Guideline for Free-Steered Vehicles

MDG 1

Produced by Mine Safety Operations Division,
New South Wales Department of
Primary Industries

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PRIMARY INDUSTRIES

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FOREWORD

This guideline specifies general safety requirements and tests for the design of free steered and self-propelled vehicles intended solely for operation at underground coal mines.

This document contains additional safety requirements to that contained in previous editions. The additional safety requirements were justified by the following:-

1. A review of 1026 injuries involving free steered vehicles in less than 4 years at NSW Underground Coal Mines.

2. Compensation payment of $3,385, 800 for the above injuries (Ref 1)

3. Reviews and system accident investigations of a number of fatalities at NSW Underground Coal Mines involving free steered vehicles.

4. Requirement and investigations in both the United Kingdom and USA. (Ref 2 and 3)

5 Papers on Diesel Engine Equipment used in NSW Underground Coal Mines.

The preparation of this document involved input and support from the following persons and organisations. Greg Isaccs (Eimco), Phil Nelthorpe (Jeffrey-Dresser), Greg Venticinque (Engineering Safety Systems), Steve Plain (Boart Longyear), Barbara McPhee (Worksafe), Graham Bailey (Domino), Phil Berriman (PJB), Dennis Pomfret (Power Coal), Gavin Black (Tahmoor), Gordon Jervis/Wally Koppe (Department of Mineral Resources) Andrew Vezos/Joe Kelly (AMMESA)

Such contribution involves representatives from colliers, manufactures and industry related experts who provided valuable input, feedback and guidance in the formulation of this document. The contribution is gratefully acknowledged and it recognised that without such contributions the document would not be to its present standard.

The edition of the guideline dated July 1995, replaces MDG 1, January 1991. As required from time to time the document shall be reviewed to reflect current safety expectations. Comments on any aspect of this guideline should submitted in writing to:

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Appendices

1.0 SCOPE

1.1 Clause 28 of the Coal Mines Regulation (Transport - Underground Mines) Regulation 1984, requires that all vehicles operated in an underground coal mine shall be approved by the Chief Inspector.

A "vehicle" as defined in the above regulation means a rubber tyred or caterpillar tracked vehicle propelled by electrical or mechanical means and used for the purpose of transporting persons, materials, coal or stone, whether by carrying, towing or otherwise and includes a shuttle car.

Note: Shuttle cars are covered by, MDG9 and continuous miners are covered by MDG17 and a separate guideline is presently being prepared for mobile drill rigs.

1.2 The following guideline is intended to help vehicle designers by indicating those parameters which will be considered in an approval assessment of free steered type vehicles. If any of the parameters as recommended are not adhered to, the approval applicant shall justify the alternative to the recommendation through a process of technical assessment, risk assessment and risk management.

This guideline primarily addresses diesel engined vehicles as they predominate in NSW underground coal mines but it should also be utilised where relevant for free steered vehicles powered by alternative means eg. compressed air or battery power.

The guidelines do not generally give quantitative information as it is not the intent to restrict innovative design. Where specific values or test procedures are required, advice should be sought from Inspectors of Mechanical Engineering of the Coal Mining Inspectorate and Engineering Branch of the Department of Mineral Resources (DMR) or an appropriate Accredited Assessing Authority.

1.3 Approval procedure shall be carried out in accordance with "The Applicants Guide to Approvals" (available from DMR). With specific regard to this guideline the following is informative.

1.3.1 Diesel Engined Vehicle or free steered vehicles powered by alternative means. eg Battery powered scoop trams. Applications for type approval should be supported by the following:-

(A) All information as requested in Appendix A1 (Application Guide) for DEV applications.

(B) A brief statement of compliance, variation or reason for non compliance with each item mentioned in these guidelines. A marked up and signed copy of these guidelines may be used.

(C) Results of tests and a statement of compliance with all requirements in accordance with the relevant standards.

1.3.2 Diesel Engined System (DES) Type approval applications should be supported by the following:-

(A) Results of tests and a statement of compliance with all requirements in accordance with Australian Standard AS 3584.

(B) All information as requested in Appendix A2 (Applicants Guide) for DES applications.

(C) A brief statement of compliance, variation or reason for non compliance with specific DES items contained in these guidelines.

1.4 A Limit of Application applies to this guideline. This guideline covers the operation of diesel powered vehicles on the following maximum grades:-

In the line of the vehicle axis - 1 in 4
Across the travel direction - 1 in 8

Use of diesel powered vehicles on steeper grades requires the application of special approval conditions after review by the OEM to ensure that the engine system remains flameproof as required and that the brakes are adequate and the vehicle is sufficiently stable. The latter constraints shall apply to vehicles powered by other means.

1.5 This guideline does not in any way negate the requirements of the NSW Coal Mines Regulation Act 67/1982 nor the NSW Occupational Health and Safety Act, 1983, No 20.

2.0 REFERENCES AND STANDARDS

Unless otherwise specified, the latest appropriate Australian Standard shall apply. Refer to Appendix A3 for a list of Standards, Guidelines and References.

3.0 DEFINITIONS

3.1 **APPROVED:** approved by the Chief Inspector of Coal Mines in accordance with the Coal Mines Regulation Act 1982.

3.2 **CABIN:** Is a fully enclosed operator compartment.

3.3 **CANOPY:** Refer **section 3.15** Protective Canopy

3.4 **CONTROLS - PRIMARY** Controls that are used continuously or frequently by the operator to maintain operational control, such as :-

(a) machine controls - steering, brakes, transmission, etc.
(b) Working tool controls - blade, bucket, etc.

CONTROLS - SECONDARY Controls that are infrequently used by the operator, such as lights, windscreen wipers, starter, etc.

3.5 **OPERATOR COMPARTMENT:** Is that area allocated to the Operator for the purpose of driving or controlling the vehicle.

3.6 **DES**: Diesel Engine System.

3.7 **DEV**: Diesel Engine Vehicle or Free Steered Vehicle

3.8 **DMR**: Department of Mineral Resources (NSW)

3.9 **ERGONOMICS:** is the design of equipment, processes and environments so that tasks and activities required of humans are within their limitations but also make the best use of their capabilities. More simply put - ergonomics is designing for people in the workplace. The application of ergonomics enhances people's ability to work safely and efficiently.

3.10 **FOPS**: falling object protective structure to AS 2294 or to any other standard acceptable to the Chief Inspector.

3.11 **FSV COMMITTEE**: A committee formed to improve safety and ergonomic aspects of free steered vehicles for use in underground coal mines. The committee includes muti-displinary personnel from all the major OEMs, Regulatory Authorises, Accredited Assessing Authorises, Relevant Experts and Coal Mining Companies.

3.12 **LHD:** Load Haul Dump Machine.

3.13 **MDG**: Mechanical Design Guideline refer to Appendix A3 for a list of relevant MDGs.

3.14 **O.E.M.:** refers to the Original Equipment Manufacturer

3.15 **PROTECTIVE CANOPY:** Is a protective device designed to protect the operator from falling coal or stone, or both, from above the machine. Refer Appendix A5; Mechanical Design Guidelines for the Construction of Continuous Miners Protective Canopies; which is part of MDG17.

3.16 **PROTECTIVE DEVICE:** a device designed to protect the operator and assistants from being injured if any of the cross supports erected in the mine were to fall in the vicinity of the vehicle. Refer to Appendix A4 for test requirements.

3.17 **RISK ASSESSMENT:** the overall process of risk analysis and risk evaluation.

3.18 **RISK MANAGEMENT PROCESS:** the systematic application of management policies, procedures and practices to the tasks of analysing, evaluating and controlling risk.

3.19 **ROPS:** roll over protective structure to AS 1636 or AS2294 or to any other standard acceptable to the Chief Inspector.

3.20 **VEHICLE:** Refer to scope **(section 1.0**).

4.0 ERGONOMIC AND ANTHROPOMETRIC REQUIREMENTS FOR OPERATOR AND PASSENGER COMPARTMENTS:

4.1 GENERAL REQUIREMENTS

4.1.1 The **ergonomic design** in this section of the guideline is based on the following fundamental premise:

Ergonomics uses the process of Risk Identification, Risk Assessment and Risk Control to examine the likelihood of risks associated with a job or a piece of equipment and how these might cause harm to a person. Ergonomics applied using this process enables the compilation of information on how risks might be minimised or eliminated, particularly at the design stage.

4.1.2 The operator station shall be located in the operator compartment to permit safe operation of the vehicle.

4.1.3 It is the responsibility of the user to determine site specific safety issues.

4.1.4 Provision shall be made for the transport of a stretcher patient on all vehicles designed to carry in excess of 2 passengers.

4.1.5 Operator compartments shall include provision such that when the operator exits or leaves the compartment the emergency / park brake shall automatically apply (for further details refer to braking section of this guideline).

4.1.6 OEMs shall avoid the inclusion of sharp edges within the compartments which could injure the operator or passengers. Movement of persons in the event of a collision and sudden stops should be considered.

4.1.7 **Minimum Head Room Requirements:** The distance from the underside of a protective device in the vicinity of a persons head to the top of the horizontal section of the persons seat shall be at least 1 metre for all combinations of seat and canopy adjustments to ensure that a seated persons head does not project higher than the protective device.

4.1.8 **Low height considerations:** It is recognised that ideal seating of personnel may not be possible where it is necessary for the overall vehicle height to be limited to suit low seam operations. Numerous additional hazards can result from the use of low height vehicles. These hazards include but are not limited to, reduced visibility, reduced comfort, increased potential to injure personnel due to jarring and greater potential for roof crush injuries. The OEM will need to demonstrate how these increased hazards are addressed.

4.1.9 **Excess Vertical Motion During Operation:** For vehicles where the operator or passengers are not situated between the axles the following shall be considered:-

Clearance between top of cab or canopy and the roof of the mine roadway, roof supports or any equipment supported from the roof should be determined in accordance with the recommendations contained in USBM Report No. HO242020.

This Report specifies nominal minimum clearance dimension which can be adjusted to take into account factors such as roadway surface quality and position of the operator compartment on the vehicle.

The additional clearance required to cater for excess vertical motion shall be shown on the vehicle operating clearance diagram required for approval of any particular type of vehicle.

4.2 ACCESS

4.2.1 Safe access to the operator and passenger compartments shall be provided, with adequate hand holds, in compliance with AS2953.1, AS2953.2 and AS3868. Notwithstanding such location of handgrips shall include:-

(a) Hand grips shall be provided on all vehicles to assist with access to any compartment.

(b) Hand grips shall also be provided to assist passengers when in a seated position.

(c) All hand grips shall be so positioned that a persons hand will not be vulnerable to danger from items external to the vehicle.

4.2.2 If the entry to the compartment is more than 400mm above ground level, a step complying with AS3868 shall be provided.

4.2.3 All vehicles and attachments which require persons to work at a height more than 1200 mm above ground level shall have handrails and access systems that comply with AS3868 “Earth moving machinery - design guide for access systems.”

4.2.4 The entrance to any compartment shall be designed to prevent personnel being thrown out of the vehicle. The design shall be such that it comfortably contains persons contained within the compartment.

ACCESS DOORS

4.2.5 LHDs shall be fitted with an approved door for access to the operators compartment (refer Appendix A6).

4.2.6 Where a hazard exists from materials entering the entrance of any compartment, a door meeting the requirements of "Design guidelines for articulated LHD vehicles operator's compartment doors" as found in Appendix A6 shall be fitted.

4.3 CONTROLS AND DISPLAYS

4.3.1 General:

Controls shall be laid out and designed to allow easy and safe operation based on the principle that a given direction of movement of any control produces a consistent and expected effect. Where confusion may result from the motion of a control, the effect from the movement of the control shall be clearly and permanently identified (refer **sections 4.3.2**). The controls should comply to **section 4.3.3** zones of comfort and reach for controls.

Note 1:- that the surfaces of frequently used pedals shall be fitted with skid resistant type materials.

Note 2**:-**Some controls may be adjustable to accommodate varying reach distances of operators eg. steering column, brake pedals.

4.3.2 Marking and illumination.

4.3.2.1 Marking of all controls shall be indelible and in accordance with AS2956.4.

4.3.2.2 All instrumentation should be colour coded to indicate normal and hazardous ranges as per SAE J209.

4.3.2.3 Display equipment should be illuminated to enable the operator to see gauges necessary for safe driving without the use of a cap lamp.

4.3.2.4 All warning signs, action prevention tags and nameplates should comply with AS1319.

4.3.3 Layout of controls.

4.3.3.1 Controls shall be laid out and designed to allow easy and safe operation and to prevent confusion over allocation of controls to functions or direction of operation (refer AS2956.5).

4.3.3.2 Controls should be organised into primary and secondary groups as detailed in AS2956.5 or SAE J898 or as shown in Appendices A10 to A12 inclusive.

4.3.3.3 Controls, such as those for hydraulic equipment and gear changing, the accidental operation of which could cause hazardous conditions, shall be located and designed such that accidental operation, particularly when the operator is entering or leaving the compartment, is prevented.

4.3.3.4 All primary controls including their displacement should be located with their neutral position and, if possible, all other positions in the zone of comfort as per AS2956.5 or SAE J898.

4.3.3.5 All secondary controls should be located within the zones of reach.

4.3.3.6 Controls, control linkages, hoses, tubes and connections shall be located in such a manner that they are not likely to be damaged by foreseeable external forces (ie. used as a step, maximum hand or foot force exerted) and are easily accessible for inspection.

4.3.3.7 If a wheel is used for steering, at least 180 degrees of arc should be located within the zone of comfort.

4.3.3.8. The distance between control levers, adjacent foot pedals, knobs, handles, operator's body and other machine parts shall be sufficient to allow unhindered operation without unintentional actuation of adjacent controls.

4.3.3.9 Controls should be designed to be actuated within the appropriate zones to eliminate potential interference between the body limbs when simultaneously operating the hand and foot controls. (Refer AS2956.5 or SAE J898)

4.3.4 Layout of instruments.

4.3.4.1 The layout and design of instrumentation in the panel group should comply with SAE J209.

4.3.5 Control force.

4.3.5.1 The controls should be of reliable design and construction, and arranged so that they are able to be operated with ease from the operator's seat and within the operator's force limits. Refer Table 1 below and section 4.3.3.

Table 1 - Control Force

APPENDAGE	CONTROL	DIRECTION	MAXIMUM FORCE (N)
HAND	WHEEL	STEERING AT RIM	115
	LEVER	FORWARD/BACKWARD	230
	LEVER	SIDEWAYS	100
	LEVER	BRAKE, UPWARDS	400
FOOT	PEDAL		450
	TREADLE	CENTRE-PIVOTED	230
TOE	PEDAL		90

4.3.6 Control functions

4.3.6.1 Machine motion controls should generally be left hand operated and working tool controls should generally be right hand operated.

4.3.6.2 All controls shall return to their neutral position when the operator releases control of them, unless the functional control of the vehicle or its equipment dictate otherwise, as in controls which:-

a) are continuously activated
b) are automatically activated
c) have a functionally related detent position, eg. gear change.

4.3.6.3 An “emergency brake” control consisting of a large red button requiring a push to stop with a detent in the stop position shall be provided in the operators compartment and easily accessible by the operator.

4.3.6.4 Primary controls should be similarly located for all vehicles, to assist operators who may regularly drive different vehicles.

4.3.6.5 The operating controls shall be clearly marked to show their function. Direction of movement is specified Table 2 below:

Table 2

FUNCTION	DIRECTION
ON	Down, right, forward, clockwise, pull (push / pull type switch).
OFF	Up, left, backward, anti - clockwise, push.
RIGHT	Clockwise, right.
LEFT	Anti - clockwise, left.
FORWARD	Forward, down.
REVERSE	Backward, up.
RAISE	Up, back.
LOWER	Down, forward.
RETRACT	Up, backward, pull.
EXTEND	Down, forward, push.
INCREASE	Forward, away, right, clockwise.
DECREASE	Backward, toward, left, anti - clockwise
OPEN VALVE	Anti - clockwise.
CLOSE VALVE	Clockwise.

4.4 OPERATORS DIMENSIONAL REQUIREMENTS / SEAT

4.4.1 Dimensional Requirements For Operators : The design of the operator's space must allow for freedom of movement and comfortable operating postures for the operator. Any manoeuvres necessary for the operation of the vehicle should be able to be performed safely and without unnecessary fatigue or discomfort.

4.4.2 Operator space envelope: Guidelines in AS2953.2 or ISO3411 shall be taken into account in the design of the operator's space. Refer also to Appendices A7 to A12 inclusive for further information.

4.4.3 Access to Controls: The layout and design of the reach envelope should allow the 5^{th} percentile and 95^{th} percentile operator to reach and operate the vehicle controls easily and without requiring awkward postures or movements.

4.4.4 Seat Design: Seating shall be provided for the operator and all passengers.

4.4.4.1 For uni-directional vehicles (that are predominantly driven in one direction) the operator should be seated in the dominant direction of travel. For bi-directional vehicles (such as single heading vehicles) two operator positions should be provided so that the operator can always face the direction of travel. This does not apply to bi- directional vehicles which frequently travel in each direction, where the operator sits at right angles to the direction of travel (such as LHDs).

4.4.4.2 The design of the operator and passenger compartments should prevent any part a persons body projecting outside the envelope of the compartment, or coming into accidental contact with the roof, canopy, or with moving parts of the vehicle.

4.4.4.3 The **design of the seat(s)** should allow for horizontal, vertical and/or swivel adjustment to accommodate smaller (5^{th} percentile) and larger (95^{th} percentile) operators. Compartment space should be sufficient to allow for the full range of adjustment required to operate the vehicle safely and comfortably.

(a) A horizontal (fore - aft) seat adjustment range of at least 150mm is recommended. Vertical adjustment of the seat also may be needed and a range of 150mm is recommended in order to accommodate the majority of operators . That is, the smallest (5^{th} percentile) operator can work comfortably with the seat in its most forward and highest positions, while the largest (95th percentile) operator can work comfortably with the seat in its most rearward and lowered position.

