SAE International

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J335 OCT2012

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Superseding J335 JUN1995

Multiposition Small Engine Exhaust System Fire Ignition Suppression

RATIONALE

Revision of SAE J335 has become necessary in order to address new exhaust system technologies present on environmentally compliant small engines.

1. SCOPE

This SAE Recommended Practice establishes equipment and test procedures for determining the performance of spark arrester exhaust systems of multiposition small engines (<19 kW) used in portable applications, including hand-held, hand-guided, and backpack mounted devices. It is not applicable to spark arresters used in vehicles or stationary equipment.

1.1 Purpose

This document provides a method of evaluating the potential of multiposition small engine exhaust systems to ignite vegetative fuels.

1.2 Performance

Recommended performance criteria are given in Appendix A. These requirements are adequate for the severe fire hazard condition posed by heavy vegetative fuels. However, during periods of extreme fire danger, exhaust systems meeting this document may not give absolute protection against fires. Additional operational restrictions may be necessary during such periods.

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 Publications

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 J1349 Engine Power Test Code - Spark Ignition and Compression Ignition - As Installed Net Power Rating

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/J335_201210

2.1.2 USDA Forest Service Publications

Available from USDA Forest Service, Technology and Development Center, 444 East Bonita Avenue, San Dimas, CA 91773-3198.

USDA Forest Service Standard 5100-1 – Standard for Spark Arresters for Internal Combustion Engines

D.S. Stocksted, "Spontaneous and Piloted Ignition of Pine Needles," Research Note INT 194, USDA Forest Service, Northern Forest Fire Laboratory (1975)

D.S. Stocksted, "Spontaneous and Piloted Ignition of Cheatgrass," Prepublication Research Note, USDA Forest Service, Northern Forest Fire Laboratory (1976)

R.T. Harrison, "Danger of Ignition of Ground Cover Fuels by Vehicle Exhaust Systems," ED&T Report 5100-15, USDA Forest Service, San Dimas Equipment Development Center (1970)

2.1.3 International Standards Organization (ISO) Publications

ISO 7293 Forestry machinery - Portable chain saws - Engine performance and fuel consumption

ISO 8178 Reciprocating internal combustion engines – Exhaust emission measurement – Part 1-8

2.1.4 United Nations Economic Commission for Europe

UN ECE-R120 "Uniform provisions concerning the approval of internal combustion engines to be installed in agricultural and forestry tractors and in non-road mobile machinery, with regard to the measurement of the net power, net torque and specific fuel consumption"

3. DEFINITIONS

3.1 BEST POWER

Power at maximum torque or rated speed achievable by a given test MSE at the maximum continuous corrected net brake power speed. (See SAE J1349 or equivalent standards, e.g. ISO 8178, ISO 7293 or UN ECE-R120)).

3.2 CERTIFYING AGENCY

The authority granting approval or disapproval of equipment tested per this standard per applicable laws or established performance standards.

3.3 CONTACT PLANE

An imaginary flat surface defined by at least three points of contact on the surface of MSE power unit extremities.

3.4 EXHAUST GAS TEMPERATURE TEST

A test to determine exhaust gas temperature at the points where the hottest gases impinge a contact plane.

3.5 EXPOSED SURFACES TEMPERATURE TEST

A test to determine exhaust system temperatures at the points where the engine exhaust system comes in contact with or intersects the contact plane surfaces established by the extremities of the MSE.

3.6 MAY

A permissive condition.

3.7 MULTIPOSITION SMALL ENGINE (MSE)

A hand-held, hand-guided, or back-pack mounted unit having an internal combustion engine operable in more than one position. MSE configurations include, but are not limited to, chain saws, weed trimmers, brush cutters, blowers, hedge trimmers, hand-held and backpack blowers, multi-task tools, and cut-off machines.

3.8 POWER UNIT

A MSE product exclusive of extensions which are not integral to the operation of the engine, or which can be removed without tools.

3.9 SHALL

Indicate a mandatory requirement exclusive of all other methods.

3.10 SHOULD

An advisory condition.

