International Standard 6597

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Road vehicles — Passenger car braking systems — Measurement of the braking performance

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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 6597 was developed by Technical Committee ISO/TC 22, *Road vehicles*, and was circulated to the member bodies in February 1979.

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

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Czechoslovakia	Netherlands	Switzerland
Egypt, Arab Rep. of	New Zealand	Turkey
France	Poland	USA
Italy	Romania	USSR

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Germany, F.R.
United Kingdom

The ISO objective is to establish uniform worldwide test procedures for braking systems.

Pending the harmonisation of individual national and international braking standards, regulations and directives, the following brake test procedure has been based on the UN/ECE Regulation No. 13.

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Road vehicles — Passenger car braking systems — Measurement of the braking performance

1 Scope and field of application

This International Standard specifies the test procedure to be adopted when testing the braking equipment of a passenger car in accordance with ECE Regulation 13.

The values in parentheses ( ) are taken from ECE Regulation 13/Rev. 2, dated 5 February 1979 and are included for convenience during brake testing.

This International Standard is applicable to passenger cars, as defined in ISO 3833 and corresponding to Category M1 in ECE Regulation 13.

2 References

ISO 611, *Braking of motor vehicles and their trailers — Terminology.*

ISO 1176, *Road vehicles — Weights — Vocabulary.*

ISO 3833, *Road vehicles — Types — Terms and definitions.*

ECE Regulation 13, United Nations Economic Commission for Europe, Regulation No. 13, *Uniform provisions concerning the approval of vehicles with regard to braking.*

3 Definitions

3.1 Vehicle loading

3.1.1 laden vehicle : The vehicle laden so as to reach its "maximum weight".

Maximum weight is the technically feasible maximum weight announced by the vehicle manufacturer and acknowledged by the Technical Services (this weight may exceed the "maximum authorized weight" permitted by national regulations).

Weight distribution on the axles shall be stated by the vehicle manufacturer.

In the event of several load distribution patterns being planned, the distribution of the maximum weight among the axles must be such that the load on each axle is proportional to the maximum permissible load for each axle.

3.1.2 unladen vehicle : The kerb weight without load or occupant but with the fuel tank filled at least up to 90 % of the capacity stated by the vehicle manufacturer at the start of the test, and complete with the cooling fluid, lubricants, tools and spare wheel.

An increase of weight up to 200 kg over this weight is allowed, which corresponds for instance to the driver, one observer and instrumentation; if necessary, some weight of the vehicle may have to be removed.

3.2 Road test parameters

V = vehicle test speed at the initiation of braking, in kilometres per hour.

V_{max} = maximum vehicle speed declared by the manufacturer, in kilometres per hour.

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3.3 Percentage of the braking efficiency

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3.3.1 Percentage of the *prescribed* braking efficiency is defined as follows :

— in terms of stopping distance

$$s_x < a\,V + \frac{V^2 \cdot 100}{b \cdot x}$$

— in terms of deceleration

$$d_x > \frac{d_m \cdot x}{100}$$

3.3.2 Percentage of the *achieved* braking efficiency is defined as follows :

— in terms of stopping distance

$$s_x < \frac{s_o - a\,V_o}{x} \cdot 100 + aV$$

— in terms of deceleration

$$d_x > \frac{d_o \cdot x}{100}$$

where

x is the required percentage efficiency;

s_x is the required stopping distance, in metres;

d_x is the required mean fully developed braking deceleration, in metres per second squared;

a,b are the stopping distance formula coefficients (0,1, 150 resp.);

V is the vehicle test speed at the initiation of braking, in kilometres per hour;

d_m is the prescribed mean fully developed braking deceleration, in metres per second squared;

s_o is the achieved stopping distance, in metres;

V_o is the initial vehicle test speed corresponding to s_o, in kilometres per hour;

d_o is the achieved mean fully developed braking deceleration, in metres per second squared.

