guidance document has been developed by NSW Mine Safety in consultation with a tri-partite working group set up to review MDG 1009. The following individuals and their organisations have provided input into the document and support its release:

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- Robert Bull – Technical Projects Officer (Coal Services)
- David Clarence – Mechanical Inspector (NSW Mine Safety)
- Greg Davey – Undermanager (Retired)
- Kylie Newton – Practice Leader Health and Human Factors (NSW Mine Safety)
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- Pat Sharpe – Production Manager (Glencore- South Blakefield Mine)
- Allan Shoesmith – Undermanager/ Outbye Services- (Centennial Coal- Mandalong Mine)
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- Ben Smith – Specialist Consultant (Mine Craft)
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- Bob Williams – Mechanical Inspector (NSW Mine Safety)
- John Sherrell – Inspector of Coal Mines (NSW Mine Safety)

Key terms

MDG	Mining design guideline
MSD	Musculoskeletal disorder
Other vehicle operating areas	All areas on or in a mine where mining operations involve the use of vehicles, for example, ROM pads and stockpiles. **Note:** Roads and other vehicle operating areas include all traffic thoroughfares used by mine mobile equipment, heavy or light vehicles and their trailer attachments.
PCBU	Person conducting a business or undertaking.
Risk assessment	The overall process of risk analysis and risk evaluation.
Risk management	Refer to the NSW Code of Practice for How to Manage Work Health and Safety Risks in the Workplace and MDG 1010 *Minerals Industry Safety and Health Risk Management Guideline*.
Road	A travel way constructed with a prepared surface between designated locations and designed to accommodate vehicles that operate at a mine.
Should	That the action or item is recommended. **Note:** If any of the parameters as recommended under a “should” instruction are not adhered to, the manager will justify the alternative to the recommendation through a process of technical assessment, risk assessment as part of overall risk management.
TARP	Trigger Action Response Plan
Vehicle	Self-propelled equipment or plant used for the carriage of goods, material or people for mining operational requirements.
WHS	Work Health and Safety

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Chapter 1 – Introduction

1.1 Purpose

This MDG provides guidance on the design, operation and maintenance of roads and vehicle operating areas in order to minimise the risk to a person's health and safety in so in as is reasonably practicable to satisfy Work Health and Safety legislative requirements. The MDG may also assist mine operators develop part of a management plan for:

- the principal mining hazard of roads and other vehicle operating areas under the proposed WHS (Mines) Regulation**.**

For further information on traffic management, please refer to codes of practice that are relevant to roads and other vehicle operating areas.

1.2 Scope

The life cycle of roads and other vehicle operating areas, taking into consideration the vehicles that travel in underground coal mines. This includes roads on the surface used by underground vehicles. This document excludes roads with rail and other infrastructure.

1.3 Who should use this MDG?

Use this MDG if you are:

- a person conducting a business or undertaking (PCBU), including the mine operator, and have management or control of roads and/or vehicles operating on them
- a Health and Safety Representative (HSR) who needs to understand the hazards and risks associated with the use of vehicles, the roads and other operating areas
- designers, manufacturers and suppliers of vehicles, component parts or materials
- road designers and contractors
- inspectors when advising mines on how to comply with legislation
- workers involved in a roadway risk assessment.

1.4 How to use this MDG

This MDG gives instruction on how to manage roads, other operating areas and vehicles to meet legislative duties.

Parts of the legislation and other codes of practice and guidance documents may also need to be read to gain a greater appreciation of what is required, or for alternative ways to control hazards. See the References section for more details.

This MDG includes references to both mandatory and non-mandatory actions. The reference to legal requirements contacted in the WHS Act and the WHS (Mines) Act, WHS Regulations and WHS (Mines) Regulations are not exhaustive and are included for context only.

The MDG has been prepared to be consistent with the WHS legislation as at the date of publication and should be interpreted, to the extent that if there is any ambiguity, in a manner that is consistent with the WHS legislation. To ensure you comply with your legal obligations you must refer to the latest legislation, which is available on the NSW legislation website. (www.legislation.nsw.gov.au).

This publication does not represent a comprehensive statement of the law as it applies to particular problems or to individuals or as a substitute for legal advice. You should seek independent legal advice if you need assistance on the application of the law to your situation.

The words 'must', 'requires' or 'mandatory' indicate that there are legal requirements to be complied with.

The word ‘should’ indicates a recommended course of action, while ‘may’ indicates an optional course of action.

Unless otherwise indicated in the text, lists of points in the code should not be read as exhaustive.

1.5 Relationship to other codes and guidance

This MDG is a renamed amended version of the original issued in April 1999 titled *Guidelines for the operational use of free-steered vehicles in underground coal mines*. The original version, by its title, focused on the use of free-steered vehicles and associated matters, such as road conditions, to satisfy the *Coal Mines Regulation Act 1982* requirement for road transport rules. This revised version has a scope to focus on roads and other operating areas so that vehicles can safely travel on them. It also follows the risk management process set out in the WHS and WHS (Mines) legislation with hazard identification, assessment and controls being the main chapters. Sample road rules are provided in Appendix D to illustrate controls that may be selected.

The MDG is a secondary guidance document that sits under the primary codes of practice that are relevant to roads, including *Managing Risks of Plant in the Workplace*.