3.11 SPARK ARRESTER

An exhaust system having the ability to control the amount and size of particulate debris emitted into the atmosphere by the exhaust flow (excluding cooling air of the engine). For the purposes of this document, the spark arrester consists of a heat and corrosion resistant metal screen with an opening size of 0.023 inches (0.58 mm) or less through which 100% of exhaust gases flow.

4. INSTRUMENTATION

The following instrumentation is required:

4.1 Calibrated Loading Device

An apparatus designed to test MSEs at given loads and speeds which display torque or power and is compatible with a multipoint recorder or data logger. A calibrated loading device is required in chain saw temperature testing and is optional in temperature testing of MSEs other than chain saws.

4.2 Tachometer

A device for determining the rotational speed (with a measurement accuracy ±5% of tachometer reading) of a MSE. It may be separate or integrated with the calibrated loading device or multipoint recorder or data logging device.

4.3 Exhaust Gas and Surface Temperature Thermocouples

Temperature thermocouple composed of Standard J or K type thermocouple wire with a grounded junction and a probe sheath diameter of 3.2 mm (1/8 in) or smaller.

4.4 Graduated Cylinders

Calibrated containers for measuring amounts of fuel and lubricant for the fuel mix with an accuracy of ±2% of the amount actually contained.

4.5 Wire Plug Gage

A round wire gage of 0.610 mm (0.024 in) diameter with precision ground squared ends. Replace if any rounding is noted.

5. SCREEN TEST

The following screen test shall be made on all MSEs with removable (serviceable) screen-type spark arresters. Products using non-servicable (sealed) mufflers shall be subject to endurance testing per Appendix A.

5.1 Screen Housing Seal

With the screen installed, probe the entire periphery for any gaps in the mounting structure. Any penetration using the wire plug test gage fails the test. When gaging, do not exceed 2 oz (0.56 N) of force.

5.2 Test With Screen Removed

Remove the screen from the exhaust system and randomly probe the screen at least 20 times. Especially pay attention to any bends, molding, or edges. Any penetration using the wire plug gage fails the test. When gaging, do not exceed 2 oz (0.56 N) of force.

5.3 Screen Housing Seal After Reassembly

Install the screen in the exhaust system and repeat 5.1.

5.4 Screen Material

Verify that the screen is constructed of a metal alloy which is heat and corrosion resistant. Verification may be performed through review of supplier material certifications or appropriate metallurgical analysis.

6. CONTACT PLANE DETERMINATION

The contact planes are determined by the following method:

6.1 General

6.1.1 Determine the configuration of the MSE to be tested in accordance with 6.2 through 6.7.

6.1.2 Place the MSE power unit on a horizontal plane in the position which places the exhaust system nearest to that plane. In this position, identify three points where the power unit contacts the horizontal surface. This is the first contact plane. Using two existing contact points in the first plane, rotate the power unit until a third contact point has been identified. This is the second contact plane. Repeat this process until a total of three contact planes have been established. Additional planes may be tested using good engineering practice. The contact plane closest to the exhaust flow direction shall be used for determination of the hot spot for the exhaust gas temperature. If any test plane contacts the exhaust system surface, the exhaust surface temperature shall be measured at this contact point. Mark the contact point accordingly. (Refer to Figure 1 for chain saws, Figure 2 for brush cutters, Figure 3 for hand held blowers and Figure 4 for backpack blowers, Figure 5 for hedge trimmers, Figure 6 for Multi-Task tool, and Figure 7 for Cut-off machines)

6.1.3 Use narrow drafting-style tape and/or stiff, straight metal rods (3.0 mm or less in diameter) to connect the contact points in each plane, as shown in Figure 1. These shall be used to provide more accurate thermocouple probe alignment during the test.

6.2 Chain Saws

6.2.1 Assemble per manufacturer's specification, without guide bar and chain, fuel, and oil.

6.2.1.1 If spikes or bumper bars are supplied and required by the manufacturer, test the saw with spikes in place. Locate the test planes from the root(s) of the uppermost bumper spike(s).

6.2.2 Fit a spacer, the same thickness as the bar, between the clutch cover and body and reinstall the clutch cover. The spacer shall not protrude beyond the body of the saw.

