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Road vehicles — Vehicle dynamics test methods —

Part 3: General conditions for passenger cars ride comfort tests

Véhicules routiers — Méthodes d'essai de la dynamique des véhicules —

Partie 3: Conditions générales pour les essais de confort de conduite des voitures particulières

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics and chassis components*.

A list of all parts in the ISO 15037 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document was developed to define general test conditions for passenger-cars ride comfort tests. Any given vehicle, together with its driver and the prevailing environment, constitutes a unique closed-loop system. The task of evaluating the dynamic behaviour of the vehicle is therefore, very difficult since there is significant interaction between these driver-vehicle-environment elements, and each of these elements is individually complex in itself.

The test conditions exert large influence on the test results. Only test results obtained at identical test conditions and environment are comparable.

Road vehicles — Vehicle dynamics test methods —

Part 3:
General conditions for passenger cars ride comfort tests

1 Scope

This document specifies the general conditions that apply to vehicle ride comfort test methods.

In particular, it specifies general conditions for:

— variables;

— measuring equipment and data processing;

— environment (test track and wind velocity);

— test vehicle preparation (tuning and loading);

— initial driving;

— test reports (general data and test conditions).

These items are of general significance, regardless of the specific vehicle ride comfort test method. They apply when vehicle ride comfort properties are determined, unless other conditions are required by the standard which is actually used for the test method.

This document is applicable to passenger cars as defined in ISO 3833 and light trucks.

NOTE The general conditions defined in existing vehicle dynamics standards are valid until a reference to this document is included.

This document mainly refers to road tests, but in many cases can be applied also for bench tests.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1176, *Road vehicles — Masses — Vocabulary and codes*

ISO 2416, *Passenger cars — Mass distribution*

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

ISO 8855, *Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8855 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Variables

4.1 Reference system

The variables of motion used to describe vehicle behaviour in a test-specific driving situation relate to the intermediate axis system (X, Y, Z) (see ISO 8855).

4.2 Variables to be determined

To describe the vehicle ride comfort in terms of vehicle response, the principal relevant variables are the following:

— general vehicle dynamics variables, as defined in ISO 8855:
  — longitudinal velocity (v_X);
  — roll velocity ($\mathrm{d}\varphi/\mathrm{d}t$);
  — pitch velocity ($\mathrm{d}\theta/\mathrm{d}t$);
  — roll angle (φ);
  — pitch angle (θ);
— whole-body vibrations (WBV), like accelerations on hands, feet, pelvis and back;
— accelerations on the unsprung masses (i.e. on hubs, etc.);
— accelerations on the sprung mass:
  — outside the cockpit (i.e. on suspension attachments points, etc.);
  — inside the cockpit (i.e. on steering wheel, seat rail, drive floor, etc.);
— accelerations in the engine compartment.

All standards that make reference to this document shall specify which variables apply. Depending on the specific standard, additional variables can be required or recommended.

NOTE These variables can be determined directly by measuring or by calculation from measured values.

5 Measuring equipment

5.1 Description

Time histories of the measured variables shall be recorded by a time-based multi-channel recording system by means of appropriate transducers (see Annex C). Typical operating ranges and recommended maximum errors of the transducer and recording system are shown in Table 1. The specified accuracies should be achieved whether the variables are measured or are calculated. In Table 1 there are also the typical temperature operating ranges and the recommended transducers' IP code (the classification of degrees of protection provided by enclosures for electrical equipment from external influences or conditions like dirt and water).

