
INTERNATIONAL STANDARD



3450

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Off-highway earth-moving machinery – Minimum performance criteria for brake systems

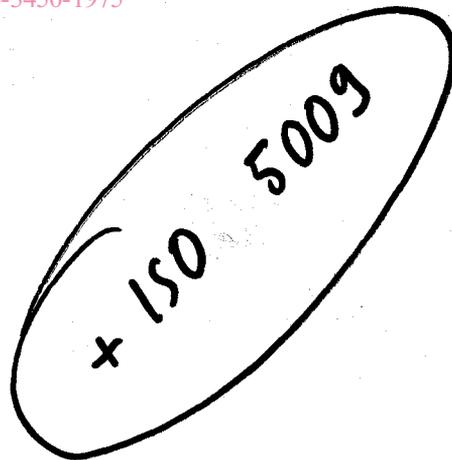
Engins de terrassement hors-route – Critères de performance minimale des systèmes de freinage

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3450 was drawn up by Technical Committee ISO/TC 127, *Earth-moving machinery*, and circulated to the Member Bodies in February 1974.

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It has been approved by the Member Bodies of the following countries :

Brazil	Ireland	Spain
Bulgaria	Italy	Turkey
Canada	Japan	U.S.A.
Chile	Netherlands	U.S.S.R.
Czechoslovakia	Poland	Yugoslavia
Finland	Romania	
France	South Africa, Rep. of	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
United Kingdom

Off-highway earth-moving machinery — Minimum performance criteria for brake systems

1 SCOPE

This International Standard lays down the minimum performance criteria for service brake systems, emergency stopping systems and parking brake systems for off-highway earth-moving machinery.

2 FIELD OF APPLICATION

This International Standard applies to operator-controlled rubber-tyred front-end loaders, rubber-tyred motor graders, self-propelled scrapers, dozers, off-highway trucks and wagons designed for use off the highway.

3 DEFINITIONS

For the purposes of this International Standard the following definitions apply :

3.1 front-end loader (rubber tyred) : A machine composed of a wheeled tractor with an integral linkage system on the front of which is mounted a bucket that loads material through forward motion of a machine capable of transporting and discharging material. See figure 1.

3.2 motor grader (rubber tyred) : A self-propelled rubber-tyred machine having an adjustable blade positioned between the front and rear wheels. See figure 2.

3.3 self-propelled scraper : A mobile machine equipped with its own power unit for movement and control of attachments. This group of self-propelled scrapers includes those scrapers mounted on two or more wheels (including multiple engine units) drawn by a tractor of two or more wheels. See figure 3.

3.4 dozer (rubber tyred) : A machine composed of a wheeled tractor with a bulldozer blade mounted at the front of the machine. See figure 4.

3.5 off-highway truck : A self-propelled machine of the dump type in which a load-retaining body is supported by the machine frame and located generally between the front and rear axles of the prime mover. The machine ordinarily employs a power-actuated means for raising the body to dump the load. See figure 5.

3.6 off-highway wagon : A machine composed of a wheeled tractor and a wheeled material-hauling device connected at a common pivot centre. See figure 6.

NOTE — The definitions in 3.1 to 3.6 and figures 1 to 6 are presented for information and will be co-ordinated by ISO/TC 127/SC 4.

3.7 off-highway machine : A machine designed for use in undeveloped areas, in open-pit mines and on private haul roads temporarily built for use during the life of a project; usually, a machine that is too heavy or too large to be used on public highways.

3.8 service brake system : The primary braking system used for stopping the machine.

3.9 emergency stopping system : The system used for stopping the machine in the event of any single failure in the service brake system.

3.10 parking brake system : A system used to hold a stopped machine in a stationary position.

3.11 gross machine mass : The maximum operating mass of the machine with pay-load as rated by the manufacturers of the machine, with the vehicle fully fueled and serviced. It shall be expressed in kilograms and pounds.

