

Australian/New Zealand Standard™

Remote control systems for mining equipment

Part 2: Operation and maintenance for underground metalliferous mining



AS/NZS 4240.2:2009

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-023, Electrical equipment in mines.

It is based on document MDG 5002, *Guidelines for the use of remote controlled mining equipment—Underground metalliferous mines*, which was developed for the Mine Safety Operations Division of the NSW Department of Primary Industries by a working group consisting of representatives from major underground metalliferous mines operating remote controlled mining equipment along with equipment suppliers, maintenance personnel and regulators.

The objective of this Standard is to provide mine sites with the information to assist in the management of risks associated with the use of remote controlled mining equipment in underground metalliferous mines.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

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SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for the work system design, equipment operation, maintenance, equipment, personnel and environment of remote controlled mining equipment in underground metalliferous operations. Technical requirements for the design of remote control equipment are given in AS/NZS 4240.1.

1.2 APPLICATION

This Standard applies to remote controlled mining equipment used in underground metalliferous mines and focuses on load haul dump (LHD) equipment. It applies to both line of sight and teleremote systems.

This Standard does not apply to the following equipment:

- (a) Automatic conveyor and shuttle systems.
- (b) Gantry cranes.
- (c) Shaft and drift winders.
- (d) Machines that are isolated from personnel.

It is important to note that—

- (i) adherence to the Standard does not itself assure compliance with the general duty of care; and
- (ii) mine operators deviating from the Standard should document a risk assessment supporting the alternative arrangements.

1.3 REFERENCED DOCUMENTS

AS

2187 Explosives—Storage and use

2187.2 Part 2: Use of explosives

4024 Safety of machinery

5062 Fire protection of mobile and transportable equipment

61508 Functional safety of electrical/electronic/programmable electronic safety-related systems

AS/NZS

4240 Remote control systems for mining equipment

4240.1 Part 1: Design, construction, testing, installation and commissioning

4360 Risk management

MDG 1010 Risk management handbook for the mining industry

1.4 DEFINITIONS

1.4.1 Back

The roof or upper part in any underground mining cavity.

1.4.2 Brow

The leading edge of an opening at the point where a stope or other opening commences.

1.4.3 Bund

A safety barrier usually built of broken rock that is installed near a vertical opening to prevent access into the opening.

1.4.4 Check sheet

A reminder of what you're looking for and a record of what you found.

1.4.5 Communication

Process of passing on information in a variety of ways so that the receiver understands the same message as the transmitter intended to give.

1.4.6 Competent person

A person who can demonstrate a combination of knowledge and skills to effectively, efficiently and safely carry out activities related to the operating of remote control machinery equipment as covered by this Standard.

1.4.7 Competency

Ability to apply appropriate skills and knowledge for the effective and efficient completion of a job or task in a variety of situations.

1.4.8 Cuddy

Deliberately cut place of refuge in a drive or drawpoint for the remote control operator to stand.

1.4.9 Development

Any combination of shafts, drives, cross-cuts, inclines and declines by which an underground mining operation is opened up.

1.4.10 Drawpoint

Opening into the bottom of a stope through which the ore from the stope is extracted.

1.4.11 Exclusion zone

A restricted zone around operating remote equipment that is under the control of the remote operator.

1.4.12 Ground control

The ability to predict and influence the behaviour of rock in a mining environment, having due regard for the safety of the workforce and the required serviceability and design life of the openings.

1.4.13 Hazard

Environmental or physical condition that can cause injury to people, property, or the environment.

1.4.14 Knowledge

Ability to obtain and retain theoretical information relating to a specific subject and being able to research further information.

1.4.15 Load haul dump (LHD)

Underground mobile equipment used to load and relocate materials.

1.4.16 Line of sight (LOS)

Where the remote controls are located with the operator who remains within natural visual and audible range of the equipment being controlled.

1.4.17 Mobile equipment

Equipment used to excavate, load or transport material that moves on wheels, tracks or skids.

1.4.18 Monitor

To check, supervise, observe critically or measure the progress of an activity, action or system on a regular basis in order to identify change from the performance level required or expected.

1.4.19 Mucking cycle

Process of loading the bucket of an LHD.

1.4.20 Risk

The chance of something happening that will have an impact on objectives.

1.4.21 Risk analysis

Systematic process to understand the nature of and deduce the level of risk.

1.4.22 Risk assessment

The overall process of risk identification, risk analysis and risk evaluation.

1.4.23 Risk criteria

Terms of reference by which the significance of risk is assessed.

1.4.24 Risk evaluation

Process of comparing the level of risk against risk criteria.

1.4.25 Risk identification

The process of determining what, where, when, why and how something could happen.

1.4.26 Risk management

The culture, processes and structures that are directed towards realizing potential opportunities whilst managing adverse effects.