Chapter 2 - Importance of risk-managing roads and other vehicle operating areas

2.1 Responsibilities of duty holders

Duty holders under the WHS legislation need to manage the risks associated with roads, and the vehicles that use them, for a number of legislative and other reasons:

- Under WHS legislation, PCBUs, including mine operators, must select, implement and review controls for hazards that may arise from roads and the vehicles that travel on them.
- The risk of people developing musculoskeletal disorders from exposure to vibrations that are generated by rough road surfaces causing jolts and jars or from the condition of the vehicles (see further details below).
- A management plan will be required for the major hazard of underground road transport or principal mining hazard of roads and other vehicle operating areas. There is a history of serious injuries and fatalities resulting from roadway incidents that should be considered in this plan.
- The MDG aims to promote the maintenance of road conditions by mine operators so worker safety concerns are addressed satisfactorily, including under WHS Act consultation requirements.
- As a mine develops and roadway distances get longer it is important that road surfaces are even and well maintained as they may provide the only practical option for a vehicle's escape in an emergency. These escapes are usually aided by breathing apparatus and are attempted when visibility is poor.
- Additional benefits of well-maintained roads and vehicles to a mine operator or PCBU may be:
  - reduced operational and maintenance costs
  - lower diesel emissions and reduction of worker exposure
  - reduction of injuries
  - efficient travelling times
  - increased productivity
  - lower exposure to hazards such as heat, noise and dust.

2.2 Musculoskeletal disorders

Musculoskeletal disorder (MSD) is an umbrella term for a number of injuries and disorders and can occur suddenly, develop over time or through a combination of both. MSDs are the most common cause of workers compensation claims in the mining industry. Refer to *Managing Musculoskeletal Disorders: A practical guide preventing musculoskeletal disorders in the NSW mining and extractives industry* for more details.
www.resources.nsw.gov.au/__data/assets/pdf_file/0004/291784/Guide-to-the-prevention-of-musculoskeletal-disorders-in-the-mining-and-extractives-industry-in-NSW.pdf

- Travelling on rough roads over time can contribute to a musculoskeletal disorder. Vibration arises from rough roads, and this energy can be passed on to the operators and passengers, most commonly through their buttocks, while they are in the vehicle. The magnitude and effect of the vibration depends on the length and severity of exposures. (McPhee, 2009)
- Vibration-related musculoskeletal claims in mining are much higher than in any other sector. This figure may also be much higher than recorded in injury statistics. For example, a debilitating MSD injury may have occurred due to another event, but the person's exposure to vibration from travelling on rough roads may contribute to the injury as the person sustains small injuries over time. This subsequently weakens the musculoskeletal system.

Chapter 3 – Managing the risk associated with vehicles, roads and other vehicles operating areas

3.1 General legislative risk management requirements

Legislation overview of:

Work Health and Safety (Mines) Regulation:

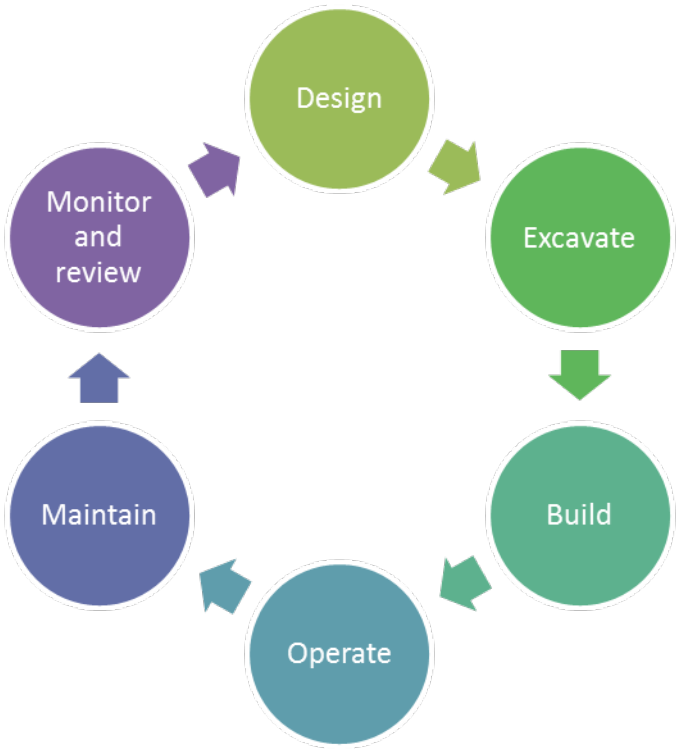
- clause 9: all PCBUs at a mine must manage risks to health and safety, including conducting a risk assessment and keeping a record of it in the safety management system;
- clause 28: the mine operator must manage risks associated with mobile plant, including:
  a) the design, maintenance, construction and maintenance of all roads and other areas at the mine used by mobile plant
  b) the interaction of mobile plant, including those remotely controlled, with other plant, structures and pedestrians
- clause 24: prepare a principal mining hazard management plan that addresses roads and other vehicle operating areas (if it is a principal mining hazard at the mine), with reference to the considerations for controls selection in Schedule 1.

3.2 Risk-management approach to roads and their life cycle

For mine operators, an overall approach to managing their risks before and after the mine starts operating may be to do the following for roads:

- complete a broad brush risk assessment for the whole mine, where the mine operators, workers, and possibly any regular contractors used, brainstorm all the hazards that generally exist, risk-assess them and select controls. The hazards identified and controls may vary according to which stage the mine is at in its life cycle (see diagram below), such as:
  - mine design: foreseeable risks are identified in planning, such as road access ways
  - mine development: when setting up activities for mining and identifying their risks e.g. portable plant
  - mining operations: risks when making roads and operating vehicles
  - mine suspension/closure: making the mine safe for any person to access it as planned and required

Figure 1 - Roadway life cycle



Note: Further information on considerations for roadway life cycle can be found in Appendix A

Some mines may have several stages of the mine life cycle occurring at the same time e.g. exploration and mining operations.