3.12 retarders : See ISO . . . , *Earth-moving machinery — Retarders*.¹⁾

4 MACHINE REQUIREMENTS

4.1 All machines shall be equipped with :

- a) a service brake system;
- b) an emergency stopping system;
- c) a parking brake system.

4.2 The above braking systems may use common components. However, a failure of a common component shall not reduce the effectiveness of the machine stopping capability below the emergency stopping performance as specified in 6.2.

1) In preparation.

5 BRAKE TESTS¹⁾

This clause sets forth items which become part of a brake test.

5.1 Facilities and instrumentation

The following facilities and instrumentation shall be provided :

a) A test track which consists of a clean-swept, level, dry concrete or other similar surface of adequate length to conduct the test. The approach shall be of sufficient length, smoothness, and uniformity of grade to ensure stabilized travel speed of the machine.

The braking surface shall not have over 1 % grade in the direction of travel, and no more than 3 % grade at right angles to the direction of travel.

b) A means for determining the instant when the brake is applied and when the machine comes to a complete stop.

c) A means for measuring the braking system energy level.

d) A means for measuring the stopping distance.

e) A means for measuring the test speed.

f) A means for weighing the machine.

5.2 Test requirements

In conducting the test, the following requirements shall apply :

a) All tests shall be conducted with the brake system at the machine's fully charged system energy level.

b) The test machine shall be at the manufacturer's gross machine mass with weight distribution as determined by the manufacturer. The bucket on front-end loaders shall be empty and in the carry position. The blade on dozers shall be at 460 mm (18 in) ± 10 % above the test surface.

c) Stopping distance shall be measured in metres (feet) from the instant the brake control is applied.

d) Stopping tests shall be conducted at the machine speed given in the table.

e) Stopping tests shall be conducted with the transmission in the gear commensurate with the speeds given in the table.

f) Auxiliary retarders shall not be used in the tests unless the retarder is simultaneously actuated by the applicable brake system control.

g) The brake test shall be conducted in both directions on the test course, and the stopping distance shall be calculated as the mean value of the tests.

h) The test machine shall be in a fully serviced condition, including fuel, oil and water, and with the manufacturer's approved standard accessories, if so equipped, and one operator. The brake systems shall be maintained in accordance with the manufacturer's instructions.

5.3 Measuring accuracy

The following measuring accuracy shall be adhered to when conducting the test :

Measurement	Accuracy
Stopping distance	± 1 %
Test speed	± 2,5 %
Machine mass	± 2,5 %

Correction formula for stopping distance :

$$L_s = L'_s \left(\frac{V}{V_1} \right)^2$$

where

L_s is the corrected stopping distance;

L'_s is the measured stopping distance;

V is the specified machine speed for the brake test;

V_1 is the measured machine speed in the brake test.

NOTE — The correction formula shall only be used if the actual test speed is within ± 10 % of the test speed specified in the table.

5.4 Failure of parts

Failure or malfunction of any one part in either the emergency stopping system or the service brake system shall not leave the machine without an operative system capable of bringing the machine to a controlled stop on the test track (5.1.a) with the manufacturer's rated gross machine mass and from the speed specified in the table. Rolling resistance and other parasitic losses shall not be considered adequate to meet this requirement.

6 PERFORMANCE REQUIREMENTS

6.1 Service brake system

6.1.1 System capacity (stored energy systems)

The service brake system shall be capable of delivering 70 % or more of the full energy capacity of the system to the brakes, when the brakes are applied at a rate of once per 20 s (or 3 applications per minute) with the engine at the maximum governed revolutions per minute (rev/min); for front-end loaders the application is once per 10 s (or 6 applications per minute).

1) TC 127/SC 1 is studying the question of test methods for braking efficiency of machines.

6.1.2 Warning device (stored energy systems)

The service brake system shall be equipped with a warning device which actuates when system energy drops below 50 % of the manufacturer's specified maximum operating energy level. The device shall be readily discernible (visual or audible) to the operator and provide a continuous warning. Gauges indicating pressure or vacuum are not acceptable to meet these requirements.