(b) Sufficient leg space both vertically and horizontally is essential for comfort and safety in the operation of foot controls. Foot controls should be placed low enough so that the operator's knees can bend at least 40 degrees from the straight position (140 degrees to 105 degrees is the preferred range) with the heel resting on the floor while operating. Refer to Appendix A7

(c) Where unavoidable space limitations require the seat to be smaller than optimum, the design of the seat and the compartment should be modified to allow for the difficulties imposed on the user. Consideration through the risk control process should then be given to improving the compartment design in areas where it is deficient. This would include the instance of low height as per **section 4.1.8.**

4.4.4.4 Optimum seat design should be:-

(i) stable and safe to adjust, work from and travel on.

(ii) correctly dimensioned and shaped in the seat and the backrest.(refer Appendices A13 to A15 inclusive). As a guide to operator's seat design or selection, the specifications and dimensions included in Appendices A13 and A14- may be useful. To accommodate 95% of the target user population some adjustability can be incorporated into the design eg. seat height, backrest angle, horizontal and vertical adjustments.

(iii) Adjustments should be easy to achieve for any user, preferably in the seated position. For practical purposes some dimensions eg. seat depth, backrest size, have to be fixed and compromises have to be made. As far as possible these compromises should not disadvantage one group in favour of another.

(iv) covered and padded so as to minimise discomfort from sitting on a hard impermeable surface. A minimum of 35mm of high density foam (preferably with 15- 20mm of soft foam on top) with water proof covering is suitable.

(v) designed in such a way as to minimise interference to trunk, head and limb movement and vision.

4.4.4.5 The seat and it's suspension should be designed to `reduce vibration transmitted to the operator to the lowest level that can be reasonably achieved, when measured in accordance with BS 6841 or AS 2670.

4.4.5 Seating and Seat Suspension:

As a guide to operator and passenger seat design or selection the dimensions shown in Appendices A13 to A15 inclusive 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. 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.

4.4.6 Seat belts:

Seat belts shall be fitted to all skid steer vehicle operator compartments for the operator and passengers on all vehicles, particularly those capable of speeds in excess of 20 Kph. The following criteria applies for seat belt installations:

(a) All seat belts and anchorages shall comply with AS 2664 or SAE J 386 or ISO 6683.

(b) Safety belts should be anchored to the seat rather than the floor to maintain operator comfort as large seat to floor movement can occur on some vehicles.

(c) Seats should be robust enough and anchored securely in order to provide adequate anchorage points for safety belts.

4.5 NOISE

This section describes the maximum noise exposure for FSV operators and passengers, and a means of determining this noise exposure.

The noise level requirements in this section are related to noise generated by the vehicle itself. They are not intended to cover noise sources produced by other equipment in the mine environment. However, the designer of a fully enclosed cab should consider noise reduction measures that cater for the general environment the vehicle will work in, in addition to those generated by the vehicle.

4.5.1 Noise Levels

4.5.1.1 The operator and passengers shall not be exposed to noise level that exceeds an eight hour equivalent continuous A-weighted sound pressure level, LAeq,8h, of 85 dB(A).

4.5.1.2 The operator and passengers shall not be exposed to a peak noise level, Lpeak, in excess of 140dB(lin).

4.5.1.3 Where the noise levels under any of the test conditions as specified in Appendix A16 exceeds 85dB(A), a sign shall be conspicuously displayed within the seated operator and passengers (as applicable) primary field of vision indicating that noise levels exceed permissible levels and that hearing protection should be worn.

4.5.2 **Testing:** refer to **section 5.20.5** and Appendix A16

4.6 STRENGTH AND PROTECTION REQUIREMENTS

4.6.1 Manufacturer to ensure that:

(a) the operator and passenger compartments are suitable for their intended design use and environment and be capable of providing a safe envelope in which the operator or passenger would not be injured in the case of an unplanned event or accident (that is yielding to a safe envelope is permitted), or

(b) The strength of all compartments shall exceed the maximum tractive effort and steering force developed by the vehicle and any forces emanating from either:-

- operational impact
- accidental impact.

Note: The forces referred to above should be identified through risk assessment.

4.6.2 The operator shall be protected from falls of roof or rib.

It is the responsibility of the user to determine the class or type of protection required to suit the mine specific environment and use.

4.6.3 Protection shall be available to minimise the possible ingress of substantial materials from the surrounds of the vehicle into the operators compartment or passenger compartments.

4.6.4 Passenger carrying vehicles shall be fitted with at least sufficient protection to shield the head and the major part of the body when the passenger is in a seated position.

4.6.5 The movement of any bucket on a loading machine shall be so restricted that it is not possible for any material to fall towards the seated operator. Alternatively "FOPS" may be fitted in accordance with **section 3.10**

4.6.6 Cabin roofs and/or protective devices shall meet the following minimum requirements:

Class 1
Vehicles travelling or working only under fully supported roof shall at least meet the requirements of Appendix A4 "Protective Devices for Free Steered Vehicles and Locomotives". Examples of this type of vehicle include: personnel and light materials transporters.

Additional protection to that afforded by protective devices should be considered. ROPS or ROPS in conjunction with FOPS to the relevant AS, SAE or ISO standard should be considered as alternative or additive to the protective devices.

Class 2
Vehicles travelling under fully supported roof which may need to work near to or under unsupported roof shall at least meet the requirements of the following:-

> A "Protective Canopy" in accordance with the Mechanical Design Guideline for the Construction of Continuous Miners, (MDG17) refer Appendix A5 for the relevant section.

Examples of this type of vehicle are LHDs.

4.7 VISIBILITY:

The operator's field of view shall comply with the acceptance criteria specified in ISO 5006.3 when tested in accordance with ISO 5006.1 and evaluated in accordance with ISO 5006.2.

Note: OEMs will need to extend the basic principle from ISO 5006.2 to ensure that it covers their equipment as the standard applies mainly to surface vehicles.

4.7.1 Line of Sight: Vision from the operator's position is an important consideration in the design of operator's cabs. Where a standard horizontal line of sight is established for optimum vision, the eye position for most operators (90%) would be in a range 50mm above or below this. Therefore, where seat height adjustment is not possible, achieving optimum sight lines for operators within this range shall be essential.

The driving position should be located so that the operator has good visibility in the direction of travel and is able to drive the vehicle safely. Where necessary, optical aids or other means of enhancing vision shall be provided.

The line of sight for a 5th percentile and 95 th percentile operators shall be drawn on a general arrangement drawing, from the eyes of the operator to 1500mm from level roadway and nearest point on the roadway in all directions. Such should include an overlay of the vehicle. The line of sight to the sides of the vehicle should be enhanced where necessary and should not be impeded by structures on the vehicle. Where necessary chamfering of external machine components should be considered to improve sightlines.

The manufacturer shall provide information on the field of view available to the operator (in accordance with ISO5006-1).

4.7.2 Illumination of Roadway

4.7.2.1 Lighting should be designed so that there is sufficient illumination so as to detect an obstacle on a typical Mine roadway and to bring the vehicle to a safe stop before any impact with such an obstacle.

A minimum of two headlights on each end of each vehicle shall be provided.

The end of the vehicle opposite to the direction of travel should be fitted with red lights which are readily visible from a distance of at least 40 metres.

The height of lights should suit undulating terrain. The installation of appropriate brake lights should be considered particularly for passenger carrying vehicles. Illumination should be such as to meet all of the minimum requirements. **See 4.7.2.1 (a) - (e).**

(a) The minimum illumination in the forward direction should be a minimum of 50 lux, being measured in front and on the centre line of the vehicle, one metre above floor level and ten metres forward of the operators eyes. (For Photometric Chart, See Appendix A17 and Appendix A18 for testing procedure).

(b) A vehicle being designed to operate equally in both direction, or which by reason of application shall be required to be driven for protracted distances in the reverse direction should provide 50 lux minimum, being measured at the rear and on the centre line of the vehicle, one metre above floor level and ten metres rearward of the operators eyes. (For Photometric Chart, See Appendix A17 and Appendix A18 for testing procedure)

(c) The minimum illumination in the rearward direction, provided that the vehicle design is such that the vehicle is not normally driven for protracted distances and that the maximum rearward speed of the vehicle is limited to less than 10 Kph, in the rearward direction should be 20 lux minimum, being measured at the rear and on the centre line of the vehicle, one metre above floor level and ten metres rearward of the operators eyes. (For Photometric Chart, See Appendix A17 and Appendix A18 for testing procedure).

(d) The maximum stopping distance of the vehicle should be calculated when operated at maximum speed on a typical Mine roadway. This distance (metres) should be multiplied by a factor of 1.5. The illumination at this distance (metres) shall not be less than 20 lux. See Appendix A18 for relevant calculations.

(e) The line of sight in both forward and rearward directions, for a 5^{th} percentile operator should be drawn on a general arrangement drawing, from the eyes of the operator to the nearest point on the roadway, being on the centre-line of the vehicle. The illumination at the roadway surface at these points should be measured. the illumination should not be less than 50 lux in the forward direction and 20 lux in the rearward direction.

4.7.2.2 Reflective media shall be provided at each end and the sides of the vehicles, on all steps and along the top edge of the cabin entrance in a position where it can be easily seen (as per AS 3836).

4.8 VIBRATION

This section of the guideline specifies the requirements and methods for determining the vibration exposure limits for operators of Free Steered Vehicles. A history of serious bodily injuries in relation to spine, neck and lower back muscle has prompted the inclusion of this section. It is recognised that the injuries were primarily caused by "jarring". This refers to the inability of the vehicle suspension systems (seat included) to dampen sudden changes in direction created as a result of abrupt road condition change. Hence primary concern regarding the safe design, construction and operation of vehicles rests with the ability to dampen jarring to a degree as not to cause injury to the operator or passengers. This section also includes a recommendation on rotational vibration.

4.8.1 **Vibration Exposure Limits:** Vibration exposure limits should satisfy the following requirements for the operation of Free Steered Vehicles over a single shift of 8 hours.

The vibration exposure limits should be determined for constant speed test runs over a standard mine roadway or equivalent. Testing should relate to travelling and transport applications. Test results should be recorded and presented as per Appendix A19.

All vehicles with the potential of causing injury to personnel resulting from vibration or repeated shock in the above applications should satisfy the recommended degraded health limits as specified in BS684 Clause 4 and AS2670 and ISO 2631 and Appendix A19.

4.8.1.1 The test results obtained for the five 'x' second runs specified in Appendix A19 shall be combined with the methods specified in BS6841 as if the free steered vehicle had been tested continuously for 4 hours at 5 distinct vehicle speeds. The 4 hours of continuous operation shall be considered equivalent to a typical 8 hour shift of vehicle operation.

4.9 WINDSCREENS, WINDOWS

4.9.1 Windscreens should be angled to the direction of travel to:

(a) stops light reflecting

(b) prevent build up of dirt.

4.9.2 Any glazing shall be made of safety glass or other material which provides similar safety and is scratch resistant.

4.9.3 Windscreen wipers, washers, demisters etc, shall be provided if the conditions under which the vehicle is to be operate makes these necessary.

5.0 GENERAL REQUIREMENTS

5.1 ALARMS

5.1.1 All **remote operated equipment** shall be fitted with automatic pre start warning alarms, preferably both audible and visual. Refer to **section 5.15** of this guideline.

5.1.2 **Reversing alarms** are required on all vehicles with the exception of vehicles generally driven equally in both directions (refer to Appendix A20).

5.1.3 Provision shall be made for at least one passenger in every passenger compartment to have access to an alarm which shall be audible to the operator in the operators compartment and others in the vicinity of the vehicle.

5.2 ALUMINIUM

(Refer to the materials **section 5.14**).

5.3 AUXILIARY EQUIPMENT

All auxiliary equipment shall as a minimum comply with the relevant Australian Standard and any additional requirements contained within this guideline. This includes both permanent and removable devices. Where relevant the equipment shall be tested and certified by a qualified engineer.

5.3.1 **Crane** type devices shall comply with AS1418.2 and AS1418.5.

5.3.2 **Forklift** type devices shall comply with AS2359.

5.3.3 **Quick** attachment systems shall:-

(a) utilise factors of safety equivalent to the requirements of either of AS2359 or AS1418.5 as applicable;

(b) include a separately operated locking device for secure retention;

(c) shall not rely on stored energy for secure retention;

(d) shall not require a person to be exposed to any hazards for the attachment and removal of the attachment from the vehicle.

5.3.4 **Winches** shall comply with AS1418.2

5.3.4.2 Rope hooks or rope ends shall comply with the relevant Australian Standard.

5.3.4.3 Overload protection shall be provided to prevent rope or component breakage which may result in injury to persons in the vicinity.

The overload protection shall be specifically for the winch, ie not for other functions of the vehicle.

5.3.4.4 Winch drives which do not run in reverse in the event of an overload should be avoided.

5.3.4.5 The winch cable or chain shall have a minimum of 4:1 safety factor on maximum winch tension.

If the winch is not self relieving then it shall be designed and tested to ensure that under all conditions, the maximum tractive effort of the vehicle does not exceeded the rating of the winch, cable and attachment.

All winch rope attachments shall have at least the same rating as the winch rope and shall comply with the following standards

Lifting components for grade T chain slings	AS3776
Chains (Grade T)	AS2321
Eye Bolts	AS2317
Swivels	AS2318
Wedge Type Sockets	AS2740
Shackles	AS2741
Steel Wire Rope	AS3569

All winch ropes shall comply with AS2759 (steel wire rope application guide.) The operator's compartment on all vehicles fitted with a winch shall be protected from a broken cable lashing into the cabin. Heavy duty meshed openings on the compartment satisfy this requirement. Winches shall not be loaded beyond the manufacturer's recommended load and shall comply with AS1418.2 (Serial hoists and winches.)

5.3.5 **Work platforms** shall comply with Australian Standard AS1418.10 and should comply with the following:

5.3.5.1 Provision of **hand rails and toe rails** refer to AS1657.

5.3.5.2 Provision of non-slip flooring.

5.3.5.3 Provision of an inward opening door.

5.3.5.4 Provision for attachment point for safety lines.

5.3.5.5 Platforms that raise above 1500mm from ground level shall be fitted with an emergency egress system.

5.3.5.6 Controls on the platform should include at least the functions of raise, lower, tilt emergency stop and provision to lower the platform in the event of a power failure.

5.3.5.7 Provision should be made to afford personnel on the work platform sufficient protection to avoid injury in the event of the platform being inadvertently raised to the roof or against other obstructions.

5.3.5.8 A sign will be displayed in a prominent position to indicate maximum load, maximum number of persons and safe operating instructions.

5.3.5.9 Provision for load locks on the platform elevating hydraulics.

5.3.5.10 Provision to isolate vehicle movement whilst the work platform is in use.

5.3.5.11 An emergency stop which shuts down the diesel engine shall be fitted so that it is accessible from the platform.

5.3.5.12 A method or system shall be developed to prevent inadvertent movement of the vehicle whilst personnel are in the work platform. Accidental control from the operator's compartment such as steering, increase/decrease of engine speed release of the park or the service brakes, tramming forward or reverse and lift and tilt of the platform should all be considered.

5.3.5.13 provision of adequate stability to prevent a flat tyre or contact with the roof resulting in the platform becoming critically unstable ie. roll over.

5.4 AUXILIARY TRANSMISSION BELTS

Auxiliary transmission belts and fan belts not being part of the engine system shall comply with the requirements of AS3584, which includes the provision that the belts be fire resistant and anti-static to AS2784.

5.5 BRAKES

Four (4) types of braking systems shall be provided for use on any vehicle. These systems are classified as follows:

5.5.1 Service brakes - to be used as the primary braking system during normal operation of the vehicle.

5.5.2 Emergency brakes - to be applied by the operator in the event of a failure of the service brakes.

5.5.3 Parking brakes - used to prevent movement of a stationary vehicle.; and

5.5.4 Automatic brakes - which need not be intentionally applied by the operator.

5.5.5 Brake Independence

The service brakes shall be sufficiently independent of the other systems so that failure of the service brakes will not prevent the operation of the other systems.

5.5.6 Brake Combinations

Nothing prevents the three (3) non service brake systems being combined in any combination providing the other requirements for each individual brake contained in this guideline are satisfied.

5.5.7 Failsafe

At least the emergency, automatic and park brake systems shall fail to safety. Brakes applied by springs on the release of fluid pressure satisfy this requirement.

5.5.8 General

5.5.8.1 All braking systems should be designed to eliminate, or minimise as far as practicable, locking of wheels.

5.5.8.2 Power assisted braking shall be capable of operation in the event of engine failure to enable the vehicle to be brought safely to rest. For brakes operated by stored pressure systems, the capacity of the stored pressure shall be such as to permit at least five applications of the service brakes, after the engine has stopped.

5.5.8.3 Hydraulic or pneumatic, pressure applied, braking systems shall include a pressure gauge clearly marked to indicate the minimum safe brake operating pressure. The gauge shall be easily visible from the operator's seat.

5.5.8.4 Hydraulic braking systems shall use approved fire resistant oil or fluid except where hydrostatic service braking is used or totally enclosed and oil immersed brakes are used.

5.5.8.5 The emergency brake, automatic brake and the park brake (which may be combined) once applied shall require the control to be manually reset before the brakes may be released.

5.5.8.6 An effective interlock should be provided to protect against the vehicle being driven with the park brake, automatic brake or the emergency brake (which may be combined) applied. A brake which applies sufficient braking effort such that it exceeds the tractive effort of the vehicle meets this requirement.

5.5.8.7 Mechanical brake assemblies shall be of fully enclosed liquid cooled type or a brake type which limits surface temperature to a maximum of 150 degrees centigrade.

