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## Passenger car tyres — Verifying tyre capabilities — Laboratory test methods

*Pneumatiques pour voitures particulières — Vérification de l'aptitude  
des pneumatiques — Méthodes d'essai en laboratoire*

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## 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.

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](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

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For an explanation of 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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 31, *Tyres, rims and valves*, Subcommittee SC 3, *Passenger car tyres and rims*.

This fourth edition cancels and replaces the third edition (ISO 10191:2010), which has been technically revised. The main changes compared with the previous edition are as follows:

- separation of test methods and requirements for radial tyres and diagonal tyres, bias-belted tyres and T-type temporary spare tyres;
- replace the descriptions of strength test and bead unseating test by reference to the corresponding ASTM standards;
- align endurance test and high-speed test for radial tyres with UN GTR No. 16<sup>[1]</sup>;
- allow PTFE coating of drums for endurance test;
- reduce conditioning time for high-speed test;
- allow drum acceleration in steps;
- editorial changes to improve consistency of the text and align with terms defined in ISO 4223-1:2017.

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](http://www.iso.org/members.html).

# Passenger car tyres — Verifying tyre capabilities — Laboratory test methods

## 1 Scope

This document specifies test methods for verifying the capabilities of tyres for passenger cars. Of the test methods presented, it is possible that only some will be required depending on the construction of the tyre (diagonal, bias-belted, radial or T-type construction) to be tested. The tests are carried out in a laboratory under controlled conditions.

This document includes endurance tests, a low-pressure performance test and high-speed tests and requirements for bead unseating and tyre strength.

The test methods presented in this document are not intended for gradation of tyre performance or quality levels. This document applies to all passenger car tyres.

## 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 4223-1:2017, *Definitions of some terms used in the tyre industry — Part 1: Pneumatic tyres*

ASTM F414-15, *Standard Test Method for Energy Absorbed by a Tire When Deformed by Slow-Moving Plunger*

<https://standards.iteh.ai/catalog/standards/sist/76a91e15-031b-44ea-9aa4-9f475201e3cc/iso-fdis-10191>

ASTM F2663-15, *Standard Test Method for Bead Unseating of Tubeless Passenger and Light Truck Tires*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4223-1:2017 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 3.1

#### **bead separation**

breakdown of bond between components in the bead area

[SOURCE: ISO 4223-1:2017, 3.8.1]

### 3.2

#### **belt separation**

parting of rubber compound between belt layers or between belts and plies

[SOURCE: ISO 4223-1:2017, 3.8.2]

### 3.3

#### **chunking**

breaking away of pieces of rubber from the tread that can expose reinforcing material

Note 1 to entry: Examples for reinforcing material that can be exposed include a polyamide overlay or steel belts.

#### 3.3.1

##### **parasitic tread block chunking**

##### **PTBC**

breaking away of pieces, or tearing, of rubber within a tread block without exposing reinforcing material

Note 1 to entry: PTBC is an artefact of testing a loaded tire on a roadwheel; it is not indicative of a tire structural problem and does not occur in real-world operation. It generally occurs in the endurance test of tyres with soft tread compounds and/or complex tread geometry, e.g. including many sipes.

Note 2 to entry: Examples for reinforcing material that shall not be exposed include a polyamide overlay or steel belts.

### 3.4

#### **cord separation**

parting of the cords from their rubber coating

[SOURCE: ISO 4223-1:2017, 3.8.4]

### 3.5

#### **cracking**

any parting within the tread, sidewall or inner liner of the tyre that may extend to cord material

[SOURCE: ISO 4223-1:2017, 3.8.5]

### 3.6

#### **inner liner separation**

parting of inner liner from cord material in the carcass

[SOURCE: ISO 4223-1:2017, 3.8.6]

### 3.7

#### **open splice**

any parting at any junction of tread, sidewall or inner liner that that may extend to cord material

[SOURCE: ISO 4223-1:2017, 3.8.11]

### 3.8

#### **ply separation**

parting of adjacent plies

[SOURCE: ISO 4223-1:2017, 3.8.7]

### 3.9

#### **sidewall separation**

parting of the rubber compound from the cord material in the sidewall

[SOURCE: ISO 4223-1:2017, 3.8.13]

### 3.10

#### **tread separation**

pulling away of the tread from the carcass

[SOURCE: ISO 4223-1:2017, 3.8.9]

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**3.11****test rim**

rim on which the tyre is fitted for specific testing and, unless specified otherwise, approved or recommended or permitted in one of the regional tyre standards for a tyre of that size designation and type

[SOURCE: ISO 4223-1:2017, 3.8.8, modified — “pneumatic tyre” has been changed to “tyre”.]

