International Standard ISO 5697

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Agricultural and forestry vehicles — Determination of braking performance

Véhicules agricoles et forestiers — Détermination des performances de freinage

First edition — 1982-09-15

UDC 631.3 — 59 **Ref. No. ISO 5697-1982 (E)**

Descriptors : agricultural machinery, braking systems, definitions, performance evaluation, braking tests, test results.

Price based on 15 pages

Foreword

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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 5697 was developed by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, and was circulated to the member bodies in April 1981.

It has been approved by the member bodies of the following countries :

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Austria	Iraq	South Africa, Rep. of
Belgium	Italy	Sweden
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The member bodies of the following countries expressed disapproval of the document on technical grounds :

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Agricultural and forestry vehicles — Determination of braking performance

1 Scope and field of application

This International Standard specifies methods of measuring the performance of service brakes, based on measured deceleration and on measured stopping distance, and of parking brakes of agricultural and forestry vehicles.

It is applicable to :

a) tractors and self-propelled vehicles having a maximum design speed exceeding 6 km/h;

b) trailed agricultural vehicles designed for use at speeds exceeding 6 km/h, comprising agricultural trailers, towed agricultural machines and implements.

2 Reference

ISO 3965, *Agricultural wheeled tractors. Determination of maximum travel speed.*

Section one : General

3 Definitions

For the purpose of this International Standard, the following definitions apply.

3.1 agricultural tractor : A self-propelled wheeled or track-laying vehicle, more particularly designed to pull, push, carry and operate implements including trailers used for agricultural work (including forestry work). It may be provided with a detachable loading platform.

3.2 self-propelled agricultural vehicle : Any vehicle, other than a tractor, having its own means of propulsion, which is used in agriculture or forestry and which according to its design and the devices fixed to the vehicle is suitable and intended for doing the work.

Such vehicles may be equipped to pull implements and trailers. Additionally, there may be means for receiving the implements and devices required for doing work as well as for intermediate storing of materials which are produced and/or needed during the work.

3.3 agricultural trailer : A transport vehicle used in agriculture or forestry and which, according to its design, is suitable and intended for coupling to an agricultural tractor or to a self-propelled agricultural vehicle.

The term "agricultural trailer" includes agricultural semi-trailers, only part of the mass of which is supported by the axle or axles.

3.4 agricultural machine or implement : A trailed vehicle used in agriculture or forestry and which, according to its design and the devices fixed to the vehicle, is suitable and intended for doing the work.

Additionally, there may be means for receiving the implements and devices required for doing work as well as for intermediate storing of materials which are produced and/or needed during the work.

3.5 unladen mass : Mass of the unladen vehicle.

3.6 unladen vehicle : A vehicle in running order, complete with fuel, coolant and lubricant (where appropriate) and carrying a driver (if applicable) of 75 kg but not attendants, optional accessories or load.

3.7 laden vehicle : Unless otherwise stated, a vehicle so laden as to attain its maximum mass.

3.8 maximum axle load : The technically permissible axle load for each axle stated by the manufacturer. (The sum of the maximum axle loads may be higher than the technically permissible maximum mass of the vehicle).

3.9 maximum mass : The technically permissible maximum mass of the vehicle stated by the manufacturer. (This may be higher than the maximum mass authorized by a national administration).

3.10 braking device : A combination of parts, the function of which is to reduce the speed of a moving vehicle or to bring it to a halt or to keep it stationary if already halted. The braking device consists of the braking device control, the braking device transmission and the brakes themselves.

3.10.1 braking device control : The part of the braking device actuated directly by the driver to supply to the braking device transmission the energy required for operating the brakes.

3.10.2 braking device transmission : The combination of components connecting the braking device control and the brakes.

The transmission may be mechanical, hydraulic, pneumatic, electrical or mixed. If the braking power is derived from, or assisted by, a source of energy independent of, but controlled by, the driver, the reserve of energy in the device is regarded as part of the transmission.

