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SANS 1589 – REVIEW PROCESS

DR NDL BURGER

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SANS 1589 REVIEW PROCESS

- SANS 1589:2012 CONSISTED OUT OF 5 PARTS
  - Part 1: General requirements
  - Part 2: Self-propelled machines with friction brake system
  - Part 5: Self-propelled machine using hydrostatic drive systems
  - Part 6: Self-propelled road going vehicles modified for mining use
  - Part 7: Tractor towed trailers
- Committee had felt that
  - The standard can be simplified with less parts
  - More attention must be given to in-service brake testing
- Work was divided as follows:
  - Part 1: Gerotek team to compile as they must do the testing
  - Part 3: Danie Burger/De Wet Strydom and Willem Odendaal to do draft
  - Part 2: Just taken from Part 7 in SANS 1589: 2012
- Committee attempted to align SANS 1589 with MHS Act, MCOP, ISO 3450 and MDG 39 (Australian)
- Committee then discussed and shaped drafts
- Part 1 and 3 were out for voting and comments
- Danie Burger had discussed new standard with Mr Alfred Maki – happy with approach and standard
- SANS busy with final editing

SANS 1589: 2021

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- Part 1: Design, performance requirements and test methods.
- Part 2: Tractor/Trailer combinations
- Part 3: In service brake testing of Trackless Mobile Machines

MHS ACT – RELEVANT SECTIONS

REGULATION 8

Braking systems

(7) The *employer* must take *reasonably practicable* measures to ensure that persons are prevented from being injured as a result of brake failure. Such measures must include ensuring:

(7.1). **that trackless mobile machines are operated with adequate and effective braking systems;** ← Part 1

(7.2). all braking systems are adequately and routinely tested for intended functionality; ← Part 3

(7.3). all braking systems are regularly maintained; and ← Part 3

(7.4). that where a combined braking system is used, the design of the braking system is such that it complies with the requirements for the separate systems and that it fails to safe. ← Part 1

Pre-use inspection procedures

(24) The *employer* must take *reasonably practicable* measures to ensure that procedures are prepared and implemented for inspecting trackless mobile machines immediately prior to use, which procedures must include:

(24.1). **that the operator of the trackless mobile machines physically inspects and ensures that the brakes, lights and any other defined safety features and devices are functioning as intended prior to setting such trackless mobile machines in motion;**

(24.2). pre-use check lists that have to be completed by all operators of trackless mobile machines at the beginning of their shift. Such check lists must clearly identify all the components, features and functionalities to be inspected by the operator. For each component, feature or functionality, the check list must clearly indicate the pre-established criteria under which the trackless mobile machines mayor may not be put in motion.

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MCOP TMM– RELEVANT SECTIONS

8.2.2 Testing of braking systems
The COP must describe the procedures for testing of braking systems to ensure functionality in terms of brake design specifications, including the following:
a) **Static testing of braking systems;**
b) Where appropriate, dynamic type or other tests;
c) Recording and safe keeping of test results, for a period to be sspecified in the COP.

Part 3

8.10 Maintenance and inspection of trackless mobile machines
In order to ensure that the maintenance and inspection of trackless mobile machines are appropriate for the specific circumstances at the mine, the COP must describe:
8.10.1 Scheduling of maintenance, inspections and over inspections.
8.10.2 **The use of pre -use checklists to identify components critical for the safe operation of the type of trackless mobile machines and keeping of such completed checklists for at least three months.**
8.10.3 The conditions under which trackless mobile machines may be used, for example "go ", "go but" or "no go" options.
8.10.4 Changing wheels and rims.
8.10.5 Changing, inflating and repairing of tyres.
8.10.6 Changing components where significant risk may exist.

SANS 1589

Approved by CCME Committee from Minerals Council and recommended for use
Covid had just delayed complete process

SANS 1589 PART 3
In-Service Brake testing
Rev 2021

FUNCTIONAL TESTING
Daily

CONFORMANCE TESTING
After every intervention, incident etc.

