### M424.3-22 Workshop

Braking Performance - Rubber-Tired, Self-Propelled Underground Mining Machines



The working group members:

Lead – Cynthia Matikainen – Ontario Ministry of Labour Paul Summers – Miller Technology John Botelho – MacLean Engineering Len Kaskiw – Saskatchewan Ministry of Labour Relations & Workplace Safety Richard Riach – Epiroc Chuck Crowell – Caterpillar Steven Holmik – Glencore John Le – CanmetMINING Brent Rubeli – CanmetMINING David Young – CanmetMINING

1

### M424.3-22 Workshop

#### Braking Performance - Rubber-Tired, Self-Propelled Underground Mining Machines

**Revision objectives:** 

- Harmonize with ISO 19296 Mining-Mobile machines working underground-Machine safety and ISO 3450 (CSA M3450) Earth-moving machinerywheeled or high-speed rubber-tracked machines-performance requirements and test procedures for brake systems
- Update requirements to include all machines regardless of mass or rated speed.
- · Update for technological change and terminology



3



## Test ramp at Vale, Copper Cliff, ON

#### • Video

5

## M424.3 – M90 Changes by clause

Clause	Title	Original Text	Revision 2022 text
1.1	Scope	This Standard describes minimum performance criteria for the service braking system, secondary braking system, and parking system for rubber-tired, self-propelled underground mining machines with maximum rated speeds of 32 kph or less and having a rated gross mass of 45 000 kg or less.	This Standard describes minimum performance criteria for the service braking system, secondary braking system, and parking system for rubber- tired, self-propelled underground mining machines.
1.1.1	Scope		Additional requirements for brake systems on machines used in coal and gassy underground mines are found in M424.1.
1.1.2	Scope		Additional requirements for dynamic and continuous retarding systems are found in M424.4.

Clause	Title	Original Text	Revision 2022 text	ISO 3450
4.1	Braking System Performance - General	The maximum allowable force to actuate the braking systems shall be 700 N for a foot- operated system and 400 N for a hand- operated system. Note: Some regulatory authorities may require the brake(s) to be automatically applied if the engine stops or upon the loss of hydrodynamic/ transmission pressure, where applicable.	The maximum allowable force to actuate the braking systems shall comply with ISO 3450 Clause 6.2. Note: Some regulatory authorities can require the brake(s) to be automatically applied if the engine stops or upon the loss of hydrodynamic/ transmission pressure, where applicable.	Clause 6.2 Braking System Controls During the performance tests the control forces shall not exceed the values given in Table 1.
	Modulation		The service brakes shall have modulated braking for machines designed for maximum speeds greater than 6 km/hr.	
4.2.2	System Recovery	With the machine stationary, the primary power source of the service braking system shall have the capability of delivering at least 70% of maximum brake pressure measured at the brakes when the brakes are fully applied 20 times at the rate of six applications per minute with engine at high idle.	With the machine stationary, the primary power source of the service braking system shall have the capability of delivering at least 70% of maximum brake pressure measured at the brakes when the brakes are fully applied 20 times at the rate of six applications per minute at maximum brake system supply capability.	

7

# M424.3 – M90 Changes by clause

Clause	Title	<b>Original Text</b>	Revision 2022 text	ISO 3450
4.2.4	Hydrostatic drive systems		Brake systems on machines with hydrostatic drive systems shall comply with ISO 3450 Clause 4.7.	ISO 3450 Earth moving machinery-wheeled or high-speed rubber-tracked machines- performance requirements and test procedures for brake systems, Clause 4.7
4.2.5	Systems with combined brake and steering function		Systems with combined brake and steer function shall comply with ISO 3450 Clause 4.8.	ISO 3450 Earth moving machinery-wheeled or high-speed rubber-tracked machines- performance requirements and test procedures for brake systems, Clause 4.8
4.2.6	Machines designed to tow trailers		Machines designed to tow trailers shall comply with ISO 19296 Clause A.4.11.	ISO 19296 Mining-mobile machines working underground- machine safety, Clause A.4.11

Clause	Title	Original Text	Revision 2022 text
5.2.4	Instrumentation	A means for measuring the braking system energy level with an accuracy of 3% shall be used.	Braking system pressures shall be measured with an accuracy within 3%, if applicable.
5.3.7		Service brake performance shall be tested from a machine speed of at least 20 kph or the machine's maximum rated level surface speed if less.	Service brake performance shall be tested from the maximum OEM intended machine speed. Service brake performance shall be tested from a machine speed of at least 20 kph or the machine's maximum rated level surface speed if less.
5.3.8		Secondary brake performance shall be tested from a machine speed of at least 15 kph or the machine's maximum rated level surface speed if less.	Secondary brake performance shall be tested from the maximum OEM intended machine speed. Secondary brake performance shall be tested from a machine speed of at least 20 kph or the machine's maximum rated level surface speed if less.
5.3.9			The maximum operating speed shall not exceed the maximum test speed.

9

450 Clause 7 wit fter the brake				
450 Clause 7 wit fter the brake				
450 Clause 7 wil				
fter the brake				
iter the drake				
During the performance tests, the control forces shall not exceed the values				
given in ISO 3450 Table 1.				
Table 1 — Maximum force levels for braking system controls during performance tests				
XCe				

## Opportunities for next revision

Next revision considerations	ISO 19296	Comments
Develop an equivalent test on horizontal surface	The brake test to determine the stopping distance shall be run on level ground. The service brake stopping distance shall be given by formula A1.	Formulas differ in other jurisdictions Does not account for changes in stability of the machine and load when stopping on a 20% grade. Research is needed to develop the formula.
Operator comfort	The machine during the test shall demonstrate a minimum of 0.75 m/s <sup>2</sup> peak deceleration on the design slope.	There is no requirement for maximum deceleration nor jerk which can affect operator safety.
Autonomous vehicles	No reference to autonomous machines	Research needed to determine if provisions for autonomous vehicles is needed.

11