5.5.8.8 A clearly identifiable means of monitoring brake wear and the safe adjustment range should be provided.

5.5.8.9 Vehicles carrying more than two persons, including the operator, shall have the service and emergency brake acting on all wheels.

Note: Braking should be provided on all wheels of all vehicles.

5.5.8.10 See **sections 4.3** for details of brake control function and location.

5.5.8.11 Service and emergency braking systems shall be so constructed that the response time between initiation and commencement of braking does not exceed 0.7 seconds (excludes human response time).

5.5.8.12 Brakes shall not contain asbestos materials.

5.5.8.13 If wear of any brake components reduces brake effectiveness then this shall be catered for in the design of the system.

5.5.8.14 Effective means shall be provided to limit the surface temperature of brake systems to a maximum of 150 degrees centigrade.

5.5.8.15 All interlocks, valves, logic components, associated mechanical devices (eg door hinges) shall be engineered, so as to minimise as far as practicable any accidental application of any brade, by reason of system, design or component failure.

5.5.9 Service brakes.

5.5.9.1 Mechanical service brakes are preferred.

5.5.9.2 Hydrostatic service braking is permitted for skid steer vehicles provided dual circuits are used such that the failure of one circuit will not prevent the other from acting to apply the respective brake. Hydrostatic service braking for other vehicles shall be permitted provided adequate factors of safety are included in the design.

5.5.9.3 The service brakes shall bring the fully laden vehicle to rest from full speed in both directions on a dry level concrete surface in the distance specified in the following Table 3 when travelling at its maximum designed speed as detailed in section **5.19.**

Table 3

TABLE-BRAKE PERFORMANCE REQUIREMENTS

VEHICLE SPEED	STOPPING DISTANCE
km/hr	metres
6	0.31
10	1.47
14	2.88
18	5.18
22	7.06
26	9.19

NOTE: The above table is based on SAE J1152 in reference to a retardation of approximately 2.8 metres per second per second.

5.5.10 Emergency brake

5.5.10.1 The emergency brake system shall be:

(a) brakes which are automatically applied on the loss of brake / hydraulic fluid or air pressure (fail to safety) or

(b) may utilise parking brakes provided it complies with all other requirements of emergency brakes.

5.5.10.2 The emergency brake shall bring the fully laden vehicle to rest from full speed in both directions on a dry level concrete surface in not more than double the stopping distance recorded for service brake test as per **5.5.5.3.**

5.5.10.3 The severity of the emergency systems shall be such that there is minimal risk of injury to personnel within the vehicle.

5.5.10.4 Emergency braking should not utilise hydrostatic braking.

5.5.10.5 The emergency brake control should be a large red button readily visible which is pushed to apply the brakes. This button shall be located in a position readily accessible to the operator.

5.5.11 Parking brakes

Parking brakes shall hold the vehicle including 110% of the maximum permissible load which may be carried or hauled thereby, stationary on the maximum gradient on which that vehicle is designed to operate (refer to **section 1.4**). In addition parking brakes shall comply with the following:-

5.5.11.1 Parking brakes shall be applied automatically on the loss of brake / hydraulic fluid or air pressure (fail to safety).

5.5.11.2 Cables shall not be used for the application of the parking brake.

5.5.11.3 Parking brakes shall not rely on stored fluid pressure for their application or retention.

5.5.12 Automatic brakes

Automatic brakes shall hold the vehicle including the maximum permissible load which may be carried or hauled thereby, stationary on the maximum gradient on which that vehicle is designed to operate (refer to **section 5.5.11**). Automatic brakes shall also be capable of bring the vehicle safely to rest when travelling at maximum speed with maximum permissible load. In addition automatic brakes shall comply with the following:-

5.5.12.1 Automatic brakes shall be applied automatically on the loss of brake / hydraulic fluid or air pressure (fail to safety).

5.5.12.2 Cables shall not be used for the application of the automatic brake.

5.5.12.3 Automatic brakes shall not rely on stored fluid pressure for their application or retention.

5.5.12.4 The automatic brake shall be automatically applied whenever the operator leaves the vehicles operator compartment.

5.5.12.5 The automatic brake shall be automatically applied whenever the operator stops the engine.

5.5.12.6 The automatic brake shall be automatically applied whenever the engine stops for any cause (eg the operation of the engine safety protection system). This provision shall apply to all vehicles, except small skid steer loaders, where an inadvertent stoppage may cause instability.

5.5.12.7 The severity of the automatic brake system shall be such that there is minimal risk of injury to personnel within the vehicle during operation (including inadvertent operation).

5.6 VEHICLE CONTROL SYSTEMS.

Refer to **section 5.8.3**

5.7 ELECTRICAL

All electrical apparatus shall comply with the requirements of the Coal Mines Regulation Act 67 / 1982, subsequent Regulations and relevant Australian Standards.

AS2595 part 1 is one of the relevant standards.

All work on explosion protected electrical apparatus shall be processed through a facility approved for the purpose in accordance with the Coal Mines Regulation Act 1982 No.67.

5.8 DIESEL ENGINE SYSTEMS

5.8.1 General

(a) Diesel engine system shall comply with Australian Standards AS3584 Diesel Engine Systems for underground coal mines

(b) All vehicles should be fitted with a meter to measure engine operating hours.

(c) Routine testing of the engine system components and systems shall conform to AS3584.

(d) Guards- All rotating elements shall be guarded in accordance with AS4024.

5.8.2 Engine Controls

5.8.2.1 A means should be provided for readily identifying the reason for automatic shutdown of an engine automatic safety shutdown system.

5.8.2.2 There should be no readily accessible means other than the nominated device of defeating the engine automatic safety shutdown system.

5.8.2.3 Normal manual shutdown system shall automatically remain in the shutdown position until manually reset for starting.

5.8.3 Control interlocking for starting.

5.8.3.1 Neutral interlock shall be provided on all vehicles. Such provision is to allow the vehicle to be started only when the transmission and transmission control are in neutral. The neutral interlock shall also prevent the operator engaging the transmission drive position whilst ever the engine safety shutdown system override is engaged.

5.8.3.2 Interlocking shall be provided so that the park brake and park brake control are applied before a vehicle can be started.

5.8.3.3 Any hazardous movement of the vehicle or its working equipment shall be avoided whilst starting the engine.

5.8.4 Exhaust emission testing.

5.8.4.1 Exhaust emission testing shall be conducted in accordance with MDG29 and AS3584.

5.8.4.2 The OEM shall recommend a suitable method of loading the engine whilst it is in the vehicle.

5.8.4.3 The loading of the engine shall as closely as possible match that established during the original type approval testing.

5.8.5 Exhaust conditioner. Where a water based exhaust conditioner system is used the following shall apply.

5.8.5.1 Consideration should be given to providing sufficient water in the conditioner header tank, to permit operation of the vehicle under normal operating conditions for a full shift.

5.8.5.2 To minimise the ingress of foreign material which could cause safety devices to malfunction header tanks should be made from a corrosion resistant material and a strainer should be utilised in the header tank discharge line.

5.8.5.3 Hoses from the header tank to the conditioner should be arranged so that a sediment trap is not formed and they are not vulnerable to damage.

5.8.5.4 Testing to ensure that the engine exhaust remains flameproof at all angles of vehicle operation shall be conducted in accordance with **section 5.20** of this guideline.

Note: This is required as DES type approval packages are not normally tested with the final header tank and the low water shutdown sensor which may be located differently in a vehicle.

5.8.6 Exhaust flametrap. As required by AS3584 two separate systems shall be provided to ensure the exhaust system has a reliable flame trap eg the low water shutdown on a water based exhaust system is backed up by a thermal sensing device as specified by AS3584, however alternative devices such as a second low water shutdown sensing device may be acceptable.

5.8.7 Exhaust outlet.

5.8.7.1 The exhaust outlet from the conditioner shall be designed to:-
(a) effectively channel exhaust gases away from the operator and passengers.

(b) be located on the opposite side of the vehicle to the operator.
(c) to avoid recirculation of the exhaust gas.
(d) minimise disturbance of roadway dust.
(e) include a system of dilution of the exhaust gases where this can be achieved without any increased exposure to the operator or passengers.

5.8.8 Fuel tank.

5.8.8.1 Fuel tank capacity should not exceed a maximum of six hours engine running at the maximum rated engine power. A rule of thumb is maximum fuel tank size (in litres) = maximum approved power rating in kilowatt multiplied by two.

5.8.8.2 Fuel filling points shall be fitted with spring closed caps which effectively prevent the spillage of fuel under any condition of operation of the vehicle.

5.9 FIRE SUPPRESSION EQUIPMENT

5.9.1 Portable systems. The NSW Coal Mines Regulations 1984 require approved portable fire extinguisher to be installed on all vehicles. The extinguisher shall have a minimum SAA rating of 80BE.

The fire extinguisher is to be mounted on the vehicle within easy access by the operator. The location should be nominated by the manufacture taking into account that operator movement and visibility is not impaired.

5.9.2 Fixed systems. Fixed fire extinguishing systems are not currently generally required by the Coal Mines Regulations. An OEM or end user may use these systems to address the apparent risk in the intended environment. Fixed systems shall comply with the intent of MDG 13 and the following : -

A formal risk assessment shall be conducted to ensure the system is adequate and suitable for underground use and does not introduce additional hazards eg. reduction in visibility, reduction in oxygen content or the release of hazardous gases which may affect personnel.

5.10 FLUID POWER.

All fluid power systems shall comply with AS2671, AS4024.1 and AS4024.2.

5.10.1 Accumulators

All hydraulic accumulators shall be certified in compliance with Australian Standard AS1210 or British Standard BS7201.

5.10.1.1 Where a hydraulic system incorporates an accumulator the attachment to the accumulator shall be by means of a minimal length adaptor and flexible hose.

5.10.1.2 Fittings shall be located or otherwise guarded to provide mechanical protection.

5.10.1.3 A manual bleed valve shall be fitted to allow pressure relief for maintenance. Fluid should return to tank.

5.10.1.4 Accumulators shall be securely installed.

5.10.2 Air compressors.

Air compressors shall be of a liquid cooled type in accordance with AS3584.

5.10.3 Fluid reservoirs.

5.10.3.1 All fluid reservoirs shall be fitted with a robust filler cap that is rated for the maximum pressure in the reservoir system. The cap shall effectively seal the tank from any leakage and be positioned to minimise impact damage in the event of a vehicle collision.

5.10.3.2 Filler caps should be self closing.

5.10.4 Hoses

5.10.4.1 Flexible hoses shall be compatible with the hydraulic fluid used, maximum system pressure and temperature.

5.10.4.2 The hose factor of safety shall be a minimum of 4 to 1 based on hose burst pressure to maximum working pressure.

5.10.4.3 Hydraulic hose shall comply with the provisions of AS3791. The requirements for flame resistance shall be in accordance with testing to AS1180.10B and acceptance to AS2660 or alternately satisfy Schedule 2G of the U.S. Bureau of Mines or comply with type 1 or 3 hose specifications as listed in ISO 6805.

5.10.4.4 The use of nylon or PVC piping for pneumatic control systems will be acceptable only in cases where loss of pressure within these systems cause the system to fail to safety. All such piping shall be adequately protected and shielded from contact with hot and/or sharp surfaces.

5.10.4.5 Air hoses shall be in accordance with AS2660 unless specified otherwise.

Water hoses should be in accordance with AS2660.

5.10.4.6 Elastomeric (rubber type) hose shall not be used between an air compressor and air receiver. Teflon with steel braid is necessary.

5.10.5 Pressure vessels.

5.10.5.1 All pressure vessels of capacity greater than 30 litres shall comply with AS1210 - Unfired Pressure Vessels.

5.10.5.2 Pressure vessels having a capacity of 30- litres or less which do not comply with AS1210 shall comply with at least one of the following

(a) AS2971 Serially Produced Pressure Vessels
(b) SAE.J10 Automotive and Off - Highway Air Brake Reservoir Performance and Identification Requirements.

5.10.5.3 A drain line with a manual valve should be provided to drain the lowest point of all air receivers. This line and valve should be suitably protected against damage during transport.

5.10.5.4 The OEM shall provide a current “Certificate of Inspection” issued by a “Licensed Boiler Inspector” in compliance with the “Coal Mines Regulation (Mechanical - Underground Mines) Regulation 1984.

5.11 LABELLING

In addition to the labelling requirements for the operator compartment contained in section 4 of this guideline the following labels shall be required as applicable.

5.11.1 The DEV and DES numbers.

5.11.2 The date of manufacture.

5.11.3 The tare and gross weight of the vehicle.

5.11.4 The maximum number of personnel for which seating is provided in each compartment.

5.11.5 The ventilating air quantity required at maximum power output. This shall be based on a minimum of 0.06 cubic metres per second (Coal Mines Regulations 1984) or 3.5 cubic metres per second which ever is the greater.

5.11.6 Maximum operating grade.

5.11.7 Towing instructions

(a) for the vehicle if inoperable.
(b) for towing a load.
(c) maximum load to be towed.

5.11.8 A warning sign adjacent to the fan.

5.11.9 A warning at all accumulators that pressure must be safely released before work commences.

5.11.10 A warning on any spring applied brake chamber that it contains a spring under pressure.

5.11.11 An operator check list is to be provided within the control compartment denoting the minimum operator checks prior to operating the machine. The checklist will be constructed of engraved “Traffolyte” or similar. (See Appendix A21).

5.11.12 A danger sign shall be fitted at each side of the hinge on any articulated vehicle instructing that the articulating locking device shall be used before commencing maintenance.

5.11.13 A danger sign shall be fitted on any skid steer loader instructing operators to lower the bucket for access and that they must wear their seatbelts.

5.11.14 Tyre pressure shall be clearly displayed in the vicinity of each tyre except where the tyre is solid, filled with polyurethane or similar material, partial water fill, in which case there shall be a sign in the vicinity of each tyre to that effect.

5.11.15 A warning that hearing protection must be worn if noise level exceeds 85dB(A) for that vehicle.

5.11.16 Minimum safe operating pressure shall be marked on the pressure gauges of hydraulic and/or pneumatic braking systems.

5.11.17 The exhaust conditioner “test point”. The exhaust conditioner “drain point”.

5.11.18 A danger sign shall be placed in the proximity of the raising / lowering device instructing that the mechanical locking device (section **5.16**) shall be used before commencing maintenance.

5.11.19 A warning that the park brake should be applied before leaving the vehicle.

5.11.20 A warning sign shall be fitted to all vehicles with winches warning nearby personnel to stand clear when in operation and giving the maximum allowable tension in kilograms.

5.11.21 A warning sign shall be fitted to all elevating work platforms, cranes and forklifts indicating safe maximum load, maximum operating grades and safe lifting height.

5.13 MANUALS AND OEM INFORMATION TO CLIENT

5.13.1 A recommended operating manual and maintenance manual must be provided. Such manuals shall relate where required to general items under the Coal Mines Regulation Act Section 101 Transport Rules and Section 103 Schemes for testing of Electrical or Mechanical Apparatus.

5.13.2 Sufficient information must be supplied by the manufacturer to ensure that the requirements of the Occupational Health and Safety Act, 1983. No 20 are complied with, this includes but is not limited to Section 18.

5.14 MATERIALS

5.14.1 The use of significant quantities of non fire resistant polyurethane shall be avoided. This is to minimise the risk of toxic fumes in the event of fire.

5.14.2 The use of aluminium or light metal alloys shall be avoided where practical. The use of light metal alloys or aluminium is only permitted if it complies with either AS3584 or MDG 11.

5.14.3 Vehicles shall, as far as practicable be constructed of non-flammable material.

5.15 REMOTE CONTROL

Vehicles controlled remotely shall comply with AS4240.

5.15.1 The emergency stop on a remote control panel shall apply the brakes and stop the vehicle with minimal delay.

5.15.2 The emergency system shall be fail to safety.

5.15.3 Critical control valves and hydraulic circuits shall be designed for maximum reliability ie filtration systems, preference for poppet valves rather than spool type (found to be more reliable in operation when using slightly contaminated hydraulic fluid).

5.15.4 Remote radio control panels should be individually marked to match a specific vehicle so controls cannot be confused between vehicles.

5.15.5 Pre - start warning shall be provided. Refer to **section 5.1** of this guideline.

5.15.6 External emergency stops fixed to the vehicle should be considered during the risk assessment for the operation of this type of vehicle.

5.16 SAFETY DEVICES

Mechanical safety devices shall be provided as follows:-

5.16.1 All articulated vehicles shall be equipped with a safety bar or equivalent device which can readily be fitted without special tools to prevent movement of the articulation joint during maintenance work in the vicinity of this joint. Refer SAE J276.

5.16.2 All items raised and lowered by hydraulic power shall be fitted with a device which will hold the item stationary should a loss of hydraulic pressure occur. This applies to crane jibs, skid steer loader implements and all man lift devices. A typical device fitted to hydraulic lift cylinders is called a load locking valve. It is preferred that these devices be fitted directly to the cylinders. If this is not feasible the connection between the device and the cylinder should be made of steel pipe. In all respects the device shall comply with the requirements of the Mine Safety and Health Administration of the U.S. Department of Labour issued on 17th October, 1990 (attached as Appendix A22, MDG10).

5.16.3 A mechanical locking device shall be provided captive on the vehicle to adequately support the raising / lowering device for the purposes of maintenance. This provision includes bucket loaders and skid steer loaders. Refer SAE J38.

5.16.4 All vehicles in which access is over the bucket shall be equipped with a bar or bars which effectively isolate the bucket movements when a person is entering or leaving the operators seat. This device should be fail to safety eg skid steer loaders.

5.17 STEERING

5.17.1 All vehicles which have a maximum speed exceeding 10 kph shall have a steering system which is capable of being safely operated to enable the vehicle to be bought safely to rest in the event of an engine shutdown.

5.17.2 Emergency steering shall at least comply with SAE J53.

5.17.3 Means shall be provided to prevent injury to the operator from shock loads applied to the driving wheels being transmitted to the steering wheel or steering device.