6.2.3 Secure the hand guard in the position specified by the minimum handle clearance of 35 mm (1.38 in) as required in ISO 7914.

6.2.4 Determine the planes per 6.1.

6.3 String Trimmers and Brush Cutters

Use the power head and lower end shaft to determine the planes per 6.1.

6.4 Blower

Test planes shall be identified per 6.1, excluding all blower tubes that can be removed without the use of tools. Where the exhaust port is vented within the blower duct, thermocouples should be attached to the outlet surface of the exhaust outlet duct. Thermocouples should be attached to the outlet surface of the exhaust outlet.

6.5 Hedge Trimmers

Contact planes for trimmers shall be determined per 6.1, with the cutting attachment installed.

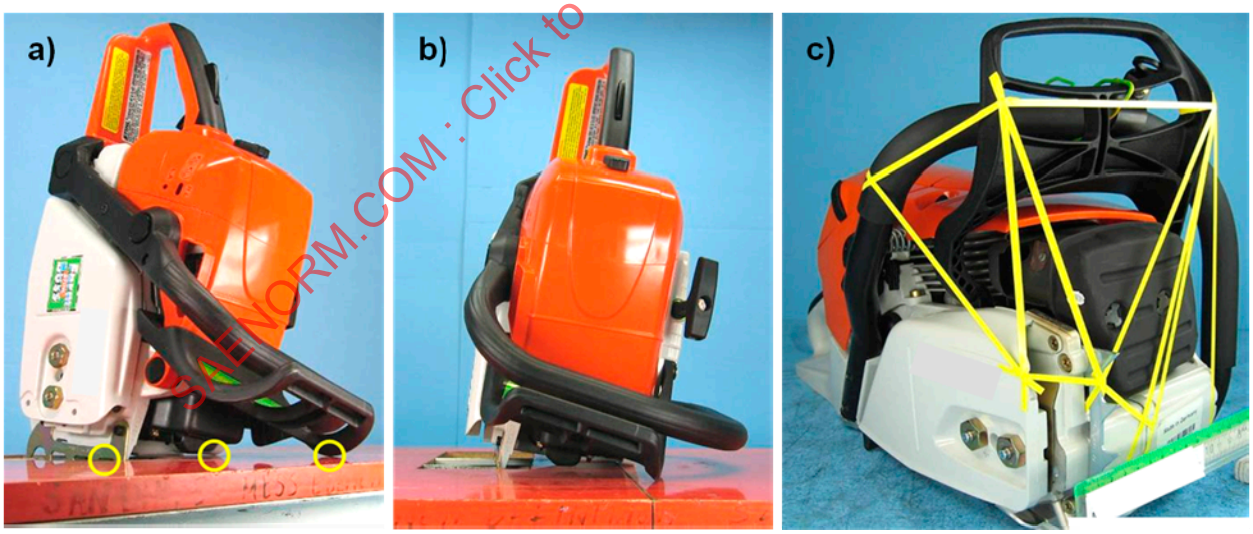

FIGURE 1 - CHAINSAW WITH CONTACT PLANES IDENTIFIED

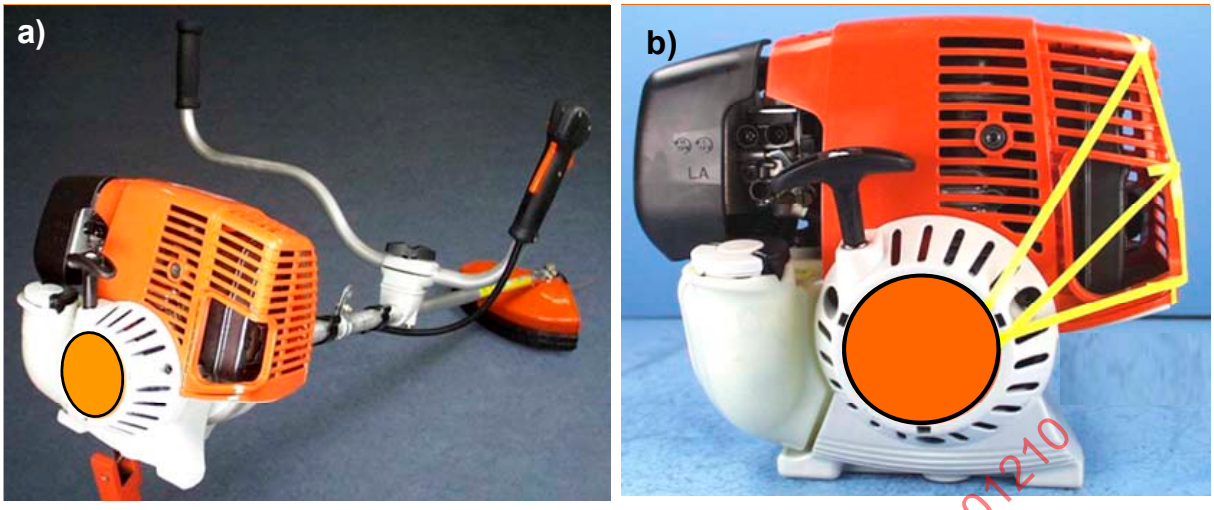

FIGURE 2 - (A) STRING TRIMMER IN DESIGN CONFIGURATION, (B) WITH CONTACT PLANES IDENTIFIED

FIGURE 3 - (A) BLOWER IN DESIGN CONFIGURATION, (B) IN TEST CONFIGURATION (FIRST BLOWER TUBE REQUIRES TOOLS FOR REMOVAL), (C) TEST PLANES IDENTIFIED

