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Road vehicles — Spark-plugs — Test methods and requirements

Véhicules routiers — Bougies d'allumage — Méthodes d'essai et exigences

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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 document 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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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects.*

This third edition cancels and replaces the second edition edition (ISO 11565:2006), which has been technically revised. It also incorporates the Technical Corrigendum ISO 11565:2006/Cor. 1:2007.

The main changes are as follows:

— the test procedures have been divided into spark plugs for natural aspirated engines and boosted engines;

— the test sequences have been modified.

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.

Road vehicles — Spark-plugs — Test methods and requirements

1 Scope

This document specifies the test methods and requirements for the mechanical and electrical performance of spark-plugs for use with spark ignition engines.

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 6518-1, *Road vehicles — Ignition systems — Part 1: Vocabulary*

ISO 28741, *Road vehicles — Spark-plugs and their cylinder head housings — Basic characteristics and dimensions*

IEC 60068-2-6, *Environmental Testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6518-1 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 Test methods and requirements

4.1 General

The tests shall be carried out at an ambient temperature of (20 ± 15) °C and a relative humidity of (65 ± 20) % unless otherwise specified.

For each test sample in Table 1, the test sequence is indicated by "X" from top to bottom.

Each test sequence shall be started with unused samples.

“Type A” refers to normally aspirated engines and “Type B” refers to boosted engines.

Which type (A or B) to be applied for each test shall be agreed between the customer and the supplier.

Table 1 — Test sequences

Characteristic to be checked	In accordance with sub-clause	Test sample					
		A	B	C	D	E	F
General characteristics (visual examination)	4.2	X	X	X	X	X	X
Dimensions	4.3	X	X	X	X	X	X
Resistance of the incorporated element for electromagnetic interference (EMI) suppression	4.7.1	-	-	-	-	-	X
Loading life of the incorporated resistor	4.8						X
Mechanical strength of the shell	4.4.1	X					-
Tear off resistance of the high voltage terminal	4.4.2	-	X				
Bending resistance	4.4.3		-	X		-	
Gas tightness	4.5			-	X		
Withstand voltage of the insulator	4.7.2				X		
Vibration resistance	4.4.4				X		
Gas tightness	4.5				X		
Withstand voltage of the insulator	4.7.2				X		
Thermal shock, thermal resistance	4.6				-	X	
General characteristics (visual examination)	4.2		X	X	X	X	

4.2 General characteristics

4.2.1 Test

Check the characteristics specified in 4.2.2 by visual examination. Carry out the visual examination using the naked eye, at normal strength of vision and normal colour perception, at the most favourable viewing distance and with suitable illumination.

The user shall be able to identify the item and verify its appearance, workmanship and finish against the relevant specification based on a visual examination.

4.2.2 Requirements

4.2.2.1 The external gasket, if any, shall conform to ISO 28741 for the relevant spark plug.

4.2.2.2 The scavenging area shall be clean and without any foreign body.

4.2.2.3 The electrodes shall be fixed in position.

4.2.2.4 The shell shall be properly fixed to the insulator. There shall be no visible sign of corrosion. The thread shall be free from burrs or damage.

4.2.2.5 The insulator shall be smooth and uniform without abnormal appearance. The insulator shall not show chips, cracks or signs of shock damage.

4.2.2.6 The marking shall be as specified between customer and supplier.

4.3 Dimensions

4.3.1 Test

The dimensions shall be checked in accordance with ISO 28741, using random samples.

4.3.2 Requirement

All dimensions shall conform to ISO 28741.

4.4 Mechanical performance

4.4.1 Mechanical strength of the shell

4.4.1.1 General

The purpose of this test is to determine the breaking torque of the shell and to show the safety margin of the required installation torque.

4.4.1.2 Test fixture

The thread and the seat of the test fixture shall conform to ISO 28741.