5.17.4 Where power assisted steering is provided, the hydraulic power source shall only be combined with other hydraulic equipment if the steering system has priority from the pump and will not be affected by leaks or failure of the other hydraulic equipment.

5.18 STRETCHER PROVISIONS

Provision shall be made for the transport of a stretcher patient on all vehicles designed to carry 3 or more people, including the operator. Design of the stretcher carrying device should be suitable for a Stokes Litter Stretcher.

5.19 SURFACE TEMPERATURE

No external surface temperature shall exceed 150 degrees centigrade under any conditions of vehicle usage. Such includes brake devices, compressors and all other heat sources.

5.20 TESTING

Significant testing details are as follows. It is noted that this is not a complete list of all testing required however the intent is to provide guidance on specific tests.

5.20.1 Brakes.

Brake testing shall be conducted with brakes adjusted to simulate maximum recommended brake wear as stipulated by the OEM, or alternatively brake retardation rates for worn brakes may be calculated from results of testing of new brake linings. Brake test equipment shall automatically record operator force, brake response time, maximum and average deceleration rate, speed and stopping distance. All testing shall be conducted in both directions of travel. Testing shall be conducted with the vehicle loaded to maximum capacity. Brake testing shall be conducted at a sufficient frequency and rate to ensure that surface temperatures do not exceed 150 degrees centigrade ie. tests should be conducted until external brake temperatures stabilise.

Note: Performance of the park brake and automatic may be determined by testing on level surface and conducting calculations to ensure that the requirements for the brakes relevant to grades are complied with.

5.20.2 Canopy.

Canopies and protective devices shall be tested as follows:

(a) Class 1 (minimum requirements) - test in accordance with Appendix A4 Protective Devices for Free Steered Vehicles and Locomotives.

(b) ROPS and FOPS. Shall be tested in accordance with the relevant AS, SAE or ISO standard.

(c) Class 2 . Compliance with MDG17 is required. Testing is in accordance with Appendix A5.

5.20.3 Illumination

Illumination testing should be conducted in accordance with the standards and procedure stipulated in **section 4.7.2** "Illumination of Roadways" of this guideline.

5.20.4 Low water shutdown.

The complete low water shutdown system shall be tested as installed within the vehicle by repeating the angle shutdown tests as required by AS3584 for the engine package. This will require shutdown tests with the vehicle angled to the same angles as in AS3584. Once the engine shutdown has occurred the conditioner shutdown valve shall be closed, the vehicle placed horizontally (level) and the water level in the conditioner checked to ensure it equals or exceeds the minimum shutdown level. This may be determined by ensuring that water runs out of the conditioner when the low water shut down valve is opened.

5.20.5 Noise

Refer to Appendix A16 for details of noise testing requirements.

5.20.6 Routine engine testing.

All engine systems shall be routinely tested as required by section 3.3 of AS3584, this includes

(a) Safety shutdown systems

(b) Exhaust emission for CO, NO_x and CO_2.

(c) Surface temperature checking

(d) Pressure tightness by hydrostatic pressure testing.

5.20.7 Vibration

Refer to Appendix A19 for details of vibration testing requirements.

5.21 TOWING

The installation of devices for the purposes of towing shall comply with this section.

5.21.1 The vehicle towing attachment including coupling pins and other associated components shall be designed and tested to a minimum safety factor of 2.5 times the maximum tractive effort of the vehicle.

5.21.2 Safety chains shall be fitted to the towed load (trailer) and shall be rated as per the AS2321(lifting materials - chains) and AS2741 (shackles). The capacity of all safety chains and components shall exceed the maximum tractive effort of the vehicle.

5.21.3 The towbar assembly shall be of a type that will not allow the trailer to inadvertently separate from the vehicle.

5.21.4 The maximum towable weight (gross load) for a towed apparatus shall be as per the OEMs recommendation which shall address;-

(a) towed loads not fitted with brakes.
(b) towed loads fitted with brakes.
(c) reference made to grades for the towable weight recommended.

5.21.5 All braking systems used when a vehicle tows a trailer fitted with brakes shall comply with **section 5.5** of this guideline.

5.21.6 Towing of vehicles which are inoperable. A means of towing shall be recommended by the OEM and provisions to be made shall include the following:-

(a) a suitable towing point shall be provided on the vehicle. Examples are captive clevis pins or a “Holland Hitch”.
(b) a means of releasing fail to safety brakes.
(c) a means of steering or guiding the vehicle.

5.21.6 The towing of vehicles or trailers carrying personnel shall be required to comply with this guideline.

5.22 TRANSMISSIONS

5.22.1 Surface temperature of transmissions shall not exceed 150 degrees centigrade.

5.22.2 Mechanical transmissions should be effectively isolated from the vehicle to prevent the transmission of vibration and noise to adjacent components. The intent is to minimise the effect of noise and vibration on the passengers and operator. Note that any materials used to reduce noise emitted from the transmission shall not cause the build up of combustible materials eg coal dust, oil or cause excessive surface temperatures.

5.23 WHEEL RIMS

Generally wheel rims should be of the heaviest duty available to cater for the high uneven load conditions, rough roads and corrosive environment present at many mines.

5.23.1 Wheel rims incorporating safety and /or locking rims shall be positioned facing inwards toward the centre line of the vehicle.

5.23.2 The air fill point shall be located for easy access.

APPENDIX A1

DIESEL ENGINED VEHICLE (DEV) DOCUMENTATION REQUIREMENTS

In addition to the requirements of this guideline, the following information shall be supplied with an application for approval and for each new vehicle supplied in NSW.

1. General arrangement drawing. Commonly know as the DEV approval drawing. This drawing shall include:

1.1 The overall dimensions of the vehicle in plan, side and end elevations.

1.2 Indication of the position of the:
*Diesel engine
*Air intake system,
*Exhaust system Including conditioner and water make up tank
*Exhaust gas dilution system
*Fuel tank
*Operator and passenger compartments (including maximum number of persons for each compartment)
*Headlights and electrical components.
*Fuel system schematic
*Fire extinguisher type, approvals numbers and position.
*Instrument panel and primary control position. Direction and operation of controls to be shown.
*Dimensions showing the minimum safe operating clearances.
*The capacity of all winch and associated lifting pulling or carrying attachments.

1.3 The model and type of the vehicle

1.4 Liquid capacities of all tanks

1.5 Tramming speed and tractive effort for each gear.

1.6 Centre of gravity and weight for the Laden and unladen vehicle.

1.7 A list of associated approvals including the approval number. The DES approval is to be included.

1.8 A list of associated approvals drawings including:
*Hydraulic schematic
*Pneumatic schematic
*Electrical schematic
*DES (Diesel Engine System) approval drawing.
*Braking system drawing
*Door layout approval drawing (if applicable)
*Protective device approval drawing/s
*Operator's compartment drawing
*Passenger compartment drawing.
*General arrangement drawings of permanent or removable attachments such as Man riding, fork lifts, elevating work platforms, cranes and winches.

1.9 The results of noise testing as per this guideline.

1.10 The maximum braked and unbraked trailer mass.

1.11 Stretcher positions if applicable.

1.12 A list of aluminium items and the method of protection.

APPENDIX A1 continues

2. The hydraulic schematic shall include::

   2.1 The complete base operating system for the machine.
   2.2 All safety related pressures and flows including relief and charging pressures.
   2.3 All symbols to comply with AS1101.1
   2.4 A list of associated approvals for components including approvals numbers were applicable.

3. The pneumatic schematic shall include:

   3.1 The complete base operating system for the machine.
   3.2 All safety related pressures and flows including relief and charging pressures.
   3.3 All symbols to comply with AS1101
   3.4 A list of associated approvals for components including approvals numbers where applicable.

4. The electrical schematic shall include:

   4.1 The complete base operating system for the machine.
   4.2 All safety related voltages, currents, fuse ratings, overload settings etc.
   4.3 All symbols to comply with AS1102
   4.4 A list of associated approvals for components including approvals numbers

5. DES (Diesel Engine System) approval drawing as approved.

6. Braking system drawing for the Park Emergency Service, and Automatic systems including:

   6.1 An assembly drawing of the braking system showing the position of components.
   6.2 Brake system operating characteristics including:
   *Operating pressures
   *Brake friction materials
   *Maximum braking effort
   *Minimum braking effort
   *Typical brake deceleration figures.
   6.3 A narrative of the operation of the braking systems including warning devices and safe operating pressures.

7. Door layout approval drawing (if applicable) including:

   7.1 Overall and maintenance dimensions for the door as approved.
   7.2 Interlock types and position

APPENDIX A1 continues

8. Protective Device approval drawing/s (Operators and passengers) including:

    8.1 Overall and maintenance dimensions for the protective device as approved. This is to including minimum welding, fastener and main structural member sizes.
    8.2 The relevant MDG clause that the protective Device was assessed to.
    8.3 The clearance between the seat and the under side of the protective device in the location of the operator's head in the seat lowered and seat raised position.
    8.4 The overall height and width of the protective device and minimum underground operating clearances.

9. Operator's compartment approval drawing including:

    9.1 Position of the seat, all controls and compartment overall dimensions.
    9.2 An ergonomic assessment of the zone of reach and comfort as per AS2956.5
    9.3 Requirements for access systems.
    9.4 Visibility survey results in accordance with this guideline

10. Passenger compartment approval drawing including:

    10.1 Position of the seat, all controls and compartment overall dimensions.
    10.2 Requirements for access systems.
    10.3 Any special requirements
    10.4 The overall height and width of the protective device and minimum underground operating clearances.

11. Passenger compartment approval drawing including:

    11.1 Position of the seat, all controls and compartment overall dimensions.
    11.2 Requirements for access systems.
    11.3 Any special requirements
    11.4 The overall height and width of the protective device and minimum underground operating clearances.

12. General arrangement drawings of permanent or removable attachments such as Man riding, fork lifts, elevating work platforms, cranes and winches:

    12.1 Overall dimensions including size and capacity and operating clearances.
    12.2 Relevant Australian Standard compliance statement.

APPENDIX A1 continues

13. A letter of compliance including:

    13.1 The manufacturer's letter head
    13.2 A statement indicating compliance with the DEV approval and MDG1.
    13.3 The machine's model number, serial number, date of manufacture and DEV & DES approval numbers.
    13.4 An authorised person signature indicating compliance.

14. The application for approval shall also include
    14.1 A marked up copy of MDG1 showing compliance and non compliance.
    14.2 The braking test report.
    14.3 The noise test report.
    14.4 The visibility test report.
    14.5 The lighting test report.
    14.6 All relevant approval letters and drawings for associated items including electric, and engine components .
    14.7 Letters or test reports for attachments requiring certification to Australian standards (eg fork lifts, cranes, winches, elevating work platforms etc.)
    14.8 Other test reports as may be required by the approvals authority .
    14.9 An electrical system letter of compliance and relevant approvals.

NOTE: All test reports and documents supplied for the purposes of approval application shall be completed and signed by a competent person mechanical (Competent person approval number to be noted). The competent person is to indicate all compliances and non compliances and recommend approval based upon competent review.

APPENDIX A2

APPROVAL FOR DIESEL ENGINE POWERED SYSTEM (DES) FOR USE IN UNDERGROUND COAL MINES

In conjunction with the submission of an Approval Application From seeking a DES Approval the following information is required:-

(a) A general arrangement drawing showing the overall dimensions of the diesel engine and safety components showing location and identification by drawing number of all pertinent parts including all flame arresters, the exhaust gas conditioner and its water supply tank, the intake system, the exhaust system, safety components, and any other components that are essential to the performance of the diesel power system.

(b) Diesel engine specifications shall include:-

(1) A copy of the Certificate of Examination that has been issued for the diesel engine an a notice in writing from the engine supplier certifying that the particular engine supplied is in accordance with the engine provided for Certificate of Examination in so far the purpose of Certification.

NOTE: It may be convenient to conduct testing for engine certification and system approval simultaneously.

(2) the model and serial number of the diesel engine.
(3) rated speed, maximum brake horsepower at rated speed, peak torque speed, maximum rated torque, full throttle no load speed.
(4) fuel consumption at maximum rated horsepower and at maximum rate torque.
(5) specifications of the complete cooling system.

(c) All drawings, specifications, descriptions and related material necessary to evaluate and determine that the Design Requirements for Flameproof Diesel Engines have met.

As a minimum, this shall include detailed drawing of the following:-

(1) air intake system including piping, flame arrester, flanges and gaskets, air shut-off device.
(2) exhaust systems including water-cooling manifolds, exhaust gas conditioner and its water supply, low water shut-down system, flanges and gaskets.
(3) a drawing showing the path of the exhaust gas through the exhaust system.
(4) a complete description of the safety shut-down system including a schematic drawing of the system and specifications of component parts.
(5) detailed drawings of all safety components including flame arresters, water-cooling manifolds and exhaust conditioners, and
(6) information that should be included with exhaust conditioners:-

(a) quantity of water under normal operating conditions
(b) level of water at normal operation
(c) level of water at low water shut-down

APPENDIX A2 continues

NOTE It is preferred that only the information required to determine compliance with the Design Requirements is provided, ie. it is not necessary or preferred to have detail manufacturing drawings supplied.

(d) A DES Approval can only be obtained when:-

(1) a diesel engine system has been dynamometer load tested for exhaust gas emissions, surface temperatures, etc, either by the Londonderry Occupational Safety Centre or a workshop approved for this purpose and witnessed by a person authorised by the Department.

(2) hydrostatic pressure testing of components had been carried out as per (1).

(3) explosion testing for flame arresters by the Londonderry Occupational Safety Centre.

To assist with dynamometer load testing at Londonderry a diesel engine system shall be supplied as follows:-

(1) The engine shall be provided with an adaptor to fit the dynamometer coupling. Drawings of the Centre's dynamometer coupling are available upon request.

(2) power transmission drives such as clutches, torque converters and hydrostatic drives should not be supplied.

(3) the engine shall be supplied with an electric starter.

(4) a copy of the operating and maintenance manual shall be supplied with the engine together with any other data which may be necessary to assist with testing.

APPENDIX A3

List of Standards, Guidelines and References

Australian Standards

AS1180-10B	Determination of Combustion Propagation Characteristics of Horizontally Oriented Specimen of Hose Using Surface Ignition
AS1210	Unfired Pressure Vessels
AS1319	Safety Signs for the Occupational Environment
AS1657	Fixed Platforms, walkways, stairways and ladders - Design, construction and installation.
AS2012.2	Acoustics - Measurement of airborne noise - Operator's position.
AS2317	Collared eyebolts
AS2318	Swivels for hoists
AS2321	Short-link chain for lifting purposes (non-calibrated)
AS2595	Electrical Equipment for Coal Mines - Electrical Requirements for Underground Coal Mining Machines and Accessories
AS2660	Hose and Hose Assemblies - Air/Water for Underground Coal Mines
AS2664	Earthmoving machinery - Seat Belts and Seat Belt Anchorages
AS2670.1	Evaluation of Human Exposure to Whole Body Vibration- General Requirements
AS2670.2	Continuous and Shock- Induced Vibration in Building (1 to 80Hz)
AS2670.3	Evaluation of human exposure to whole-body z-axis vertical vibration in the frequency range 0,1 to 0, 63 Hz.
AS2671	Fluid Power - Hydraulic Systems and Components
AS2740	Wedge-type Sockets
AS2740	Shackles
AS2784	Endless Wedge Belt and V-belt Drives

APPENDIX A3 continues

AS2953.1	Earth Moving Machinery - Human dimensions - Minimum access.
AS2953.2	Physical dimensions of operators and minimum operator space envelope.
AS2953.3	Seat Index Point
AS2955.6	Operator seat transmitted vibration.
AS2956.4	Instrumentation and Operator's Controls - Symbols.
AS2956.5	Zones of comfort and reach for controls.
AS2956.6	Crawler Tractors and Crawler Loaders - Operator's Controls
AS2958.1	Wheeled Machines - Performance Requirements and Test Procedures for Braking Systems
AS2973	Vibration and Shock - Human Response Vibration - Measuring Instruments
AS3569	Steel wire ropes
AS3584	Diesel Engine Systems for underground Coal Mines
AS3776	Lifting components for Grade T chain slings
AS3791	Hydraulic Hose
AS3868	Earth Moving Machinery - Design Guide for Access Systems
AS4024.1	Safe Guarding of Machinery - General Principles
AS4024.2	Safe Guarding of Machinery - Pressure Sensing Systems
AS4240	Remote Control for Mining Equipment

ISO Standards

ISO 2631.1	Evaluation of human exposure to whole body vibration - General Requirements
ISO 2631.2	Evaluation of human exposure to whole body vibration - Continuous and Shock-Induced Vibration in Building (1 to 80Hz)

APPENDIX A3 continues

ISO Standards continues

ISO 2631.3 Evaluation of human exposure to whole body vibration - Evaluation of human exposure to whole-body z-axis vertical vibration in the frequency range 0,1 to 0, 63 Hz.