NOTE — Suffix o would normally refer to the type 0 cold effectiveness test of the service braking system (vehicle laden, engine disconnected).

4 Test site conditions

NOTE — The conditions listed below represent reasonable limits of extremes at which the braking tests may be conducted. Brake testing beyond these limits is governed by the conditions described in 6.4.

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4.1 Road surface condition

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4.1.1 Surface

The road surface should be dry, smooth hard-surfaced roadway of Portland cement concrete or other surfaces with equivalent coefficient of surface friction.

4.1.2 Gradient

The road surface shall be substantially level; a tolerance of ± 1 % average gradient, measured over a minimum distance of 50 m, is allowed.

NOTE — The Parking Brake hill-holding test is conducted on a specified gradient.

4.1.3 Camber (transverse gradient)

The camber across the road surface should not exceed 2 % gradient.

4.2 Ambient conditions

4.2.1 Wind speed

The wind speed should not exceed 5 m/s average.

4.2.2 Air temperature

The air temperature should not exceed 34 °C.

5 Vehicle preparation

5.1 Instrumentation

The vehicle shall be prepared for testing by the addition of the following instruments and/or calibration of existing standard instruments, as required.

Other instruments may be useful in providing accurate data, but care must be exercised to ensure that instruments added to the standard vehicle braking equipment do not significantly affect the brake system performance.

5.1.1 Control force gauge for the service braking system.

5.1.2 Control force gauge for the parking braking system.

5.1.3 Control force gauge for the secondary braking system (if it is not the service or parking brake control).

5.1.4 Decelerometer.

5.1.5 Speed measuring device or calibrated speedometer.

5.1.6 Stopping distance measuring device.

5.1.7 Time measuring instrument.

5.1.8 Brake temperature indicating system.

5.1.9 Initial response time and build-up time measuring equipment.

5.1.10 Optional instruments :

5.1.10.1 Control travel gauges

5.1.10.2 Line pressure gauges/transducers

5.1.10.3 Wheel lock indicator

5.2 Provision for failure simulation

The vehicle shall be equipped with the necessary added devices and piping to provide the required failure simulations. Such added devices and piping shall not interact with the standard vehicle braking equipment in such a manner as to significantly affect the intact and/or failed system performance.

5.3 Tyre conditions

5.3.1 The tyres should be inflated to the vehicle manufacturer's recommanded pressure levels.

5.3.2 It is recommended that the tyre tread wear should not exceed 50 % of the new conditions.

5.4 Adjustment of braking equipment

Adjustable brake components should be set to the vehicle manufacturer's recommendations.

Re-adjustments of the brakes, in accordance with the vehicle manufacturer's recommendations, may be made during the course of the test.

5.5 Braking system condition

Braking system components shall be new, or capable of functioning as new, and within the vehicle manufacturer's specifications.

The brakes should be bedded according to the vehicle manufacturer's requirements.

6 Test comments

6.1 During all phases of this procedure, any unusual braking performance characteristics, such as undue deviation or abnormal vibration, should be observed and reported.

6.2 During the tests with the engine connected on vehicles with a manual gearbox, the clutch may be disengaged just before the vehicle stops to avoid engine stalling.

6.3 Unless otherwise stated, deceleration measurements used in this procedure refer to the "mean fully developed deceleration" (NOT to the mean deceleration based on the stopping distance/time relationship).

6.4 Tests may be carried out under adverse conditions to avoid (expensive) delays, but with due consideration for safety; such adverse conditions should be reported.

Any test failures under such conditions must be repeated under the correct conditions, but not all tests need necessarily be repeated.

6.5 The tests should preferably be carried out in the recommended sequence described in this procedure; however, the parking brake tests and the reaction time measurements may be carried out at any time selected by the vehicle manufacturer during the procedure.

Furthermore, all unladen tests may be grouped together and be followed by the laden tests.

Any variations in the recommended sequence should be noted.