**3.12****test drum speed**

peripheral speed of the steel test drum

**3.13****maximum load rating**

reference mass corresponding to the load index used to define the *load capacity* (3.14) of a tyre

**3.14****load capacity**

maximum load that the tyre is able to carry subject to its operating speed and its speed category

**4 Test equipment and conditions**

**4.1 Test drum**, cylindrical driven flywheel (drum) having a diameter of  $1,7 \text{ m} \pm 1 \%$  or  $2,0 \text{ m} \pm 1 \%$ .

The surface of the drum shall be smooth steel. For the endurance test according to 7.1, the drum may be coated with a thin layer of non-stick material, e.g. polytetrafluoroethylene (PTFE), to eliminate parasitic tread block chunking (PTBC), provided that the total drum diameter remains within above limits. The width of the test surface and, if applicable, the width of the thin layer of the non-stick material shall be equal to or exceed the overall width of the test tyre.

When PTFE lubricant is used as non-stick material, care shall be taken that the composition of the lubricant is suitable for use with rubber compounds. For example, silicone-oil-based lubricants with PTFE content between 40 % and 55 % have shown appropriate performance for this purpose.

For the test drum, the loading device shall have a capacity of at least 1 000 kg and the accuracy shall be within  $\pm 1 \%$  of the full scale. The speed capability of the equipment shall be adequate for the requirements of the test methods. The accuracy of the test drum speed shall be within  $^{+2}_0 \text{ km/h}$ .

**4.2 Inflation pressure gauges**, with a maximum scale value of at least 500 kPa and an accuracy within  $\pm 5 \text{ kPa}$ .

**4.3 Conditioning and test room temperature:** If a tyre manufacture desires to increase test severity, tyre conditioning and the tests may be carried out at a higher temperature than specified in the respective subclauses.

## 5 Testing of tyres with diagonal or bias-belted structure and of T-type temporary-use spare tyres

### 5.1 Endurance test

#### 5.1.1 Preparation of tyre

5.1.1.1 Mount the tyre on a test rim and inflate it to the pressure specified in [Table 1](#).

**Table 1 — Test inflation pressures for endurance test**

Tyre type	Test inflation pressure kPa
Standard	180
Reinforced/extra load	220
T type (temporary use)	360

5.1.1.2 Maintain the tyre and rim assembly at an ambient temperature of not less than 35 °C for at least 3 h.

#### 5.1.2 Test procedure

5.1.2.1 Readjust the inflation pressure to the value specified in [Table 1](#) immediately before testing.

5.1.2.2 Mount the tyre and rim assembly on a test axle and press the tyre radially against the outer face of the test drum.

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5.1.2.3 During the test, the ambient temperature, at a distance of not less than 150 mm and not more than 1,0 m from the tyre, shall be at least 35 °C. No provision shall be made for cooling the tyre during the test.

5.1.2.4 Conduct the test, without interruptions, at not less than 80 km/h test speed with loads and test periods not less than those shown in [Table 2](#).

**Table 2 — Test parameters for endurance test of tyres with diagonal or bias-belted structure**

Test period	Duration min.	Test load as percentage of maximum load rating min.
1	4 h	85 %
2	6 h	90 %
3	24 h	100 %

5.1.2.5 Throughout the test, the inflation pressure shall not be corrected, and the test loads shall be kept constant at the value corresponding to each test period.



## 5.2 High-speed test

### 5.2.1 General

For those tyres not marked with a service description, note should be taken of the additional test conditions given in [Annex A](#).

### 5.2.2 Preparation of tyre

**5.2.2.1** Mount the tyre on a test rim, inflate it to a pressure related to its speed symbol, tyre version and load type, as shown in [Table 3](#).

In exceptional cases, a different test inflation pressure may be used. In such a case, the tyre shall be inflated to that pressure.

**Table 3 — Test inflation pressures for high-speed test**

Speed symbol	Test inflation pressure				
	kPa				
	Diagonal			Bias-belted	
	LR B / 4PR	LR C / 6PR	LR D / 8PR	Normal (stand-ard)	Reinforced (extra load)
L, M, N	230	270	300	240	280
P, Q, R, S	260	300	330	260	300
T, U, H	280	320	350	280	320
V	300	340	370	300	340
W, Y	n. def.	n. def.	n. def.	320	360
In the case of T-type temporary-use spare tyres, the tyre shall be inflated to 420 kPa.					

**5.2.2.2** Maintain the tyre and rim assembly at test room temperature for at least 3 h.

### 5.2.3 Test method

**5.2.3.1** Before or after mounting the tyre and rim assembly on a test axle, re-adjust the inflation pressure to that specified in [5.2.2](#).

**5.2.3.2** Press the tyre and rim assembly against the outer face of the test drum.

**5.2.3.3** Apply a load to the test axle according to [Table 4](#).

**Table 4 — Test loads for high-speed test**

Speed symbol	Test load as percentage of the maximum load rating
L, M, N, P, Q, R, S, T, U, H	80 %
V	73 %
W, Y	68 %

**5.2.3.4** Throughout the test, the inflation pressure shall not be corrected, and the test load shall be kept constant.

