
**Earth-moving machinery — Crawler
machines — Performance requirements
and test procedures for braking systems**

*Engins de terrassement — Engins à chenilles — Exigences de
performance et modes opératoires d'essai des dispositifs de freinage*



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Contents

Page

Foreword.....	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 General requirements	3
4.1 Required brake systems	3
4.2 Brake controls	4
4.3 Common components	5
4.4 Warning device for exhaustible energy sources	5
4.5 Braking systems with an electronic control system	5
5 Test conditions	5
5.1 Test sites	5
5.2 Test preparations	6
5.3 Instrumentation	6
5.4 Towing or pulling means	6
6 Test and performance criteria for brake systems	6
6.1 Tests for service and secondary brakes	6
6.2 Tests for parking brake	8
6.3 Analytical and component level verification	9
7 Machine instructions and labels	9
8 Test report	10
Bibliography	11

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10265 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 1, *Test methods relating to machine performance*.

This second edition cancels and replaces the first edition (ISO 10265:1998), which has been technically revised.

Earth-moving machinery — Crawler machines — Performance requirements and test procedures for braking systems

1 Scope

This International Standard specifies minimum performance criteria and test methods to enable uniform assessment of the service, secondary and parking brake systems of crawler machines.

It is applicable to self-propelled crawler machines, as defined in ISO 6165 including derivative earth-moving machines with rubber tracks, with a maximum design speed of 20 km/h or less. This International Standard does not cover those machines that are covered by ISO 17063 or wheeled machines equipped with over-the-tyre tracks. Crawler machines with maximum design speed greater than 20 km/h conform to ISO 3450.

NOTE Crawler machines used in underground mining applications might have other regional or local brake system requirements.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6014:1986, *Earth-moving machinery — Determination of ground speed*

ISO 6016:1998, *Earth-moving machinery — Methods of measuring the masses of whole machines, their equipment and components*

ISO 9248:1992, *Earth-moving machinery — Units for dimensions, performance and capacities and their measurement accuracies*

ISO 10266:1992, *Earth-moving machinery — Determination of slope limits for machine fluid systems operation — Static test method*

ISO 10968:2004, *Earth-moving machinery — Operator's controls*

ISO 15998:—¹⁾, *Earth-moving machinery — Machine-control system (MCS) using electronic components — Performance criteria and tests for functional safety*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Brake systems

1) To be published.

3.1.1

brake system

all the components that combine to stop and/or hold the machine, including the control(s), the brake actuation system, the brake(s) and all parts connecting the brake to the track

3.1.2

service brake system

primary system used for stopping and holding the machine

3.1.3

secondary brake system

system used for stopping the machine in the event of any single failure in the service brake system

3.1.4

parking brake system

system used to hold a stopped machine in a stationary position

3.2 Brake system components

3.2.1

control

component directly activated by the operator to cause a force, a braking signal or braking request to be transmitted to the brake(s)

3.2.2

brake actuation system

all the components between the control(s) and the brake(s) which connect(s) them functionally

3.2.3

brake

components that directly apply a force to oppose movement of the machine

NOTE Brakes can, for example, be of friction, electrical, regenerative device, hydrostatic or other fluid types.

3.3

brake retarding force

decelerating or holding force due to brake system action plus rolling resistance, but excluding any braking effect by the engine (i.e., engine brakes, retarders, exhaust brakes)

NOTE In practice, this is the force measured in a line connecting the machine being tested to a pulling or anchoring machine or device.

3.4

common component

component that performs a function in two or more brake systems

3.5

machine mass

M

operating mass of a machine which includes the heaviest combination of cab, canopy, operator protective structures, if required, with all their components and mountings, any combination of equipment approved by the manufacturer of the machine, including operator and full liquid systems in accordance with ISO 6016

NOTE The machine mass for crawler tractors (i.e., machines with integrated buckets, bins, bowls which typically travel with a load) is to include a payload.