FIGURE 4 - BACK PACK BLOWER WITH TEST PLANES IDENTIFIED

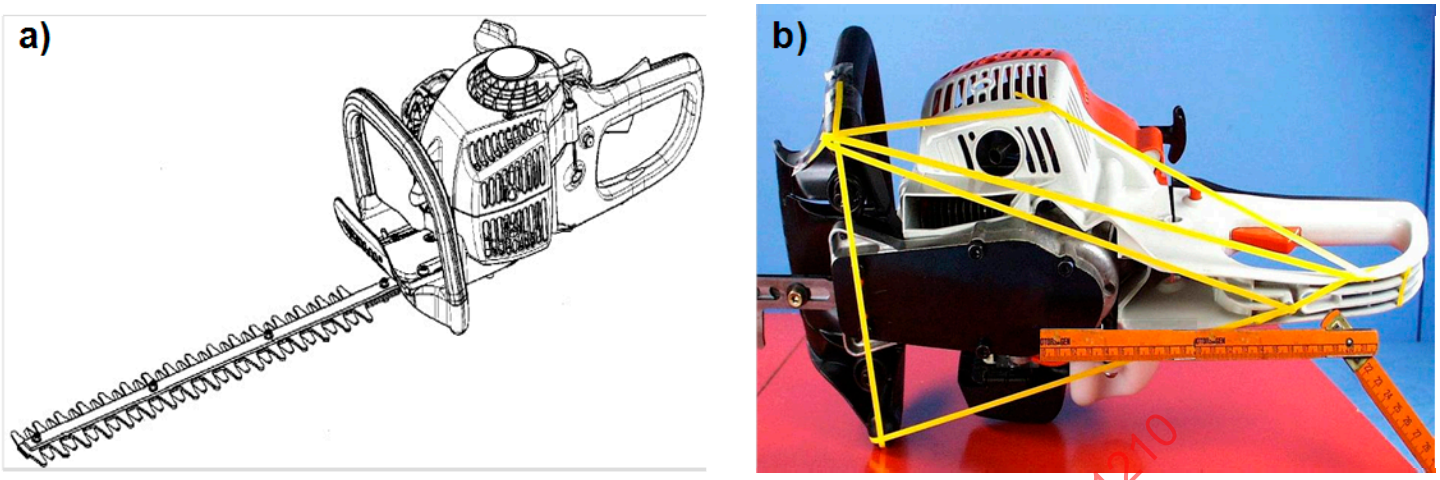

FIGURE 5 - (A) HEDGE TRIMMER IN DESIGN CONFIGURATION, (B) TEST PLANES IDENTIFIED

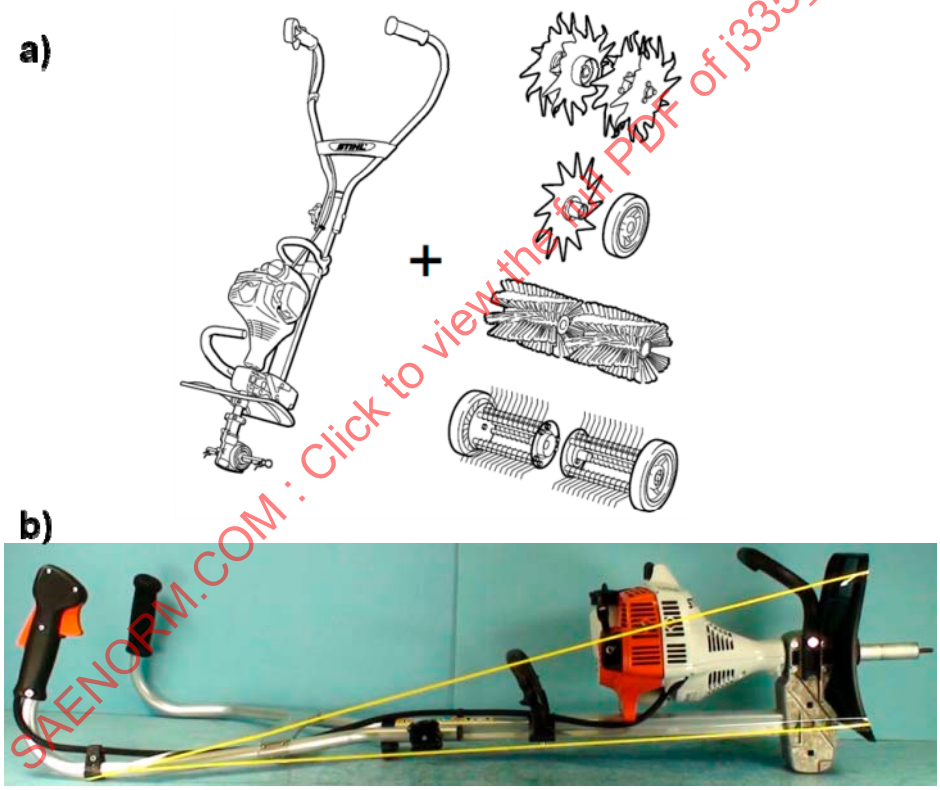

FIGURE 6 - (A) MULTI-TASK TOOL IN DESIGN CONFIGURATION, (B) TEST PLANES IDENTIFIED

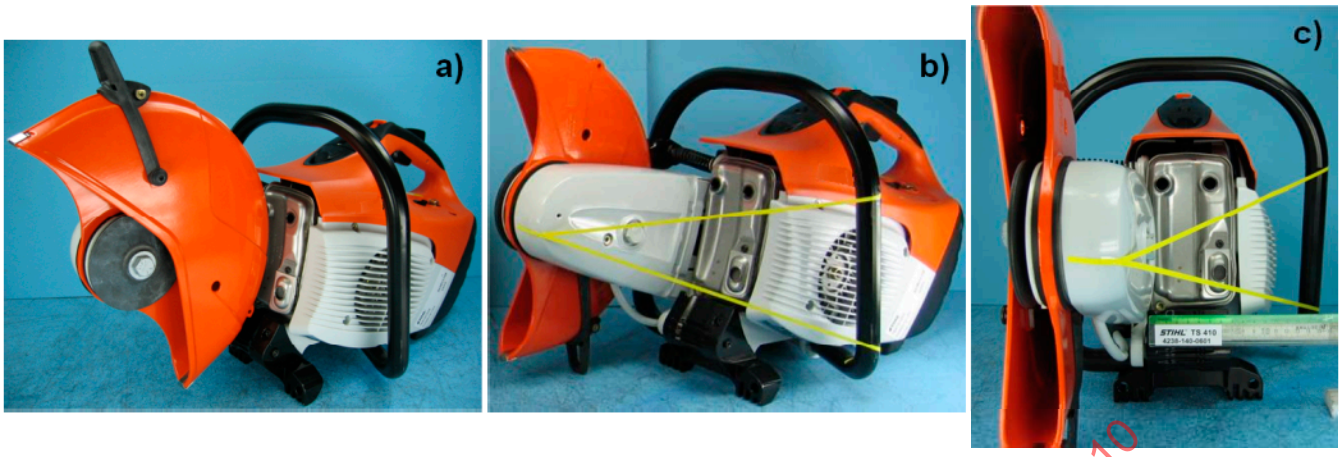

FIGURE 6 - (A) CUT-OFF MACHINE IN DESIGN CONFIGURATION (LESS BLADE), (B), (C) TEST PLANES IDENTIFIED

6.6 Cut-Off Machines

Remove blade guard and blade (if design allows). If design allows re-install blade guard towards outside. Establish contact plane as the closest possible plane to the muffler and exhaust outlet.

6.7 Other MSE Configurations

Determine planes for other configurations (that is, power drills, impact devices, and compactors) without attachments or detachable accessories.

7. TEMPERATURE TEST

Perform the following temperature tests on all MSEs:

7.1 Exposed Surface and Accumulation Area Temperature Test

Measure exhaust system temperatures at the points where the engine exhaust system comes in contact with the plane surfaces established per 6.1. If the surface of the exhaust system contains pockets, recessions, or cavities which would preclude the removal of debris by gravity and/or normal operating motions of the device, the temperature in these accumulation areas must be measured.