TESTING AND ACCEPTING REQUIREMENTS. QUALITY OF INSTRUMENTS, TEST SITE, TEST MACHINE CONFIGURATION, COMPENSATION, ACCEPTANCE CRITERIA

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SANS 1589 – PART 3: IN-SERVICE BRAKE TESTING

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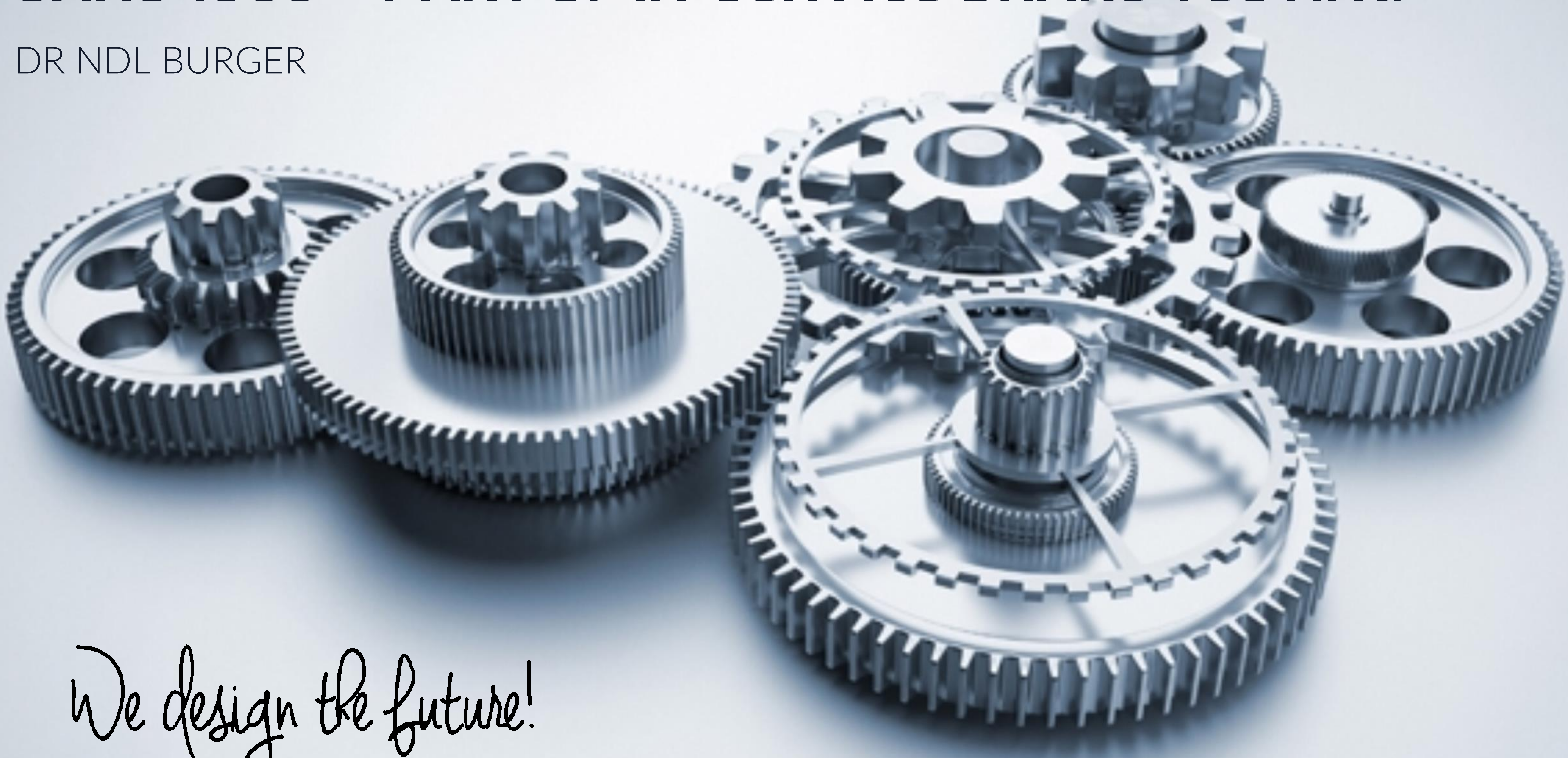

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Part 3: Inservice brake testing (trailers excluded)

Functional test

4.1.1 Interval of tests

Interval and method of the functional test shall be determined by a site risk assessment, this should typically be daily or before a TMM enters operation.