3.6 slope capability

α

slope that establishes brake performance for a specific machine between the minimum 17° and maximum 45° criteria or the maximum slope specified by the manufacturer for travel or operation between 17° and 45°

3.7 back throttling

action of applying slight forward or reverse power to a hydrostatic drive system or similar propel drive systems to hold the machine stationary on a slope

3.8 modulated braking

capability to continuously and progressively increase and decrease the braking force by operation of the brake control (i.e., hand, foot, combined brake/deceleration or other variations)

3.9 maximum machine level surface speed

maximum speed determined in accordance with ISO 6014, or equivalent

3.10 derivative earth-moving machine

earth-moving machine forms that are a combination of features from other earth-moving machines creating different configurations or arrangements (e.g., backhoe loader with four separate rubber tracks replacing four wheels)

3.11 safe state

state in which the controlled equipment, process, or system is automatically or manually stopped or switched into a mode to prevent unexpected movements or potentially hazardous release of stored energy, after a malfunction of the machine-control system

3.12 hydrostatic drive system

closed loop hydraulic system to propel and retard machine movement

3.13 brake slope capability

maximum slope advertised by the machine manufacturer, on which the service brakes are capable of stopping the machine and the service and park brakes are each capable of holding the machine stationary, whichever is the least slope value

4 General requirements

4.1 Required brake systems

4.1.1 Functions

All machines shall be equipped with:

- a service brake system;
- a secondary brake system;
- a parking brake system.

NOTE Service, secondary and parking brake systems can share common components and do not have to be three independent and separate systems. Subclause 4.3 gives the required performance if there is any single component failure.

4.1.2 Disconnecting device

4.1.2.1 General

No brake system shall contain a disconnecting device, such as a clutch or shiftable gear box, which allows disabling the brake(s) with the exception of 4.1.2.2 and 4.1.2.3 which are permissible arrangements.

4.1.2.2 Parking brake disconnecting device

A parking brake disconnecting device designed to allow movement of a disabled machine shall be located outside the operator's station, unless the parking brake can be re-applied immediately from within the operator's station.

4.1.2.3 Service or secondary brake disconnecting device

Any device designed to disconnect the service or secondary brake power source for cold weather starting, shall require application of the parking brake before disconnecting the service or secondary brakes.

4.2 Brake controls

4.2.1 General

All brake system controls shall be capable of being applied by an operator from the operating position. Parking brake system's control(s) shall be arranged so that they cannot be released once they have been applied unless they can be immediately re-applied by the operator. Arrangement of brake controls is covered by ISO 10968.

Machines equipped with any brake system including an electronic brake control system shall prevent or minimize an uncontrolled braking performance (i.e., random brake applied, released or sporadic braking performance) during normal operation (e.g., during start, stop or normal travel operation of the machine) of the brake control systems.

4.2.2 Automatic application

Secondary and parking brake systems may be applied automatically (e.g., spring activated). Automatic application does not require modulation.

4.2.3 Control force

The force applied to the brake control shall not exceed the levels specified in Table 1 when the required brake system performance (see Table 2) is measured.

Table 1 — Maximum control force for brake tests

Control type	Maximum force applied N
Finger grasp (flip levers, switches)	20
Hand grasp: — upwards	400
— fore-aft, sideways, downward	300
Foot treadle (ankle control)	350
Foot pedal (leg control)	600

4.3 Common components

Brake systems (service, secondary and parking functions) may use common components. However, a failure of any single component shall not reduce the effectiveness of the machine's stopping capability to less than the secondary brake system performance, as defined in 6.1.4.

The failure of a common component (lever, pedal, switch, micro-processor, wiring harness, valves, etc.), that may be used to actuate one of the brake systems, is permitted, provided that the machine's stopping capability meets the secondary brake performance, as defined in 6.1.4, after the failure. This braking capability may be applied automatically and without modulation.

4.4 Warning device for exhaustible energy sources

If exhaustible energy is used for the service brake system, the exhaustible energy system shall be equipped with a warning device. The warning device shall activate before the system energy drops below the greater of the following:

- 50 % of the manufacturer's specified maximum operating energy level or
- the exhaustible energy level required to meet the secondary brake performance requirements, as defined in 6.1.4.