1. complete risk assessments for each work process or major work activity at the mine, using techniques such as a safe work method statement with associated templates, particularly with any relevant contractors
2. conduct further risk assessments when new or irregular activities occur or hazards are identified through planned processes, such as inspections, and
3. review, revise and record changes to existing risk-management documentation and controls, such as with Safe Work Procedures and their controls, as the need arises and as prescribed in legislation (see WHS (Mines) Regulations Clauses 10 and 11).

Guidance on the general risk management process is available in the *Code of Practice: How to Manage Work Health and Safety Risks.*

Chapter 4 - Selecting controls for hazards

This chapter provides guidance on the controls that may be selected according to the roadway life cycle and its hazards. It builds on advice provided in other guidance and codes of practice listed in the references section, in particular the codes of practice for managing the risks of plant in the workplace. Reference should also be made to the abstract of the *ACARP Operator Underground Roads Manual* contained in Appendix E for specific technical guidance.

Note: the table in section 3.2 provides a list of possible controls for typical hazards.

4.1 Specific controls

Traditionally, control options are evaluated according to the hierarchy of controls. This hierarchy also applies to controls for the management of underground road conditions. When managing roads elimination of the hazard is the first step. This will be the most effective way of reducing injuries. The management of underground road conditions can be divided into design controls and administrative controls.

Design controls

Design refers to a control strategy that involves redesigning the roadway, workplace or the task or tool to reduce the risk. Design Controls include substitution and engineering controls.

Substitution

- Concreting trouble areas of the mine roadway.
- Adding special material to prevent breakdown of roadway in adverse locations.
- Upgrade of machinery to reduce expose to vibration.
- Replace vehicle seats with anti-vibration seats.

Isolation

- Operate machinery remotely.

Engineering

- Redesigning and upgrading the roadway, for example using graders and ballast material to regrade roadways.
- Construction and maintenance of drainage systems to reduce/ remove accumulation of water along roadways.
- Ensure transporters and machinery seats are designed to reduce exposure to whole body vibration.

Administrative controls

Administrative controls are far less effective than design controls. Rather than controlling the risk directly, by designing out the hazard, administrative controls rely on the behaviour or actions of the worker or Deputies/ under manager to control the risk. Administrative controls are best used as part of a comprehensive control strategy, to compliment design control or for short term risk management.

4.2 Administrative scheme for classifying roads and setting standards

As stated in section 4.1, for specific controls a mine operator may choose to develop and apply a scheme to classify their roads and set standards so there are appropriate controls to manage the risks of hazards.

To help develop a scheme, details of a possible plan are below. There are variables, such as a speed limit, which the mine operator should consider setting and implementing as far as is reasonably practicable e.g. do vehicles have speedometers? What is an appropriate speed for the risks?

There are specific controls that should be considered in the mining operations stage of roads, it is important to remember that the decision with regards to controls needs to be made in consultation with the workers. Some examples include:

- Roadway design, this would include but not limited to the consideration of water flow and drainage to ensure the integrity of the road.
- Provision of ballast material and fit for purpose road maintenance equipment for upkeep of roads.
- The availability of skilled and competent people to maintain roadways.
- Systems for inspection and determining the level of risks for hazards so that controls are maintained. These systems may take many forms, but may include:
  - visual inspections by competent people, using aids such as checklists.
  - assessments by users of the roads, such as passengers (see sample checklist in Appendix C).
- Equipment that can scientifically assess the condition of a road, such as vibration in vehicle seating generated by uneven surfaces. Mine operators should investigate what valid equipment and services are available for this purpose by referring to the mining safety regulator, industry groups or other reliable sources. Refer to Appendix G on whole body vibration information.
- A scheme to classify roads and set standards for their controls. Further details of this scheme are set out in section 4.3.
- Managing roads under a Trigger Action Response Plan (TARP). A TARP may be developed and applied so that when there are certain triggers, actions are automatically taken so controls continue to manage the risks. A sample TARP is provided in Appendix F.
- A structured process for shift task handover to ensure safety information is provided to all relevant staff with regards to roadways and the up keep.

Typical hazards, risks and their controls

The following table is a risk assessment of hazards and controls relating to roads and vehicles. Chapter 4 provides further guidance on the controls.

Hazard	Source example	Risks to health and safety	Possible control measures
Potholes and adverse roadway conditions	Deteriorating or wet road conditions	Personal Injuries MSD	• Provision of quality ballast material and fit for purpose equipment to maintain roads; • A quality roadway maintenance and Inspection program • Provision of a quality TARP
Steep Grades	Inclines/ undulating seams & drifts	Loss of vehicle control and possible rollover	• Fit for purpose vehicles on inclines; • Hazard warning signs and driver awareness.

Hazard	Source example	Risks to health and safety	Possible control measures
Slippery road surfaces	Water or treatment for road way dust by suppressants	Loss of vehicle control and possible impact	• Control of water on roads • Operator and driver awareness in the application and location of dust suppressants.
Water	Seepage or leaking pipes	Roadway damage, machinery damage, MSD, slips and falls and exposure to excessive water and flooding	• Roadway design to manage water concerns in the design phase; • Provision of drainage and pumps to remove water • Inspection programme and TARP
Collisions with vehicles and people	Blind Corners Speed Visibility	Fatalities, serious injuries and damage to plant	• Roadway design to eliminate blind corners • Provision of mirrors • Signage and signalling • Transport rules
Slurry	Soft floors	Slips and falls	• Provision of ballast material and the regular maintenance of roads to eliminate slurry conditions • Inspection programme and TARP
Dust	Movement of machinery Dust circulated by ventilation After stone dusting signs unreadable due to excess dust	Dust diseases and lung conditions Explosive conditions Safety signage obscured by dust deposition	• Monitoring of dust levels • Provision of dust suppression- stone dusting • Ensure signs are cleaned after the application of stone dust in the road.