3.10.3 brake : The element of the braking device in which the forces opposed to the motion or tendency to motion are produced.

3.11 service braking device : A device, the function of which is to reduce the speed of a moving vehicle or to bring it to a halt.

3.12 parking braking device : Assembly of parts by means of which the vehicle can be maintained at rest even on a slope and in the absence of the driver.

3.13 retarder : A device, the function of which is either to assist the service braking device or to reduce the speed but not to stop the vehicle.

3.14 over-run (inertia) braking device : A braking device in which the energy needed to produce the braking force is generated by movement of the towed vehicle towards the towing vehicle.

3.15 spring brake : A braking device in which the energy required for braking is supplied by one or more springs acting as an energy accumulator.

3.16 brake control input force : The sum of all forces applied by the operator to the braking device control(s), measured at the point of load application, in a line from the point of application through the operator's hip joint for foot pedal controls, or through the arm to shoulder joint for hand operated controls.

3.17 stopping distance : The distance travelled by a vehicle between the point at which the first movement of the braking device control is made, and the point at which the vehicle comes to a halt.

3.18 mean deceleration : The average deceleration calculated from initial speed and stopping distance as defined by the formula

$$a = \frac{v^2}{2s}$$

where

a is the average deceleration, in metres per second squared;

v is the initial speed, in metres per second;

s is the stopping distance, in metres.

3.19 measured deceleration : The mean of the sustained deceleration recorded, for example, on a decelerometer.

3.20 release pressure : The pressure required, within the transmission system of a fluid or pneumatic released spring brake, to release the brakes fully.

3.21 release force : The force required, on the control of a mechanically released spring brake, to release the brakes fully.

3.22 maximum design speed :

See ISO 3965.

4 General requirements

The following general requirements shall be observed when performing the methods of test specified in this International Standard.

4.1 A towing vehicle shall be fitted with components intended by the manufacturer for the operation of the towed vehicle braking devices if the latter affect the braking performance of the towing vehicle.

4.2 The vehicle's condition, as regards mass, shall be as specified for each type of test and shall be recorded in the test report.

4.3 The test track or test site shall have a dry, clean concrete, bituminous or equivalent surface, affording good adhesion.

4.4 The test shall be performed when the wind velocity is below 10 m/s.

4.5 The ambient temperature shall be within the range − 10 °C to + 35 °C and shall be recorded.

4.6 The braked axle(s) shall be equipped with the largest diameter tyres specified by the vehicle manufacturer. The tyres shall be inflated to the pressure(s) specified by the vehicle manufacturer.

4.7 Prior to the start of a series of tests, the brakes shall have been fully bedded in (burnished) and adjusted in accordance with the manufacturer's instructions. Thereafter, the brakes shall not be further manually adjusted during the same series of tests.

At the start of each test, the brakes shall be cold. A brake is deemed to be cold if one of the following conditions is met :

a) the temperature measured on the disc or on the outside of the drum is below 100 °C;

b) in the case of totally enclosed brakes, including oil-immersed brakes, the temperature measured on the outside of the housing is below 50 °C, or within the manufacturer's specifications;

c) the brakes have not been actuated in the previous 1 h.

4.8 The performance of service braking devices shall be measured without locking of the wheels until the vehicle has come to a halt.

4.9 The requirements for measuring accuracy, given in the table, shall be observed when conducting tests.

Table — Requirements for measuring accuracy

Measurement	Tolerance, %
Travel speed	± 3
Vehicle mass	± 3
Deceleration	± 3
Stopping distance	± 1
Brake control input force	± 5
Tyre inflation pressure	± 5
Brake system fluid (gas) pressures	± 5

Section two : Determination of service brakes performance

5 Introduction

This section specifies methods of measuring service brake performance based on measured deceleration (clause 6) or measured stopping distance (clause 7).