1.4.27 Risk management process

The systematic application of management policies, procedures and practices to the tasks of communicating, establishing the context, identifying, analysing, evaluating, treating, monitoring and reviewing risk.

1.4.28 Self contained self rescuer (SCSR)

Emergency respirator to provide protection against contaminated air in an emergency.

1.4.29 Stope

Excavation, other than development, made for the purpose of excavating ore.

1.4.30 Teleremote operation

The operation of remote control equipment utilizing a control set that consists of both a remote control unit coupled with a system of closed circuit monitors.

1.4.31 Underground

Having an overlying cover of rock.

SECTION 2 MINE SAFETY MANAGEMENT PLAN

2.1 GENERAL

Management systems for the use of remote control mining equipment should be integrated with the Mine Safety Management Plan (MSMP) and be based on a risk management approach to safety. Users of this Standard should refer to AS/NZS 4360 or MDG 1010 for more information on this approach.

Systems and procedures for each of the planning, management and operational steps identified in this Standard should, where appropriate, be developed in consultation with mine design engineers, equipment suppliers and maintenance personnel, equipment operators and supervisors. These should be considered when developing hazard controls and safe systems of work for remote control mining equipment operations.

Procedures for monitoring and evaluating the entire remote controlled mining equipment process and environment should be developed as an initial part of developing safety work systems and procedures. That is, no system/procedure is complete without a monitoring, evaluation and review component.

Safe work systems for the use and maintenance of remote controlled mining equipment should be determined by a risk management approach. All hazards associated with the use and maintenance of remote control mining equipment should be identified, assessed and eliminated or adequately controlled using the hierarchy of controls

2.2 RECORD KEEPING AND DOCUMENTATION

The records and documentation of the design, planning, development (if applicable) and operation of remote control mining equipment should be integrated with the MSMP document control system. Accurate records should be kept of all stages of the remote controlled mining equipment operation, from the initial stope design stage to the selection, purchasing, commissioning, use and decommissioning of remote controlled equipment. Particular documents that may be considered include the following:

- (a) Documented risk assessments associated with the mine planning process. These should include selection of a mining method (stope design) that provides a safe work environment for the remote controlled equipment operator.
- (b) Safe work procedures for high risk activities.
- (c) Records of remote equipment selection process and purchase details.
- (d) Records of operational checks.
- (e) Records of workplace inspections.
- (f) Testing and maintenance records for remote controlled equipment, including the remote control receiver, transmitter and ancillary equipment.
- (g) Records of training and competency assessments.
- (h) Records of hazard reporting and follow up.
- (i) Audit and monitoring records.
- (j) Pro forma documents for daily and regular checks on equipment functionality, based on the risks identified.

2.3 TRAINING

The MSMP should include a training plan that ensures remote controlled equipment operators, supervisors and maintenance personnel are trained and competent to perform the tasks required of them. Training should include a documented training assessment process that includes both a practical and theory component. This may be a component of a safe work procedure competency based assessment. A reassessment program should be included in the training plan.

Training and skills should be recorded on each operator's personnel files.

2.4 MONITORING, SYSTEMS AUDIT AND REVIEW

Remote control equipment operations and procedures should include an auditing and review process to ensure required procedures and standards are being complied with. The auditing and review process should be part of the continuous improvement process under the MSMP. This includes action to—

- (a) monitor record keeping;
- (b) audit procedural compliance;
- (c) audit implementation of remedial action from hazard identification;
- (d) analyse results, both routinely and after unplanned movements or incidents/accidents involving remote control equipment;
- (e) feed outcomes from analysis back into future planning and operational processes; and
- (f) integrate the monitoring and review of remote control operations and procedures into the MSMP review and continuous improvement process.

SECTION 3 REMOTE CONTROLLED MINING EQUIPMENT — RISK IDENTIFICATION

3.1 SCOPE

This Section lists the main hazards associated with the use of remote controlled mining equipment in underground metalliferous mines and outlines some of the controls currently used in the industry to address them.

These lists are not exhaustive. There may be other hazards, including site specific hazards, which must be identified and controlled.

NOTE: Additional information that may assist the risk management process is contained in Appendix A. It provides supporting reference material and tables key system components, issues to be considered and possible controls.

For more information on how to conduct a risk assessment refer to AS/NZS 4360 or MDG 1010.

3.2 LINE OF SIGHT (LOS) OPERATIONS

3.2.1 Required outcome

Line of sight operations shall be undertaken in a safe and effective manner.

Due to the hazards associated with LOS operations, in this section a detailed risk assessment should be carried out prior to the commencement of LOS operations. The risk assessment needs to consider each of the main risks set out in this Section. A detailed action plan should then be developed and implemented to ensure that LOS operations do not expose personnel to any intolerable risks from the use of such equipment. As part of the risk assessment process the use of teleremote equipment should be considered to mitigate the hazards associated with the use of LOS equipment.