The test fixture shall have a hardness of HRC 20 or greater. The surface roughness across the seating surface shall be R_a maximum 0,2 µm. To cover wear of the seating surface during several tests, the spark plug manufacturer may test with a seating surface of R_a max. 0,8 µm. All threads shall be free of lubricants.

4.4.1.3 Test

Install the fully assembled spark plug on the test fixture specified in 4.4.1.2 and tighten it with a torque wrench or a corresponding device, until the shell breaks.

4.4.1.4 Requirement

The measured torque shall not be less than the values stated in Table 2.

Table 2 — Breaking torque

	M10 × 1,0	M12 × 1,25	M14 × 1,25	M18 × 1,5
Flat	≥25 Nm	≥35 Nm	≥60 Nm	≥80 Nm
Conical	-	≥35 Nm	≥40 Nm	≥60 Nm

4.4.2 Tear-off resistance of the high voltage terminal

The purpose of this test is to ensure that the tensile strength of the terminal is higher than the tensile load of the spark plug connector during operation and removal. This test is valid only for connector types that apply longitudinal forces while connecting and disconnecting.

4.4.2.1 Test

Mount the spark plug on a tensile strength test bench using a suitable device. Apply a force linearly increasing from zero to (400 ± 10) N with a rate of less than 500 N/s to the high voltage terminal in the axial direction.

4.4.2.2 Requirement

After the test, the spark plug shall be intact.

4.4.3 Bending resistance

4.4.3.1 General

The purpose of this test is to ensure that the bending moment of the insulator is higher than the lateral load caused by installation tools. The maximum allowed lateral moment is 15 Nm.

4.4.3.2 Test

Mount the spark plug on a suitable test block at the maximum installation torque specified in ISO 28741. Apply a force perpendicular to the insulator axis and within 5 mm of the insulator's end. The moment arm shall be defined as referenced from the seating surface (gauging point for conical seating) of the spark plug in the cylinder head. The touch down velocity of the force applied shall be less than 10 mm/min to avoid impact damage.

4.4.3.3 Requirement

The spark plug shall withstand a bending moment of 15 Nm.

NOTE An example of a device to test the bending resistance of the insulator is given in Annex A.

4.4.4 Vibration resistance

4.4.4.1 General

The purpose of this test is to precondition the spark plug to simulate engine operation. Further tests shall be performed after the preconditioning.

4.4.4.2 Test

Subject the spark plug, mounted and tightened as specified in ISO 28741, to a vibration test Fc in accordance with IEC 60068-2-6:

— frequency range: 50 Hz to 500 Hz, sinusoidal;

— sweep rate: 1 octave/min;

— acceleration: 30 g (294 m/s^2);

— vibration directions: spark plug axis and perpendicular;

— duration: 8 h in each direction.

4.4.4.3 Requirement

After this test the spark plug shall show no abnormalities and shall fulfil all subsequent tests listed in Table 1.

4.5 Gas tightness

4.5.1 General

The purpose of this test is to ensure that the combustion chamber will be sealed under all conditions.

4.5.2 Test

Mount the spark plug on a test device that represents the configuration given for mounting the spark-plug to the cylinder head. Tighten the spark plug with an installation torque that is adapted depending on the friction factor between the test fixture material and the spark plug as specified in Table 3.

The material of the test fixture shall be agreed between the customer and the supplier.

If the test fixture seat is not of aluminium alloy, it shall have a hardness of HRC 20 or greater. The surface roughness across the seating surface shall be R_a max. 0,2 µm. To cover wear of the seating surface during several tests, the spark plug manufacturer may test with a seating surface of R_a max. 0,8 µm. All threads shall be free of lubricants.

Table 3 — Installation torque

Seating	Thread	Installation torque in the test fixture (tool adjustment value [a]) Nm	
		Aluminium alloy	Hardened steel
Flat	M 10 × 1	15	20
	M 12 × 1,25	25	35
	M 14 × 1,25	30	45
	M 14 × 1,25 compact	20	35
	M 18 × 1,5	Not defined	70
Conical	M 12 × 1,25	15	25
	M 14 × 1,25	20	35
	M 18 × 1,5	23	45

[a] Tool calibrated according to ISO 6789-1.