Hazard	Source example	Risks to health and safety	Possible control measures
Structures/ pipe cables	Pipes, pipelines, electrical cables, services, air and water, ventilation, control devices and belt structure.	Collisions between vehicles, people and items. Electric shock	• Ensure road way design takes into consideration structures and pipes and cables and good roadways are provided to provide easy access for mine workers; • Provision of adequate roof clearance • Installation procedure and standards for structures • Inspection programme and TARP
Trenches	Open pits for dewatering and drainage	Falls and slips	• Designing of trenches to ensure appropriate drainage away from roadways • Designated barriers and signage
Distance	Length of roads particularly gate roads for escape	Fatality Delayed escape, rescue	• If roadway is a designated escape route that the mine establishes a quality roadway maintenance and Inspection program • Signage and markers for reduced visibility
Speed	Vehicle speeds	Collision injuries (fatalities), MSD, risk of overturning, occupants hitting interior of vehicle	• Speed limiting vehicles • Training and education • Adequate supervision
Strata conditions	Poor roof, ribs and low clearance Type and condition of road floor, steep gradients and poor horizon control	Injuries due to impact MSD injuries Uncontrolled vehicles	• Roadway design to ensure strata conditions are considered • Strata support plans outlining the design requirements • Transport rules • Education and training • Fit for purpose equipment
Poor Visibility	Excessive smoke or dust	Respiratory conditions Impact injuries	• Monitoring of dust levels • Dust suppression - stone dusting • Maintenance and Inspection program • Roadway design

Hazard	Source example	Risks to health and safety	Possible control measures
Gas Particulates	Diesel exhausts	Respiratory conditions	• Roadway, vehicle and mine design • Maintenance emission management system • Ventilation arrangements
Debris /housekeeping	Inadequate maintenance standards Inappropriate storage of material Materials handling, for example importing road base and other items Roof or rib spall	MSD injuries Reduced roadway clearance	• Maintenance and Inspection program • fit for purpose equipment to maintain roads • Inspection programme and TARP
Intersections	Reduced visibility	Collisions	• Signalling, signage, mirrors, horn, driver training and education and transport rules
Vibration from travelling in vehicles	Poor road conditions Poor vehicle design and maintenance Potholes Poor driving After heavy loads or track machines have travelled on the road	MSD injuries	• Roadway design, standards, inspections and TARPS; • Education and training of drivers • Excavation standards • Vehicle design and maintenance • Equipment selection and vibration monitoring
Occupants hitting the interior of the vehicle	Poor road condition Poor vehicle design and maintenance Potholes Poor driving	MSD injuries	• Maintenance and equipment selection and vibration monitoring

4.3 Selecting controls from the hierarchy and implementation

Clause 36 of the WHS Regulations requires PCBUs, including mine operators, to select controls from as high in the hierarchy as possible, so far as reasonably practicable.

For a best practice case study of implementing an effective roadway management plan/system, refer to Appendix B.

4.3 General requirements - roadway standards

The PCBU/mine operator should provide a plan at suitable locations around the mine that indicates main roads, secondary roads and roads of infrequent use, as well as the type of vehicle/s that use each road. Such a plan should be updated as required by the transport rules and/or applicable management plans.

*A **primary road** is:*

A road that extends from the surface muster area to the crib room/caches in each production area or where work is frequently performed. The maximum speed is defined by the mine operator and will be listed in its transport management plan.

Primary roads are to be maintained to such a standard as to allow the efficient evacuation of an injured person with minimum discomfort to them and without further aggravating their injuries and condition. Furthermore, it minimises the impact on the health and safety of workers. Pot holes and water holes are a roadway defect. This defect is to be reported to the section Deputy/ Under manager and this information conveyed to workers/drivers at the next start of shift meeting and/or subsequent tool-box talks. Signs will be erected at both ends of the defect site: 'Reduce speed – (Poor roadway conditions) or (Roadway repair zone) or (Slow speed zone)' and the defect must be repaired as soon as practicable. The signs may also indicate when exiting the repair zone so normal speeds may be resumed.

If the roadway is not restored to the required standard within 24 hours, the roadway is deemed a secondary road and the conditions for this level will apply until the roadway is restored to a primary standard. Remedial actions will be as per the mine's TARP.

*A **secondary road** is:*

Another road within the mine that is not used as frequently by working crews or for maintenance and associated purposes. The maximum speed (which should be lower than primary roads) will be defined by the mine operator and will be listed in the transport management plan.

Pot holes and water holes will have warning signs. Dewatering locations or water courses will be indicated on the roadway plan, essential for efficient planning as preferred routes can be determined at the earliest time.

Drivers will be informed of these offending locations and travel at speeds suitable for the roadway conditions.

The time taken to travel these roads will be monitored in the event of emergency escape and that adequate rescuers/breathing apparatus are available in caches along extended routes.

*A **tertiary road (infrequent road)** is:*

A road used infrequently either for inspection, maintenance and/or egress purposes. These roadways are to be travelled at speeds to suit the conditions on these routes so there is minimum discomfort to the driver and passengers.

Where these roads are designated as alternate egress routes and may be upgraded to main egress routes, conditions attached to primary roads will apply, for example longwall installation and reclamation of "old workings."

Chapter 5 - Monitoring, review and audit

5.1 Monitoring

Once the controls for roads and other vehicle operating areas are established, it is important to ensure they remain effective and are maintained. To achieve this, regular inspection and monitoring systems should be established. The inspection and monitoring systems may include:

- review of effectiveness of training provided
- review to determine the effectiveness of the underground transport or proposed principal mining hazard management plan
- regular inspection and maintenance of roads and other vehicle operating areas, signage and traffic controls
- conducting a whole body vibration testing audit
- auditing by external competent people.