7.1.1 Test Apparatus

Use thermocouples welded or brazed to the exhaust system to determine temperatures. For chain saws, a calibrated loading device is required (Section 8).

NOTE: During all tests, a thermocouple should be mounted to the cylinder head or spark plug gasket to monitor the head temperature.

7.2 Exhaust Gas Temperature Test

Measure exhaust gas temperature at the points where the hottest gases impinge a plane established per 6.1.

7.2.1 Test Apparatus

Use thermocouples to measure the exhaust gas temperature. For chain saws, a calibrated loading device is required. For other MSE devices, excluding blowers, use of a calibrated loading device is optional.

NOTE: During all tests, a thermocouple should be mounted to cylinder head or spark plug gasket to monitor head temperature.

7.3 Test Data

The test data to be recorded for MSE temperature testing shall include the time, exhaust gas temperature, head and ambient temperatures, engine speed, torque and the exhaust surface temperature, if required. Recorded test data for MSEs other than chain saws may omit the torque data, if a calibrated loading device was not used. Recorded test data for MSEs other than chain saws shall include the method of loading, including the approximate percentage of the intake and/or discharge area blocked for blowers.

8. DETAILED TEMPERATURE TEST METHODS

Use the following temperature test methods to test MSE exhaust systems. The ambient temperature during test runs shall be not less than 15 °C (59 °F).

8.1 Chain Saws

8.1.1 Preparation

8.1.1.1 Mount the test unit to the calibrated loading device as recommended by the manufacturer, without interference of the test plane. The width of the guide bar shall be simulated by an adapted guide bar or spacer of equivalent thickness.

8.1.1.2 Weld or braze surface temperature probes to all points found by the methods described in 6.1 and 6.2 where the test plane touches any part of the muffler surface. Use spark plug or cylinder head thermocouples for all tests.

8.1.1.3 Prepare a fresh fuel and oil mixture as provided by the manufacturer's recommendations.

8.1.1.4 Construct the contact planes as described in Section 6.

8.1.1.5 Start measuring recorder prior to first cold start. Set loading device for the best power speed stated by the manufacturer.

8.1.1.6 **For carburetors with limited adjustment (limiter cap):**
Adjust the high speed mixture jet adjustment to factory setting (rich). Then turn towards lean to maximum torque at best power speed (back it out slightly to allow proper lubrication) or to lean stop position of limiter cap, maintain the head temperatures below manufacturer's maximum head temperature limit.

