TECHNICAL REPORT

ISO/TR 15409

First edition
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Road vehicles — Heat rating of spark plugs

Véhicules routiers — Évaluation du degré thermique des bougies d'allumage

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this Technical Report may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 15409 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 1, *Ignition equipment*.

Introduction

ISO/TC22/SC1, *Ignition equipmen*t, has studied different methods of spark-plug heat rating. It noted that there exist different measuring methods, each of them requiring costly equipment and a lot of experience, but each of these methods seems to produce sufficient results, one as satisfactory as the others.

The discussions showed no substantial support of any of these methods.

The Subcommittee 1 decided therefore to propose the publication of this information as a Technical Report.

Road vehicles — Heat rating of spark plugs

1 Scope

This Technical Report describes the heat-rating methods of spark plugs used with spark-ignition engines.

2 Reference

ISO 2542:1980, *Internal combustion engines — Spark plug ignition — Terminology*

3 Terms and definitions

For the purposes of this Technical Report, the following terms and definitions apply.

3.1
heat rating
measurement of the thermal characteristics of a spark-plug under operating conditions

3.2
heat-rating value
the outcome of heat rating

NOTE This will be expressed in units corresponding to the heat transfer from a spark plug's firing end or insulator tip.

3.3
heat-rating identifier
numbers, letters or a combination of these, relative to the heat-rating value depending on the spark-plug manufacturer's classification system

3.4
heat range
ability of a spark plug to avoid depositions of soot and carbon as well as to avoid auto-ignition in the vehicle engine application

NOTE 1 That is, a given spark-plug type should operate at as hot a temperature as possible at slow engine speeds and light load conditions, and as cool as possible at wide-open throttle.

NOTE 2 The heat range of a spark plug depends on the design of the electrodes, the insulator nose, the shell and the materials of construction, and the engine used.

4 Heat-rating methods

4.1 For heat rating using the SAE 17,6 in^3 spark-plug heat-rating engine, see annexes A and B.

4.2 For heat rating using vehicle engines, see the methods below.

a) For heat rating by measuring pre- and/or post-ignition and temperature, see annex C.

b) For heat rating by measuring pre- and/or post-ignition and comparison with master spark–plugs, see annex D.

4.3 For heat rating by measuring pre- and/or post-ignition and comparison with master spark–plugs measured in the SAE 17,6 in^3 engine, see annex E.

Annex A
(informative)

The SAE heat-rating method

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SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J549 | REV. MAR95

Issued 1947-12
Revised 1995-03

Superseding J549 JUN90

Submitted for recognition as an American National Standard

PREIGNITION RATING OF SPARK PLUGS

***Foreword*—**This Document has not changed other than to put it into the new SAE Technical Standards Board Format.

1. ***Scope*—**This SAE Recommended Practice describes the equipment and procedures used in obtaining preignition ratings of spark plugs.

1.1 The spark plug preignition ratings obtained with the equipment and procedure specified herein are useful for comparative purposes and are not to be considered as absolute values since different numerical values may be obtained in different laboratories.

2. ***References***

2.1 **Applicable Publications—**The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J2203—SAE 17.6 Cubic Inch Spark Plug Rating Engine

2.1.2 U.S. GOVERNMENT PUBLICATION—Available from DODSSP, Subscripton Services Desk, Building 4D, 700 Robins Avenue, Philadelphia, PA 19111-5094.

MIL-L-6082D

3. ***Equipment*—**SAE 17.6 engine (see SAE J2203) with the cylinder barrel having knurled and chemically treated surface and compression piston rings chromium plated.

4. ***Speed*—**The nominal speed is to be 2700 rpm, but is not to be over 2765 rpm when firing, nor below 2670 rpm when motoring.

5. ***Compression Ratio*—**5.6:1.

6. ***Spark Advance*—**30 degrees Before Top Dead Center (BTDC) for nonaviation plugs, 40 degrees BTDC for aviation plugs or nonaviation plugs that cannot be rated at 30 degrees BTDC.

7. ***Ignition Source*—**Magneto or approved alternate.

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8. ***Spark Plug Installation—***The thread in the spark plug hole opening should conform in size and length to the standards established by SAE for the rating engine.

8.1 SAE recommended torque values should be used when installing plugs in the engine.

8.1.1 Reducer bushings or adaptors should not be used.

9. ***Fuel—***98%—one degree Benzene, 2%—Specification MIL-L-6082D Grade 1100 SAE 60 Nonadditive aviation oil, with 0.8 mL/L (3 cc/gal) T.E.L. added.

10. ***Fuel Injection Timing—***The fuel injection pump port shall begin to close 60 degrees ± 5 degrees of crankshaft angle After Top Dead Center (ATDC) on the intake stroke.

11. ***Fuel Circulation Rate—***2 L/min ± 1 L/min (1/2 gal/min ± 1/4 gal/min).

12. ***Fuel Injection Pump—***The gallery pressure of the fuel injection pump is to be 100 kPa ± 10 kPa (15 psi ± 2 psi).

13. ***Fuel Pressures-Injection—***5170 kPa (750 psi) minimum.

14. ***Mixture Strength—***The mixture strength is that which gives maximum thermal plug temperature.

15. ***Inlet Air Temperature—***107 °C ± 3 °C (225 °F ± 5 °F).

16. ***Inlet Air Humidity—***0.453 kg (75 g ± 25 g of moisture/lb) of dry air.

17. ***Coolant—***The coolant should be water plus 3 L (1 g/gal) of an inhibitor. The total dissolved and suspended solids should not exceed 120 ppm.