5.2 Audit

The audit determines whether controls for roads and other vehicle operating areas are in place, including:

- mine workers understanding their responsibilities
- training has been carried out
- equipment is available, including monitoring equipment
- inspections have been carried out
- appropriate responses to any triggers that have occurred
- required reports have been completed.

The audit will provide information regarding how well the plan is being maintained.

The audit plan should include the:

- frequency of the audits
- scope of the audit
- audit methodologies
- competency of the auditor
- responsibility for seeing the audit is conducted
- reporting protocol for the audit and
- responsibility for acting on the audit report
- performance standards, which should be for the audit to find 100% compliance with legislation.

5.3 Review

Note: Refer to the life cycle document in Appendix A when considering reviews.

It is important to continually monitor risks and check control measures to ensure they remain effective. Control measures should also be reviewed when an incident occurs, or when any changes may raise a new or different risk associated with the road or other vehicle operating area.

In undertaking the review, workers using the road or vehicle operating area, and their site health and safety representatives, should be consulted and the following questions considered:

- Are the control measures working effectively in both their design and operation?

- How effective is the risk assessment process? Are all hazards being identified?
- Are workers actively involved in the risk management process? Are they openly raising health and safety concerns and reporting problems promptly?
- What has been the impact, if any, of new work methods or changes in equipment?
- Are safety procedures being followed?
- Has the instruction and training provided to workers been successful?
- If new legislation, information or technology becomes available, does it indicate current controls may no longer be the most effective?

Referenced documents

A1 Referenced documents

Standards referenced in this guideline:

- Safe Work Australia, July 2010. National Hazard Exposure Worker Surveillance: Vibration exposure and the provision of vibration control measures in Australia.
- The NSW Code for the Mechanical Engineering Control Plan

A2 Referenced guidance documents

The following guidance documents are referenced in this guideline:

- ACARP Project C3026, Coffey Partners International. 1994. Underground Road Manual: Maintenance and Construction
- The Australian standard AS2670.1-2001/ Amdt1-2013, Evaluation of human exposure to whole-body vibration, Standards Australia,
- Whole-Body Vibration Factsheet, September 2012, Safe Work Australia,

Reference List

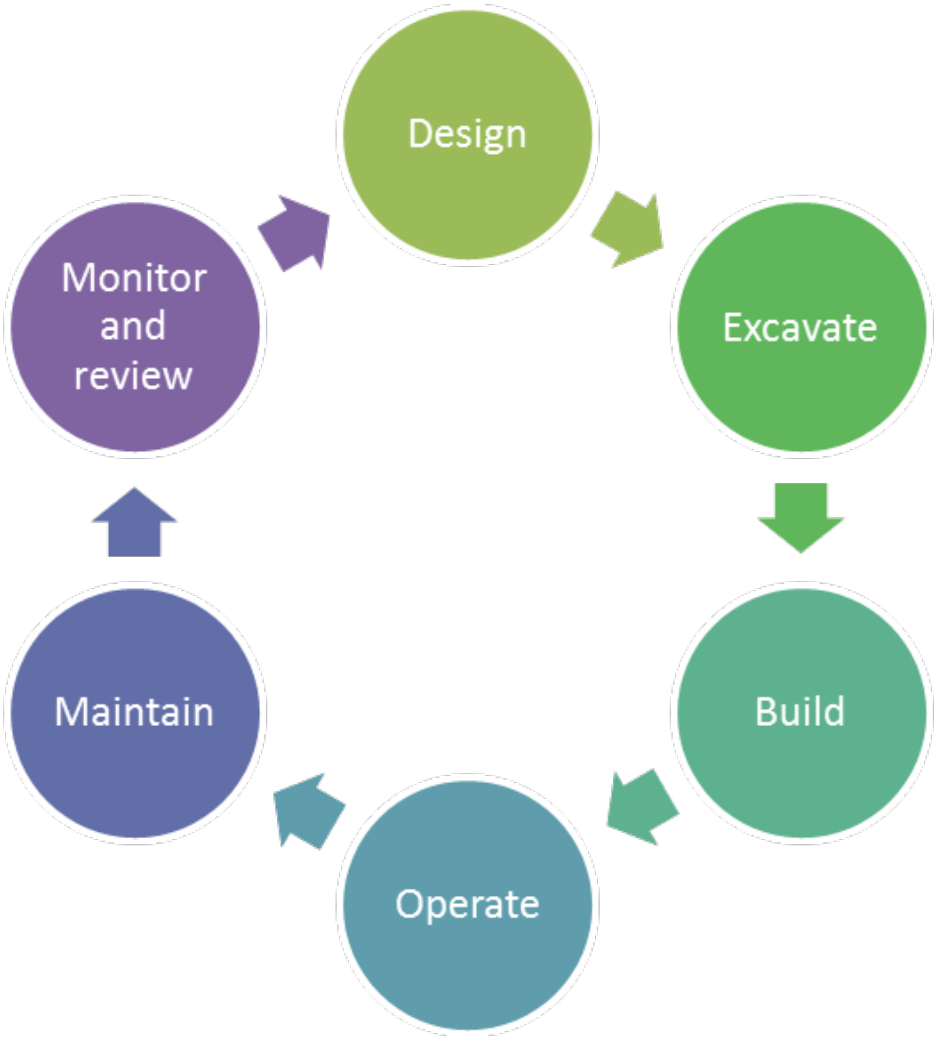
McPhee, B. (2005). *Practical Ergonomics.* Sydney: Coal Services Health and Safety Trust.

McPhee, B., Foster, G., & Long, A. (2009). *Bad Vibrations.* Sydney: Coal Services Health and Safety trust.

