

### **M424.3 -22 Braking Performance - Rubber-Tired, Self-Propelled Underground Mining Machines**

**S. Holmik (Glencore)**

- Legislative requirement in Ontario
- Prior to use in an underground mine the brake systems of a rubber-tired motor vehicle shall meet the requirements of CSA M424.3

MDEC 2022



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### **Test ramp at Vale, Copper Cliff, ON**



Photo courtesy of Miller Technology

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## M424.3-22 Working Group

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



The working group members:

Lead – Cynthia Matikainen – Ontario Ministry of Labour

Paul Summers – Miller Technologies

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

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## M424.3-22 Revision Summary

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

#### Objective:

- Harmonize with M3450 (ISO 3450) and ISO 19296
- Update requirements to include all machines regardless of mass or rated speed.
- Update for technological change and terminology

#### Changes:

- Scope to include all underground vehicles, remove limit for mass and speed.
- Add definition of modulated braking, and requirement for greater than 6 km/hr.
- Change the brake actuator limits to the same as M3450 (ISO 3450 -2011), specifically reducing foot pedal force to 600N (clause 4.1.1).

Many machines currently in use exceeded the test scope.

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### **M424.3-22 Braking Performance - Rubber-Tired, Self-Propelled Underground Mining Machines**

Changes:

- Hydrostatic drive, Combined brake and steering, reference to ISO 3450 requirements
- Machines designed to tow trailers, reference ISO 19296

Test speed:

- Service brakes tested at same speed as secondary brakes (clause 5.3.7 and 5.3.8),
- New clause (5.3.9): The max operating speed not to exceed the max test speed.
- Test report requirements, ISO 3450 plus results of clause 4.2.2. and dynamic wheel chock test.
- Add Appendix B, table of values for stopping distance

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## **Opportunities**



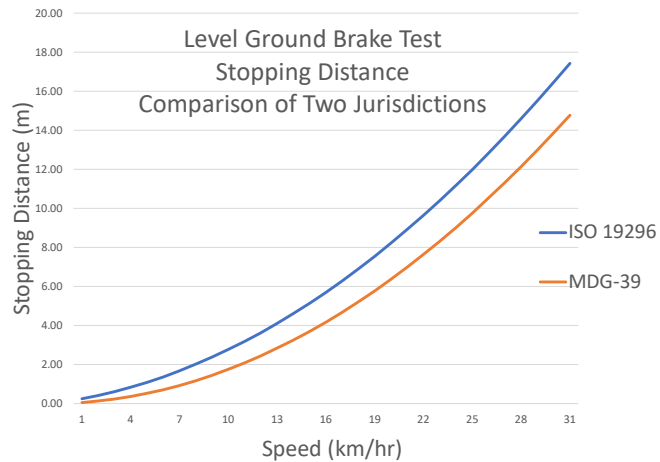
- It is a legal requirement for all underground mobile machines to have the brake systems tested according to M424.3
- Currently done on a ramp with a 20% grade, smooth surface and adequate lead in and run out.
- Currently there are only a few ramps available that meet the standard (M424.3) for testing and during the past 2.5 years one of the most used ramps in Ontario was not available.
- Representatives from mobile equipment manufacturers and mining companies have requested a test on level ground because it would save money and time.
- Ramps must be maintained in acceptable condition for testing requiring audits of the parameters.

**1. Request for M424.3 to provide a level ground test**

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## Considerations

- Other jurisdictions allow testing on level ground and provide a formula to calculate the stopping distance that would be equivalent to that required on a 20% grade.
- The formulas differ for each jurisdiction reviewed and it is not known how the formulas were derived.
- Stability of the machines and load must be considered. A shift of the center of gravity of the machine and the load are not accounted for in the current level ground test.



A study of underground mine ramps, drift surfaces and grades would provide information to assist in evaluating the adequacy of such a formula.

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## Opportunities



- Minimum deceleration is specified in ISO 19296, no maximum.
- Deceleration and jerk should be studied to gain understanding of the operator experience during braking as there are currently no limits protecting the operator.

2. Consideration for operator comfort and safety.

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## Opportunities



Autonomous machines are in use in Canadian mines.

Currently there are no considerations in the test procedure for autonomous machines.