6.6 Re-testing in the course of the full procedure should be avoided; although one or two extra stops are unlikely to prejudice subsequent road test results.

6.7 Full or partial re-tests, after a test failure or to approve alternative brake components, should again follow this procedure and with particular emphasis on the vehicle preparation and bedding procedures.

6.8 Control forces should be applied rapidly, but without significant overshoot — and then be maintained constant during the stop or varied progressively, as required.

6.9 The use of pedal-apply machines ("robots") does not reflect real-life vehicle braking and should be discouraged.

6.10 Skilled test drivers should be used to determine the optimum vehicle braking performance without wheel-locking and without deviation, after appropriately familiarising themselves with the vehicle braking, steering and suspension system.

6.11 Tests with the engine connected should be carried out in the appropriate gear; defined as that gear used normally to reach the test speed without exceeding the manufacturer's recommended maximum engine speed.

6.12 Unless otherwise stated, all brake tests should be carried out with cold brakes.

The brakes are deemed to be cold, when the initial temperature of the hottest brake measured on the disc or on the outside of the drum is between 50 and 100 °C before each stop.

7 Service brake — Cold effectiveness test (including ECE Type 0 tests of Regulation 13)

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7.1 Test conditions (see clauses 4, 5 and 6)

Tests should be carried out on a straight level road, free from loose material, offering adhesion consistent with the performance level required and of sufficient length and width to enable the tests to be carried out in safety.

Before commencing this test, it is essential that the brake linings are adequately bedded, and the brakes correctly adjusted. All tyres should be in good condition with adequate depth of tread to complete the test series, of a size and type approved and inflated to the pressures recommended by the vehicle manufacturer.

The tests should not be performed when the atmospheric conditions are likely to affect the results significantly.

7.2 Instrumentation (see clause 5)

The following instrumentation is essential:

a) means of measuring control forces,

b) deceleration and/or

c) stopping distance, vehicle speed and brake temperatures.

The installed instruments should be checked to ensure that they are functioning correctly and with the vehicle stationary on the test surface, all the test instruments must be "set".

7.3 Test procedure

This test procedure shall be carried out for each specified loading condition and from all the nominated vehicle speeds,

with the engine disconnected and connected as prescribed. The "appropriate gear" for engine-connected tests is defined in 6.11.

Each test stop shall be made with "cold brakes" as defined in 6.12.

Determine the optimum mean fully developed deceleration and/or stopping distance for each vehicle speed/vehicle loading condition, without exceeding the maximum permitted control force (500 N) and without wheel-locking.

A preliminary series of five brake applications may be carried out for vehicle familiarisation, but because the total number of stops can significantly change the thermal and mechnical history of the friction materials (and thus possibly the vehicle performance), it is recommended that each test condition should be run no more than twice (unless otherwise specified); in any event, the total number of stops made in 7.3 should not exceed 35.

The following test sequence is recommended :

7.3.1 Unladen stops

7.3.1.1 From the prescribed test speed (80 km/h) — Engine disconnected. The result of this test must be at least equal to the prescribed braking efficiency.

7.3.1.2 From 30 % V_{max}, engine connected in appropriate gear.

7.3.1.3 From 55 % V_{max}, engine connected in appropriate gear but not exceeding 140 km/h.

7.3.1.4 From 80 % V_{max}, engine connected in appropriate gear but not exceeding 140 km/h.

7.3.2 Laden stops

7.3.2.1 From the prescribed test speed (80 km/h) — engine disconnected.

This test shall consist of five stops from the specified speed and using reasonably spaced increments of control force to generate the graph of "braking performance" against "input force".

One measurement must be at least equal to the prescribed braking performance (5,8 m/s^2), which will be used as the "Type 0 test reference value".