NSW Industry & Investment. (2009). *Managing Musculoskeletal Disorders.* NSW Mine Safety Advisory Council.

Appendix A - Roadway life cycle

Figure 1 - Roadway life cycle (also in section 3.2)



The following are considerations for a mine to risk manage roads during their life cycle. Each mine may need to consider other factors according to their circumstances, for example classification of roads systems outlined in section 4.3.

Needs analysis

- What is the roadway intended to do?
- Who needs to use it? What are their requirements?
- What loads does it need to carry?
- What do the finished dimensions of the roadway need to be?
- What is the life span of this roadway – life of mine, panel life or short term?
- What will this roadway be used for long-term – return, alternate travel road, segregated intake/egress, main travel road, belt road?

Environmental analysis

- What water make is expected in the area? Is it expected to come from the floor, ribs (seam) or roof? Is it significant or 'nuisance'?
- Are there natural rolls/depressions where water may accumulate?
- Are there areas where rolls/depressions may reduce visibility?
- What is the floor strength in this area expected to be (from drilling/exploration/previous panel experience)?
- What services and other installations/equipment will need to be located in or proximate to this roadway.

Key considerations

- One-way traffic flow.
- Avoidance of unnecessary intersections where traffic flows meet.
- Signalling or traffic control systems (block lights etc).
- Pavement design (stone, compacted earth, concrete).
- Water management.
- Lighting.
- Dust management.
- Stone dusting.
- Lighting behind/in front of large towed/carried loads.
- Grades, cross-grades.
- Drains, gutters, trenches.

Design directives

- What key design outcomes need to be met?
- What is required during excavation (development mining) to support creating the eventual design.
- What equipment will be used to excavate the opening?
- Are there any limitations on this equipment or process?
- Are there any supplementary excavation steps required (i.e. brushing, grubbing, over casts, belt overpass, sumps etc.)?
- What are the 'pressure points' during excavation where the biggest difference can be made (i.e. cutting profile, floor profile, rib profile, clean-up of slack coal, digging of holes, canches, tail length of bolts, rubbish, materials left behind, etc)?

Key considerations

- Clear set of drawings outlining what is required.
- Development of excavation standard.
- Incorporating excavation into development process (cutting/loading/support).
- Communication to, and training/supervision of crews and Deputies and Under managers.

Requirements

- What is required to achieve the design given the excavation provided?
- Are any specialised equipment, tools, consumables, skills or processes needed?

Key considerations

- Clean-up of excavation.
- Management of water make (floor, ribs, roof).
- Basement layer – required? Need compaction? What materials to use (from design)?
- Pavement layer – required? Need to be sealed (i.e. concrete).
- Installations required in the design – lighting, communications, signage, etc.

Check

- Will the equipment, loads and other requirements be met?
- Has there been sign-off from the relevant 'owner' – i.e. LW, outbye, development etc and a handover process – i.e. development to longwall so that it is 'owned' by someone.
- Checklist of completion- same as any other process, task or project.

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Considerations

- What is required to maintain to an appropriate standard, given the use/type of roadway?
- Are there special tools, equipment, supplies etc required to maintain?
- What training and communication do we need to give our people?
- What inspection regime is in place to determine whether the road is being maintained, or meets the appropriate standard – part of 103 scheme? Work order system?
- How do we measure compliance to the standard – qualitative/quantitative?
- Action needed if it is not to standard (TARP for roadway type)

Review

- Review effectiveness of controls
- Determine if there have been any changes and if they have been documented
- Is there a regular inspection and maintenance regime on the roads?
- Has a whole body vibration audit taken place on the roads?
- Has an external audit been carried out by competent people?

Appendix B - Case Study examples for underground roads

The following is an example of a response to road way issues at a mine. The mine has not been identified, however, it is an underground coal mine based in the Hunter Valley, NSW.

Problem	The operation received feedback from its workforce about poor roadway conditions. This was coupled with an increase in the reporting of musculoskeletal-based injuries caused by travelling on rough roads. The operation also identified that it needed to increase production. The operation identified that improved roadways would decrease travel time to the face.
Solution	The mine held collaborative consultation, including receiving feedback from workers, managers and deputies/under managers. The mine's holistic approach to road management was achieved by: • having a dedicated road crew, with the right people, who were experienced in building roads. The crew needed to be committed to the job • removing water from roads including using sub terrain trenches and pumps • hiring the right equipment to fill, grade and roll (i.e. graders and rollers) • having the right ballast material, for example for larger holes, gabion rocks could be used, followed by 20.mm ballast/skulls. To finish, small 7mm fines could be used • ensuring the right roof-to-floor height, for example to make sure the road was not built up too high so that gear cannot be brought in, and to ensure safe clearances were maintained between supports, cables, pipes and other structure. • daily and weekly work plans • ensuring all people, including the road workers, are consulted in regard to the daily and weekly plan • keeping information between shifts, including shift documents and verbal hand overs • having a dedicated road person allocated to the life of a road.
Cost to implement solution	The total cost to implement the solution over one year included: • plant hire (**Note:** it was not cheaper to buy the equipment , as the hire company is responsible for the upkeep and maintenance of the plant) • labour • ballast and other forms of road materials • dust suppression controls such as watering.

Primary objective/ benefits	The benefits and main objective of having a dedicated and managed approach to roadway conditions were: • significant reduction in diesel exhaust emissions • decreased travel time (see details below) • increased worker safety • longwall moves and panel relocations completed in significantly less time • fewer injuries associated with rough roads and conditions • decrease in maintenance on machines.
Secondary opportunities / benefits	The secondary benefits are: • Increased production. For example, saving 10 minutes per unit day travel time, which is 173.3 hours a year/ unit.
Projected savings to the organisation	In this example at the mine, it is commonly agreed that the cost of road maintenance are far out-weighed by the savings and benefits including: • fewer injuries, which can be a saving of hundreds and thousands of dollars • more opportunity to cut coal • increase in workforce morale and • less wear and tear on machinery.