Table 1 — Variables, their typical operating ranges and recommended maximum errors

Variable	Axes	Typical operating range	Recommended maximum "overall" error	Temperature operating range	Recommended IP (IEC 60529)
Velocity	X	0 km/h to 180 km/h	±1 km/h for v_X < 100 km/h ±2 km/h for v_X > 100 km/h	-10/+40 °C	1st digit: 5 or higher 2nd digit: 1 or higher
Pitch velocity	Y	−50°/s to 50°/s	±0,3°/s for $d\theta/dt$ < 20°/s ±1°/s for $d\theta/dt$ > 20°/s	-10/+40 °C	1st digit: 5 or higher 2nd digit: 1 or higher
Roll velocity	X	−50°/s to 50°/s	±0,3°/s for $d\varphi/dt$ < 20°/s ±1°/s for $d\varphi/dt$ > 20°/s	-10/+40 °C	1st digit: 5 or higher 2nd digit: 1 or higher
Roll angle	X	−15° to 15°	±0,15°	-10/+40 °C	1st digit: 5 or higher 2nd digit: 1 or higher
Pitch angle	Y	−15° to 15°	±0,15°	-10/+40 °C	1st digit: 5 or higher 2nd digit: 1 or higher
Accelerations WBV	X,Y,Z	−30 m/s^2 to 30 m/s^2	±0,3 m/s^2	-10/+40 °C	1st digit: 5 or higher 2nd digit: 1 or higher
Accelerations on sprung masses inside the cockpit	X,Y,Z	−15 m/s^2 to 15 m/s^2	±0,15 m/s^2	-10/+40 °C	1st digit: 5 or higher 2nd digit: 1 or higher
Accelerations on sprung masses outside the cockpit	X,Y,Z	−20 m/s^2 to 20 m/s^2	±0,2 m/s^2	-30/+70 °C	1st digit: 6 2nd digit: 2 or higher
Accelerations on the unsprung masses	X,Y,Z	−50 m/s^2 to 50 m/s^2	±0,5 m/s^2	-30/+70 °C	1st digit: 6 2nd digit: 5 or higher
Accelerations in the engine compartment	X,Y,Z	−50 m/s^2 to 50 m/s^2	±0,5 m/s^2	-10/+90 °C	1st digit: 6 2nd digit: 2 or higher
Increased measurement accuracy may be desirable for computation of some of the characteristic values. If any system error exceeds the recommended maximum value, this and the actual maximum error shall be stated in the test report (see Annex A).					

Some of the variables included in Table 1 are measured directly on driver/vehicle interface, in particular accelerations WBV and some accelerations on sprung masses inside the cockpit such as steering wheel accelerations. For this reason, they are strongly influenced by the driver. When different vehicles are compared it is recommended to have the same driver in all the tests used in the comparison.

5.2 Transducer installations

The transducers shall be installed according to the manufacturer's instructions when such instructions exist, so that the variables corresponding to the terms and definitions of ISO 8855, or the variables defined in this norm, can be determined.

If a transducer does not measure a variable in the defined position, appropriate transformation shall be carried out.

All the positions of the transducers shall be stated in Annex A.

NOTE The correct position of these transducers, that determinate the new variables, is in Annex C.

5.3 Data processing

The band of human sensitivity is between 0 Hz and 100 Hz (see ISO 2631/ISO 8041), but for the analysis, the frequency range relevant for tests on comfort dynamics of passenger cars is between 0 Hz and the maximum utilized frequency: f_{max} = 50 Hz.

The bandwidth of the entire, combined transducer/recording system shall be more than 500 Hz and amplitude errors shall be less than ±0,5 %.

If the time history has an offset, that is the time history is not centred around 0, it is important to cancel this offset calculating the mean value of the points of the time history (all or only a section) and subtract it from all the points. The signals also shall be filtered with a low-pass filter (like a Butterworth filter), with a gain in the passband of 1 ± 0,005 (100 ± 0,5 %) and in the stopband ±0,01 (±1 %) with the cut-off frequency not before 100 Hz. All the data have to be resampling at the same frequency, not less than 500 Hz.

See ISO 15037-1 for an example of filter.

6 Test conditions

6.1 General

Limits and specifications for the ambient conditions and vehicle test conditions are established in Clause 6. These shall be maintained during the specific test. Any deviations shall be shown in the test report (see Annexes A and B), including the individual diagrams of the presentation of results. For each test method, the test-specific conditions and those which cannot be kept constant (e.g. tread depths) shall be recorded in a separate test report in accordance with Annex B.