7.3.2.2 From 30 % V_{max}, engine connected in appropriate gear.

7.3.2.3 From 55 % V_{max}, engine connected in appropriate gear, but not exceeding 140 km/h.

7.3.2.4 From 80 % V_{max}, engine connected in appropriate gear but not exceeding 140 km/h.

7.4 Presentation of results

7.4.1 During each brake test stop, the following information shall be noted :

— the actual speed of the vehicle at the initiation of braking;

— the control force;

— the mean fully developed deceleration and/or stopping distance;

— any locking of the wheels, deviation of the vehicle from its course or abnormal vibration.

7.4.2 The following additional information should be noted for the test series :

— the ambient conditions;

— the vehicle identification;

— the vehicle loading conditions (including individual axle weights for each loading condition);

— the relevant tyre information.

7.4.3 All the above-mentioned results may be appropriately tabulated and presented in a suitable format.

The tests corresponding to 7.3.2.1 should be presented in graphical form.

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7.5 Complementary test

The following complementary tests, to generate base data for subsequent performance tests, may conveniently be carried out at the time of the "cold effectiveness tests, as required.

7.5.1 Preliminary test for the reaction time measurement (see clause 11)

It is recommended that line pressure gauges/transducers (see 5.1.10.2) should be installed in each service brake circuit, in order to determine the line pressure at the least favourably placed axle corresponding to the prescribed braking performance, when carrying out the test described in 7.3.2.1.

7.5.2 Preliminary test for the fade test (see clause 9)

The fade test snubs are to be carried out with a constant input force which generates a deceleration of 3 m/s^2 on the first snub; this control force may conveniently be determined after the tests described in 7.3.2.4, with the vehicle laden, engine connected in the highest gear ratio (excluding overdrive), braking from 80 % V_{max} to 40 % V_{max}.

NOTE — If 80 % V_{max} exceeds 120 km/h, then the snubs are carried out from 120 to 60 km/h.

The relevant control force (or line pressure) may be determined directly from tests or by interpolation using a graphic method.

8 Secondary brake — Partial failure tests (ECE Type 0 tests of Regulation 13)

8.1 Test conditions

See 7.1.

8.2 Instrumentation

See 7.2.

8.3 Test procedure

This test procedure shall be carried out for each specified failure mode appropriate to the vehicle braking equipment; at the specified loading conditions and vehicle speeds, with the engine disconnected and connected as prescribed.

The "appropriate gear" for engine-connected tests is defined in 6.11.

Each test stop shall be made with "cold brakes" as defined in 6.12.

Determine the optimum mean fully developed deceleration and/or stopping distance for each failure mode and vehicle speed/vehicle loading condition, without exceeding the maximum permitted control force and without wheel-locking.

A single stop should suffice for each test condition.

There are two types of secondary braking systems, the choice being made by the vehicle manufacturer :

a) secondary braking system combined with the service braking system;

b) secondary braking system independent of the service braking system.

The recommended test procedures are as follows :

8.3.1 Circuit failure (for divided circuit service braking systems)

The failure of one circuit of the service braking system should be simulated by an open-circuit leakage-type failure which ensures that the circuit line pressure remains at zero during the entire test phase.

8.3.1.1

Unladen
From the prescribed test speed (80 km/h)
Engine disconnected
Not exceeding the maximum control force (500 N)

8.3.1.2

Unladen
From 30 % V_{max}
Engine connected in appropriate gear
Not exceeding the maximum control force (500 N)

8.3.1.3

Unladen
From 55 % V_{max} but not exceeding 120 km/h
Engine connected in appropriate gear
Not exceeding the maximum control force (500 N)

8.3.1.4

Unladen
From 80 % V_{max} but not exceeding 120 km/h
Engine connected in appropriate gear
Not exceeding the maximum control force (500 N)

8.3.1.5

Laden
From the prescribed test speed (80 km/h)
Engine disconnected
Not exceeding the maximum control force (500 N)

8.3.1.6

Laden
From 30 % V_{max}
Engine connected in appropriate gear
Not exceeding the maximum control force (500 N)

8.3.1.7

Laden
From 55 % V_{max} but not exceeding 120 km/h
Engine connected in appropriate gear
Not exceeding the maximum control force (500 N)

8.3.1.8

Laden
From 80 % V_{max} but not exceeding 120 km/h
Engine connected in appropriate gear
Not exceeding the maximum control force (500 N)

This entire test series should be repeated for every other service braking system circuit; by inducing one circuit failure at a time.