The warning device shall readily attract the operator's attention by providing a continuous visible and/or audible warning. Gauges indicating pressure or vacuum do not meet this requirement.

NOTE Mechanical springs are not considered to be an exhaustible energy source.

4.5 Braking systems with an electronic control system

The electronic control system of a brake system shall meet the safe state as determined by the manufacturer using risk assessment methodology. An electronic control system complying with ISO 15998 meets the requirements of this subclause.

If the maximum travel speed for the machine with an electronic control system is designer limited to 6 km/h, the safe state requirements defined in this subclause are fulfilled when any of the brake systems can meet the service brake performance requirements, as defined in 6.1.3.

NOTE 1 Safe state can be achieved with robust design, high reliability or emergency stop controls for failure modes where there are no practical means to provide advance warnings.

NOTE 2 Equivalent ISO or IEC electric/electronic control system safety standards such as ISO 15998 can be used to meet the safe state through risk assessments and control measures.

5 Test conditions

5.1 Test sites

5.1.1 Level test course

The test course shall be relatively flat and smooth with a slope no greater than 1 % in the direction of travel, or 3 % transversely. The course shall be of sufficient size, material and condition to provide the traction required for conducting the towing or pulling tests described in Clause 6. Moisture content of a soil test course shall be such that the mass of the test machine can be supported with only nominal sinkage.

5.1.2 Alternate static test site

If the alternate static test, of 6.1.2, is used, it may be conducted on the level test course or in a level laboratory setting. The test machine shall be set up to measure propulsion forces with tracks on a traction surface, or tracks secured to a ground surface, or axles connected to a dynamometer.

5.2 Test preparations

- a) Brake tests shall be performed using the machine configuration having the most adverse effect on braking. Machine mass shall be according to the definition provided in this International Standard unless otherwise specified in this International Standard.
- b) All parameters relating to braking systems shall be within the machine manufacturer's specifications, i.e., brake adjustment, brake pressures, track tension, etc. No manual adjustment(s) shall be made to the brake system(s) during any single test.
- c) Each brake test shall be performed without influence from another brake system. For example, when testing the service brake, the parking brake shall not be used to improve the performance of the service brake.
- d) Connections for towing or pulling shall be made as low as practical on the drawbar or other appropriate connecting point(s). The pulling force shall be applied horizontally in order to not influence the ground contact of the machine being measured.
- e) Blades, buckets, chains, dozers and other equipment shall be carried in the transport or travel position recommended by the manufacturer.
- f) Burnishing (conditioning) of brakes before testing is permissible. The burnishing procedure shall be indicated in the operator's manual for the machine and shall be verified by consultation with the machine or brake manufacturer.
- g) Immediately prior to a test, the machine shall be operated until the machine fluids, i.e., engine and transmission oils, are at the normal operating temperature specified by the manufacturer unless otherwise specified in this International Standard.

5.3 Instrumentation

Instrumentation to measure and record the test parameters within the accuracy specified in ISO 9248 shall be provided.

5.4 Towing or pulling means

A means (for example, another machine or winch) shall be provided to generate the brake retarding, towing or pulling force required by the performance criteria, described in Clause 6.

6 Test and performance criteria for brake systems

6.1 Tests for service and secondary brakes

6.1.1 Towing test on level test course

The service and secondary brake performance is tested by towing the machine with the transmission control in neutral at a speed of 10 % to 40 % of the maximum machine level surface speed. The brake(s) shall be applied and the brake retarding (towing) and brake control forces shall be measured.

Machines designed with hydrostatic or other similar propel drive system or with automatic brakes which are applied when the transmission control is in the neutral position may be tested by driving at the same speed as the towing machine and then applying the brake system being tested by placing the appropriate control in the brake or neutral position.

6.1.2 Alternate static test for certain service and secondary brakes

A hydrostatic or other similar propel drive system, or other brakes without friction material, which have equivalent retarding performance in both a stationary and moving mode, may be tested using a static test procedure (see 5.1.2 for test course or laboratory setting description).