In both cases, if more than one type of test is required, they shall be carried out in the following order :

a) cold performance test — type 0 (see 6.1.2, 6.2.2, 7.1.2 and 7.2.2);

b) fade test — type 1 (see 6.1.3, 6.2.3, 7.1.3 and 7.2.3);

c) recovery test — type 3 (optional) (see 6.1.4, 6.2.4, 7.1.4 and 7.2.4);

d) fade test — type 2 (where appropriate) (see 6.1.5, 6.2.5, 7.1.5 and 7.2.5);

NOTE — This test applies only to vehicles having a maximum design speed exceeding 35 km/h and a maximum mass exceeding 12 000 kg.

e) recovery test — type 3 (optional) (see 6.1.6, 6.2.6, 7.1.6 and 7.2.6).

6 Method based on measured deceleration

6.1 Procedure for agricultural tractors and self-propelled agricultural vehicles

6.1.1 General

The temperature of the vehicle transmission and final drive shall be as indicated by the manufacturer for transport.

6.1.2 Cold performance test — Type 0

6.1.2.1 Test conditions

The test surface shall not have a longitudinal slope exceeding 1 %, nor a side slope exceeding 3 %. During the braking test, an unbraked axle, if capable of being declutched, shall not be connected with a braked axle.

In the case of a laden vehicle, the unbraked axle shall be loaded to its maximum axle load. For wheeled vehicles, the braked axle(s) wheels shall be fitted with the largest diameter tyres intended by the manufacturer for that vehicle type. For a vehicle braking on all wheels, the front axle shall be laden to its technically permissible maximum axle load.

NOTE — For self-propelled agricultural vehicles, the masses and the axle loads shall be those specified by the manufacturer for transport.

6.1.2.2 Procedure

With the laden vehicle travelling at its stabilized maximum design speed, or 50 km/h $^{+10}_{0}$ % if the design speed is more than 50 km/h, declutch the engine from the driven axles or, if that is not possible, move the engine speed control to the minimum engine speed position.

NOTE — Auxiliary retarder, variable ratio drive, or other auxiliary braking devices shall not be used in the brake tests unless they are simultaneously actuated by the braking device control, or unless such retardation is automatic with normal braking procedure. A description and the use of such devices shall be noted in the test report.

Immediately apply a constant force to the braking device control until the vehicle comes to a halt and measure the deceleration.

Repeat the procedure for a series of different forces applied to the braking device control up to the maximum force which can be applied without locking of the wheels, or up to a maximum input force of 600 N for foot-operated controls or 400 N for hand-operated controls if the braked wheels do not lock.

Repeat the test on the unladen vehicle carrying only the driver and, if necessary, a person responsible for monitoring the results of the test.

6.1.2.3 Test report

Report, for both the laden, and the unladen, vehicle, the relationship between measured deceleration and input force applied to the braking device control, either in the form of a graph or as a table of corresponding values (see annex A).

6.1.3 Fade test — Type 1

6.1.3.1 General

All vehicles submitted to this test shall have been submitted to the type 0 test (6.1.2).

6.1.3.2 Procedure

6.1.3.2.1 Maximum design speed not exceeding 35 km/h

With the engine disconnected from the driving wheels, wherever possible, heat the service brakes by operating the vehicle laden as in 6.1.2.1 in such a manner that the energy input is equivalent to that occurring over the same period with a laden vehicle braked at a steady speed equal to (80 ± 5) % of the speed specified for the tests with brakes cold (type 0), for a distance of 1 km on a 10 % downhill gradient.

Immediately, with the brakes hot, repeat the laden vehicle type 0 test, applying the input force which produced the highest measured deceleration in that test.

6.1.3.2.2 Maximum design speed exceeding 35 km/h

With the vehicle laden as in 6.1.2.1, heat the service brakes by successively applying and releasing them as follows :

a) initial speed (v_1), when brake application starts : (80 ± 5) % of the maximum speed, but not exceeding 60 km/h;

b) speed at end of brake application (v_2) : one-half of initial speed (0,5 v_1);

c) number of brake applications : total 20, for heating cycle;

d) duration of braking cycle : elapsed time between the initiation of one brake application and the initiation of the next (Δt) : 60 s.