6.2 Test track

Ride comfort analysis is really sensitive to roughness and road profile. The track profile shall be added in the test report.

The track shall have different characteristics as a function of the type of the test: smooth road (like a highway), uneven road (like a rough country road) and urban obstacles (like cleats, humps, steps etc.).

6.3 Wind velocity

The ambient wind velocity shall not exceed 5 m/s and not have gusts during a test. For each test method, the climatic conditions shall be recorded in the test report (see Annex B).

The tests shall not be performed with heavy rain and puddles.

6.4 Test vehicle

6.4.1 General data

General data of the test vehicle shall be presented in the test report shown in Annex A. For any change of the vehicle's specification (e.g. load), the general data shall be documented again.

The test vehicle shall be a passenger car or light truck in accordance with ISO 3833. If a new vehicle is used, it is recommended to make an adequate run-in before starting the tests.

Since in certain cases the ambient temperature has a significant influence on test results, this should be taken into account when making comparisons between vehicles. Before the test start, it is recommended the have the vehicle in a garage with a temperature between 0 and 40 °C.

6.4.2 Tyres

For a general tyre condition, new tyres shall be fitted on the test vehicle according to the vehicle manufacturer's specifications. If not specified otherwise by the tyre manufacturer, they shall be run in for at least 150 km on the test vehicle or an equivalent vehicle without excessively harsh use, for example, braking, acceleration, cornering, hitting the kerb, etc. After being run in, the tyres shall be maintained in the same positions in the vehicle for the tests.

Tyres shall have a tread depth of at least 90 % of the original value across the whole breadth of the tread and around the whole circumference of the tyre.

Tyres shall not be manufactured more than one year before the test. The date of manufacturing shall be noted in the presentation of test conditions (see Annex B).

Tyres shall be inflated to the pressure as specified by the vehicle manufacturer for the test vehicle configuration at the ambient temperature of the test.

Inflation pressure and tread depth of the tyres determined before tyre warm-up shall be recorded in the test report (see Annex B).

Tests may also be performed under conditions other than general tyre conditions. The details shall be noted in the test report (see Annex B).

NOTE Tread breadth is the width of that part of the tread that, with the tyre correctly inflated, contacts the road in normal straight-line driving.

As the tread depth or uneven tread wear can have a significant influence on test results, it is recommended that it is taken into account when making comparisons between vehicles or between tyres.

6.4.3 Operating components

For the standard test condition, the type (e.g. part number or model number) and condition (e.g. shock-absorber settings and suspension-geometry adjustments) of all components likely to influence the test results shall be as specified by the manufacturer. Any deviations from manufacturer's specifications shall be noted in the presentation of general data (see Annex A).

6.4.4 Loading conditions of the vehicle

The test mass shall be between the complete vehicle kerb mass in accordance with ISO 1176 (code ISO-M06) plus driver and test equipment (combined mass should not exceed 150 kg) and the maximum authorized total mass in accordance with ISO 1176 (code ISO-M08).

The maximum authorized axle loads in accordance with ISO 1176 (code ISO-M13) shall not be exceeded.

Care shall be taken to generate a minimum deviation in the location of the centre of gravity and in the moments of inertia as compared to the loading conditions of the vehicle in normal use, in accordance with ISO 2416. The resulting wheel loads shall be determined and recorded in the test report (see Annex A).

6.4.5 Drivetrain conditions of the vehicle

For vehicles with regenerative braking capabilities, the specific vehicle configuration can alter the dynamic vehicle behaviour while releasing the accelerator pedal and/or while pressing the brake pedal. For these vehicles, the different dynamic vehicle behaviour with or without active regenerative braking shall be considered while performing the tests. The selected level of regenerative braking capability and the transmission lever position shall be documented in the test report.