8.3.2 Energy failure (for power-assisted service braking systems)

Two types of energy failure have been foreseen :

8.3.2.1 Power-assist failure

This failure should be simulated by depleting all stored energy in the power-assist device.

Test stop : see 8.3.1.5.

If more than one power-assist device is fitted in the service braking system, the test shall be repeated with one power-assist failure at a time.

8.3.2.2 Engine stopped

This failure should be simulated by charging the power-assist

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device(s) to the normal operating level and then stopping the engine (or disconnecting the supply of energy from the engine). The test stop should be carried out as soon as possible. (see 8.3.1.5).

8.3.3 Separate secondary braking system

In the case where the vehicle manufacturer nominates a separate secondary braking system control (independent from the service braking system control), then both the secondary braking system and the service braking system with a partial failure shall be tested.

The following test sequence is recommended :

8.3.3.1 Separate secondary braking system test.

a) Unladen

From the prescribed test speed (80 km/h)

Engine disconnected

Not exceeding the maximum control force (400 N by hand, 500 N by foot).

b) Unladen

From 30 % V_{max}

Engine connected in appropriate gear

Not exceeding the maximum control force (400 N by hand, 500 N by foot).

c) Unladen

From 55 % V_{max} but not exceeding 120 km/h

Engine connected in appropriate gear

Not exceeding the maximum control force (400 N by hand, 500 N by foot).

d) Unladen

From 80 % V_{max} but not exceeding 120 km/h

Engine connected in appropriate gear

Not exceeding the maximum control force (400 N by hand, 500 N by foot).

e) Laden

From the prescribed test speed (80 km/h)

Engine disconnected

Not exceeding the maximum control force (400 N by hand, 500 N by foot).

f) Laden

From 30 % V_{max}

Engine connected in appropriate gear

Not exceeding the maximum control force(400 N by hand, 500 N by foot).

g) Laden

From 55 % V_{max} but not exceeding 120 km/h

Engine connected in appropriate gear

Not exceeding the maximum control force (400 N by hand, 500 N by foot).

h) Laden

From 80 % V_{max} but not exceeding 120 km/h

Engine connected in appropriate gear

Not exceeding the maximum control force (400 N by hand, 500 N by foot).

8.3.3.2 Service braking system tests with partial failure

a) Circuit failure (see 8.3.1)

— Unladen

From the prescribed test speed (80 km/h)

Engine disconnected

Not exceeding the maximum control force (700 N).

— Laden

From the prescribed test speed (80 km/h)

Engine disconnected

Not exceeding the maximum control force (700 N).

b) Power-assist failure (see 8.3.2.1)

Laden

From the prescribed test speed (80 km/h)

Engine disconnected

Not exceeding the maximum control force (700 N).

c) Engine stopped (see 8.3.2.2)

Laden

From the prescribed test speed (80 km/h)

Engine disconnected

Not exceeding the maximum control force (500 N)

Carried out as soon as possible.

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8.4 Failure indication

The partial failure tests described in this sub-clause provide a logical opportunity to check the correct functioning of some failure warning devices.

In any event, the satisfactory function of the failure warning device must be verified at some time during the course of the complete procedure.

8.5 Recording of results

As 7.4, but with the following additional information for each stop :

— the nominated secondary braking system and control device;

— the partial failure condition under test;

— the general vehicle behaviour.