Figure 2 – Example of a well-maintained roadway

Photo credit: Allan Shoesmith, Centennial Mandalong

Appendix C - Checklist for underground road conditions

Audit checklist for underground roadway condition	**Audit checklist scoring criteria➢**	**Fully documented** **Fully controlled**	**Partially documented** **Partially controlled**	**Not documented** **Partially controlled**	**Partially documented** **Not controlled**	**Not documented** **Not controlled**	**Audit checklist evidence**	**Improvement**
Use the checklist to compare the requirement of the MDG against the existing travel management system.	Type an 'x' in only one of the five compliance level columns ➢	**Compliant**	**Minor non-compliance**	**Major non-compliance**	**Major non-compliance**	**Major non-compliance**	Provide information on documentation seen during the audit. If any are not applicable, please type NA.	Provide suggestion for improvement.
Pot holes & adverse roadway conditions								
Water on roadway (seepage or leaking pipes)								
Collisions (has there been any recent reports of collisions with vehicles or people)								
Slurry								
Dust								
Structure/ pipes & cables								
Trenches								
Clearance (clearance from electrical cables, pipes and structures , clearance of roof support)								

Audit checklist for underground roadway condition	**Audit checklist scoring criteria➢**	**Fully documented** **Fully controlled**	**Partially documented** **Partially controlled**	**Not documented** **Partially controlled**	**Partially documented** **Not controlled**	**Not documented** **Not controlled**	**Audit checklist evidence**	**Improvement**
Use the checklist to compare the requirement of the MDG against the existing travel management system.	Type an 'x' in only one of the five compliance level columns ➢	**Compliant**	**Minor non-compliance**	**Major non-compliance**	**Major non-compliance**	**Major non-compliance**	Provide information on documentation seen during the audit. If any are not applicable, please type NA.	Provide suggestion for improvement.
Speed (are speed limits identified and are these monitored)								
Strata conditions (poor roof, ribs and low clearance, type and condition of road fill and steep gradient)								
Poor visibility (excessive smoke or dust)								
Ventilation (diesel exhaust and gas particulate)								
Housekeeping (maintenance standards, appropriate storage of materials, secure loads of mobile plant)								
Intersections (intersections signposted, provision of convex mirrors, signage block lights)								

Audit checklist for underground roadway condition	**Audit checklist scoring criteria➢**	**Fully documented** **Fully controlled**	**Partially documented** **Partially controlled**	**Not documented** **Partially controlled**	**Partially documented** **Not controlled**	**Not documented** **Not controlled**	**Audit checklist evidence**	**Improvement**
Use the checklist to compare the requirement of the MDG against the existing travel management system.	Type an 'x' in only one of the five compliance level columns ➢	**Compliant**	**Minor non-compliance**	**Major non-compliance**	**Major non-compliance**	**Major non-compliance**	Provide information on documentation seen during the audit. If any are not applicable, please type NA.	Provide suggestion for improvement.
Vibration, jolts and jars from travelling in vehicles (WBV testing can be organised to obtain an objective reading on WBV)								
Occupants hitting the interior of the vehicle (has there been any reports or incidents)								
Steep Grades (fit for purpose vehicles on inclines, hazard warning signs)								
Slippery road surfaces								

Appendix D- Sample transport and road rules

The following sample rules are taken from the 1998 version of MDG 1009 *Operation of free skid steered vehicles.* They have been retained in this revised version of the MDG focusing on roads as a valuable body of learnt knowledge, even though some rules relate only to vehicle use, not just roads.

The following sample rules should be considered when a mine is updating its transport management system:

- Risk assessment should be carried out on the mine's transport system.
- All obstructions or restrictions in roadways should be illuminated or have reflective markings.
- After using fill material on a roadway, the overall dimensions of the roadway could result in reduced clearances. Be mindful of the material used for silica content.
- Drivers will report any changed roadway conditions to an immediate Deputy/Under Manager.
- Signs:
    - Speed signs should be quantified.
    - Directional signs should be used to control traffic flow.
    - Safety signs should be used to control traffic flow.
    - Safety signs should be used to indicate grades, blind corners, major intersections etc.
    - All grades steeper than 1 in 14 are to be specified with a sign.

Appendix E - Abstract of ACARP Report for Underground Roads

The ACARP (Australian Coal Association Research Program) produced a report and an *Underground Roads Manual: Construction and Maintenance*, which 'provide the means to improve underground pavement construction and maintenance'.

For more information please refer to the full report and manual: ACARP Project C3026, Coffey Partners International. 1994.

www.acarp.com.au/reports.aspx?catId=1&subCatId=10&sO=n

ACARP is acknowledged for kindly allowing access to the abstract of this report in this publication.

Appendix F – Sample TARP for roads in an underground coal mine

This TARP is a sample to help mine operators develop their own plan. An effective TARP would need to take into account any conditions at the mine that may be different to this sample.