4.12.2 Braking system and periodic verification instructions

Information on brakes may be provided in manuals, labels or other means readily available to the operator while in the operator's station along with precautions about the limitation of this information. If braking system and periodic verification instructions are provided by the machine manufacturer, they should include the following:

a) daily brake check method instructions:— a method for verifying the functionality of the service and parking brakes;— provisions for verifying the functionality of the secondary brakes if the service and/or parking brake check method does not verify functionality of the secondary brakes;

b) in-service, periodic or post-maintenance brake verification instructions:— a method for verifying the functionality of the service and parking brakes including acceptance criteria;— a means of verifying the functionality of the secondary brakes

Conformance test

4.2 Conformance testing

4.2.1 Frequency of test

The frequency and method of conformance tests are to be determined by a site risk assessment. The conformance test shall as a minimum be performed after every, intervention or after the TMM has been involved in an incident

FUNCTIONAL TESTING (DAILY TEST)

BRAKE	TESTING METHOD (any one of methods)
Service Brake	a) Holding performance test, or I. Brake test ramp, or II. Stall test b) Stopping distance test
Park brake	a) Holding performance test I. Brake test ramp, or II. Stall test
Emergency brake (secondary)	a) Holding performance test, or I. Brake test ramp, or II. Stall test b) Stopping distance test
Automatic brake (where applicable)	To be tested separately according site standards and/or procedures

Note 1:	Depending on the brake system design the park and emergency brake might be combined.
Note 2:	The stopping distance shall meet the acceptance criteria set in accordance with paragraph 5.1 and 5.4.
Note 3:	Any tests as prescribed by the OEM are also acceptable provided that the test meets the intent of the table.

BACK TO DIAGRAM

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CONFORMANCE TEST

TYPICALLY AFTER EVERY SERVICE, INTERVENTION, INCIDENT

CONFORMANCE TESTING

BRAKE	TESTING METHOD	NOTES
Service Brake	a) Dynamic testing using: I. Average deceleration **and/or** II. Stopping distance as per performance criteria **or** b) Static pull test combined with stopping distance test.	1. Stopping distance as a test method is acceptable provided that the test results can be recorded. 2. For slow moving TMM (less than 10 km/h) a static pull test is considered to be satisfactory, no further stopping distance test[1] is required. 3. Hydrostatic and electrical driven TMM may be tested using only a static pull or stall to evaluate performance.
Park brake	a) Static pull test, **or** b) Holding performance test on brake test ramp	1. Hydrostatic and electrical driven TMM may be tested using only a static pull, stall or hold test to evaluate performance.
Emergency Brake (secondary)	a) Dynamic testing using: I. Average deceleration **and/or** II. Stopping distance as per performance criteria. **or** b) Static pull test combined with stopping distance test.	1. It is not recommended to test the emergency brake making use of dynamic testing on some TMM. Consult the TMM OEM where required for an alternative method. 2. Stopping distance as a test method is acceptable provided that the test results can be recorded. 3. For slow moving machines (less than 10 km/h) a static pull test is considered to be satisfactory, no further stopping distance test is required. 4. Hydrostatic and electrical driven TMM may be tested using only a static pull, stall or hold test to evaluate.
Automatic brake - functionality (where applicable)	To be tested separately according to site requirements.	

5.2.1. Static pull test

The TMM shall remain stationary for the duration of the application of the pull force where the horizontal pull force applied to the TMM, in Newton (N), shall be:

$$\text{Static pull force} = m \times 9.81 \times \sin\theta$$

Where,

- m = GVM of TMM to be tested (kg)
- θ is the maximum grade, as the specified maximum grade in the mine as per COP plus 4° (4 degrees)

Note: When performing a static pull test the machine might not be in the GVM condition. Wheel slip on the test surface may occur due to the lower vehicle weight. If that is the case the machine needs to be tested at a higher test mass.