If the characteristics of the vehicle do not allow the specified period (Δt) to be obtained, the duration may be increased.

For each cycle, a period of 10 s for stabilizing the speed (v_1) shall be allowed in addition to the time necessary for braking and accelerating the vehicle;

e) force applied to the control : within ± 5 % of the force corresponding to a sustained deceleration of 60 % of the maximum value obtained in the laden vehicle type 0 test and constant for each brake application;

f) acceleration to initial speed (v_1) : as rapid as possible.

Immediately, within a period not exceeding 3 min, with the brakes hot, repeat the laden vehicle type 0 test applying the input force which produced the highest measured deceleration reported in 6.1.2.3.

6.1.3.3 Test report

Report the force applied in accordance with 6.1.3.2.1 or 6.1.3.2.2, as appropriate, and the deceleration measured in this test. (See annex A.)

Report the heating cycle if it exceeded 60 s.

6.1.4 Recovery test — Type 3 (optional)

The optional recovery test may be performed after the brakes have cooled to a cold condition by repeating the laden vehicle type 0 test, applying the brake input force reported in 6.1.2.3 for maximum deceleration.

6.1.5 Fade test — Type 2

6.1.5.1 General

All vehicles submitted to this test shall have been submitted to the type 1 test (6.1.3).

6.1.5.2 Procedure

Heat the service brakes by operating the vehicle laden as in 6.1.2.1 in such a manner that the energy input is equivalent to that recorded in the same period of time with the vehicle driven at an average speed of 30 km/h on a 6 % downhill gradient for a distance of 6 km, with the retarder, if fitted, in use and the appropriate gear engaged such that the engine speed does not exceed the maximum value specified by the manufacturer.

For a vehicle in which the energy is absorbed by the braking action of the engine alone, a tolerance of ± 5 km/h on the average speed shall be permitted, and the gear enabling the speed to be stabilized at the value closest to 30 km/h on the 6 % downhill gradient shall be engaged.

Repeat the laden vehicle type 0 test, applying the input force which produced the highest measured deceleration reported in 6.1.2.3.

6.1.5.3 Test report

Report the force applied and the deceleration measured in the test. (See annex A.)

6.1.6 Recovery test — Type 3 (optional)

The optional recovery test may be performed as described in 6.1.4.

6.2 Procedure for trailed vehicles

6.2.1 General

During all tests of service brakes performance, the trailed vehicle shall be coupled to a towing vehicle with which it is recommended for use by the manufacturer.

6.2.2 Cold performance test — Type 0

6.2.2.1 Test conditions

The test surface shall not have a longitudinal slope exceeding 1 %, nor a side slope exceeding 3 %.

In the case of a laden trailed vehicle, the unbraked axle shall be loaded to its maximum axle load. For trailed vehicles having more than one axle and braked on all wheels, the front axle shall be laden to its maximum axle load.

6.2.2.2 Procedure

6.2.2.2.1 With the towing vehicle and laden trailed vehicle travelling at the stabilized maximum design speed of the trailed vehicle, but not exceeding 50 km/h, measure the deceleration for a series of different forces applied to the braking device control.

6.2.2.2.2 If the trailed vehicle service braking device control is independent of the towing vehicle braking device control, apply the trailed vehicle brakes only.

6.2.2.2.3 If the braking device transmission is not mechanical, measure an appropriate transmission parameter, such as fluid pressure, during each stop, in such a way that the measure-

ment does not interfere with the dynamic characteristics of the braking system.

6.2.2.2.4 Repeat the procedure for a series of different forces applied to the braking device control up to the maximum force which can be applied without locking of the wheels, or up to a maximum input force of 600 N for foot-operated controls or 400 N for hand-operated controls if the braked wheels do not lock.