**5.2.4.5** During the test, the temperature in the test room, measured at a distance of not less than 150 mm and not more than 1,0 m from the tyre, shall be maintained at between 20 °C and 30 °C.

**5.2.4.6** The initial test speed is equal to the tyre's speed category:

- less 40 km/h on a 1,7 m drum; or
- less 30 km/h on a 2,0 m drum.

#### 5.2.4.7 Test procedure

Conduct the test, without interruptions, according to [Table 5](#) in relation to the tyre's speed symbol.

**Table 5 — Test speed steps for high-speed test of tyres**

Step	Test drum speed	Minimum duration for tyres with speed category 270 km/h (speed symbol W) or below	Minimum duration for tyres with speed category 300 km/h (speed symbol Y)
1	Acceleration from zero to initial test speed <sup>a</sup>	10 min	10 min
2	initial test speed	10 min	20 min
3	initial test speed plus 10 km/h	10 min	10 min
4	initial test speed plus 20 km/h	10 min	10 min
5	initial test speed plus 30 km/h	10 min	10 min
6	initial test speed plus 30 km/h <sup>b</sup>	10 min	not applicable

<sup>a</sup> The acceleration from zero to the initial test speed can be done at a constant rate or in several steps, whereby the area under the speed-time curve shall not be smaller than that with constant acceleration.

<sup>b</sup> On 1,7 m drums, the tyre manufacturer may use a test drum speed equal to the initial test speed plus 40 km/h, if increasing test severity is desired.

### 5.3 Strength test

The strength test shall be performed pursuant to ASTM F414-15.

### 5.4 Bead unseating test (of tubeless tyres)

The bead unseating test of tubeless tyres shall be performed pursuant to ASTM F2663-15.

## 6 Requirements for tyres with diagonal or bias-belted structure and for T-type temporary-use spare tyres

### 6.1 Test sample

Two or three tyres with identical characteristics, e.g. size designation and service description or maximum load rating and speed capability, shall comprise a test sample:

- a) one tyre shall be used for the endurance test;
- b) a second tyre shall be used for the high-speed performance test;
- c) for tyres with diagonal or bias-belted structure, a third tyre shall be used for the measurement of bead unseating, if applicable, and then of strength.

The inflation pressures, loads, speeds and durations shall be as specified for each test method.

Each test sample shall conform to the requirements specified in [6.2](#) to [6.5](#).

## 6.2 Endurance test

**6.2.1** When a tyre has been subjected to the laboratory endurance test specified in 5.1, using a test rim and a valve that undergo no permanent deformation and allow no loss of air; there shall be no visual evidence of tread, sidewall, ply, cord, inner liner, belt or bead separation, chunking, open splices, cracking or broken cords. Notwithstanding the above, PTBC would be acceptable.

**6.2.2** The inflation pressure measured immediately after the test shall not be less than the initial pressure specified in 5.1.1.1.

## 6.3 High-speed test

**6.3.1** When a tyre has been subjected to the laboratory high-speed test specified in 5.2, using a test rim and a valve that undergo no permanent deformation and allow no loss of air; there shall be no visual evidence of tread, sidewall, ply, cord, inner liner, belt or bead separation, chunking (including PTBC), open splices, cracking or broken cords.

**6.3.2** The inflation pressure measured immediately after the test shall not be less than the initial pressure specified in 5.2.2.2.

**6.3.3** The outer diameter of the tyre, measured 2 h after completion of the laboratory high-speed test, shall not differ by more than  $\pm 3,5$  % from the outer diameter as measured before the test.

## 6.4 Strength test

**6.4.1** When tested in accordance with ASTM F414-15, a tyre with diagonal or bias-belted structure shall meet the requirements for minimum breaking energy specified in 6.4.2 or 6.4.3, as applicable.

**6.4.2** For tyres in a standard or reinforced version with a nominal section width of 160 mm or above, the minimum breaking energy value is that specified in Table 6.

For tyres in a light load, standard load or reinforced version with a nominal section width less than 160 mm, the minimum breaking energy value shall be reduced by 25 % compared with those specified in Table 6.

**Table 6 — Minimum breaking energy**

Tyre version	Minimum breaking energy
	J
Light load, standard load	295
Reinforced/extra load	585

In the case of other tyre versions or when test inflation pressures differ from those recommended for tyre measurements in Table 1, the value of the minimum breaking energy,  $E_{\min}$ , in joules, is calculated using the equation:

$$E_{\min} = 7,35 \frac{\text{J}}{\text{kPa}} (p_1 - 140 \text{ kPa})$$

where  $p_1$  is the test inflation pressure, in kilopascals, specified for the test, provided that the test inflation pressure is 165 kPa or more.

**6.4.3** For T-type temporary-use spare tyres, the minimum breaking energy required shall be:

- 295 J for tyres with a maximum load rating of 400 kg (load index 76) and above;
- 220 J for tyres with a maximum load rating below 400 kg (load index 76).