The service or secondary brake performance is tested in a static mode by engaging propel to exert, for example, a pull against an anchor or to resist a pull from a winch. The resultant propel pulling force shall be considered to be the brake retarding force and no corrections are made for track or machine rolling resistance. The brake retarding (pulling) and brake control forces shall be measured.

6.1.3 Service brake performance criteria

The service brake system shall be applied in accordance with the control forces in Table 1 and meet or exceed the brake retarding force listed in Table 2 in both the forward and reverse directions. The slope capability, α , as defined and limited by definition 3.6, is the maximum that the machine in transport mode and prepared in accordance with 5.2 can ascend unaided with a ground friction (traction) coefficient, μ , of 1,0. Brake performance shall be equivalent to the minimum 17° slope capability angle regardless of limitations for fluid system operation (see ISO 10266) or tipping or tractive pulling force.

NOTE The maximum slope capability by definition is 45°.

Table 2 — Performance criteria for crawler brake systems

Brake system	Brake retarding force N
Service	$9,8M \sin \alpha$
Secondary	$4,9M \sin \alpha$
Parking	$9,8M \sin \alpha$
α is the slope capability angle, in degrees (see 3.6);	
M is the machine mass, in kilograms (see 3.5).	

6.1.4 Secondary brake performance criteria

Crawler machines may have independent brakes of nominally equal capacity for each track. Following a brake failure of one track, having the brake of the other track in working order is sufficient if the secondary braking performance of this section is met. The secondary brake system shall be applied in accordance with the same slope capability as tested for service brakes (see 6.1.3), the control forces in Table 1 and meet or exceed the brake retarding force listed in Table 2 in both the forward and reverse directions.

6.1.5 Holding performance test for service brake

6.1.5.1 General

All machines shall be tested in either the forward or reverse direction, whichever is the least effective, in accordance with the test conditions, specified in Clause 5.

6.1.5.2 Service brake holding performance test

The tests may be carried out either:

- a) at a test site with the appropriate 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 required pulling force is given in Table 2.

The pulling force shall be applied horizontally to achieve a minimum force equivalent to the slopes specified in 6.1.5.3.

6.1.5.3 Service brake holding performance criteria

For machines with the power train disengaged (unless a hydrostatic or other similar propel drive system is used) the service brake system shall be capable of holding the machine motionless at the slope capability of the machine with the engine running. For hydrostatic or similar propel drive systems, back throttling may be used to meet this requirement.

NOTE The slope capability of the machine can be from 17° to 45° or the manufacturer's specified slope between 17° and 45°.

6.2 Tests for the parking brake

6.2.1 Parking brake test

The parking brake performance is tested by pulling on the stationary test machine with the parking brake applied and the transmission control in neutral. The static brake retarding (pulling) and brake control forces shall be measured.

The minimum braking torque applied by a mechanical parking brake shall exceed the maximum torque of the propel drive system or a control system shall be in place that neutralizes the transmission when the parking braking is applied (i.e., prevents driving through the parking brake). For a parking brake system that does not meet the above requirement, an indication shall be given to the operator that the machine is propelling through the parking brake that could result in parking brake damage or the need for parking brake adjustments.

6.2.2 Parking brake performance criteria

The parking brake system shall be applied in accordance with the control forces in Table 1 and meet or exceed the brake retarding force listed in Table 2 with no track movement in either the forward or reverse direction.

6.2.3 Parking brake application and durability

A spring applied parking brake system shall apply and attain parking brake holding criteria, as specified in 6.2.2, by one of the following.

- a) Within 2,5 s at -25 °C: a maximum 5 min engine warm up (i.e., engine running at recommended operation speed without any other operations) is allowed after cold soak of the machine before conducting this test.
- b) Parking brake shall be applied before the machine can move 300 mm due to creep movement. For this evaluation, creep movement is the machine travel movement from a stationary state with the transmission in neutral and parking brake released on a 10° slope and the machine at normal operating temperature.

If the parking brake system is also the secondary brake system then the parking brake system shall meet the static holding criteria following one dynamic stop from maximum machine level speed with no adjustments to the parking brake. The required dynamic stop is made without payload for payload carrying machines.