6.2.2.2.5 If the trailed vehicle has over-run brakes or if the service braking device control is not independent of the towing vehicle braking device control, carry out a type 0 test on the towing vehicle in accordance with 6.1.2. Use the same mass as when connected to the trailed vehicle and the same braking device control forces as in the test specified in 6.2.2.2.4.

6.2.2.2.6 For each value of force applied to the braking device control, calculate the trailed vehicle braking force, in newtons, from whichever of the following formulae is appropriate.

a) If the trailed vehicle brakes only are applied :

$$F_2 = (m_1 + m_2)\, a_3$$

where

F_2 is the trailed vehicle braking force, in newtons;

m_1 is the mass, in kilograms, of the towing vehicle;

m_2 is the mass, in kilograms, of the trailed vehicle;

a_3 is the measured deceleration, in metres per second squared, of the towing and trailed vehicle combination.

b) If the towing and trailed vehicle brakes are applied :

$$F_2 = (m_1 + m_2)\, a_3 - m_1 a_1$$

where

F_2, m_1, m_2 and a_3 have the same meanings as in a);

a_1 is the deceleration, in metres per second squared, measured with the towing vehicle alone at the same value of force applied to the towing vehicle braking device control which produced deceleration a_3 of the vehicle combination.

6.2.2.2.7 For each value of the braking force F_2, calculate the equivalent deceleration a_2, in metres per second squared, of the trailed vehicle from the formula

$$a_2 = \frac{F_2}{m_2}$$

6.2.2.2.8 Repeat the test with the trailed vehicle unladen.

6.2.2.3 Test report

Report, for both the laden, and the unladen, trailed vehicle, the relationship between equivalent deceleration and input force applied to the braking device control, either in the form of a graph or as a table of corresponding values. (See annex B.)

If the braking device transmission is not mechanical, report the relationship between equivalent deceleration and an appropriate transmission parameter, such as fluid pressure, in the form of a graph or as a table of corresponding values. (See annex B.)

6.2.3 Fade test — Type 1

6.2.3.1 General

All vehicles submitted to this test shall have been submitted to the type 0 test (6.2.2).

6.2.3.2 Procedure

6.2.3.2.1 Maximum design speed not exceeding 35 km/h

The service brake shall be tested in such a manner that, with the vehicle laden to the maximum mass specified for the type 0 test, the energy input to heat the brakes is equivalent to that recorded in the same period of time with the vehicle towed at a constant speed of (80 ± 5) % of its maximum design speed for a distance of 1 km with the service brakes applied such that the equivalent towing force at the trailed vehicle coupling is 10 % of the trailed vehicle weight at maximum mass.

Immediately, with the brakes hot, repeat the laden vehicle type 0 test, applying the input force which produced the highest measured deceleration in that test.

6.2.3.2.2 Maximum design speed exceeding 35 km/h

The service brake shall be tested in such a manner that, with the vehicle laden to the maximum mass specified for the type 0 test, the energy input to heat the brakes is equivalent to that recorded in the same period of time with the vehicle towed at a steady speed of 40 km/h for a distance of 1,7 km with the service brakes applied to maintain a constant towing force at the trailed vehicle coupling equivalent to 7 % of the trailed vehicle weight at maximum mass.

Immediately, with the brakes hot, repeat the laden vehicle type 0 test, applying the input force which produced the highest measured deceleration in that test.

6.2.3.3 Test report

Report the input force used and the resulting equivalent deceleration, calculated in accordance with 6.2.2.2.6 and 6.2.2.2.7.

6.2.4 Recovery test — Type 3 (optional)

The optional recovery test may be performed after the brakes have cooled to a cold condition by repeating the laden vehicle type 0 test, applying the brake input force reported in 6.2.2.3 for maximum deceleration.

6.2.5 Fade test — Type 2

6.2.5.1 General

All vehicles submitted to this test shall have been submitted to the type 1 test (6.2.3).