Ensure that the spark plug temperature and the test fixture temperature, measured close to the seat as shown in Figure 1, have reached (200 ± 10) °C.

Apply the following pressure (air, nitrogen, carbon dioxide or any other detection gas) to the spark plug face for a duration of 5 min:

— (2,0 ± 0,2) MPa [(20 ± 2) bar] for Type A;

— (2,5 ± 0,2) MPa [(25 ± 2) bar] for Type B.

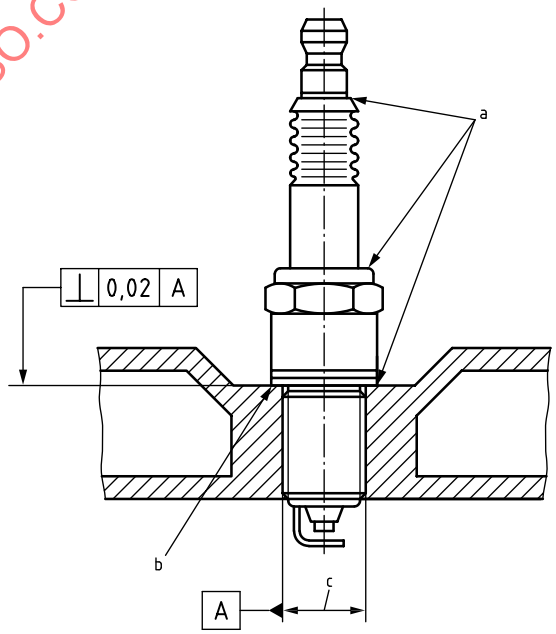
Determine the accumulative leakage rate between:

— shell and test fixture seat;

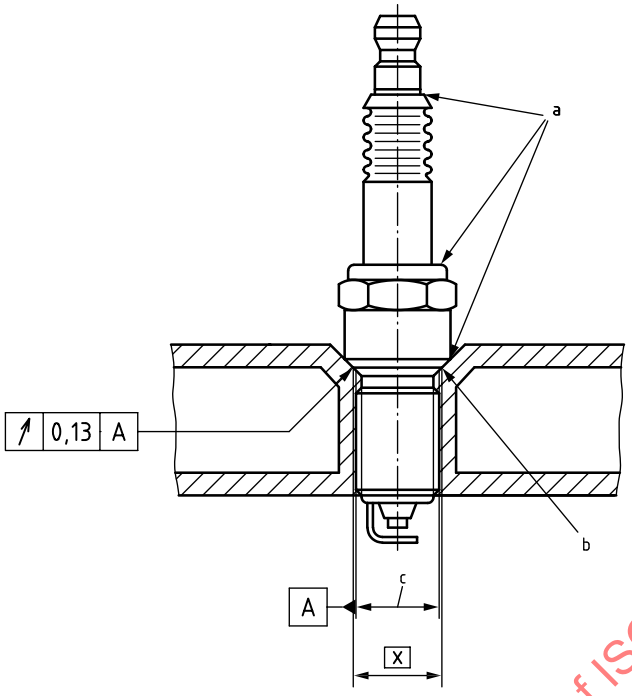
— shell and insulator;

— insulator and high voltage terminal.

Dimensions in millimetres



a) Flat seating



b) Conical seating

Key

a limited leakage possible

b temperature of (200 ± 10) °C in this area

c pitch diameter

x for the gauge point, see ISO 28741:2023, Table 8 (Ø x)

Figure 1 — Leakage

4.5.3 Requirement

The measured total leakage rate shall not exceed 2 cm^3/min. If air or nitrogen are not used, convert the leakage rate to that of air using the specific volume of the detection gas.