6.2.4 Maintained application criteria

After application, the parking brake system, operating according to manufacturer's specifications, shall maintain the parking brake performance, as specified in Table 2, regardless of any contraction of the brake parts or leakage of any kind. This system shall not be dependent upon an exhaustible energy source to maintain performance.

6.3 Analytical and component level verification

6.3.1 General

Analytical and component level verification that the criteria in Table 2 are met can be used providing that there is a proven correlation (e.g., actual test data showing correlation with a reasonable engineering certainty that the analytical results are equivalent or more conservative than the actual tests) between the analytical model and actual field tests. The test report shall indicate if analytical results were used for performance verification along with a reference to the source of proven correlation. The tests shall be retained by the machine manufacturer as part of the verification records according to the manufacturer's document retention policy.

6.3.2 Alternative lab testing for braking systems

For braking system functions capable of being reproduced in a lab environment, alternative lab testing may be used to determine service, secondary and parking brake capacity. The laboratory test equipment should be capable of supplying the same control pressures and flow rates as supplied on the machine within a testing tolerance of 2 % in accordance with ISO 9248. The test system shall be able to resist and measure torque to the brake at a torque level exceeding the brake holding force or brake retarding force, whichever is greater. For service and secondary brake systems, the rotational speed of the brakes shall also be determined from the track speed to meet the test requirements, described in 6.1.1. For parking brake systems, the maximum brake holding torque should be measured. The test report shall indicate if laboratory testing was used for performance verification including the name and address of the laboratory (i.e., manufacturer's or other supplier's laboratory).

6.3.3 Calculating tow force from lab based tests

Static and dynamic brake torque measured in a lab environment shall be translated into an equivalent tow force at the track, using calculations. The equivalent lab based tow force shall meet requirements of Table 2. Any gear ratios between the track and the brake must be taken into consideration in the calculations. All calculations shall be included in the test document.

7 Machine instructions and labels

Operational limitation(s) of the brake control system according to the manufacturer's specifications shall be included in one of the following:

- the operator's manual;
- instructional sign or informational readouts from the machine monitor.

The instructions shall include operating precautions for brake system default conditions where the brake or retarding operating limitations may be automatically changed creating new brake performance characteristics (i.e., automatic shift of the transmission to neutral) or damage to the parking brake because it is applied.

If brake burnishing is recommended by the brake or machine manufacturer, the brake burnishing procedure shall be included in the operator's and/or maintenance manual for the machine.

The brake slope capacity of the machine shall be provided in operating instructions or machine instructional signs. A means for the periodic evaluations of the service and parking brakes systems to assess the performance condition shall be provided.

8 Test report

The test report shall contain at least the following information:

- a) reference to this International Standard, i.e., ISO 10265:2007;
- b) the type of machine;
- c) the make of the machine;
- d) the model and serial number of the machine;
- e) the condition of the brake system (e.g., new, in operation for 1 000 h);
- f) the mass of the machine as tested, in kilograms;
- g) the manufacturer's approved maximum machine mass, in kilograms;
- h) description of the brakes (e.g., disc, drum, hand or foot control);
- i) the type of brake systems (e.g., mechanical, hydraulic, spring applied, hydrostatic);
- j) the longitudinal and cross slope of the test course;
- k) the results of all brake tests;
- l) the force levels applied to the controls (see 4.2.3);
- m) the test setup and method used for the alternate static test, in 6.1.2;
- n) the dimensions, construction and condition of the test course;
- o) identification that analytical analysis was used along with reference to the source of proven correlation; calculations associated with 6.3 and correlation data to validate analytical verification in 6.3.2 and 6.3.3;
- p) identification of the test laboratory including name and address.

NOTE Manufacturer's or supplier's laboratory documents meet this requirement.

Bibliography

- [1] ISO 3450:1996. *Earth-moving machinery — Braking systems of rubber-tyred machines — Systems and performance requirements and test procedures*
- [2] ISO 6165: 2006, *Earth-moving machinery — Basic types — Identification and terms and definitions*
- [3] ISO 17063:2003, *Earth-moving machinery — Braking systems of pedestrian-controlled machines — Performance requirements and test procedures*

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