### 3. Consideration for autonomous machines.

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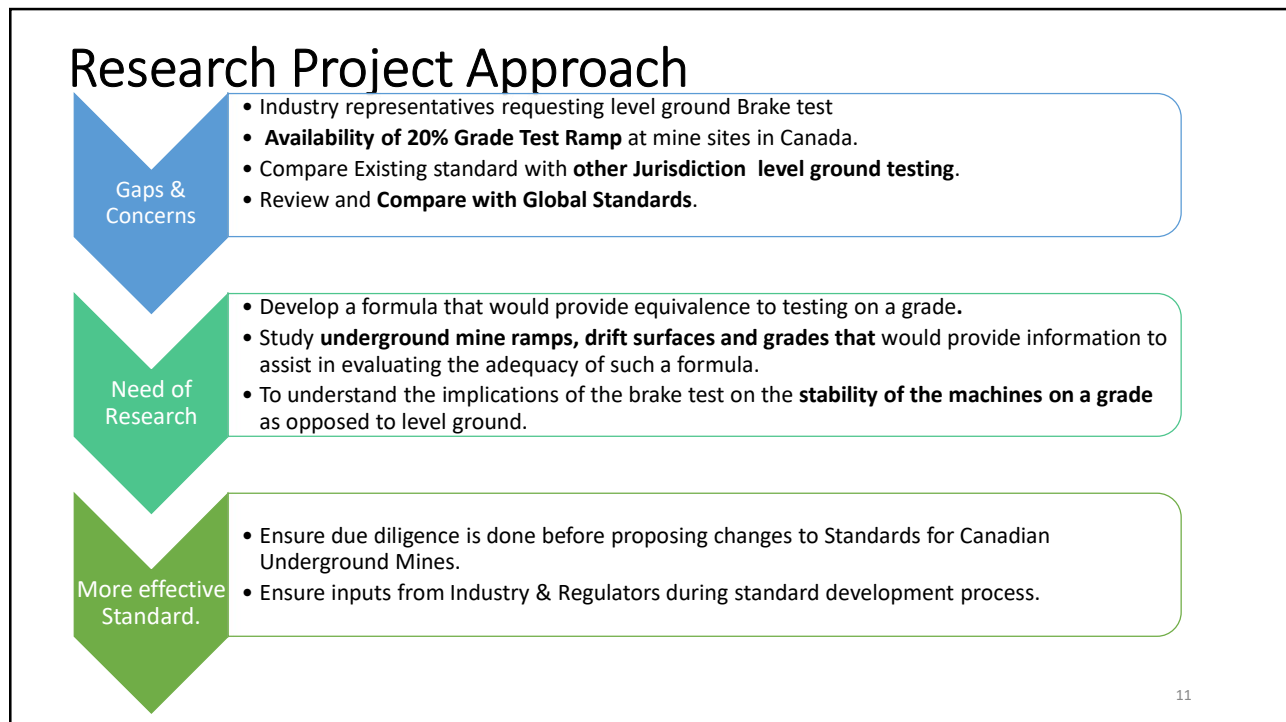
## Opportunities for next revision

1. Request for M424.3 to provide a level ground test
2. Consideration for operator comfort, example deceleration limits.
3. Consideration for autonomous machines.

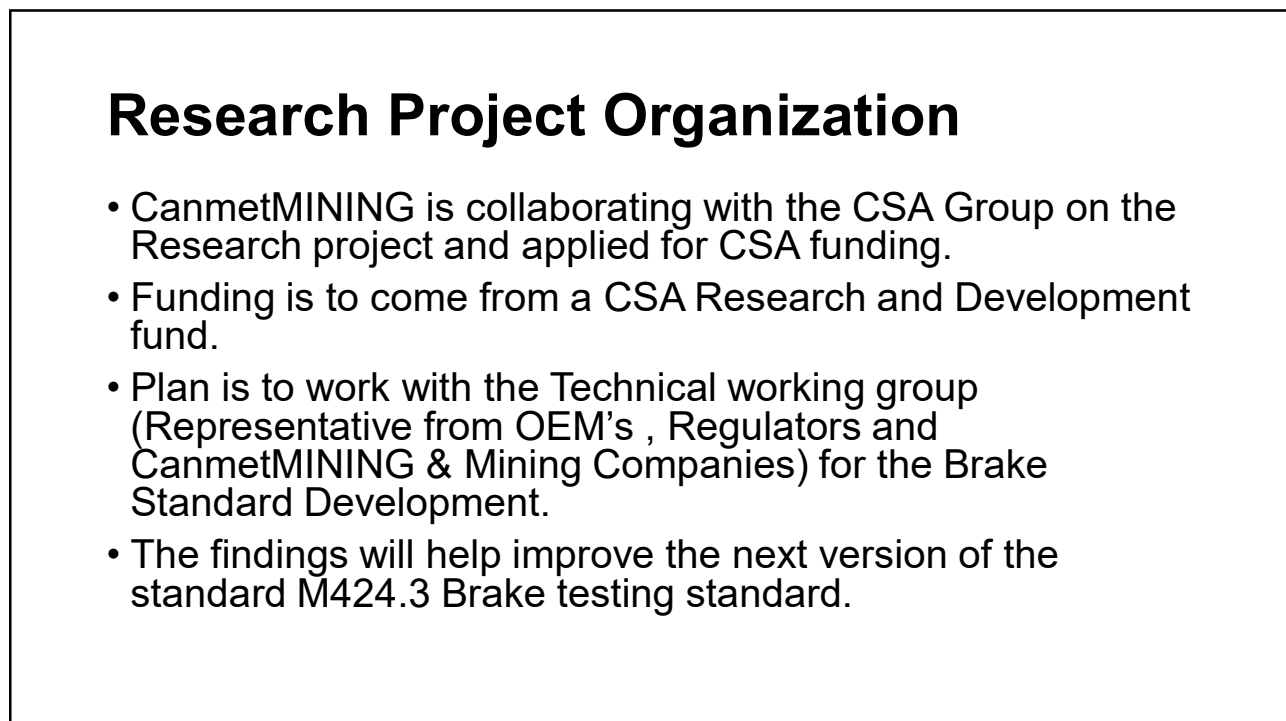
Research is required to evaluate potential changes to the M424.3 standard.

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