ISO 5006.1 Earth Moving Machinery - Operator's Field of View - Test Method

ISO 5006.2 Earth Moving Machinery - Operator's Field of View - Evaluation Method

ISO 5006.3 Earth Moving Machinery - Operator's Field of View - Criteria

ISO 6683 Earth Moving Machinery - Seat Belts and Seat Belt Anchorages

ISO 6683 AMD 1 Earth Moving Machinery - Seat Belts and Seat Belt Anchorages - Amendment 1

ISO 6805 Rubber Hoses and Hose Assemblies for Underground Mining - Wire Reinforced Hydraulic Types for Coal Mining - Specification

ISO 8042 Shock and Vibration Measurements; Characteristics to be Specified for Seismic Pick-Ups

SAE Standards

SAEJ10 Automotive and Off Highway Air Brakes Reservoirs Performance and Identification Requirements

SAEJ209 Instruments Face Design and Location for Construction and Industrial Equipment

SAEJ386 Operators Restraint Systems for Off-Road Work machines

SAEJ898 Includes Control Locations for Off-Road Vehicles

SAEJ1013 Measurement of Whole Body Vibration of the Seated Operator of Off-Highway Work Machines

SAEJ1152 Braking Performance - Rubber Tired Construction Machines

SAEJ1163 Includes Seat Index Point

SAEJ1362 Symbols for Controls, Indicators, and Tell-Tales for Off-Road, Self Propelled Work Machines

APPENDIX A3 continues

SAEXJ1314 Human Factors Design Guidelines for Mobile Underground Mining Equipment

NOTE - SAE - STANDARDS MAY BE OBTAINED FROM, THE SYDNEY BOOKSHOP 7 SHANNON STREET ST IVES, NSW 2075

PHONE: (02) 449 6551
FAX: (02) 449 1052

Mechanical Design Guidelines

MDG 9 Design Guideline for the Construction of Electrical Powered Shuttle Cars for Use in Coal Mines

MDG10 Design Guidelines for Hydraulic Load Locking Valves for Use in Coal Mines

MDG11 Guidelines for the Use of Aluminium in Underground Coal Mines

MDG13 Design Guidelines for Fire-Fighting Systems to be Installed in Surface Transportable Equipment for Use in Coal Mines and Declared Coal Preparation Plants.

MDG17 Mechanical Design Guideline No17. Design Guideline for the Construction of Continuous Miners.

MDG29 Guidelines for Diesel and Operator Environment Testingd in Underground Coal Mines

British Standards

Br. Coal British Coal. Noise. A Code of Practice for the procurement of Underground Machinery and Procedure for Noise Testing.

BS6472

BS6841:1987 Guide to the Measurement and Evaluation of Human Exposure to Whole - Body Mechanical Vibration and Repeated Shock .

BS7201

APPENDIX A3 continues

CEN/TC:196N80 Draft CEN Standard CEN/TC:196N80

Machines for Underground Mines - Mobile Machines Working Underground - Safety - Part 1: Free - steered Road Vehicles. Section 5:4 (pp 31-33).

MSHA CFR 30 Part 70, Subpart F - Noise Standard.

NOHSC: 1007(1993) Worksafe Australia National Standard for Occupational Noise.
SAE770253
SAEJ209
SAEJ1013

SAEXJ1314 Human Factors Design Guidelines for Mobile Underground Mining Equipment.

References

1. Safe Operation of Free Steered Vehicles in Underground Coal Mines. Third Mechanical Colliery Engineering Safety Seminar Date: 6th April, 1993.

2. The Safety of Free Steered Vehicle Operations Below Ground in British Coal Mines ISBN 011 885996X HSE Topic Report.

3. Panic Bars and Automatic Brakes IR1012 MESA Information Report/1975 United States Department of the Interior.

APPENDIX A4

Test Data Sheet
Protective Devices For Free Steered Vehicles

Date: _____

Mine or Company:_____

Mine or Company Address:_____

_____

Test Carried Out at:_____

Protective Device for Vehicle Type:_____

_____ model number _____

Drawing Number:_____

Manufacture's stated strength (based on U.T.S.)

in vertical direction_____

in lateral horizontal direction_____

in longitudinal horizontal direction_____

Note 1) A protective device will only be accepted if it can elastically resist a minimum test load of 1.0 tonnes applied vertically and minimum test load of 0.5 tonnes applied horizontally in both longitudinal and transverse directions independently. Vertical test loads may be shared between 2 separate protective devices, but other test loads must be applied to each protective device individually.

2) Larger test loads should be considered by applicants where considered appropriate for conditions where the protective device is to be used. The test document will record the maximum load for which tests are successful.

APPENDIX A4 continues

Test Method

With the protective device fully extended unless otherwise stated the following tests of the maximum span.

1. Apply vertical test load distributed over a width of 300mm at the centre of the maximum span.

   (a) apply preload of between 10-100kg to remove slack from joints, set dial indicators to zero then apply test load. Record deflection "A" under the test load and the residual deflection "B" on removal of the test load.

   (b) "B" divided by "A" must be less than 10% for the protective device to be satisfactory.

   NOTE It may be necessary to repeat this test or other tests in order to further eliminate any initial movement in pinned or bolted connections.

   If protected device consists of 2 separate bars then vertical load may be shared between the 2 bars

2. With protective devices at its maximum height apply a horizontal test load along the middle one third of the protective device edge directing the load from the centre-line of the vehicle (loco).

   Preload and deflection measurements are in 1(a) above

3. Repeat test 2 but with the load applied towards the centre-line of the vehicle. This test is only necessary if there is a significant difference in the strength of the protective device supports between the 2 directions.

4. Apply horizontal test load along the middle one third of the protective device edge directing the load from the rear to the front of the vehicle.

5. Repeat test 4 but with the load applied directly from the front to the back of the vehicle. This test is only necessary if there is a significant difference in the strength of the protective device supports between the 2 directions.

APPENDIX A4 continues

	Test Results	Test Remarks
1. Vertical test - test load (kN)	:	
initial deflection "A" (mm)	:	
residual deflection "B" (mm)	:	
(B/A) x 100 (%)	:	
	:	
Additional : Vertical test for hydraulic supported canopies	:	
- test load (kN)	:	
pressure in cylinders (kPa)	:	
effective area of canopy cylinders (mm^2)	:	
calculated load on canopy cylinders (kN)	:	
calculated yield pressure on canopy cylinders (kPa)	:	
calculated yield load on canopy cylinders (kN)	:	
does relief system reseat	:	
	:	
2. Horizontal test away from machine centre-line	:	
test load - (kN)	:	
initial deflection "A" (mm)	:	
residual deflection "B" (mm)	:	
(B/A) x 100 (%)	:	
	:	
3. Horizontal test towards machine centre-line	:	
test load - (kN)	:	
initial deflection "A" (mm)	:	
residual deflection "B" (mm)	:	
(B/A) x 100 (%)	:	
	:	
4. Horizontal test towards front of machine	:	
test load - (kN)	:	
initial deflection "A" (mm)	:	
residual deflection "B" (mm)	:	
(B/A) x 100 (%)	:	
	:	
5. Horizontal test towards rear of machine	:	
test load - (kN)	:	
initial deflection "A" (mm)	:	
residual deflection "B" (mm)	:	
(B/A) x 100 (%)	:	
	:	
6. Distance from underside of canopy in the vicinity of mans head to the top	:	
of the horizontal section of the drivers seat with the canopy in its lowest position (must be +1metre)	:	
	:	
7. Welding specifications as per Design Guidelines	:	
	:	
comments:	:	
	:	
8. Spatial and other relevant requirements as per Design Guidelines	:	
must have at least 1 metre as per clause 4.2.8	:	
	:	
comment:	:	

APPENDIX A4 continues

NOTE pass or fail must be nominated in remarks column for each test.

Tests may be carried out by NATA Registered Testing Laboratory or alternatively witnessed by an Inspector of Mechanical Engineering from the Coal Mining Inspectorate and Engineering Branch.

Name and Number of NATA registered testing laboratory

Signed: Authorised NATA signatory

OR

Signed:
Inspector of Mechanical Engineering

Date:

Approval recommended : YES / NO

Signed:
Inspector of Mechanical Engineering
Date:

APPENDIX A5

MECHANICAL DESIGN GUIDELINES FOR THE CONSTRUCTION OF

CONTINUOUS MINER PROTECTIVE CANOPIES

Issue Date: 24th May, 1989

SCOPE

Clause 32(1) of the Coal Mines Regulation (Mechanical-Underground Mines) Regulation, 1984 requires that all continuous mining machines operating at the mine and designed to carry a driver shall be equipped with a protective canopy of an approved type.

The following guidelines are intended to assist continuous miner canopy designers by indicating those parameters which will be considered in an approval assessment of the protective canopy.

The guidelines do not generally give quantitative information as it is not intended to restrict innovative design.

Where specific values or tests procedure information, or even changes to the guidelines are required advice should be sought from Inspectors of Mechanical Engineering, Coal Mining Inspectorate of the Department of Mineral Resources.

BACKGROUND

The installation of approved protective canopies on continuous miners was made mandatory in 1979 under General Rule 49, Section 54 of the Coal Mines Regulation Act, 1912.

The requirements for approval which have been applied since the inception of canopies were adopted from the U.S. Bureau of Mines. Basically the canopy had to be capable of elastically withstanding a vertical load of 8.2 tonnes applied to the canopy roof. It is to be noted that the ultimate strength of the canopy to withstand vertical loading had not been incorporated in the assessment of canopies submitted for approval.

From a review of damage to canopies as a result of roof falls it has been verified that the criteria of an 8.2 tonne load test provides for canopy designs that will allow protection to a practical degree. The review however established that resistance against side loading was warranted. The design criteria for canopies now includes in these guidelines provision for the additional evaluation of the design to elastically withstand a side load of 2.0 tonne applied both laterally and longitudinally.

APPENDIX A5 continues

INTERPRETATION

In these guidelines, except in so far as the context or subject matter otherwise indicates or requires -

"canopy roof"	includes the platework and any associated bracing commonly utilised to provide protection above the driver's enclosure.
"lateral edge"	defines the edge of the canopy roof usually located at 90 degrees to the centreline running from the head to the tail of the continuous miner.
"longitudinal edge"	defines the edge of the canopy roof usually located parallel to the centreline defined above.
"support"	includes the support legs and any associated steel work, other than the canopy roof, which interconnects the support legs.
"support leg"	is the vertical or near vertical member connecting the continuous miner chassis or driver's enclosure to the canopy roof.

1.0 CONCEPTUAL ASPECTS

1.1 In the event of the canopy being subjected to a fall of roof which exceeds the elastic limit of the canopy design then yielding should be progressive and limited to the extent that the driver can safely remain within the operator compartment i.e. 1000mm minimum headroom space remains between the seat and canopy roof for all combinations of seat and canopy adjustments.

Note: Consideration should be given to suspending the driver's seat from the underside of the canopy roof.

1.2 It is acknowledged that there are practical limitations in the design of canopies. However, each canopy design together with the operator compartment should endeavour to provide an enclosure which will prevent driver injury in the event of a fall from the roof.

1.3 The canopy design should consider access into the operator compartment and the driver's visibility in all directions particularly to the driver's front and rear and as far as reasonably practical to the sides.

2.0 CANOPY DESIGN MATERIAL AND LOADING CRITERIA

2.1 Materials

All main load bearing components used in the construction of protective canopies shall be in accordance with Standards Australia AS1250 - Steel Structures Code.

APPENDIX A5 continues

2.2 Welding

2.2.1 All welding carried out during the construction of protective canopies shall be in accordance with Standards Australia AS1554-Part 1 - Structural Welding Code for Weld Category SP.

2.2.2 All welded joints shall be non-destructively examined in accordance with the above welding code.

2.3 There shall be a minimum of four supports for the canopy roof.

2.4 It is preferred that the canopy roof be attached to the support legs by either bolted or welded-connections.

However, where pinned connections are used, maximum clearances shall not exceed Standards Australia AS1654-H7 and C9.

2.5 The base of the canopy support legs shall be securely bolted or welded to the main frame of the continuous miner or driver enclosure.

2.6 The canopy roof shall be constructed by utilising a substantial one piece solid plate devoid of uneven structural protrusions above the roof line (including cable support structures etc).

2.7 The design of the canopy roof and seat should be such that when the driver leans slightly to his right, as is customary by many drivers, his head remains underneath the canopy roof.

3.0 TESTING CRITERIA

All types of continuous miner canopy shall be load tested either in the presence of an Inspector of Mechanical Engineering of the Coal Mining Inspectorate or by a N.A.T.A. Laboratory registered for the tests specified under this section or a competent person mechanical category CAN as nominated by the Department of Mineral Resources.

3.1 Vertical Load Test

The protective canopy is required to have a minimum structural capacity to support elastically a static uniform load of 8.2 tonnes or a force equivalent to a static load of 105 kilopascals distributed uniformly over the greatest plan view area of the canopy roof whichever is the lesser.

An acceptable method of test provides for the test load to be distributed within the middle ninth of the roof's plan view area.

3.2 Horizontal Load Test

The protective canopy is required to have a minimum structural capacity to support elastically a static uniform load of 2 tonnes applied horizontally to the edge of the canopy roof.

APPENDIX A5 continues

An acceptable method of test provides for the test load to be distributed along the middle third of the longitudinal and lateral edge of the roof separately.

The horizontal loading must be applied in both the longitudinal and lateral directions separately and the results must be satisfactory in both directions.

3.3 Test Criteria

For all the load tests as per 3.1 and 3.2 the permanent set shall be less than 10% of the maximum deflection measured with the load applied.

A dial indicator is suitable for measurement of the maximum deflection and the permanent set caused by the application of the test load.

L.J. Roberts
Senior Inspector of Mechanical Engineering

APPENDIX A5 continues

File Ref.
Approval No.:

TEST DATA SHEET
CONTINUOUS MINER PROTECTIVE CANOPIES

Date.....

Mine or Company .....

Mine or Company Address .....

.....

Test Carried out at .....

Canopy for continuous miner type: .....

..... model number .....

Drawing Number .....

Manufacturer's stated strength (based on U.T.S.)

in vertical direction .....

in lateral horizontal direction .....

in longitudinal horizontal direction .....

Note 1. A canopy will only be approved if it can elastically resist a minimum test load of 8.2 tonnes applied vertically and a minimum test load of 2.0 tonnes applied horizontally in both longitudinal and transverse directions independently.

2. Larger test loads should be considered by applicant where considered appropriate for conditions where canopy is to be used. The approval document will record the maximum load for which tests are successful.

Test Method

With canopy fully extended unless otherwise stated the following tests shall be conducted:-

1. Apply vertical test load to middle ninth plan view area i.e. to one third span of width and length.

APPENDIX A5 continues

(a) For fixed type canopy apply preload of between 300-500 Kg to remove slack from joints, set dial indicator to zero then apply test load. Record deflection "A" under the test load and the residual deflection "B" on removal of the test load.

"B" divided by "A" must be less than 10% for the canopy to be satisfactory.

NOTE It may be necessary to repeat this test or other tests in order to further eliminate any initial movement in pinned or bolted connections.

(b) For canopies initially supported by hydraulic cylinders measure pressure and load at hydraulic cylinders when full test load is applied then increase test load till cylinders yield, record yield pressure and load. Ensure that pressure relief system reseats when load is reduced i.e. reload a second time. NOTE If the yield testing of the hydraulics requires a load which is beyond the elastic limit of the canopy then separate bench testing of the hydraulics will be permitted.

With canopy lowered to its minimum height and oil removed from the support cylinders i.e. canopy resting on its mechanical stops apply test load and record deflections as for fixed canopy previously mentioned.

2. Re extend canopy to maximum height and apply horizontal test load along the middle one third of the canopy edge directing the load away from the centreline of the machine.

Preload and deflection measurements are as in l(a) above.

3. Repeat test 2 but with the load applied towards the centreline of the machine. This test is only necessary if there is a significant difference in the strength of the canopy supports between the 2 directions.

4. Apply horizontal test load along the middle one third of the canopy edge directing the load from the rear to the front of the machine.

Preload and deflection are as in l(a) above. For canopies fitted with rear hydraulic cylinders the cylinder should not be the item that stops any upward movement that may occur i.e. a mechanical stop should prevent over extension of the canopy.

5. Repeat test 4 but with the load applied directed from the front to the back of the machine. This test is only necessary if there is a significant difference in the strength of the canopy supports between the 2 directions.

Note: Test l(b) is only applicable for canopies with hydraulic height adjustment where the support cylinders are required to elastically support the test load without pressure relief occurring. Canopies having different philosophy of hydraulic system design will require an alternative test procedure. This procedure will be determined by the Inspectorate of Mechanical Engineering upon request.

APPENDIX A5 continues

Test Results

	Test	Remarks
1. Vertical test - test load (KN)		
initial deflection "A" (mm)		
residual deflection "B" (mm)		
B x 100 (%) A		
Additional Vertical test-hydraulic supported canopies		
- test load (KN)		
pressure in cylinders (kPa)		
effective area of canopy cylinders mm^2		
calculated load on canopy cylinders (kN)		
yield pressure on canopy cylinders (kPa)		
calculated yield load on canopy cylinders (kN)		
does relief system reseat		
2. Horizontal test away from machine centreline		
test load - (KN)		
initial deflection "A" (mm)		
residual deflection "B" (mm)		
B x 100 (%) A		
3. Horizontal test towards machine centreline		
test load - (KN)		
initial deflection "A" m.m.		
residual deflection "B" m.m.		
B x 100 (%) A		
4. Horizontal test towards front of machine		
test load - (KN)		
initial deflection "A" m.m.		
residual deflection "B" m.m.		
B x 100 (%) A		
5. Horizontal test towards rear of machine		
test load - (KN)		
initial deflection "A" m.m.		
residual deflection "B" m.m.		
B x 100 (%) A		

APPENDIX A5 continues

6.	Distance from underside of canopy in the vicinity of a mans head to the top of the horizontal section of the drivers seat with the canopy in its lowest position (must be +lm)	
7.	Welding specifications as per Design Guidelines **comment**	
8.	Spatial and other relevant requirements as per Design Guidelines. **comment**	

NOTE pass or fail must be nominated in remarks column for each test.

Tests may be carried out by a NATA Registered Testing Laboratory or alternatively witnessed by an Inspector of Mechanical Engineering from the Coal Mining Inspectorate and Engineering Branch or Competent Person mechanical category CAN as nominated by the DMR.

Name and Number of NATA registered testing laboratory
Signed: Authorised NATA signatory

OR

Signed:

Inspector of Mechanical Engineering or Competent Person

Date:

Approval recommended: YES/NO

Signed:

Inspector of Mechanical Engineering or Competent Person.