Table: Underground roadway TARP for primary travel road

Primary Travel Road	Normal	Level 1	Level 2	Level 3
Triggers				
Poor road conditions - road unable to be used as emergency egress	Signage fitted as per plan Speed limit signs fitted as per plan Notification to work crews from mining deputies/ under managers	Normal roadway travel speed extended marginally the travel times into mine sections	Normal roadway travel speed extended by the travel times into mine sections	Normal roadway travel speed extended significantly, by long stoppages into mine sections
Road conditions deteriorating - for example slippery roads, slurry, soft floors	Signage fitted as per plan Speed limit signs fitted as per plan Notification to work crews from mining deputies / under managers	Vehicles losing tractive effort driving over a short section of roadway	Vehicles losing tractive effort driving over a long section of roadway	Vehicles losing tractive effort driving over a long section of roadway causing the driver to initiate 4WD
Water holes deeper than 500mm or over gum boots	Signage fitted as per plan Speed limit signs fitted as per plan Notification to work crews from mining deputies / under managers	Water deeper than 500mm or over gum boots	Vehicles driving through water/slurry a long section of roadway	Vehicles driving through water/slurry a long section of roadway causing the driver to initiate 4WD
Roadways being worked on - for example trenches, roof support	Signage fitted as per plan Speed limit signs fitted as per plan Notification to work crews from mining deputies/ under managers.	Trenches and or roof support slowing transport vehicles down	Trenches and or roof support stopping transport vehicles for a short period	Trenches and or roof support stopping transport vehicles for an extended period
Roadway dust in mine air	No dust present while driving on mine roadways	Visible dust in the air that requires treatment ASAP	Visible dust in the air that requires treatment immediately	Visible dust in the air that requires vehicles to stop and not proceed

Primary Travel Road	Normal	Level 1	Level 2	Level 3
Excess vibration from vehicle	Signage fitted as per plan Speed limit signs fitted as per plan	Vibration that causes a passenger to be concerned	Vibration that causes a passenger to fill in an incident report	Vibration that causes a passenger to be injured
Poor visibility	Signage fitted as per plan Speed limit signs fitted as per plan Notification to work crews from mining deputies/ under managers.	Poor visibility that slows a vehicle down to less than normal travel speed	Poor visibility that slows a vehicle down travel in first gear	Poor visibility that stops a vehicle
Vehicle occupants hitting roof of vehicle while in transit	Signage fitted as per plan Speed limit signs fitted as per plan Notification to work crews from mining deputies/ under managers.	Vehicle occupant strikes body against vehicle while in transit to underground work area	Vehicle occupant strikes body against vehicle while in transit to underground work area causing the occupant to fill in an incident form	Vehicle occupant strikes body against vehicle while in transit to underground work area causing the occupant to be injured
Reduced visibility at intersections	Intersections maintained as per roadway management plan CMHSR 2006 CL 31 Mirrors fitted as per plan Signage fitted as per plan Speed limit signs fitted as per plan	Minor interaction with other vehicles at intersection/s	Interaction with other vehicles causing delay and possible incident	Interaction with other vehicles causing collision
Responsibility				
Operators	Normal vehicle operator tasks Report all changes in conditions to the deputies/ under managers. Read TARP board at start of shift	Notify deputy or under manager Fix problem	Notify deputy and under manager Fix problem	Notify production manager Fix problem Stop mining and await further instruction from the deputy

Primary Travel Road	Normal	Level 1	Level 2	Level 3
Deputies & under managers	Normal duties Check TARP board at start of shift Follow work plans and comply with support and monitoring requirements Complete reports; record mining conditions and monitoring results on statutory report	Check TARP Level at start of shift Inspect and review roadway conditions Complete shiftily report Inform undermanager/ control room operator of any trigger being exceeded Communicate to oncoming shift TARP level and conditions	Check TARP Level at start of shift Fix problem Notify undermanager Note location, geological and geotechnical details and remedial action taken on shift report Communicate to oncoming shift TARP level and conditions	Restrict access to area “No Road” area Cease operations Inform undermanager and control room operator Arrange for initial materials and equipment Supervise remedial works in consultation with the management team
Shift deputies and under managers	Contact from deputies every shift for an update on roadway conditions Review any incident forms Fill-in TARP log sheet	Fill-in TARP log sheet.	Notify production manager immediately	Immediately notify the mine manager, area superintendent, undermanager and the human resources manager Fill-in TARP log sheet
Production manager	Communicate and monitor work plans and progress Allocate/procure adequate resources to meet the work plan Comply with Underground Transport Management Plan/ Investigate non-compliance Review with shift Undermanager /Deputy reports Review completed Incident forms Communicate requirements via daily plan	As in Normal Level, including: • Review and assess roadway conditions • Check that the TARP log sheet is completed and the TARP level displayed on appropriate display	As in Level 1, including: • Inspect work area as soon as practical	As in Level 2, including: • Review and assess the need for additional works to be conducted • Report results to mine manager
Safety officer	Review any incident forms	Injury management of any personnel	Injury management of any personnel Report results to mine manager	Injury management of any personnel Report results to mine manager
Manager of mining engineering	Review and authorise Underground Transport Management Plan	Review any Incident forms Review and authorise Underground Transport Management Plan	Review any Incident forms Review any changes from an incident and authorise Underground TMP	Review any changes from an incident and authorise Underground Transport Management Plan

Appendix G - Whole Body Vibration (WBV) – Measurement and Assessment

The Australian standard AS2670.1-2001/ Amdt1-2013, *Evaluation of human exposure to whole-body vibration*, provides guidance on vibration exposure duration that could lead to adverse health effects mainly concerning back pain and damage to the spine.

Vibration is measured in three axes: forward to back, side to side and up and down. The standard uses a “caution zone” for classifying vibration exposure that is between the specified vibration limits depending on the duration of the exposure. To calculate the vibration level, a sensor is placed in the seat to pick up the vibration being transmitted through the body. The sensor detects the vibration in the three axes. The vibration signal is analysed and logged by a meter. Further analysis can be performed after downloading the data to the computer.

WBV measurements should be collected and analysed by a competent person such as an appropriately trained occupational health and safety professional, occupational hygienist, maintenance technician or engineer, or human vibration specialist.

For further information please refer to
www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/712/Whole_Body_Vibration_Fact_Sheet.pdf