6.1.3 Stopping performance

When tested in accordance with clause 5, the service brake system shall stop the machine within the distance specified in the table.

6.2 Emergency stopping system

6.2.1 Performance

The emergency stopping system shall be capable of stopping the machine in the event of any single failure in the service brake system.

6.2.2 Emergency brake application

The emergency stopping system shall be capable of being applied manually by a person seated in the driver's seat. The system shall be arranged so that it cannot be released from the driver's seat after any application, unless immediate

re-application can be made from the driver's seat to stop the machine.

In addition to the manual control, the emergency stopping system(s) may also be applied automatically. If an automatic emergency stopping system is used, the automatic application shall occur after a warning device is actuated.

6.2.3 Stopping performance

When tested in accordance with clause 5, the emergency stopping system shall stop the machine within the distance specified in the table.

6.3 Parking brake system

6.3.1 Performance

The parking brake system shall be capable of holding the machine stationary on a 15 % dry, swept, concrete grade under all conditions of loading, up to the manufacturer's gross machine mass rating.

6.3.2 Remain applied

The parking brake system, when applied, shall remain in the applied position in compliance with 6.3.1, despite any contraction of the brake parts, exhaustion of the source of energy, or leakage of any kind.

TABLE - Performance requirements
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Gross machine mass kg (lb)	Maximum stopping distance m (ft)	
	Service	Emergency
Front-end loader and dozer from 24 km/h (15 mile/h)		
Up to 16 300 (36 000)	9 (28)	26 (84)
Over 16 300 (36 000) to 32 000 (70 000)	11 (37)	34 (111)
Over 32 000 (70 000) to 64 000 (140 000)	14 (45)	41 (135)
Over 64 000 (140 000) to 127 000 (280 000)	16 (53)	48 (159)
Over 127 000 (280 000)	20 (65)	59 (195)
Motor grader from 30 km/h (18 mile/h)		
Up to 16 000 (35 000)	11 (37)	32 (105)
Over 16 000 (35 000)	14 (45)	41 (135)
Scraper from 32 km/h (20 mile/h)		
Up to 23 000 (50 000)	18 (60)	55 (180)
Over 23 000 (50 000) to 45 000 (100 000)	21 (70)	64 (210)
Over 45 000 (100 000) to 68 000 (150 000)	27 (90)	82 (270)
Over 68 000 (150 000)	30 (100)	91 (300)
Truck and wagon from 32 km/h (20 mile/h)		
Up to 45 000 (100 000)	18 (60)	55 (180)
Over 45 000 (100 000) to 90 000 (200 000)	27 (90)	82 (270)
Over 90 000 (200 000) to 180 000 (400 000)	38 (125)	114 (375)
Over 180 000 (400 000)	53 (175)	160 (525)

NOTE - If the maximum machine speed is lower than that specified in the table, that speed shall be used as the test speed.

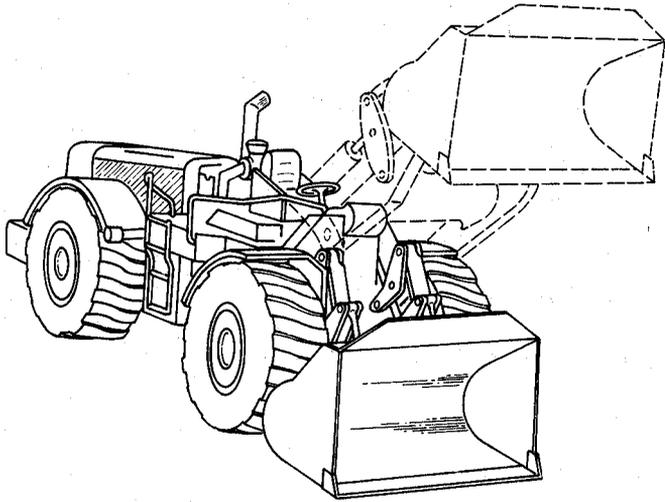
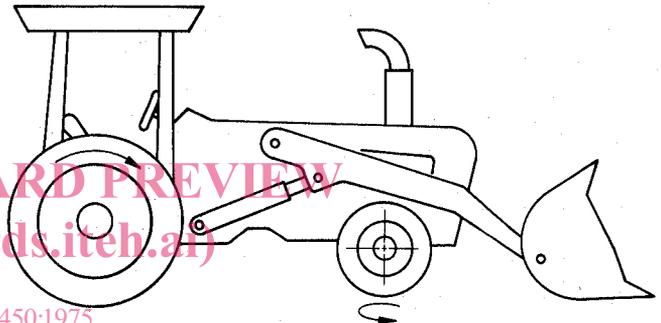