6.2.5.2 Procedure

Heat the service brakes by operating the vehicle laden as in 6.2.2.1 in such a manner that the energy input is equivalent to that recorded in the same period of time with the vehicle towed at an average speed of 30 km/h for a distance of 6 km with the service brakes applied to maintain a constant towing force at the trailed vehicle coupling equivalent to 6 % of the trailed vehicle weight at maximum mass.

Immediately, with the brakes hot, repeat the laden vehicle type 0 test, applying the input force which produced the highest equivalent deceleration reported in 6.2.2.3.

6.2.5.3 Test report

Report the input force used and the resulting equivalent deceleration in accordance with 6.2.2.2.6 and 6.2.2.2.7.

6.2.6 Recovery test — Type 3 (optional)

The optional recovery test may be performed as described in 6.2.4.

7 Method based on measured stopping distance

7.1 Procedure for agricultural tractors and self-propelled agricultural vehicles

7.1.1 General

The temperature of the vehicle transmission and final drive shall be as indicated by the manufacturer for transport.

7.1.2 Cold performance test — Type 0

7.1.2.1 Test conditions

The test surface shall not have a longitudinal slope exceeding 1 %, nor a side slope exceeding 3 %. During the braking test, an unbraked axle, if capable of being declutched, shall not be connected with a braked axle.

In the case of a laden vehicle, the unbraked axle shall be loaded to its maximum axle load. For wheeled vehicles, the braked axle(s) wheels shall be fitted with the largest diameter tyres intended by the manufacturer for that vehicle type. For a vehicle braking on all wheels, the front axle shall be laden to its technically permissible maximum axle load.

NOTE — For self-propelled agricultural vehicles, the masses and the axle loads shall be those specified by the manufacturer for transport.

7.1.2.2 Procedure

With the laden vehicle travelling at its stabilized maximum design speed, or 50 km/h $^{+10}_{0}$ % if the design speed is more than 50 km/h, declutch the engine from the driven axles or, if that is not possible, move the engine speed control to the minimum engine speed position.

NOTE — Auxiliary retarder, variable ratio drive, or other auxiliary braking devices shall not be used in the brake tests unless they are simultaneously actuated by the braking device control, or unless such retardation is automatic with normal braking procedure. A description and the use of such devices shall be noted in the test report.

Measure the stopping distance for a series of different values of force applied to the braking device control and calculate the corresponding values of mean deceleration, in metres per second squared, in accordance with 3.18.

Repeat the procedure for a series of different forces applied to the braking device control up to the maximum force which can be applied without locking of the wheels, or up to a maximum input force of 600 N for foot-operated controls or 400 N for hand-operated controls if the braked wheels do not lock.

Repeat the test on the unladen vehicle carrying only the driver and, if necessary, a person responsible for monitoring the results of the test.

7.1.2.3 Test report

Report, for both the laden, and the unladen, vehicle, the relationship between stopping distance and input force applied to the braking device control, either in the form of a graph or as a table of corresponding values. (See annex A.)

Report, for both the laden, and the unladen, vehicle, the relationship between calculated mean deceleration and input force applied to the braking device control, either in the form of a graph or as a table of corresponding values. (See annex A.)

7.1.3 Fade test — Type 1

7.1.3.1 General

All vehicles submitted to this test shall have been submitted to the type 0 test (7.1.2).

7.1.3.2 Procedure

7.1.3.2.1 Maximum design speed not exceeding 35 km/h

With the engine disconnected from the driving wheels, wherever possible, heat the service brakes by operating the vehicle laden as in 7.1.2.1 in such a manner that the energy input is equivalent to that occurring over the same period with a laden vehicle braked at a steady speed equal to (80 ± 5) % of the speed specified for the type 0 test, for a distance of 1 km on a 10 % downhill gradient.

Immediately, within a period not exceeding 3 min, with the brakes hot, repeat the laden vehicle type 0 test, applying the input force which produced the shortest stopping distance.