Example

- The maximum gradient as per site COP: 11°
- Test gradient θ = 11° + 4° = 15°
- Machine gross mass: 27 000 kg
- Test pull force [N] = 27000 x 9.81 x sin (15°) = 68 553 N

When performing the static pull test as described, the following is applicable for each of the brake systems:

- Ensure that no other braking system contribute to the braking system that is being tested.
- Where the machine must be put in a drive state in order to test the relevant brake system in isolation (e.g. neutral brake) the selected direction shall be such that it does not contribute to the braking force applied.

BRAKE PERFORMANCE REQUIREMENTS

Service brake: Dynamic testing

Service brake stopping performance requirements, excluding load compensation are based upon the following formula:	
$$s = \frac{vt}{3.6} + \frac{v^2}{13\,x\,2a}$$	
s	is the stopping distance, in metres (m);
v	is the test speed, in kilometers per hour (km/h)
t	0.35 seconds (s)
a	3.0 metres per second (m/s^2)

Note 1: The allowable mean deceleration (value a) is reduced with 25% from the value given in SANS 1589 Part 1 (4 m/s^2) to allow for operational wear and degradation.

Note 2: The stopping performance is based on a dry road at zero grade

Table 3: Service brake: Dynamic test requirements (Gross Vehicle Mass)

Start Speed (km/h)	Stopping distance level surface - Maximum value (meters)	Average deceleration Minimum value (m/s^2)	Peak Deceleration Minimum Value (m/s^2)
1	0.1	0.35	3.0
2	0.2	0.63	3.0
3	0.4	0.85	3.0
4	0.6	1.04	3.0
5	0.8	1.20	3.0
6	1.0	1.33	3.0
7	1.3	1.44	3.0
8	1.6	1.54	3.0
9	1.9	1.63	3.0
10	2.3	1.71	3.0
11	2.6	1.78	3.0
12	3.0	1.84	3.0
13	3.4	1.90	3.0
14	3.9	1.95	3.0
15	4.3	2.00	3.0
16	4.8	2.04	3.0
17	5.4	2.08	3.0
18	5.9	2.12	3.0
19	6.5	2.15	3.0
20	7.1	2.18	3.0
21	7.7	2.21	3.0
22	8.3	2.24	3.0
23	9.0	2.26	3.0
24	9.7	2.29	3.0
25	10.4	2.31	3.0
26	11.2	2.33	3.0
27	12.0	2.35	3.0
28	12.8	2.37	3.0
29	13.6	2.39	3.0
30	14.5	2.40	3.0
31	15.3	2.42	3.0
32	16.2	2.43	3.0

Note 1: The rate of deceleration as given by most of the dynamic measuring equipment is the peak deceleration and not the average deceleration rate.

Note 2: The test official to ensure that the relevant test equipment used is set up correctly to ensure that measured parameters produced by the test equipment are in accordance with the requirements as given in this document.

COMPENSATION GUIDELINE

A TMM xyz is operating at 6 km/h and is tested in an un-laden condition. Calculate the adjusted MASD, MAAD and MAPD acceptance criteria.

Compensation Guideline

Step	Requirements
1	From Table 3, for the selected test speed, obtain: • Maximum allowed stopping distance (MASD), • Minimum allowed average deceleration (MAAD) values, and • Minimum allowed peak deceleration (MAPD) values.
2	Obtain values for: • GVM • Actual Test Mass
3	Calculate two compensation factors: • Factor 1 = (Actual Test Mass / GVM) • Factor 2 = (GVM / Actual Test Mass)
4	Calculate adjusted acceptance criteria as follows: • Adjusted MASD = MASD x Factor 1 • Adjusted MAAD = MAAD x Factor 2 • Adjusted MAPD = MAPD x Factor 2