FIGURE 1a) — Front-end loader (rubber tyred)



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FIGURE 1b) — Front-end loader with rear axle drive and front axle steer

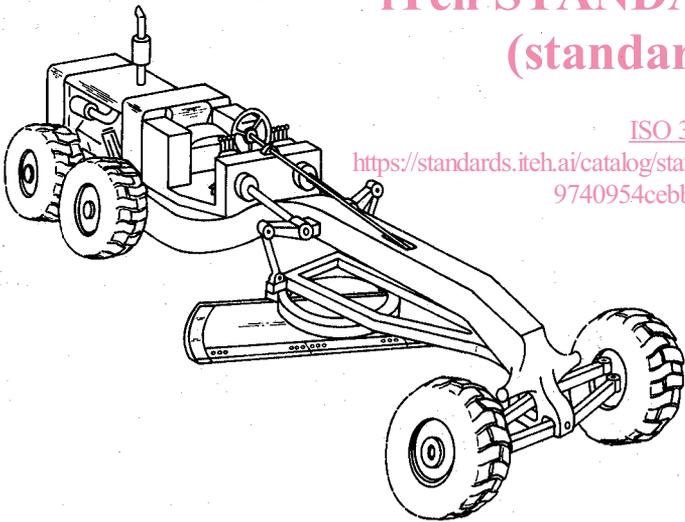


FIGURE 2 — Motor grader (rubber tyred)