Date:

APPENDIX A6

DESIGN GUIDELINES FOR ARTICULATED LHD VEHICLE OPERATOR COMPARTMENT DOORS

The following design criteria is to be used to implement the requirement that all diesel or electrically powered articulated load-haul-dump vehicles be fitted with an appropriate means of protecting the driver from being injured by entry into the driver's compartment of materials from any sourced by 1st January, 1989, reference M86/0349 dated 26th September, 1988.

DETAILS

Generally to be able to obtain "written endorsement for the driver protection" it will be necessary to comply with the following Design Criteria for Doors on L.H.D's:-

1. On a vehicle where the driver's entry point is within the articulation area, the door shall be hinged at its inner edge ie, the edge nearest to the articulation joint.

2. For the above configuration, the body of the door in the closed position shall be locate to avoid its interference with any part of the vehicle through the complete articulation arc.

3. The arc of swing of the door shall be limited to avoid its damage by any part of the vehicle throughout the complete articulation arc of the vehicle. This feature will be assessed as following:-

   (a) turn the vehicle onto full lock away from the driver's compartment,

   (b) open the door as far as possible,

   (c) carefully rearticulate the vehicle to the full opposite lock allowing the door to be pushed closed by the vehicle ensuring that as this occurs nothing interferes with free movement of the door through its closing arc.

4. The top edge of the door shall be designed to trap, and deflect to the outer edge of the vehicle, any object speared up the outside of the door. An outward facing flat, sloped upwards towards the outer edge of the vehicle is preferred.

5. The top edge of the door shall be high enough to make it uncomfortable to use as an armrest for the driver ie., approximately shoulder height.

6. The maximum opening below the bottom edge of the door shall be less than 10mm.

7. All edges including the leading and bottom edge of the door shall be designed to avoid becoming a catch point for extraneous material.

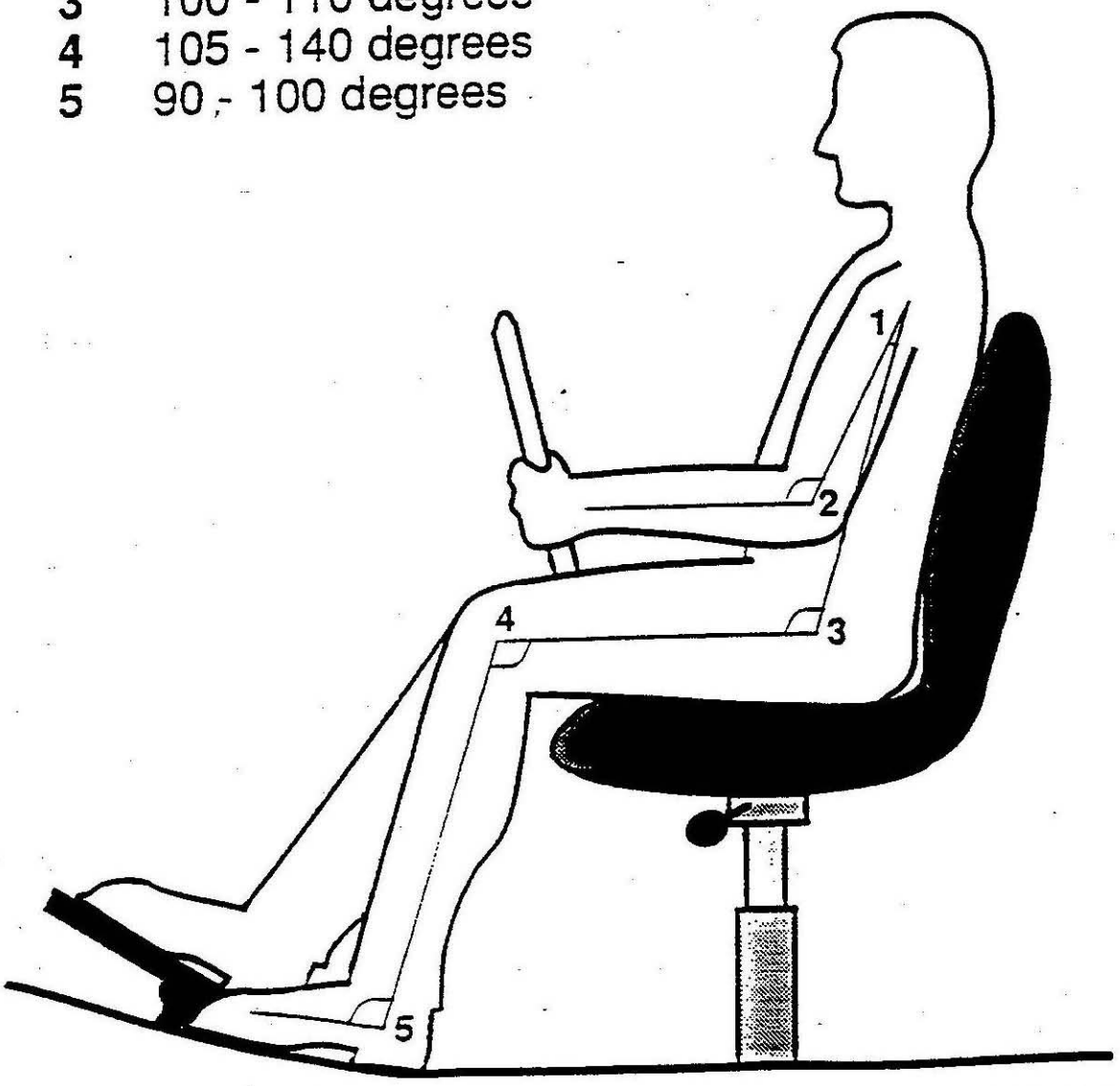
8. The door latch shall consist of a positive vertical bolt or other similar means at the edge opposite to the hinged edge. The latch shall be captive to the vehicle.

9. The whole design shall be robust enough to compensate for the rugged surroundings normally encountered by types of machines.

APPENDIX A7

Basic Posture and Angles for Driving / Operating

1 10 - 15 degrees
2 100 - 110 degrees
3 100 - 110 degrees
4 105 - 140 degrees
5 90 - 100 degrees



APPENDIX 8

CRUCIAL DIMENSIONS FOR OPERATOR'S CAB

No	Design Dimension	Related Anthropometric Dimension	Numeric Dimensions 95% ile (derived from Human Scale chart 2a - large males and small females)
1	Head clearance: must accommodate tall occupants possibly wearing hats or helmets	Sitting height	1+9 = 1403mm (tall man)
2	Knee clearance: must accommodate long legged occupants; dimensions also important in accidents	Petalla height, crotch height, trochanterion height	
3	Pedal-steering wheel distance : must allow knee travel connected with rapid foot movements between pedals		650mm (min)*
4	Width of space allotted to occupant (not shown): must accommodate big occupant with thick garment	Shoulder breadth, elbow breadth, hip breadth	1016mm (full arm movement)
5	Depth of leg room: should allow stretching legs	Buttock-foot length, trochanterion height	909 - 1003mm
6	Distance to hand-operated controls; on the board or near the steering wheel: must be within easy access of small restrained occupants	Hand reach	615 - 787mm
6a	Distance to pedals (not shown): must accommodate short-legged occupants	Trochanterion height	655 - 749mm
7	Clearance, seat back-rim of steering wheel: must accommodate heavy occupants wearing thick garments	Waist circumference, weight/height ratio	224 - 376 mm
8	Clearance, seat pan-rim of steering wheel: must accommodate thick-thighed occupants wearing heavy garments(preferably adjustable)	Thigh circumference thigh height	599mm
9 and 10	Seat height: must accommodate all drivers, hence must be adjustable independently from seat distance adjustment (12)	Popliteal height; leg, trunk and arm lengths; reach, eye height	264 - 366mm

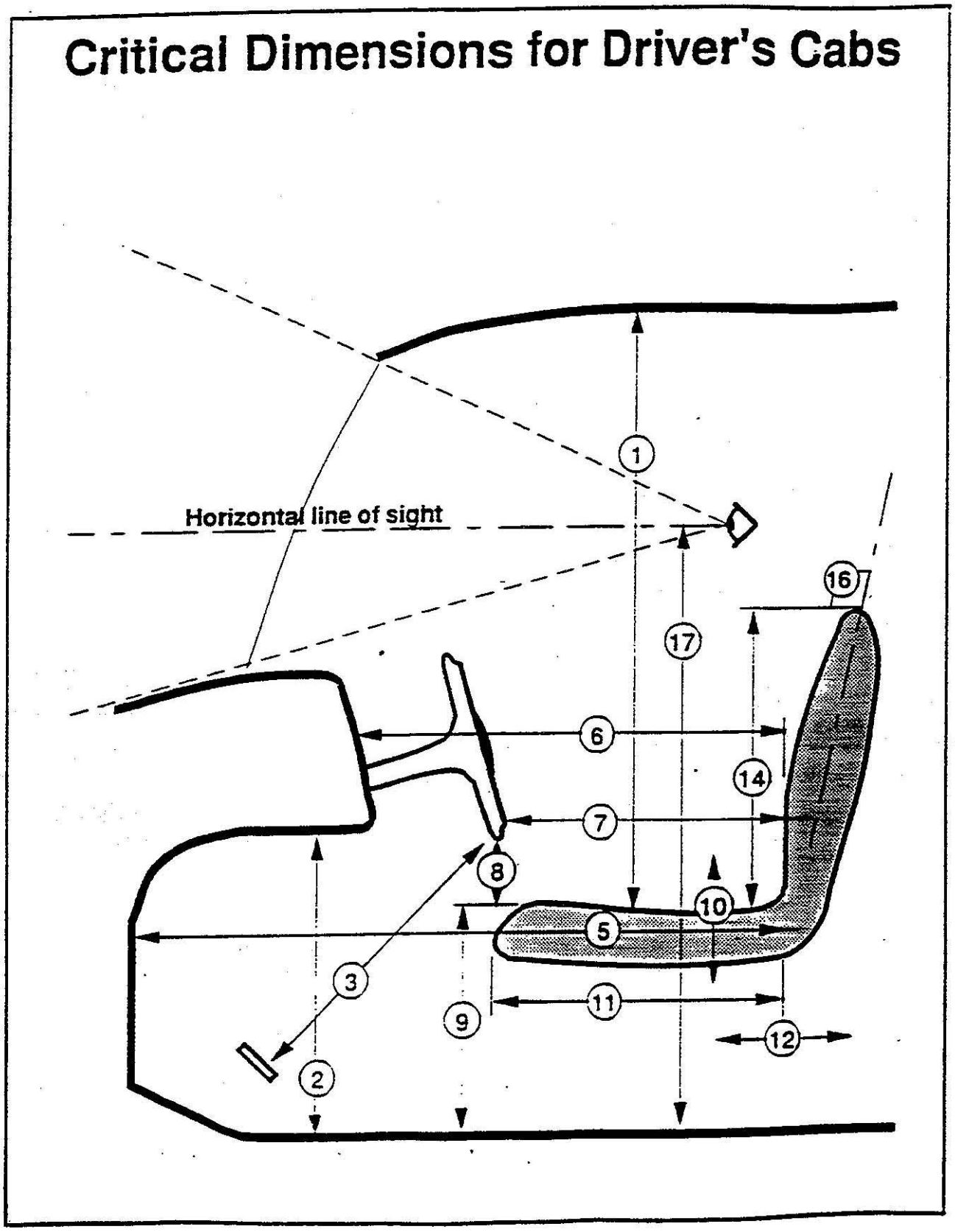
APPENDIX 8 continues

No	Design Dimension	Related Anthropometric Dimension	Numeric Dimensions
11	Seat depth: must be 'comfortable' for all occupants	Buttock-knee length	406 - 457mm
12	Seat distance adjustment: must accommodate all drivers, hence must be independent from seat height adjustment	Buttock-foot length; patella height; trochanterion height; reach	152 - 172mm (derived from 6 and 7)
13	Breadth of seat (not shown); must accommodate broad and heavy occupants; must allow changes in sitting posture	Hip breadth; buttock circumference; weight/height ratio	483mm
14	Height of backrest above seat pan: determines 9in combination with its contour mobility of shoulders (arms) and head support	Shoulder height; cervical height; sitting height	711 889mm (with headrest) 508 - 635mm (w/out headrest)
15	Breadth of backrest; determines support (see 14) and choice of body postures	Shoulder breadth	360mm*
16	Seat back angles: must accommodate all occupants, hence adjustability (in small increments) as desirable		
17	Horizontal sightline from floor	Sitting eye height	914 -1201mm
18	minimum cab depth for large male		1318mm

Note 1 These dimensions are generic rather than specific. In designing a particular workplace layout each type of dimension must be more precisely defined in terms of its starting and ending point space (orientation). All such dimensions and points must relate to each other in a consistent co-ordinate system rather than 'floating' semi-independently as shown. Similarly body dimensions need to be precisely related to known space envelopes or to joint centres and link dimensions derived from a target user population. We are concerned with knowing where as well as how long and this is part of the science of dynamics anthropometry.

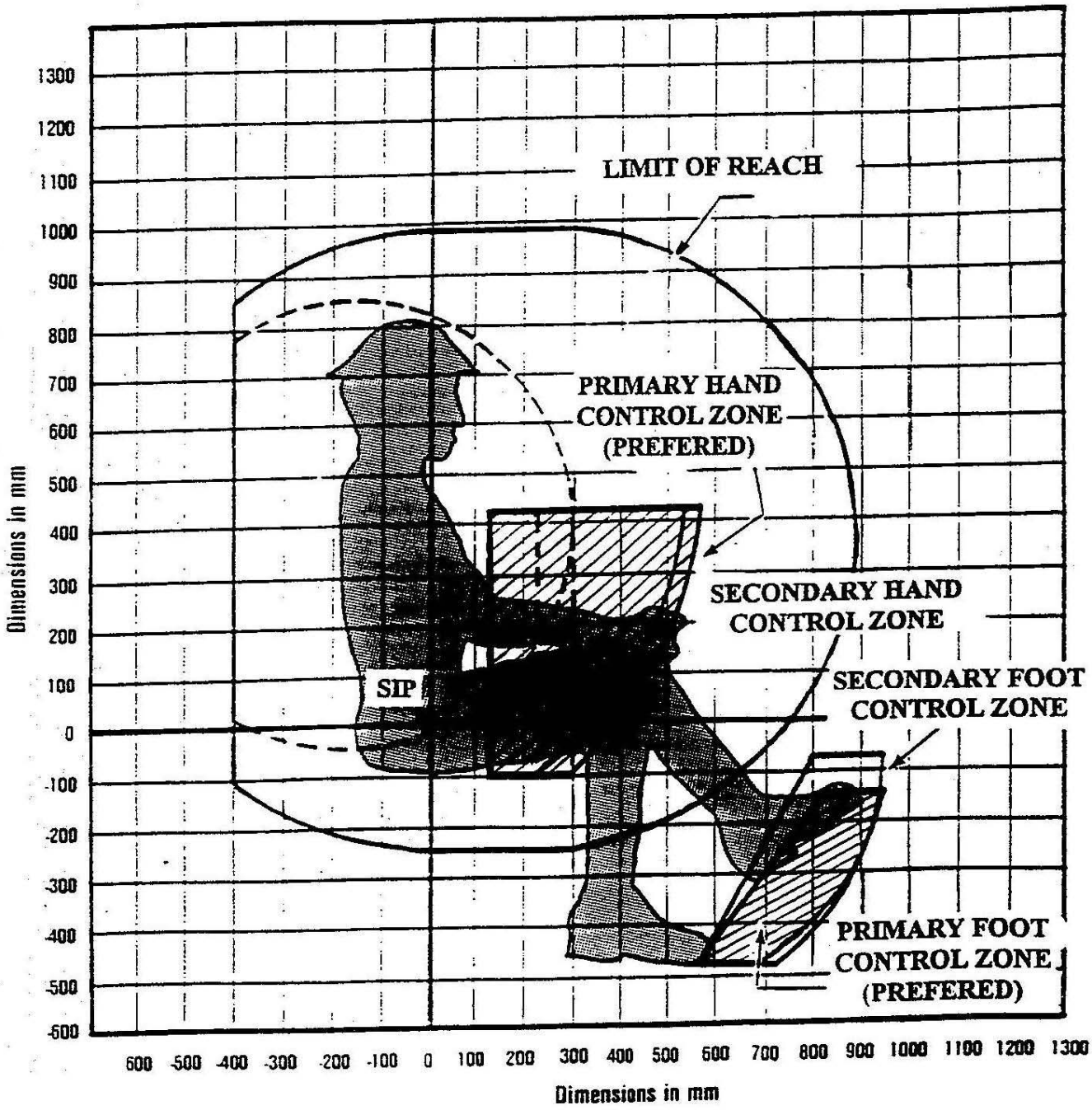
Note 2 * Dimension is derived from other sources

APPENDIX A9


Critical Dimensions for Driver's Cabs
Horizontal line of sight
1
2
3
5
6
7
8
9
10
11
12
14
16
17

