SURFACE VEHICLE RECOMMENDED PRACTICE

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Preignition Rating of Spark Plugs

RATIONALE

This document is being stabilized because it covers a test methodology which is mature and not likely to change in the foreseeable future.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE Ignition Standards Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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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 Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publication

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

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)

SAE J1966 Lubricating Oil, Aircraft Piston Engine (Non-dispersant Mineral Oil)

SAE J2203 SAE 17.6 Cubic Inch Spark Plug Rating Engine

3. EQUIPMENT

SAE 17.6 engine 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.

6. IGNITION SOURCE

Magneto or approved alternate.

7. 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.

7.1 SAE recommended torque values should be used when installing plugs in the engine/bushing.

7.1.1 Reducer bushings or adaptors should not be used.

8. FUEL

Although 98% - one degree Benzene, 2% - Specification SAE J1966 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 known 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.

9. 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.

10. FUEL CIRCULATION RATE

2 L/min ± 1 L/min (1/2 gal/min ± 1/4 gal/min).

11. FUEL INJECTION PUMP

Using a 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 is to insure that an adequate pressure is maintained for proper operation.

12. FUEL PRESSURES-INJECTION

With a mechanical system, 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.

13. MIXTURE STRENGTH (FUEL TO AIR RATIO)

The mixture strength is that which gives maximum thermal plug temperature.

14. COOLANT

The coolant should be water plus .26 g/1 L (1 g/gal) of an inhibitor. The total dissolved and suspended solids should not exceed 120 ppm.

15. 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)

16. COOLANT FLOW

20 L/min ± 2 L/min (5 gal/min ± 1/2 gal/min).

17. CRANKCASE OIL

If main and/or rod bearings are silver or suspected of being silver alloy, oil is to be nonadditive SAE J1966, SAE viscosity grade 60 aviation oil. If it is determined that bearings are not of a silver composition, then either the nonadditive SAE 60 viscosity aviation oil or an additive oil, which complies with SAE J1899 may be used. Included in this are multiviscosity lubricants approved for replacing the SAE viscosity grade 60 aviation oil.

18. 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

19. OIL TEMPERATURE

88 °C ± 5 °C (190 °F ± 10 °F).

20. 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.

21. OPERATING CONDITIONS

These operating instructions are for use with the 17.6 Spark Plug Rating Engine. It is recognized that individual laboratories will have slightly different operation requirements; however, the fundamental operations should follow these instructions as closely as possible so that the rating results will be comparable. Only those conditions that affect the rating of the spark plug or the safety of personnel and equipment are specified as required, but recommended procedures or conditions are indicated for information and guidance purposes.

21.1 Required Operating Conditions

Speed: 2700 + 65/ - 30 rpm

Ignition Timing: 30 degree btc (automotive types), 40 degree btc (aviation or others not rateable at 30 degrees)

Fuel Injection Pressure: 5.17 Mpa (750 psi) minimum.

Fuel-Air Ratio: That which produces the maximum thermal plug temperature.

Air Inlet Temperature: 107.2 °C ± 2.8 °C (225 °F ± 5 °F).

Air Inlet Humidity: 75 + grains of water per pound of dry air.

Bushing Outlet Coolant Temperature: 87.8 °C ± 1.0 °C (190 °F ± 2 °F).

Engine Oil Temperature: 87.8 °C ± 5 °C (190 °F ± 10 °F).

21.2 Step-by-Step Engine Warm-up Procedure

21.2.1 Select the proper spark plug insert (see SAE J2203 Appendix B).

21.2.2 After being sure that the cylinder head insert seat, as well as the spark plug insert itself, is clean, install the insert carefully into the cylinder head, using new O-rings. The O-rings should be assembled onto the insert and may be held in place with a small amount of petroleum jelly or light grease.

21.2.3 The hold-down nuts are to be alternately tightened so that the insert will seat evenly in the cylinder head. The nuts are to be tightened finally to a uniform 6.78 N-m (60 lb-in) torque.

21.2.4 Install a warmup spark plug similar to the type to be rated, using the specified installation torque (SAE J2203 Appendix C). A new gasket is recommended for each installation, except conical seating types.

21.2.5 Before starting the engine, be certain that it has the proper type and amount of lubricating oil in the crankcase, oil in the fuel injection pump base, cylinder jacket and spark plug insert cooling system filled, air pressure supply system filled to the proper water level, and the fuel supply tank filled with fuel. Be certain that the cylinder air pressure supply throttle valves are tightly closed and that the atmospheric air throttle valve is fully open. Turn on the electrical power to all units and set the switch on “high” for the base oil heaters. Turn on the water to the fuel cooler, the crankcase aspirator if used, and all temperature control valves. Turn on the control air supply.

21.2.6 Because there are many installations that use dynamometers other than the frequency changer synchronous type now furnished as part of the standard assembly in the United States, only typical directions will be given here for the starting of the dynamometer. However, most installations include certain safety interlocks that must be bypassed during the initial starting of the engine. This is normally accomplished by holding the “start” button depressed until the oil pressure increases to above the safety setting. As long as the fuel injection pump control is in the closed position, no fuel will be delivered to the injection valve and the engine will not fire. Under no conditions should a cold engine be motored or run at speeds above 900 rpm.

21.2.7 After any required motoring is completed, the engine can be fired by gradually increasing the displacement of the fuel injection control by means of the micrometer screw until firing takes place. The displacement should continue until the thermal plug temperature reaches a maximum. By this time, the dynamometer will have changed from motoring to absorbing. The dynamometer can now be unlocked for power and friction readings. No ratings are to be attempted until the oil temperature has been stabilized at 88 °C (190 °F). Much warmup time may be saved by leaving the crankcase oil heaters turned on - even overnight.

CAUTION: Always be certain that the dynamometer shell is locked and that the atmospheric inlet air throttle valve is fully open and the cylinder air pressure throttle valves are completely closed before the engine is started or stopped.