18. ***Jacket Inlet Temperature***

a. With pressure cooling control—107 °C ± 3 °C (225 °F ±5 °F)
b. With insert head engine—88 °C ± 1 °C (190 °F ± 2 °F)

19. ***Coolant Flow—***20 L/min ± 2 L/min (5 gal/min ± 1/2 gal/min).

20. ***Crankcase Oil—***Oil is to be nonadditive SAE 120 aviation oil.

21. ***Oil Pressure***

a. In main bearings, 650 kPa ± 40 kPa (95 psi ± 5 psi)
b. In valve gear, 100 kPa (15 psi) minimum at operating temperature

22. ***Oil Temperature—***88 °C ± 5 °C (190 °F ± 10 °F).

23. ***Oil Quantity—***Oil level is maintained at the center of the oil level sight glass.

24. ***Operating Conditions—***The plug rating is that Indicated Mean Effective Pressure (IMEP) value obtained on the engine at a point when the supercharge pressure is 3.37 kPa (1 in Hg) below the preignition point.

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24.1 Preignition Point—The following steps are recommended to attain the preignition point.

24.1.1 The supercharge pressure is increased in 13.5 kPa (4 in Hg) increments until preignition occurs as indicated by a rapid rise in thermal plug temperature. At each setting, the mixture strength is adjusted such that a maximum thermal plug temperature is obtained and held for 3 min.

24.1.2 When preignition occurs, the fuel supply is instantly cut off and the supercharge pressure is decreased 6.7 kPa (2 in Hg) at which point the fuel is turned on and again adjusted for maximum thermal plug temperature. This condition should be held for 3 min or until preignition again occurs.

24.1.3 If preignition occurs after Step 24.1.2, the supercharge pressure should be reduced by 3.37 kPa (1 in Hg) again adjusting for optimum thermal temperature until stable engine operation for 3 min is obtained or preignition occurs. If preignition occurs, refer to Step 24.1.5.

24.1.4 If, after Step 24.1.2 stable engine operation is obtained, the supercharge pressure should be increased by 3.37 kPa (1 in Hg), again adjusting for optimum thermal plug temperature until stable engine operation for 3 min is obtained or preignition occurs. If preignition occurs, refer to Step 24.1.5.

24.1.5 Friction torque should be measured at supercharge pressure 3.37 kPa (1 in Hg) below the preignition point (or previous stabilized setting prior to preignition), and within 30 s after the engine ceases to fire.

24.1.6 Rating data may be verified using a plug that has a rating point at least 50 IMEP above the plugs that have been rated.

25. Calculation of IMEP

$$\text{Indicated HP} = \text{Friction HP} + \text{Brake HP} \qquad \text{(Eq. 1)}$$

$$IHP = \frac{2700}{5252}T_F + \frac{2700}{5252}T_B$$

$$IHP = 0.51(T_F + T_B) = \frac{Plan}{33000}$$

$$0.51(T_F + T_B) - (0.04)(0.01)P = IMEP$$

$$IMEP = 8.65(T_F + T_B)$$

T_F -Friction Torque

T_B - Brake Torque

IMEP - Indicated Mean Effective Pressure

26. Notes

26.1 Marginal Indicia. The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.

PREPARED BY THE SAE IGNITION STANDARDS COMMITTEE

SAE J549 Revised MAR95

Rationale—Not applicable.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—This SAE Recommended Practice describes the equipment and procedures used in obtaining preignition ratings of spark plugs.

Reference Section

SAE J2203—SAE 17.6 Cubic Inch Spark Plug Rating Engine

MIL-L-6082D

Developed by the SAE Ignition Standards Committee

Annex B
(informative)

Description of the SAE heat-rating engine

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SURFACE VEHICLE STANDARD

SAE J2203

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SAE 17.6 Cubic Inch Spark Plug Rating Engine

Foreword—This Document has also changed to comply with the new SAE Technical Standards Board Format. Abbreviations have changed to Section 3. All other section numbers have changed accordingly.

This manual was originally prepared under the auspices of the SAE Ignition Research Committee by the Spark Plug Rating Engine Standardization Panel of the Aircraft Piston Engine Ignition Subcommittee. In 1974, the Spark Plug Rating Engine Standardization Panel was placed under the jurisdiction of the SAE Electrical Equipment Committee.

This manual defines the standard engine to be used in determining spark plug preignition ratings. The engine is known as the SAE 17.6 Cubic Inch[1] Spark Plug Rating Engine. The background of its design, development, and applications is contained in SAE publication SP-243.

In addition to describing the engine, this manual deals with maintenance and overhaul instructions for the engine. Appendices providing engine manufacturing tolerances, replacement limits, and engine bill of materials are included. The manual also includes the procedure for rating spark plugs.

The 17.6 engine has been used for many years in the spark plug industry to classify spark plugs by their preignition rating. Correlation of these ratings among the various test agencies has been accomplished with limited success primarily due to engine variations. This correlation difficulty prompted the Aircraft Piston Engine Ignition Subcommittee of the SAE Ignition Research Committee to investigate methods of standardizing and improving this engine. The Ethyl Corporation (which originated the 17.6 engine) consented to the incorporation of improvements in the engine by SAE.

The Spark Plug Rating Engine Standardization Panel, which was established to standardize and improve this engine, consists of persons who are closely associated with the use or manufacture of the engine. The sum of their individual experiences and the many special projects conducted by the panel have been gathered into this manual.

Conformance with the engine description and rating procedure included in this manual and the diligent following of the Maintenance, Overhaul, and Operation instructions will result in more uniform spark plug rating data from each engine and a closer rating correlation between engines.

1. With the advent of the metric system, the metric notation should be 288.6 cc for the ending displacement. However, since the term “17.6” is quite familiar in the industry, it will be retained in that form.