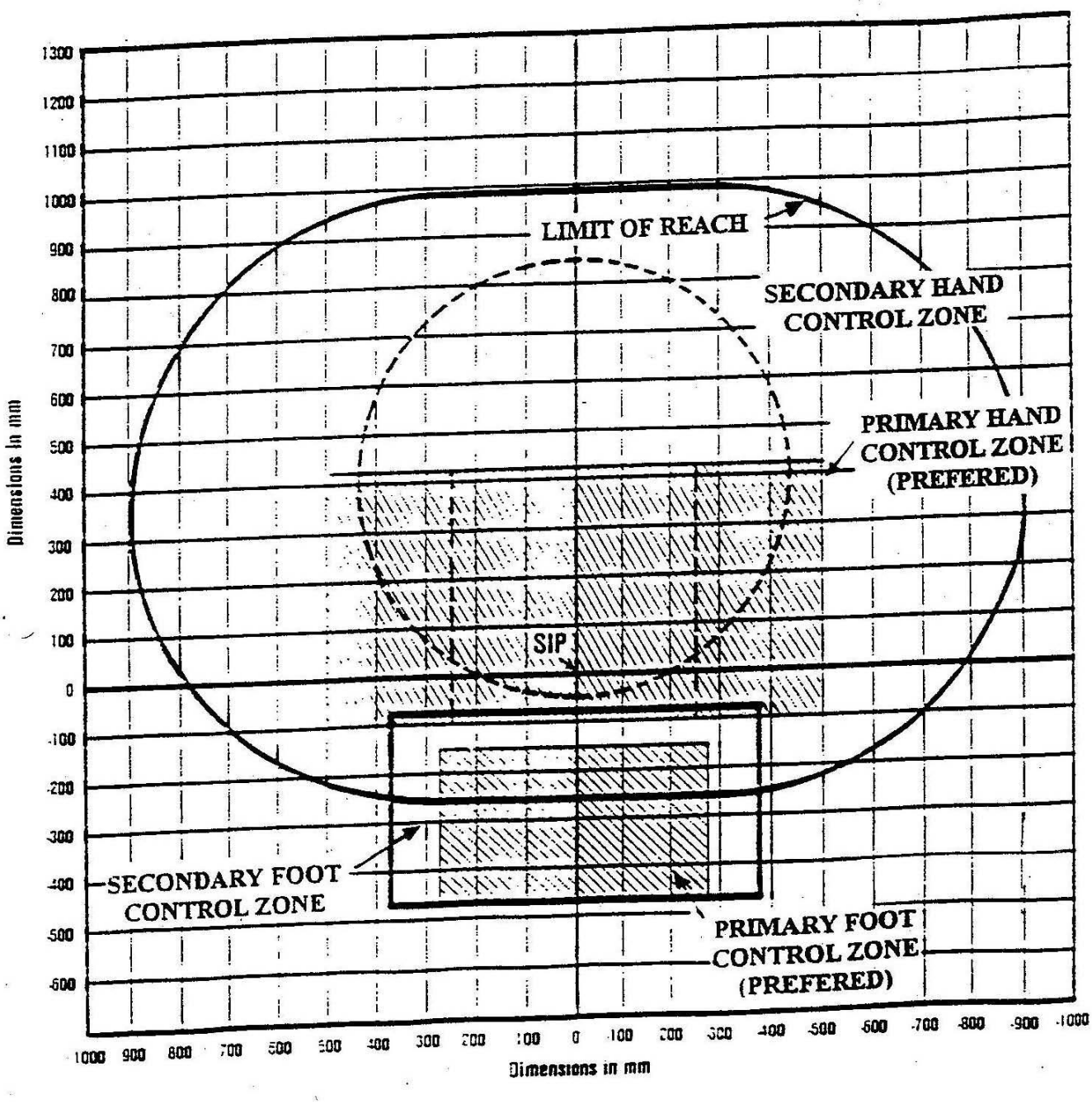
APPENDIX A10

LOCATION OF PRIMARY AND SECONDARY CONTROL ZONE
SIDE ELEVATION



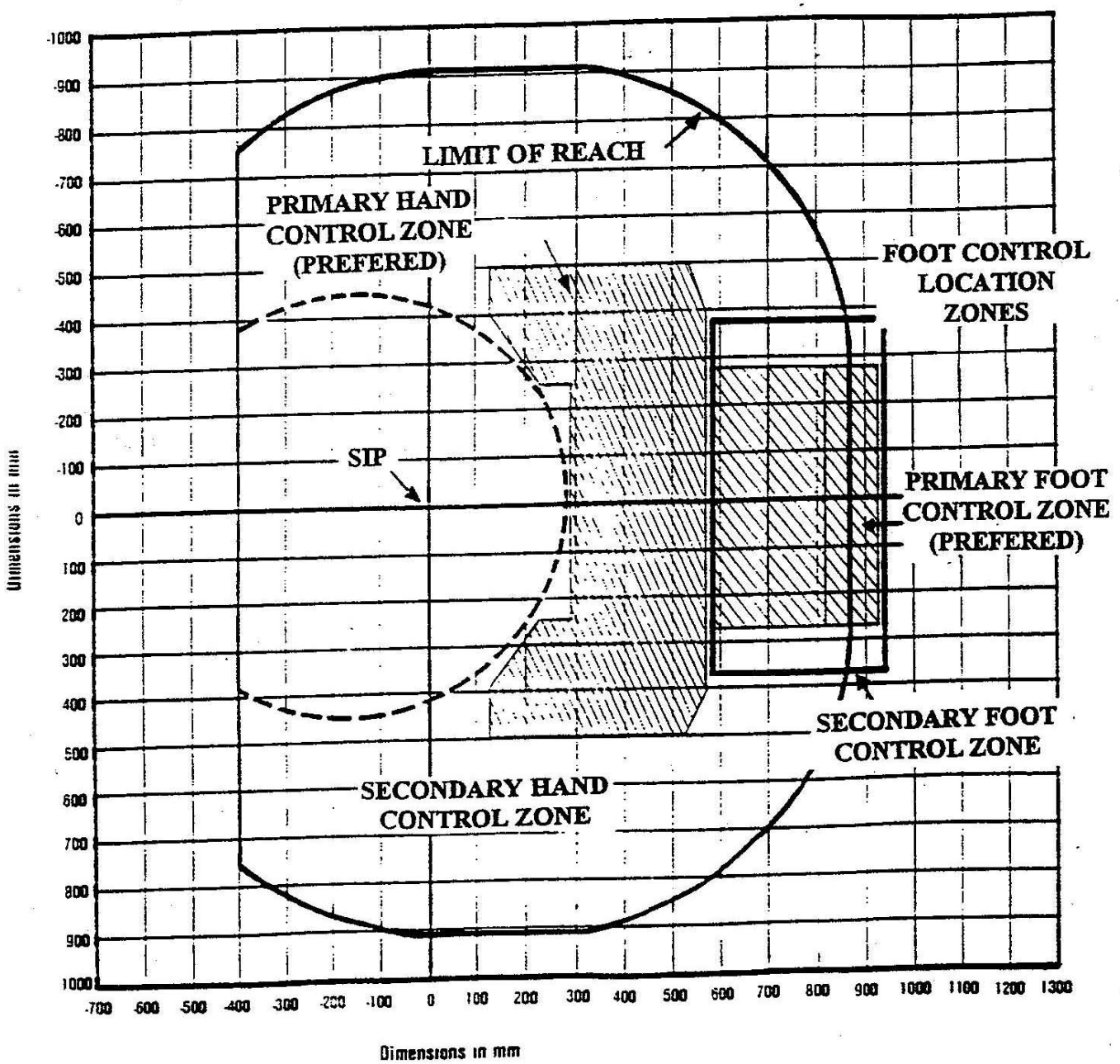
APPENDIX A11

LOCATION OF PRIMARY AND SECONDARY CONTROL ZONES FRONT ELEVATION



APPENDIX A12

LOCATION OF PRIMARY AND SECONDARY CONTROL ZONE
PLAN



APPENDIX A13

OPERATOR SEAT DESIGN SELECTION AND DIMENSIONS

As a guide to operator seat design or selection the following dimensions maybe 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.

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.

SEAT

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 (where appropriate) side of the midline.
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 25 mm in transverse direction and 40mm lengthwise).

BACKREST

Backrest vertical dimension	Between 200mm and 250mm top (lumber support area to bottom
Backrest width	Between 360mm and 400mm
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.
Back height above seat	Approx 200mm to 250mm (position of mid lumber 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 (at least 15 to 20 degrees in each direction) is required.

APPENDIX A13 continues

QUALITATIVE ITEMS

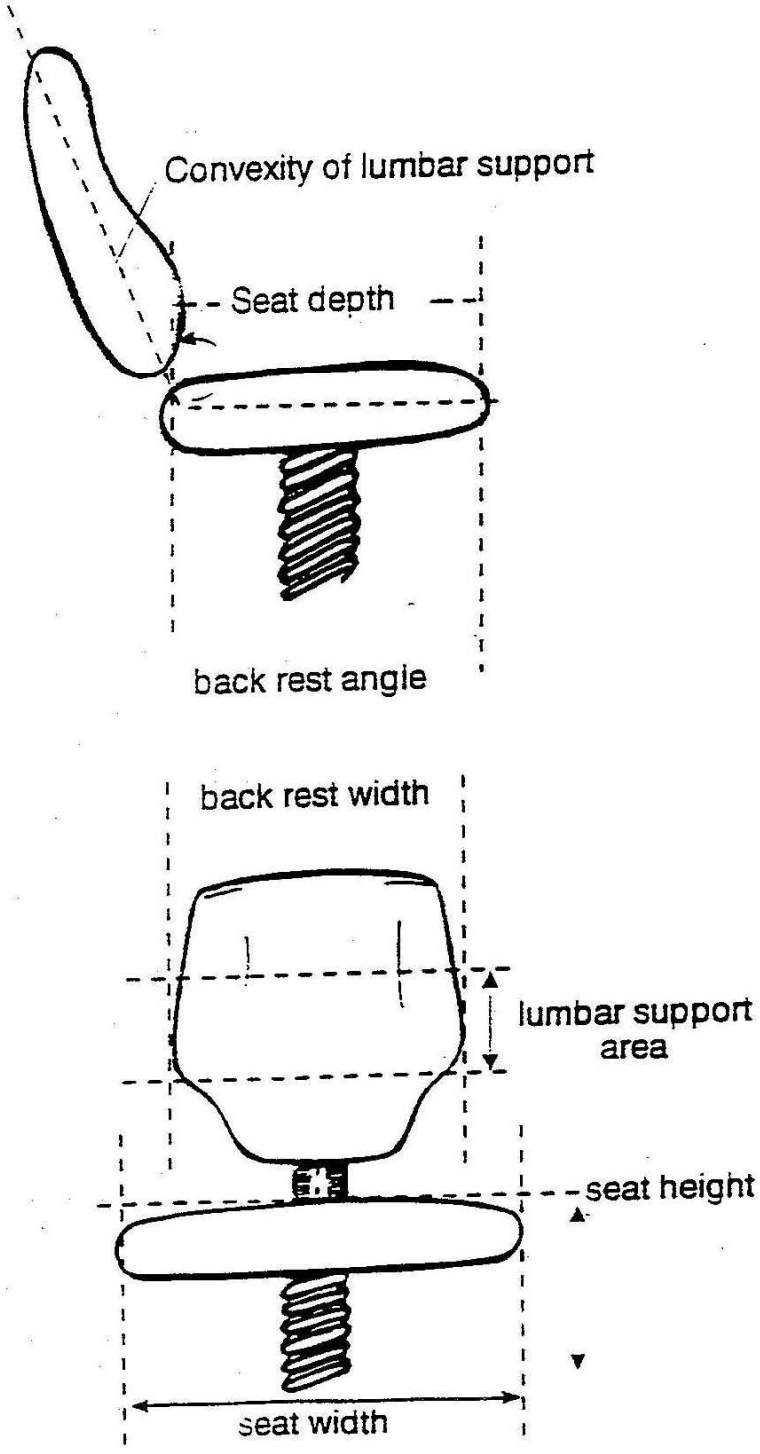
Seat height adjustment	Easily and quickly achieved from the seat position.
Seat fore/aft adjustment	Easily and quickly achieved from the seat position
Backrest angle	Easily and quickly achieved from the seat position
Seat cushion	Seat cushion should effectively distribute pressure but not 'bottom out' with heavy users.
Backrest cushion	Backrest cushion should effectively distribute pressure and protect the user from local pressure due to the frame.
Seat and 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 the operators' thighs (approx 60mm radius).
Slides of the seat	Designed to avoid pressure on underside of operations' thighs

SAFETY AND STABILITY

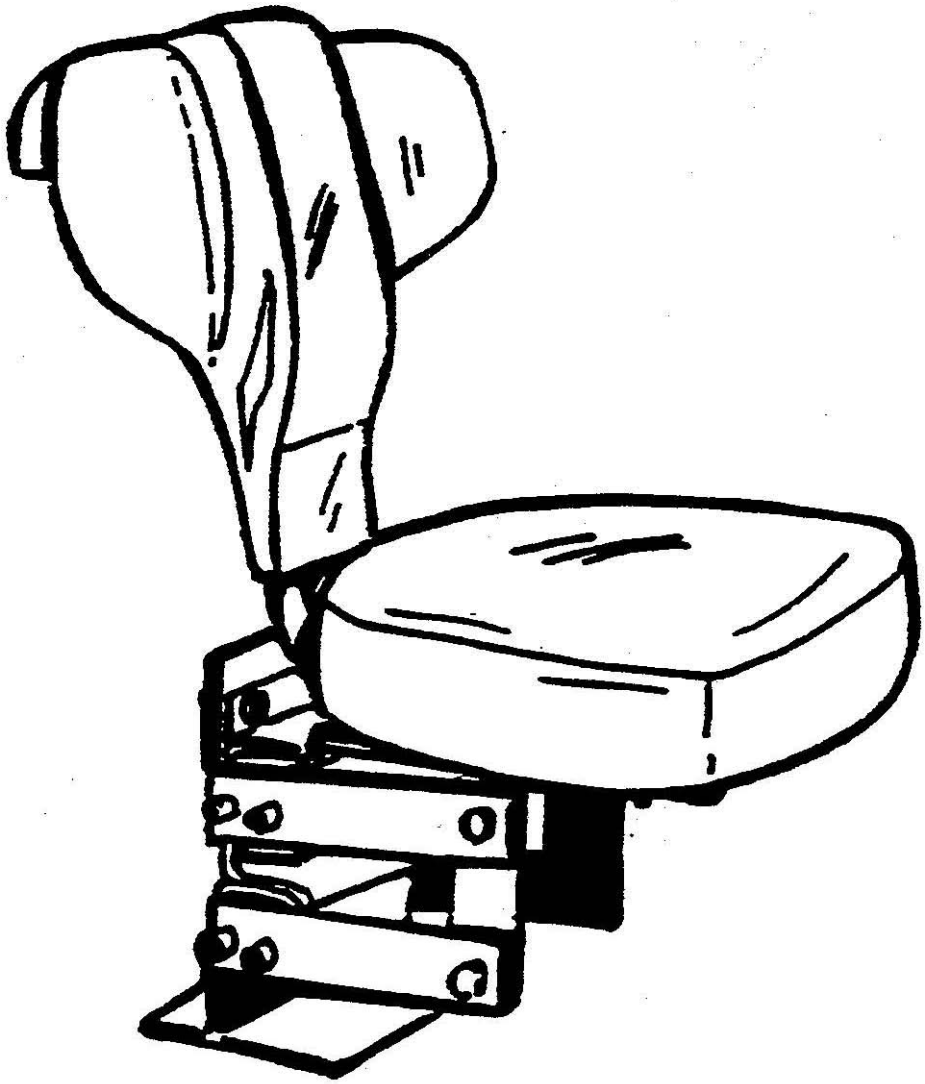
Edges	Smoothed or rounded so as not to catch clothing or equipment. Surfaces should be free of sharp edges which could snag clothing or cause discomfort or injury.
Attachment of seat	Secure and not to be inadvertently assembly to the vehicle removed or displaced under normal operating conditions.
Seat 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 and 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.

APPENDIX A14

KEY DIMENSIONS FOR OPERATOR SEAT



APPENDIX A15



An example of FSV operator's seat-designed using ergonomics guidelines and operator feedback.

APPENDIX 16

DIESEL ENGINED VEHICLE NOISE TESTING AND EVALUATION PROCEDURE

This appendix is to be used to test and evaluate the noise exposure of operator's and passengers in diesel engined free steered vehicles. The results of these tests will not directly give noise exposures for operator's and passengers in vehicles underground. The information can be used by manufacturers and end users to determine an expected DND (Daily Noise Dose) and the relative advantages of vehicles when they are used under specific conditions. This procedure should be used in conjunction with Australian Standard AS1269-1989 "Acoustics-Hearing Conservation" in particular Section 3 "Evaluation of noise"

TEST SITE

A large flat free field area is required that has no large buildings, trees, equipment etc, closer than 20 metres from the test track. This is to minimise reverberation effects. The surface of the area is to be a sealed asphalt or concrete with minimal pot-holes and irregularities. The test site should have sufficient space to drive the vehicle at full speed.

EQUIPMENT

A small integrating type 2 sound level meter which gives a minimum of 60 second $L_{Aeq,60\ sec}$ and $L_{peak\ (lin)}$ SPL. The $L_{Aeq,T}$ function is basically the average noise level over a given period. Bruel & Kjaer type 2225 or RION type NR02 meters have this feature. Many of the newer dose meters available also have his function. A stand or base can be attached to the vehicle which positions the meter near to the operator or passengers ear however ensure the microphone is isolated from vehicle borne vibration.

THE VEHICLE

The vehicle is to be complete with all covers, guards, attachments, with full tanks and unladen.

TEST PROCEDURE

The following procedure is to be applied to the operator and all passengers in the vehicle. It may be possible to minimise testing, by assessing only the operator and the passenger in the worst position for noise exposure.

1. The vehicle must be driven until all functions have reached normal operating temperatures and pressures.

2. The vehicle is then tested as a minimum (where applicable) under the following conditions for a minimum of 60 seconds to determine $L_{Aeq,T}$ and $L_{peak\ (lin)}$ SPLs. Each test is to be conducted at the operator or passenger's ear nearest the noise source and repeated three times and averaged for a final result.

   2.1 Background with vehicle engine stopped.
   2.2 Stationary vehicle low idle engine speed. (Park brake applied Transmission in Neutral)
   2.3 Stationary vehicle high idle engine speed. (Park brake applied Transmission in Neutral)
   2.4 Stationary vehicle transmission stall with engine at full throttle.
   2.5 Stationary vehicle hydraulic stall with engine at full throttle.
   2.6 Stationary vehicle combined stall (transmission and hydraulics)
   2.7 Full speed in each gear in Forward and reverse.