4.6 Thermal shock, thermal resistance

4.6.1 General

The purpose of this test is to ensure that the ceramic of a spark plug is sufficiently robust to withstand splashes of water or other liquid agents, e.g. when a power washer is used on a hot engine.

4.6.2 Test

Heat up the spark plug to 180 ± 5 °C. Hold at this temperature for 30 min, then immerse the whole spark plug immediately in a water bath at a temperature of (20 ± 15) °C (maximum temperature at test end: 35 °C). Repeat two more times.

4.6.3 Requirement

There shall be no cracks in the ceramic visible by means of a penetration dye check after three thermal cycles.

4.7 Electrical performance

4.7.1 Resistance of the incorporated element for electromagnetic interference (EMI) suppression

4.7.1.1 General

The purpose of this test is to ensure that the ohmic resistance values meet the specification limit for EMI suppression.

4.7.1.2 Test method

Apply a pulsed voltage of 1 kV to 5 kV between the centre electrode and the terminal of the resistor plug. For plugs whose resistors are not voltage sensitive, a DC voltage of up to 12 V or other suitable procedures may be used, as agreed between customer and supplier.

4.7.1.3 Requirement

The resistance of suppression spark plugs shall be as agreed between the customer and the supplier.

NOTE Typical resistance values are in the range 1 kΩ to 20 kΩ.

4.7.2 Withstand voltage of the insulator

4.7.2.1 General

The purpose of this test is to ensure that the dielectric strength is higher than the maximum voltage demand during operation.

4.7.2.2 Test

Mount the spark plug on a suitable pressure chamber and tighten it with the torque specified in ISO 28741. Apply pressure (air, nitrogen or carbon dioxide) in the pressure chamber to the firing end of the spark plug to ensure that no spark occurs between the electrodes during this test.

Apply ignition voltage pulses between shell and high voltage terminal of the spark plug with a frequency of (20 to 200) Hz, and with the voltage rising at a rate between 500 V/µs and 2 000 V/µs. At least 30 pulses shall reach a peak value given in Table 4.

The ignition coil shall be agreed between the customer and the supplier.

A spark plug boot may be used to avoid terminal to shell flash-over. The ground electrodes may be removed or the centre electrode may be insulated to prevent flash-over across the firing tip of the insulator.

Table 4 — Test voltages

Spark plug	Test voltage (peak value) kV minimum	
	Type A	Type B
M10 × 1	14	30
M12 × 1,25	20	39
M14 × 1,25	25	42
M18 × 1,5	25	48

NOTE Other test voltages can be agreed between the customer and the supplier.

4.7.2.3 Requirement

No breakdown shall occur.

4.8 Loading life of the incorporated resistor

4.8.1 General

The purpose of this test is to ensure that the resistance value under thermal and electrical load meet the specification limit.

4.8.2 Test

Measure the resistance of the resistor plugs in accordance with 4.7.1 at room temperature. Then subject them to the parameters outlined in Table 5.

For type A, measure the resistance again and compare the result with the values before testing.

For type B, measure the resistance after the spark plug has reached room temperature again.

Examine the changes of the respective resistance values.

Table 5 — Test conditions

	Type A	Type B
Temperature	Room temperature	300 ± 10 °C
Average required voltage	20 ± 2 kV	Minimum 15 kV
Spark energy	Minimum 16 mJ	90 ± 10 mJ
Spark rate	50 Hz or 60 Hz	50 Hz or 60 Hz
Number of sparks	$1{,}3 \times 10^7$	$3{,}6 \times 10^7$
Ignition coil output voltage	> 35 kV	> 35 kV
Polarity	Positive or negative	Positive or negative

4.8.3 Requirement

The resistance and the resistor change after endurance test and cooling shall be as agreed between the customer and the supplier.

Figures 2 and 3 show, as an example, the wiring diagram of a test bench for the loading life of an incorporated resistor.