NSW DEPARTMENT OF
PRIMARY INDUSTRIES

Amendments No. 1 - MDG 39 December 2006

'Handbook for Approval Assessment of Transport Braking Systems on Free-Steered Vehicles in Underground coal Mines'

Summary

This amendment seeks to clarify industry safety issues that have arisen from:

1. The recent failure of several safety critical systems on mobile plant, refer SA06-12 '*Maintenance of safety critical systems – Braking, steering & warning systems*'.
2. Recognition of the minimal stopping distances in the industry recognised braking standards, ISO 3450 and AS 2958.1 being only acceptable for grades up to 10%, refer SA06-13, '*Braking standards for trucks may not be fit for purpose*'.
3. The clarification of periodic in service testing of braking systems.
4. The clarification of braking systems on trailers.

NOTES:

1. This amendment has not been a comprehensive review of MDG 39, a comprehensive review and integration with MDG 1 is in progress.
2. Only those issues that require immediate consideration for the safe use transport braking systems in underground coal mines have been addressed.

This amendment applies only to clauses 1.3.11, 1.3.12, 4.4.4, 1.4.5, 1.4.16(f), 1.4.18, 1.4.19, 1.4.20, 1.4.21, 1.4.22, 1.4.23, 1.5.4, 1.6.4, 1.8.1, 1.8.4, 3.1, 3.4

The following requirements are to be considered to be incorporated into MDG 39 February 2001 from the date of publication of this amendment.

Amend. [1] Page 6, *'SCOPE'*

Delete any reference to the Coal mines (underground) regulation 1999 and insert the following into this clause:

This document also includes mobile plant.

Alternatives to those requirements specified in this document may be used provided it can be clearly demonstrated that the alternative provides an equivalent or higher level of safety.

Amend. [2] Page 9 New clause 1.3.11, DEFINITIONS

Insert the following new definitions:

A***pproved*** or a***pproval*** means design registered or deign registration except when referring to a competent person

Approved competent person means – A competent person, who does not have involvement in the design and independently assesses the design for compliance against this document.

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The competent person must not be involved in the design and must not be employed by the same person as the designer, unless that person uses a quality system.

The person must have relevant qualifications and experience in the assessment of transport braking systems designs against this document and in designs similar to that of which is being verified.

A relevant qualification generally means qualification recognised by a governing professional body, such as Engineers Australia and relevant experience generally means at least two years.

Mobile plant means plant capable of being readily moved about while in its operation and includes track mounted machines which travel at slow speeds.

Vehicle may be taken as a reference to mobile plant

Amend. [3] Page 10 Clause 1.4.4, DESIGN - '*Holding ability*'

Delete current clause and replace with:

With the power train disengaged the service, secondary and park brake systems shall be capable of holding the mobile plant motionless on the maximum operating grade in both the forward and reverse directions.

The maximum operating grade shall not be less than 25% for the purpose of this test.

Brake holding performance tests may be carried out either:

a) At a test site with the specified slope; or

b) On a tilt platform with a slip-resistant surface; or

c) By applying a pulling force to the stationary machine with the brake applied and with the transmission in neutral on a test course with no more than a 1 % slope in the direction of travel. The pulling force shall be applied horizontally near the ground to achieve a minimum force equivalent to the maximum operating grade

For testing as specified in a) and b) above the mobile plant shall be loaded to tare mass plus 120% of the manufacturer's specified payload.

For testing as specified in c) above the following formula shall be used:

$$\text{Force (N)} = mg \sin \tan^{-1}\left(\frac{\beta}{100}\right)$$

$$= mg\left(\frac{\beta}{\sqrt{100^2 + \beta^2}}\right)$$

where

β = maximum designed operating grade (%)

m = tare mass plus 120% of payload (kg)

g = 9.81 (m/s^2)

Amend. [4] Page 12 Clause 1.4.5, DESIGN - '*Common Components*'

Insert the following into this clause:

Failure of a single component shall not prevent the mobile plant from being held stationary on the maximum operating grade.

Amend. [5] Page 13 Clause 1.4.16(f), DESIGN – Fluid Power System - '*Filters*'

Insert the following into this clause.

Filterer shall be fitted to remove contaminates from the fluid system and selected to meet the cleanliness requirements of the system component(s) and/or valve(s)

Amend. [6] Page 14 New clause 1.4.18, DESIGN – '*Maximum Operating Grade*'

Insert the following new clause:

The maximum longitudinal operating grade in which;

a) the service and secondary brakes are able to pull up and hold the mobile plant stationary on, and

b) the park brake is able to hold the mobile plant stationary on,

at maximum gross vehicle mass (GVM) shall be:

(i) Stated by the manufacturer.