9 Service brake-fade test (ECE Type I Test of Regulation 13)

9.1 Test conditions

As 7.1, but the test track may include bends and corners, although it is preferable for the snubs and stops to be carried out on straight track sections.

9.2 Instrumentation

As 7.2.

9.3 Test procedure

This test procedure comprises three separate stages, to be carried out with the vehicle laden in accordance with 3.1.1.

9.3.1 Determination of the control force

The correct control force (or line pressure) for the heating procedure may be established in accordance with the tests described in 7.5.2; these tests may be carried out at the end of the cold effectiveness tests or just prior to the fade test heating procedure.

The correct control force (or line pressure) should generate a deceleration of 3 m/s^2 on the first snub of the heating procedure.

Alternatively, if the driver is sufficiently skilled and familiar with the vehicle braking equipment, he may proceed directly with the heating procedure and note the correct control force (or line pressure).

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9.3.2 Heating procedure with repeated braking

The brakes shall be heated by carrying out the following procedure :

9.3.2.1 The brakes shall be cold, i.e. the initial temperature of the hottest brake should be between 50 and 100 °C (at the beginning of the first snub *only*), as defined in 6.12.

9.3.2.2 The vehicle test speed at the initiation of braking should be V_1, where $V_1 = 80\ \%\ V_{max}$, but not exceeding 120 km/h.

9.3.2.3 The control force on the service braking control should generate a deceleration of 3 m/s^2; this control force should remain constant, also for subsequent snubs (although possibly generating different deceleration levels).

9.3.2.4 The brakes should be released when the vehicle speed drops to $1/2\ V_1$.

9.3.2.5 During the snub, the engine should remain connected in the highest gear (excluding overdrive).

9.3.2.6 Immediately after releasing the brakes, the gearbox shall be used to regain the speed V_1 in the shortest possible time, using the maximum acceleration allowed by the engine and the gearbox.

Continue driving at V_1, allowing at least 10 s to stabilise this vehicle speed before commencing the next braking cycle.

9.3.2.7 The next braking cycle should be initiated 45 s after initiation of the previous braking cycle (see 9.3.2.2).

If the vehicle characteristics do not permit compliance with this cycle time, then this interval may be increased, but in any case, the 10 s stabilisation period of 9.3.2.6 shall be respected.

9.3.2.8 A total of fifteen braking cycles shall be completed.

9.3.3 Braking efficiency test with hot brakes

This hot test shall be carried out under the same conditions as for the type 0 cold test and particularly with the same control force (or the same line pressure) as recorded during the type 0 test with the vehicle laden, engine disconnected, from the prescribed test speed (80 km/h) in 7.3.2.1.

The following procedure is recommended :

9.3.3.1 Immediately after the last braking period of the heating procedure, the vehicle should be accelerated as quickly as possible to the prescribed test speed in the type 0 engine disconnected test (80 km/h).

9.3.3.2 Within 60 s of completing the last brake heating cycle, one stop should be made under the conditions of 7.3.2.1 (but with different brake temperatures) and with the control force recorded during the corresponding type 0 test (vehicle laden, engine disconnected from the prescribed test speed (80 km/h).

The resultant hot brake effectiveness shall satisfy two conditions :

a) not less than 60 % of the recorded brake effectiveness during the corresponding type 0 cold test (see 7.3.2.1) at the same control force;

b) not less than 80 % of the prescribed service brake effectiveness.

If a) cannot be achieved, the test is negative.

If b) cannot be achieved during 9.3.3.2, then the hot test may be repeated immediately or after a new heating procedure under the conditions of 9.3.2.

During this second hot test under the conditions of 9.3.3.1 and 9.3.3.2, the control force may be increased up to the maximum permitted value (500 N) in order to satisfy condition b).

9.4 Alternative test procedure

If the test site does not permit the correct heating procedure to be maintained, then either the cycle times or the vehicle speeds may be varied provided that both the total testing time specified in 9.3.2 and the total energy input remain unchanged.