SAE International	SURFACE VEHICLE RECOMMENDED PRACTICE	SAE J549 MAR2013
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Preignition Rating of Spark Plugs

RATIONALE

This document has been determined to contain stable technology which is not dynamic in nature.

STABILIZED NOTICE

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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 HS840—Manual for the SAE 17.6 Cubic Inch Spark Plug Rating Engine, including Maintenance and Overhaul
SAE J1899—Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)

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

MIL-L-6082D
MIL-L-22851-D
QPL#D07LI-25W60

3. ***Equipment***—SAE 17.6 engine[1] with the cylinder barrel either knurled or honed, with or without chemically treated surface, and compression piston rings which may or may not be chrome 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.

1. See SAE JH840 currently 1989 under revision.

6. ***Spark Advance***—30 degrees Before Top Dead Center (BTDC) for nonaviation plugs with benzene as a fuel, 40 degrees BTDC for aviation plugs or nonaviation plugs which cannot be rated at 30 degrees BTDC. Additionally, any alternate fuels such as toluene or racing gasoline may require a different spark advance.

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

8. ***Spark Plug Installation***—Threads 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/bushing.

8.1.1 Reducer bushings or adaptors should not be used.

9. ***Fuel***—Although 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 has been used as the standard for many years, availability of benzene is becoming highly restricted by virtue of it being a know carcinogen. In lieu of this fact, a number of substitute or alternate fuels are being tested as replacements. Such fuels are Toluene or a suitable leaded racing gasoline, which has sufficient octane rating to insure proper operation without a propensity towards spark knock or detonation. It still must be noted that additives such as aviation oil and T.E.L. must be used in those fuels to underwrite cylinder wear and valve seat longevity. Even with those safeguards in place, the amount of boost required to preignite a plug may be limited by the octane rating of those alternate fuels, which are obtainable.

10. ***Fuel Injection Timing***—The fuel injector or injector 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***—Using a Bosch or similar mechanical fuel injection system, gallery pressure of the fuel injection pump is to be 100 kPa ± 10 kPa (15 psi ± 2 psi). However, feed system pressures to an approved alternate electronic fuel injection system could vary widely with type being used. The main requirement would be is to insure that an adequate pressure is maintained for proper operation.

13. ***Fuel Pressures-Injection***—With a Bosch or similar mechanical systems, pressure should be 5170 kPa (750 psi) minimum. When using an approved alternate electronic fuel injection system, the minimum pressure required should be adequate to guarantee sufficient fuel delivery and atomization for engine operation.

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—***If main and/or rod bearings are silver or suspected of being silver alloy, oil is to be nonadditive SAE 120 aviation oil. If it is determined that bearings are not of a silver composition, then either a nonadditive SAE 120 aviation oil, an additive oil, which complies with MIL-L22851-D, QPL#D07L1-25W60, SAE J1899 may be used. Included in this are multiviscosity lubricants approved for replacing the 120 grade 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 if so equipped without the engine rotating. If a needle valve assembly is used in place of a sight glass, oil must be released when opened.

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.

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 or as indicated by an approved ionization detection system. 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 and ignition is instantly cut off and the supercharge pressure is decreased 6.7 kPa (2 in Hg) and the plug allowed a cool down time of 10 s, at which point the fuel and ignition is turned back on. Fuel is once again adjusted for maximum thermal plug temperature until stable engine operation for 3 min is obtained or preignition occurs. If preignition occurs, refer to Step 24.1.5.

24.1.3 If preignition occurs after Step 24.1.2, the supercharge pressure should be reduced by 3.37 kPa (1 in Hg) again adjusting for peak 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 highest 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***

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