(ii) Not less than 25% for general purpose mobile plant such as personnel transporters and load haul dumpers (LHD's).

(iii) Not less than 20% for any other mobile plant.

(iv) Not less than 15% for a particular case and confirmed in writing as safe by the equipment manufacturer or a competent person.

A particular case means required for a once off particular application only.

Amend. [7] Page 14 New clause 1.4.19, DESIGN – '*Integrity of Brake Controls*'

Insert the following new clause:

The integrity of all braking systems shall be subject to a design risk assessment.

This design risk assessment shall be in the form which systematically analyses the failure modes and integrity of each brake system and associated warning devices.

Note:

1. A Failure Modes and Effects Analysis (FMEA), fault tree analysis, quantitative risk assessment, or similar analytical systematic methods are suitable
2. Guidance can be found in AS 4024.1301 & AS 4024.1302 and the National Minerals Industry Safety and Health Risk Assessment Guideline

The appropriate integrity level or category level shall be applied in accordance with AS 4024:1501 & 4024:1502, AS/IEC 62061, AS/IEC 61508, or other similar standards.

Amend. [8] Page 14 New clause 1.4.20 DESIGN – '*Single Pilot Operated Valves*'

Insert the following new clause:

A single line pilot operated control valve shall not be used for the application of dual braking systems, unless it can be reasonably demonstrated that:

a) The required system integrity or category level is determined and maintained, refer clause 1.4.19, and

b) The probability of failure upon demand of the valve has been established, and

c) The valve is installed in accordance with the conditions specified by the valve manufacturer, and

d) There is an appropriate lifecycle maintenance regime specified.

Amend. [9] Page 14 New clause 1.4.21, DESIGN – '*Wheeled towing loads*'

Insert the following new clause:

The maximum (gross) un-braked wheeled towing load shall not exceed the rated payload of the prime mover or 50% of the weight of the prime mover unless additional testing is carried out or the mobile plant is being used for a particular case as specified in writing by the OEM or a competent person.

Where additional testing is carried then the braking system shall be tested with the maximum trailer/load combinations and the following shall be specified:

a) Maximum braked towing load.

b) Maximum un-braked towing load.

c) Maximum combination of payload and towing load for the mobile plant.

Amend. [10] Page 14 New clause 1.4.22, DESIGN – '*Trailer Labels*'

All trailers shall be labelled with:

a) The gross weight of the trailer.

b) The unladen or tare weight of the trailer.

c) The safe working load for the trailer (SWL).

d) If brakes are fitted, identification of the braking systems (TBS) to which the trailer can safely attach.

Amend. [11] Page 14 New clause 1.4.23, DESIGN – '*Slow Moving Track Driven Mobile Plant*'

Insert the following new clause:

Track driven mobile plant, which transport one or more persons traveling at 4km/hr or less shall be fitted with the following:-

a) A mechanical braking system which is fail safe and capable of bringing the mobile plant to a controlled stop with the mobile plant traveling at maximum speed down a 1:3 grade.

b) An oil immersed multi disc spring applied brake on each traction drive assembly.

c) An interlocked to ensure that traction cannot be energised with the brakes applied.

Note: An emergency override of this interlock requirement may be permitted provided its inclusion is justified and that it is not convenient to use it during normal cutting operations.

d) A "dead-man" control to apply the brake(s).

Amend. [12] Page 15 Clause 1.5.1, SERVICE BRAKES - '*Brake Systems Recovery*'

Delete this clause and replace with the following:

For service brake systems which are pressure applied, the engine speed control shall be set to obtain 75% of the maximum rated engine speed (rpm) or at the mean speed at which the engine normally operates, whichever is the lower.

The service brake system shall be capable of delivering at least 70% of the pressure measured during the first brake application after the service brakes have been fully applied in the following manner:

- 20 times at the rate of six applications per minute.

The upper and lower governed set pressures for brake control systems shall be recorded at the pressure storage vessel.

Amend. [13] Page 16 Clause 1.5.4, SERVICE BRAKES - '*Stopping Distance*'

Delete the formulae in this clause and replace with:

The measured deceleration of the machine shall be greater than the following:

$$a_{brake-test} = \left(a_{safe-nett} + g\left(D - T\right)\right)$$

where

$$D = \frac{\beta}{\sqrt{100^2 + \beta^2}}$$

$$T = \frac{\alpha}{\sqrt{100^2 + \alpha^2}}$$

$a_{brake-test}$ = the mean minimum acceptable deceleration for the vehicle when measured along the test grade (m/s^2)

g = acceleration due to gravity (m/s^{-2})

β = maximum designed operating grade as a percentage, e.g. β = 25 for a 25% grade

α = test grade as a percentage

$a_{safe-nett}$ = the mean minimum safe nett deceleration to pull up the machine in the safest and shortest practicable time. (m/s^2).