3.2.2 Main risks

The main risks can be physical, operational or managerial.

NOTE: See Appendices B, C and D.

3.2.2.1 Physical

The following physical risks have been identified:

- (a) Crush injuries from being struck by the remote controlled equipment, by working too close to remote controlled equipment.
- (b) Injury from uncontrolled equipment movement whilst operating the remote controlled equipment.
- (c) Injury from material falling from LHD bucket.
- (d) Exposure to injury from falling rocks, other material and potential airblasts while working near an open brow.

3.2.2.2 Operational

The following operational risks have been identified:

- (a) Exposure to injury during change over from remote control to manual operation and vice versa. Changeover point located too close to brow/under bad ground/not following changeover standards/procedures.
- (b) Remote control operator unaware of other personnel in the exclusion zone.

- (c) Operator unable to effectively communicate with other personnel in the case of an emergency.
- (d) Pre-start and mid-shift remote equipment checks not conducted and/or recorded.

3.2.2.3 Managerial

The following managerial risks have been identified:

- (a) Exposure to injury by conventionally driving into open stope or under bad ground. The operator does not have the training or competency to determine when to go onto remote control operation.
- (b) Exposure to injury during inspection of drawpoints and stope voids. Lack of a system that allows remote inspection of drawpoints and stope voids.
- (c) Plans and procedures not available or not used by the operators in the workplace.
- (d) Inexperienced operators or supervisors signing off on remote control procedures.
NOTE: Refer to examples of remote control LHD check sheets in Appendix E.
- (e) Lack of a competency based training and assessment program for remote controlled operations.
- (f) Inappropriate barrier selection or use.
- (g) Incorrect selection of the risk assessment team for remote control operation.

3.2.3 Main risk considerations

The following shall be considered:

- (a) Development of site standards and competencies for the identification of the potential hazards around open drawpoints and brows.
- (b) Development of site specific standards for the changeover point from manual to remote operation.
- (c) Development of a competency based training program and review process.
- (d) Development of a system that allows inspections of drawpoints to be carried out without exposing personnel to an open brow.
- (e) Development of a process to ensure all personnel have access to the relevant documentation, i.e. safe work procedures, risk assessment results and plans.
- (f) Implementation of a process to ensure that the pre-start and mid-shift checks are conducted and recorded correctly.
- (g) Inclusion of the location of the operator during remote control operations as part of the risk assessment.
- (h) Development and implementation of access and entry procedures to the exclusion zone.
- (i) Clearly marking up and displaying exclusion zones on plans and signing off prior to remote operations commencing.
- (j) Inclusion of a barrier system and design as part of the operational risk assessment and utilisation of the requirements of AS 4024 or other standards as appropriate.

Consideration should also be given to the following:

- (i) Shutting down the remote control equipment during the process of accessing and egressing the equipment.
- (ii) Determination of the remote-to-conventional and vice versa changeover point by the use of an operational risk assessment.

- (iii) Inclusion of communication infrastructure and systems for the remote control operator as part of the operational risk assessment process.
- (iv) The use of teleremote operations.
- (v) Undertaking the operational risk assessment team selection as per the requirements set out in AS/NZS 4360 or MDG 1010.

3.3 TELEREMOTE (TR) OPERATIONS

3.3.1 Required outcome

Teleremote (TR) operations shall be undertaken in a safe and efficient manner.

Whilst the use of TR systems reduces the hazards to the operator due to the removal of the operator from the immediate remote equipment work area, the risk of unauthorised access is potentially increased. In many cases the risks associated with LOS operations are similar to the TR operation and consideration should also be given to the main risks associated with LOS operation, which are detailed in Clause 3.2.2. However an emphasis on personnel access should be considered due to the remote location of the TR operator. The LOS risks and considerations should be considered when reviewing the risks for TR operations to see if they apply.

3.3.2 Main risks

The main risks for teleremote operations include:

- (a) Unauthorised access to teleremote operating area whilst teleremote controlled equipment is in operation.
- (b) Ineffective barrier system that allows unauthorised access to the teleremote operating area.
- (c) Inappropriate equipment operation due to poor or no training.
- (d) Inadequate allowance for the correct operation of the remote equipment.
- (e) A barrier system that fails to activate when initiated by teleremote controlled equipment or unauthorised person.
- (f) Failure of interlocking system to initiate teleremote controlled equipment trip in the event of barrier violation.
- (g) Incorrect selection/installation of barriers for the teleremote system. A barrier system could potentially fail to operate when required.
- (h) A barrier system that does not meet the requirements of AS 4024.
- (i) Teleremote controlled equipment that violates the barrier system with insufficient distance to stop the equipment contacting personnel outside the barrier.
- (j) Operators unable to determine status of barrier system without physical checks.
- (k) Equipment collision during teleremote operation.
- (l) Inability to activate fire suppression system on teleremote controlled equipment during teleremote operation.
- (m) A fire suppression system that does not comply with AS 5062.