Step	Requirements
1	From Table 3, for the 6 km/h: • MASD = 1.0 m • MAAD = 1.33 m/s^2 • MAPD = 3.0 m/s^2
2	• GVM = 27 800 kg • Actual Test Mass = 20 100 kg
3	Calculate two compensation factors: • Factor 1 = 0.72 • Factor 2 = 1.38
4	Calculate adjusted acceptance criteria: • Adjusted MASD = 1 x 0.72 = 0.72 m • Adjusted MAAD = 1.33 x 1.38 = 1.84 m/s^2 • Adjusted MAPD = 3 x 1.38 = 4.14 m/s^2

The responsible engineer on the mine is to present the adjusted acceptance criteria for the fleet of TMM in a table format an example of which is found in the table below

Example Table: Service brake adjusted dynamic tests values for machine xyz

Operational speed as per COP [km/h]	TMM Model	Adjusted stopping distance Maximum value [m]	Adjusted mean deceleration Minimum value [m/s^2]	Adjusted peak deceleration Minimum value [m/s^2]
6	TMM xyz	0.72	1.84	4.14

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BRAKE PERFORMANCE REQUIREMENTS

Emergency brake: Dynamic testing

Emergency brake stopping performance requirements are based upon the following formula:	
$$s = \frac{vt}{3.6} + \frac{v^2}{13 \ x \ 2a}$$	
s	is the stopping distance, in meters (m);
v	is the test speed, in kilometers per hour (km/h)
t	**1.0** second (s) for emergency braking
a	2.1 metres per second squared (m/s^2).

Note 1: The deceleration (value a) is reduced with 25% from the value given in SANS 1589 Part 1 (2.8 m/s^2) to allow for operational wear and degradation and time t is taken as 1 second.

Note 2: Stopping distance values are based on a dry road at zero grade.

NOTE: SEE BULLETIN FROM SANDVIK

Table 4: Emergency brake: Dynamic test requirements (fully laden machine)

Start Speed (km/h)	Stopping distance level surface (meters)	Average deceleration (m/s^2)	Peak Deceleration (m/s^2)	Calculated slope [%]	SOP Degrees
1	0.3	0.13	1.9	11.0	6
2	0.6	0.24	1.9	11.0	6
3	1.0	0.34	1.9	11.0	6
4	1.4	0.43	1.9	11.0	6
5	1.9	0.51	1.9	11.0	6
6	2.4	0.58	1.9	11.0	6
7	2.9	0.64	1.9	11.0	6
8	3.5	0.70	1.9	11.0	6
9	4.1	0.75	1.9	11.0	6
10	4.8	0.80	1.9	11.0	6

Note 1: The rate of deceleration as given by most of the dynamic measuring equipment is the peak deceleration and not the mean deceleration rate.

Note 2: The test official to ensure that the relevant test equipment used is set up correctly to ensure that measured parameters produced by the test equipment are in accordance with the requirements as given in this document.

BRAKE PERFORMANCE REQUIREMENTS

INSTRUMENT ACCURACY

Parameter	Instrument accuracy
Stopping distance	± 3.0 %
Grade (degrees)	± 3.0 %

As a result of the inaccuracy and repeatability of the dynamic testing, for TMM operating at speeds below 10 km/h it is recommended that a minimum of three (3) runs must be performed

Note: At speed below 10-15 km/h most dynamic test equipment will not achieve repeatability over 3 runs of 3%

BRAKE EFFICIENCY

In the new standard brake efficiency will no longer be used but rather average deceleration

CHALLENGES WITH IN-SERVICE BRAKE TESTING

Brake performance

SANDVIK BULLETIN – applicable to all there hydrostatic drives

DANGER

Brake test shall not be done by pressing emergency/parking brake push button from full speed!
The tramming wheel motors braking technology only enables 10 emergency stops at full speed. After 10 emergency braking, all wheel motors brake discs must be replaced in order to ensure safe operating of the machine.
Emergency braking events must be counted and immediatly reported. Sandvik also recommends to always get wheel motors brake discs kits in stock.
This test procedure must be performed in static mode and it is not counted as one of these maximun 10 emergency brake stops from full speed.

RESULTS – THESE VEHICLES ARE NEVER TESTED

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