The minimum $a_{safe-nett}$ (service brake application when a **new machine is type** tested) is = 0.75 m/s^2

Where mean decelerations are not measured then the maximum allowable stopping distance shall be based on the following formula:

$$s = \left(\frac{V^2}{25.92\left[a_{safe-nett} + g\left(D - T\right)\right]} \right)$$

where

V = machine speed in km/hr

s = stopping distance in metres

Note: For slow moving mobile plant travelling at 10km/hr a pull test to simulate the same energy absorption is considered satisfactory.

Amend. [14] Page 18 Clause 1.6.4, SECONDARY BRAKES - '*Stopping distance*'

Delete the formulae in this clause and replace with:

The minimum $a_{safe-nett}$ (service brake application when a **new machine is type** tested) is = 0.40 m/s^2 when calculated in accordance with the formulae in clause 1.5.4.

The secondary brake system shall be tested to simulate the performance condition when the service brake system has failed under the worst case failure as identified by the risk assessment, refer clause 1.4.19. If the secondary brake system forms part of the service brake, then the service brake must be modified and separated from the secondary brake, so that secondary brake system can be operated alone for the test.

Secondary brake performance shall be able to be achieved after the following events occur simultaneously:

(i) A failure of the retarder if fitted, and

(ii) A failure of a single component of the braking system that provides the worst condition for braking as identified by the design risk assessment, and

(iii) For pressure applied systems;

- After the system pressure reaches alarm level and using only the dedicated fluid reservoir for the brake system being applied, and
- Following five applications of the operator's brake foot pedal.

The secondary system shall have sufficient energy to stop the machine on the maximum operating grade on the sixth application of the foot pedal with one brake circuit disabled.

The pressure prior to the application of the foot pedal shall be the alarm level.

The pressure following the 5^{th} application shall be the minimum pressure to achieve the secondary brake performance. This pressure and the alarm level pressure shall be recorded.

Amend. [15] Page 21 Clause 1.8.1, AUTOMATIC BRAKES - '*Operation*'

Insert the following into this clause:

Automatic brakes shall comply with the following:

(i) The braking system is designed to be applied at the vehicle speed at the time of application,

(ii) The operator is made aware the automatic brakes have applied, and

(iii) The deceleration rate applied by the automatic application will not cause the vehicle to become out of control.

Amend. [16] Page 21 Clause 1.8.4, AUTOMATIC BRAKES - '*Stopping distance*'

Delete the formulae in this clause and replace with:

The automatic brake performance shall meet the secondary performance criteria specified in clause 1.6.4.

Park brakes shall not be applied automatically at speed unless they are designed dynamically for the speed of the vehicle at the time of application.

Amend. [17] Page 25 Clause 3.1, TESTING - '*Type Testing*'

Insert the following:

All type testing shall be carried out within 10% or 2km/hr (whichever is the greater) of the maximum attainable speed for the particular loaded test condition.

Amend. [18] Page 25 Clause 3.4, TESTING - '*In Service Testing*'

Insert the following into this clause:

As a minimum, dynamic braking of the mobile plant shall be carried out annually using the formula below.

Mean brake decelerations shall not decrease by more the 125% from those result obtained from the type test result unless the manufacturer has carried out further brake testing to confirm a larger variance is safe to use.

$$a_{brake-test} = \left(a_{safe-nett} + g\left(D - T\right)\right)\left(\frac{m_{GVM}}{m_{actual}}\right)$$

$$s = \left(\frac{V^2}{25.92\left[a_{safe-nett} + g\left(D - T\right)\right]}\right)\left(\frac{m_{actual}}{m_{GVM}}\right)$$

Where,

$\left(\frac{m_{GVM}}{m_{actual}}\right)$ = ratio of gross vehicle mass to actual mass of the machine = 1 for type testing

m_{GVM} = gross vehicle mass of the machine

m_{actual} = actual mass of the machine being tested

The minimum values for $a_{safe-nett}$ when the machine is being **operated in service** are:

(i) Service brake application = 0.60 m/s^2

(ii) Secondary brake application = 0.30 m/s^2