APPENDIX A16 continues

The design of Some types of vehicles may make testing under Some of the above conditions impossible or require testing under different conditions. The conditions listed are a minimum and should be conducted if possible. Other testes may be added as required by the manufacturer or end user.

3. The data is to be recorded with date of test, make, model and serial number of the sound level meter and any special conditions of the test.

NOTES :

Tested noise levels should be more than 15 dB(A) above background to ensure background noise does not contribute.

For the purposes of calculating the effects of underground reverberation, 3 dB(A) is to be added to the final calculations of DND.

APPENDIX A16 continues

TEST EXAMPLE

DATE OF TEST:..... 12-6-95
TEST LOCATION:..... Mulhall colliery

TEST VEHICLE
MAKE: ..... Dawes
MODEL:..... XIKJM
SERIAL NUMBER..... O410T

SPECIAL CONDITIONS:..... Windy day (Wind shield fitted). Tested on large asphalt car park area.

TEST METER
MAKE:..... B & K
MODEL:..... 2225
SERIAL NUMBER..... 123456
CALIBRATED TO..... 12-8-97

TEST OFFICER..... P Farrell

T Time interval secs	60	60	60	
	Test 1 dB(A)	**Test 2 dB(A)**	**Test 3 dB(A)**	**Average**
$L_{Aeq,T}$ background eng. stopped	55	55	55	55
$L_{Aeq,T}$ High idle stationary	85	85	85	85
$L_{peak\ (lin)}$ High idle stationary	90	89	91	90
$L_{Aeq,T}$ Low idle stationary	72	73	74	73
$L_{peak\ (lin)}$ Low idle stationary	89	89	89	89
$L_{Aeq,T}$ 1st gear full speed	86	86	86	86
$L_{peak\ (lin)}$ 1st gear full speed	99	100	101	100
$L_{Aeq,T}$ 2 nd gear full speed	88	87	86	87
$L_{peak\ (lin)}$ 2 nd gear full speed	101	102	103	102
$L_{Aeq,T}$ 3 rd gear full speed	89	88	90	89
$L_{peak\ (lin)}$ 3 rd gear full speed	102	105	108	105
$L_{Aeq,T}$ Full stall (Hyd. & Trans)	83	84	85	84
$L_{peak\ (lin)}$ Full stall (Hyd. & Trans.)	93	94	95	94
$L_{Aeq,T}$ Transmission stall	83	84	85	84
$L_{peak\ (lin)}$ Transmission stall	95	96	94	95
$L_{Aeq,T}$ Hydraulic stall	82	83	84	83
$L_{peak\ (lin)}$ Hydraulic stall	92	93	94	93

APPENDIX A16 continues

EXAMPLE EVALUATION OF NOISE

These results can be used to interpolate a model for the use of the vehicle underground by applying them to Section 3 of AS1269-1989. Additionally, it is generally accepted that reverberation underground gives an additional 3-5 dB(A) to the free field results. For the purposes of this assessment 3 dB(A) will be applied. Therefore using this "underground factor" and a knowledge of the work cycle an expected noise exposure can be mathematically determined from the test results. This tool will be a valuable asset to the engineers procuring new equipment for mines because an accurate comparison can be made between manufacturers and models of machines. It also allows for upgrades to existing machine to be measured and cost benefit analysis made.

From the above example test and applying an estimate (Manufacturer or end user) of the DURATION of exposure we can develop the following table:

CONDITION	**$L_{Aeq,T}$ dB(A)**	**$L_{Aeq,T}$ dB(A) +3 dB(A)**	**DURATION (Hours)**
$L_{Aeq,T}$ Background	55	58	2
$L_{Aeq,T}$ Low idle stationary	73	76	0.75
$L_{Aeq,T}$ High idle stationary	85	88	0.25
$L_{Aeq,T}$ 1st gear full speed	86	89	0.5
$L_{Aeq,T}$ 2 nd gear full speed	87	90	0.5
$L_{Aeq,T}$ 3 rd gear full speed	89	92	1.5
$L_{Aeq,T}$ Full stall (Hyd. & Trans)	84	87	0.5
$L_{Aeq,T}$ Transmission stall	84	87	0.25
$L_{Aeq,T}$ Hydraulic stall	83	86	0
	TOTAL		6.25

This information is now used to calculate a Daily Noise dose as per AS1269-1989 Section 3. In this case the maximum 8 hour exposure is 85 dB(A).

PND (Partial Noise Dose) is calculated as follows:

$$\textbf{PND} = (\text{Duration} \times 10^{(((LAeq + 3)-85)/10))/8}$$

eg PND from example "$L_{Aeq,T}$ 3 rd gear full speed" + 3 dB(A)

$$\textbf{PND} = (2 \times 10^{((89-85)/10))/8}$$
$$= 0.63$$

The 8 hour equivalent continuous A-weighted sound level ($L_{Aeq, 8h}$) is calculated from the following equations

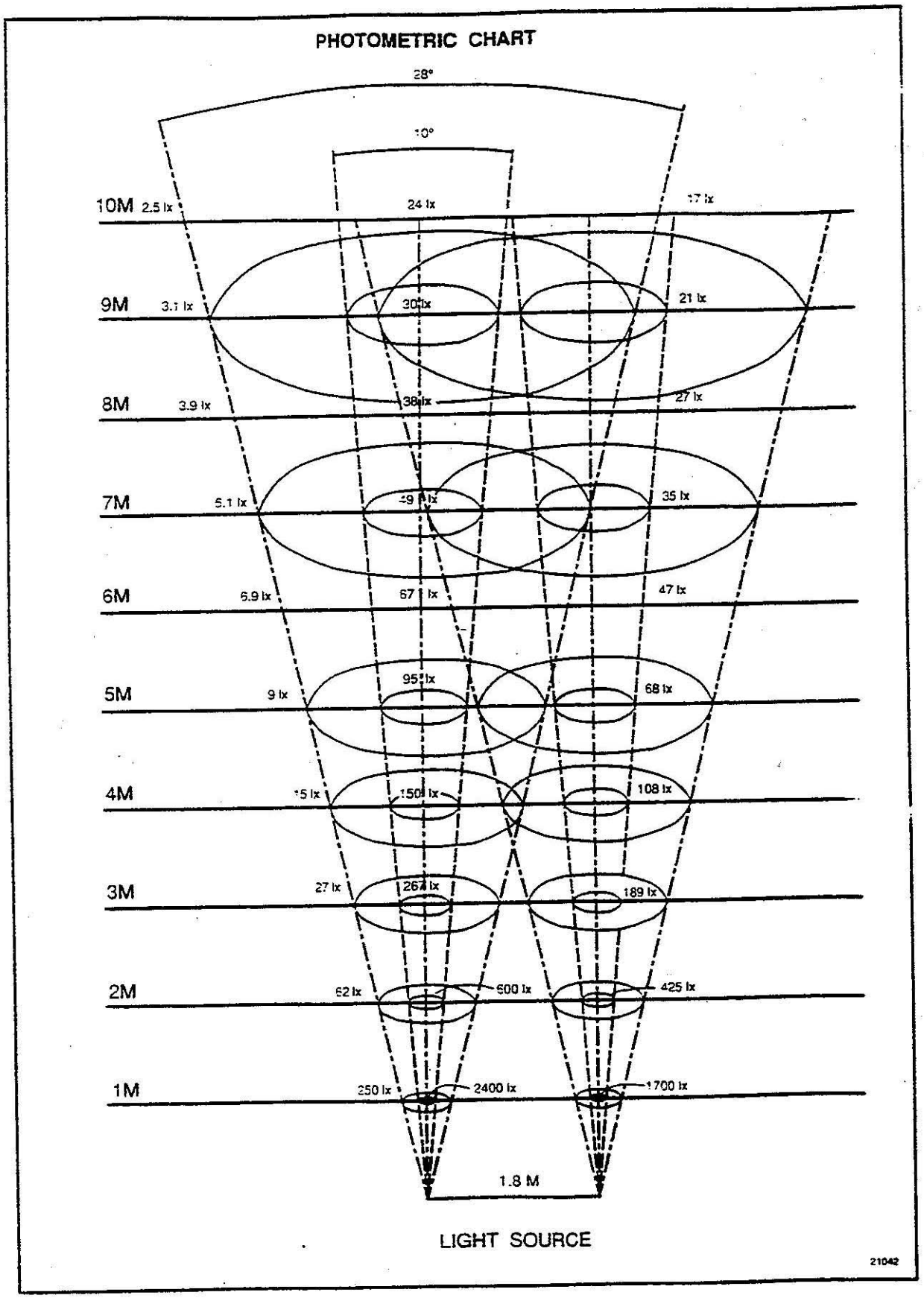
$$L_{Aeq, 8h} = 85 + 10 \log_{10} (DND)$$

APPENDIX A16 continues

CONDITION	$L_{Aeq,T}$ dB(A)	LAeq,T +3 dB(A)	DURATION (Hours)	PND Partial Noise Dose
$L_{Aeq,T}$ Background	55	58	2	0.00
$L_{Aeq,T}$ Low idle stationary	73	76	0.75	0.12
$L_{Aeq,T}$ High idle stationary	85	88	0.25	0.06
$L_{Aeq,T}$ 1st gear full speed	86	89	0.5	0.16
$L_{Aeq,T}$ 2 nd gear full speed	87	90	0.5	0.20
$L_{Aeq,T}$ 3 rd gear full speed	89	92	1.5	0.94
$L_{Aeq,T}$ Full stall (Hyd. & Trans)	84	87	0.5	0.10
$L_{Aeq,T}$ Transmission stall	84	87	0.25	0.05
$L_{Aeq,T}$ Hydraulic stall	83	86	0	0.00
	TOTAL Hours		6.25	
	TOTAL DND			1.63
	$L_{Aeq, 8h}$			87.12

Conclusion:
The operators daily noise dose exceeds 1 by 0.63 hence hearing protection is required. Refer AS51269, Appendix C for selection of hearing protection.

APPENDIX A17



APPENDIX A18

Illumination Requirements Calculation

To determine the maximum stopping distance, the vehicle shall be assumed to decelerate at 2.8 metres per second per second.

$S = [(0.28Vi)^2]/2a$

Where

Vi	=	Vehicle speed in km/h
a	=	Deceleration in m/s^2
s	=	Stopping distance in meters (m)

Example

Vi= 30km/h ; a = 2.8 m/s^2 ; the stopping distance is calculated to be:

$S = [0.28x30)^2] / (2x2.8)= (8.4)^2 / 5.6 = 12.6m$

applying the factor 1.5 (from section 4.8.2.1(d)) gives

12.6 x 1.5 = 18.9 meters

Therefore illumination at 18.9 metres must be > 20 lux

APPENDIX 19

VIBRATION TESTING

The final test results for each of the five ‘x’ second test runs is obtained by applying the following equation.

$$VDV_{5si} = {}^{4}(VDV_{WBi}{}^{4} - VDV_{WOBi}{}^{4})$$

Where

VDV_{5si} = Final test results for the ith test run to be used in Section **4.9.1.1**.

VDV_{WBi} = Vibration dose value for the ith test run with the standard mine road bumps in place.

VDV_{WOBi} = Vibration dose value for the ith test run without the standard mine road bumps in place.

APPENDIX A20

Dear Sir

REVERSING ALARMS
COAL MINES REGULATION ACT, 1982

Resulting from several accident investigations it has become apparent that the, driver's vision is severely restricted when reversing certain types of free-steered, pneumatically tyred vehicles used in underground coal mines.

The type of vehicle which have been found to be deficient in this respect are those which are generally driven in one direction only and the driver sits at the front eg, Noyes D.M.C., Noyes M.P.V., Domino P.E.T., Domino Myne Bus.

Accordingly, I require that such vehicles shall be fitted with an alarm, audible to persons in the immediate vicinity, which shall be fitted to sound automatically whenever this type of vehicle is driven in reverse. This does not apply to vehicles which are driven equally in both direction eg. shuttle cars, scoop trams.

The installation of such alarms shall be completed by 31st December, 1985.

Should further information be required, please contact the local Inspector of Mechanical Engineering.

Yours faithfully

Chief Inspector of Coal Mines

APPENDIX A21

OPERATOR CHECKS

EXAMPLE ONLY

OPERATORS CHECK LIST MACHINE TYPE (M.P.V.; etc)
* Operation of Foot Brake * Park Brake * Lights working *Horn * Fire Extinguisher * Cover & Guards In Operators cabin * Wheel Nuts Look Visually Tight * water in Exhaust Conditioner * Reversing Alarm Operation

OPERATORS TO REPORT ANY DEFECTS TO A MINING OFFICIAL

APPENDIX A22

DESIGN GUIDELINES FOR HYDRAULIC LOAD LOCKING VALVES

MDG 10

Issue Date: 26th May, 1989
Reprinted: September, 1994
File Reference No.: M81/0198

APPENDIX A22 continues

NOTE This is an extract of the Mine Safety and Health Administration of the U.S. Department of Labour issued on 17th October, 1980

1. Scope

All hydraulic cylinders used to elevate cutting heads and conveyor boom loading machines and continuous mining machines shall be equipped with hydraulic load locking valves meeting this criteria.

2. Requirements

The hydraulic cylinder assemblies which elevate conveyor booms and cutting head shall be equipped with load locking valves to prevent unintentional fall of the boom or cutting head in the event of hydraulic circuit failure. If the boom or cutting head is elevated to more than one cylinder, each cylinder shall be equipped with a load locking valve capable of holding the boom or cutting head in position.

Each cylinder load locking valve must meet the following requirements:

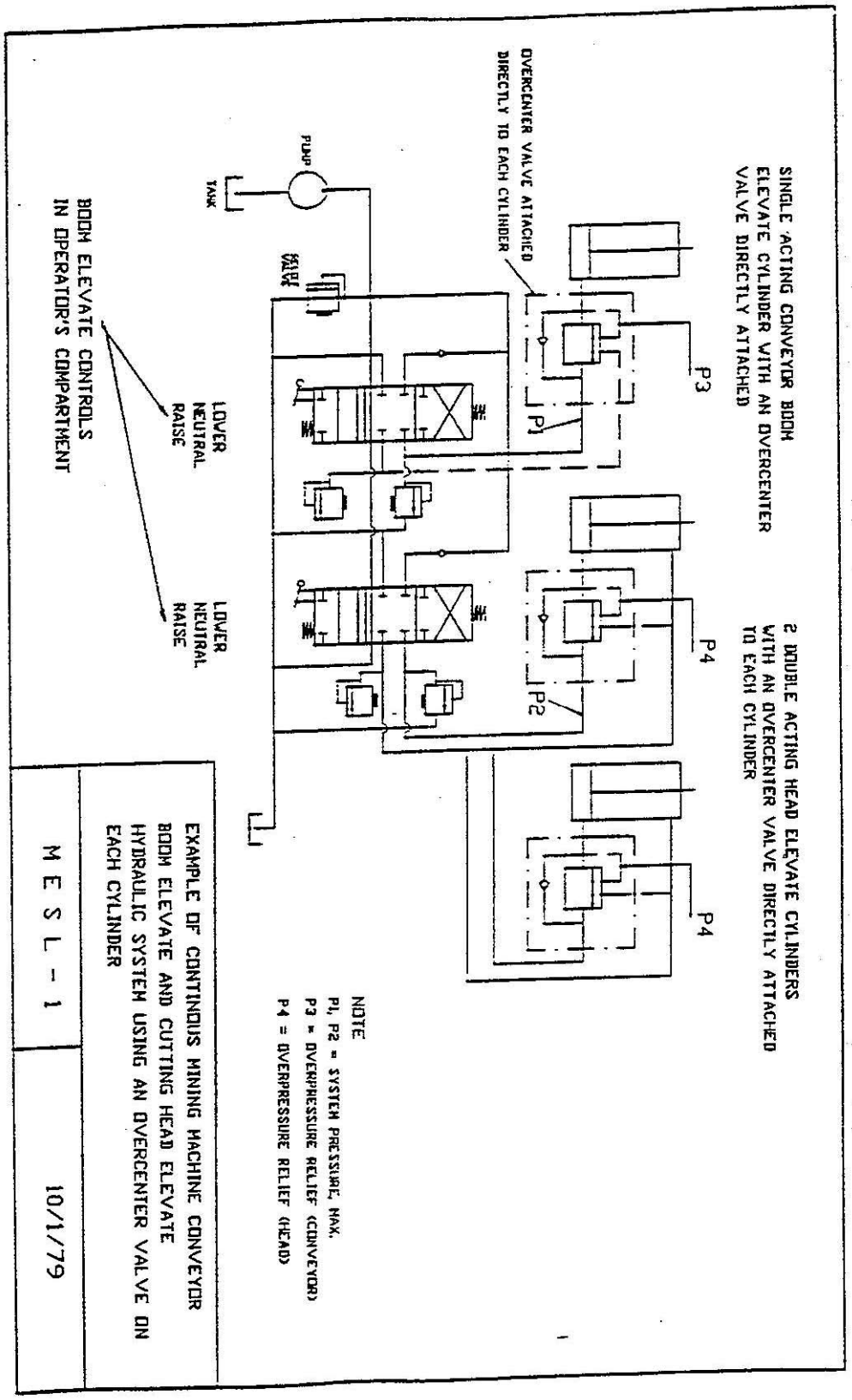
1. The load locking valve must be attached directly to the cylinder port that is subject to the hydraulic pressure induced by the weight of the boom or cutting head.

2. The rated working pressure of the load locking valve must be greater than the system operating pressure.

3. If the load locking valve has overpressure relief capability, the pressure needed to support the static weight of the boom.

4. If the load locking valve is pilot operated, the hydraulic system shall ensure that the residual pilot pressure will not hold the load locking valve open when the control valve (located in the operator's compartment) is in the neutral position.

APPENDIX A22 continues



APPENDIX A22 continues