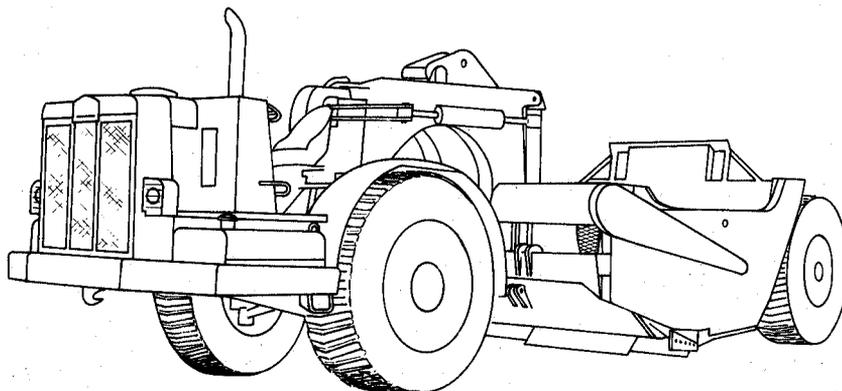


FIGURE 3 — Self-propelled scraper

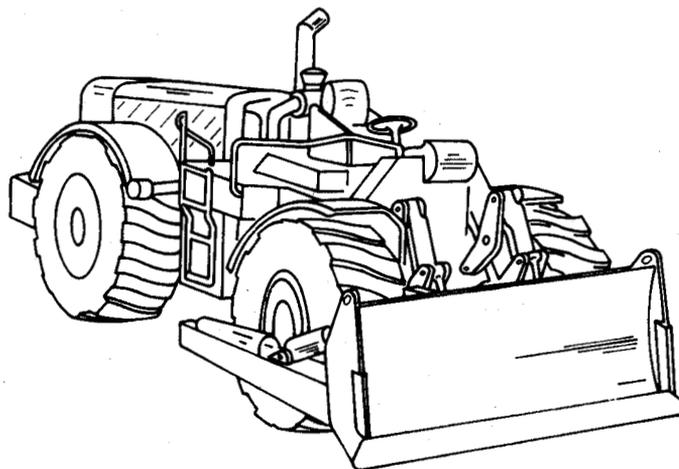


FIGURE 4 – Dozer (rubber tyred)

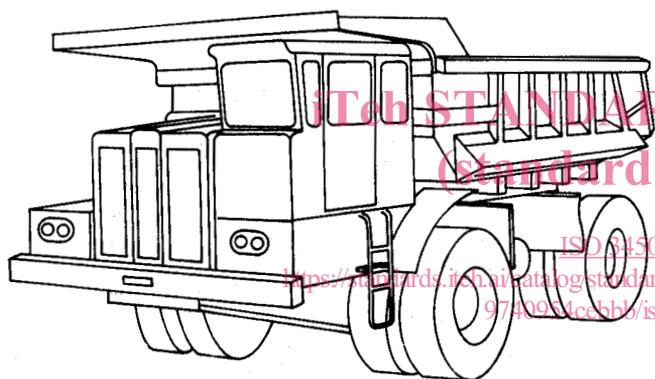


FIGURE 5 – Off-highway truck

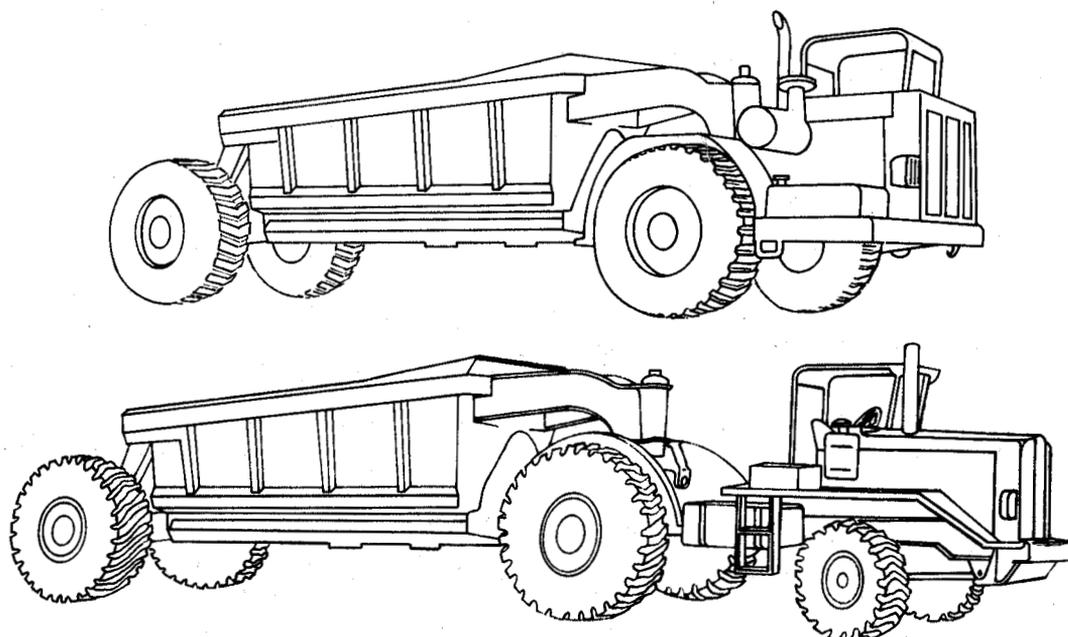


FIGURE 6 – Off-highway wagons

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