3.3.3 Main risk considerations

The following shall be considered:

- (a) Inclusion of the distance between the barrier/s and the other personnel in the operational risk assessment.
- (b) Development of appropriate monitoring and audit systems for the barrier system.

- (c) Ensuring conformance with AS 4024 minimum CAT 3 rating, including verification and validation plan.
- (d) Inclusion of the requirement for a traffic management system as part of the risk assessment.
- (e) Conformance of the TR system to AS/NZS 4240.1 including the fire suppression activation system.
- (f) Inclusion in pre-start inspections of checking the work area to ensure that no personnel are inside the barrier system prior to commencing TR operations.
- (g) Development of an isolation system for the barrier system and associated remote equipment.

Consideration should also be given to the following:

- (i) Carrying out an operational risk assessment to AS/NZS 4360 or MDG 1010 prior to the commencement of TR equipment operation. The risk assessment should address conformance with AS 4024, and consideration should be given to other workplace activities that are required in the area.
- (ii) Making the remote status of barrier system available to the TR operator or other personnel in the work area.
- (iii) Providing a fire suppression system that conforms to AS 5062.

3.4 PLANNING AND DESIGN

3.4.1 Required outcome

Remote controlled mining equipment selection and operational requirements shall be evaluated in the mine design and planning process.

This process should evaluate all possible mining and associated remote controlled equipment options with the view to providing the safest working environment for remote controlled equipment operators for the life cycle of the mining operation. Consideration to the use of line of sight and/or teleremote operations needs to be reviewed in the initial mine design process. Mine design engineers should ensure that consideration is given to providing a safe work location for remote control mining equipment operators over the life of the mine.

3.4.2 Main risks

The main risks include:

- (a) Inadequate risk assessment process at the design stage, remote control issues not considered.
- (b) Inappropriate selection of the remote control system.
- (c) Poor designs that result in a development that is not fit for purpose (FFP) for remote equipment, including small drawpoint size and length. In truck loading areas, risk to operator whilst on remotes when trucks are operating in stope vicinity, especially on the truck blind side.
- (d) Incorrectly designed development/stopes that can result in unplanned ground movements including potential for airblast.
- (e) Provision of safe work locations for remote operators not considered at design stage. Operator may lose sight of equipment and enter exclusion zone to operate equipment.
- (f) General protection systems—physical barriers for the operator—risk of equipment moving/toppling barrier or entering the barrier system.
- (g) Exposure to other personnel who enter remote operating areas.

- (h) Original equipment manufacturer (OEM) specifications not reviewed during design process.
- (i) Inappropriate design of cuddy. Equipment may contact the operator, i.e. cuddy is in the wrong position, too large.

3.4.3 Main risk considerations

The following shall be considered:

- (a) Stope and development designs to be the outcome of a formal design process with appropriate system reviews and audits.
- (b) Engaging competent persons in the design process and making them aware of remote control equipment systems requirements.
- (c) Evaluation of geological and geotechnical issues by competent person(s).
- (d) Reviewing the remote control equipment requirements in the verification and validation plan for the mine design.

Consideration should also be given to the following:

- (i) Using an operational risk assessment to AS/NZS 4360 or MDG 1010 as part of the design process. Consideration should be given as part of the risk assessment for the amount of material to be removed and dirt left in stope prior to final clean up.
- (ii) Minimizing the use of remote controlled equipment in the stope design.

3.5 SAFE WORK LOCATIONS

3.5.1 Required outcome

A safe work location shall be included as part of the mine design process to ensure that a safe area is available for the remote operator to stand/sit whilst operating remote controlled equipment.

The remote operator work location should be designed in such a manner that ensures the remote equipment cannot come into contact with the operator under any circumstances.

3.5.2 Main risks

The main risks include:

- (a) Inadequate construction, design, position or poor ground support in remote control work area.
- (b) Cuddy is too small or too big for the application.
- (c) Cuddy is too close to brow or too far away for remote operator to safely observe remote controlled equipment operation.
- (d) Remote operator is exposed to falling rocks and/or poor ground conditions.
- (e) The size and location of the concrete blocks are too small for the size of the remote controlled equipment.
- (f) Unauthorised entry into the remote controlled equipment operating area.
- (g) Inadequate dust control systems and poor ventilation system causing dust and fumes to remain in the work area.
- (h) The design and installation of the work area and cuddy floor are inadequate and does not provide safe footing for the operator and a reduction in the risk of slips, trips and falls.
- (i) Cuddy design location is inadequate and does not allow the operator effective visibility.