For non adjustable carburetors
Run engine as delivered.

For engines **with electronically controlled fuel air mixture adjustment (electronic engine management)**

Operate and set up engine according to manufacturer’s instructions.

8.1.1.7 Using a portable, hand-held, thermocouple probe, crisscross the plane surfaces to find the hottest spot. Mount a thermocouple probe to monitor the exhaust gas temperature during the test at this location.

8.1.2 Test

8.1.2.1 Run the test engine at best power speed until a stable temperature has been achieved (±3°C within a 30 second period). Run for an additional 3 minutes after the temperature as stabilized, simultaneously recording the RPM, torque and temperature information.

8.1.2.2 Increase speed slowly to 1000 rpm above best power. When the 1000 rpm speed increase has been reached and temperature has stabilized, run for at least 3 minutes, simultaneously recording test data.

8.1.2.3 Decrease speed slowly to 1000 rpm below best power. When the 1000 rpm speed reduction has been reached and temperature has stabilized, run for at least 3 minutes, simultaneously recording test data.

8.1.2.4 Increase speed slowly to best power. When best power speed has been reached and temperature has stabilized, run for at least 3 minutes, simultaneously recording test data.

8.2 String Trimmers and Brush Cutters

8.2.1 Preparation

8.2.1.1 Instrument test unit to measure speed and temperatures per Section 7. Document the method of loading.

8.2.1.2 Testing without a calibrated loading device

Start measuring recorder prior to first cold start. Run the test engine at best power speed (as stated by the manufacturer).

8.2.1.3 Testing with a calibrated loading device

Start measuring recorder prior to first cold start. Set loading device for the best power speed as stated by the manufacturer.

8.2.1.4 Fuel-air mixture adjustment

For carburetors with limited adjustment (limiter cap):

Adjust the high speed mixture jet adjustment to factory setting (rich). Then turn towards lean to maximum torque at best power speed (back it out slightly to allow proper lubrication) or to lean stop position of limiter cap. Maintain the head temperatures below manufacturer's maximum head temperature limit.

For non adjustable carburetors:

Run engine as delivered.

For engines with electronically controlled fuel air mixture adjustment (electronic engine management):

Operate and set up engine according to manufacturer’s instructions.

8.2.2 Test

8.2.2.1 Run the test engine at best power speed until a stable temperature has been achieved (±3°C within a 30 second period). Run for an additional 3 minutes after the temperature as stabilized, simultaneously recording the RPM, torque and temperature information.

8.2.2.2 Increase speed slowly to 1000 rpm above best power. When the 1000 rpm speed increase has been reached and temperature has stabilized, run for at least 3 minutes, simultaneously recording test data.

8.2.2.3 Decrease speed slowly to 1000 rpm below best power. When the 1000 rpm speed reduction has been reached and temperature has stabilized, run for at least 3 minutes, simultaneously recording test data.

8.2.2.4 Increase speed slowly to best power. When best power speed has been reached and temperature has stabilized, run for at least 3 minutes, simultaneously recording test data.

8.3 Blowers

8.3.1 Preparation

8.3.1.1 Instrument the test engine to measure speed and temperatures per Section 7. Start measuring recorder prior to first cold start. To determine operational speed, set the unit up with the first blower tube mounted as specified by manufacturer.

8.3.1.2 Fuel-air mixture adjustment

For carburetors with limited adjustment (limiter cap):

Adjust the high speed mixture jet adjustment to factory setting (rich). Then turn towards lean to maximum torque at operational speed (back it out slightly to allow proper lubrication) or to lean stop position of limiter cap. Maintain the head temperatures below manufacturer's maximum head temperature limit.

For non adjustable carburetors:

Run engine as delivered.

For engines with electronically controlled fuel air mixture adjustment (electronic engine management):

Operate and set up engine according to manufacturer’s instructions.

8.3.2 Test

8.3.2.1 Run test engine at wide open throttle at the operational speed specified by the manufacturer for at least three minutes after until a stable temperature has been achieved (±3°C within a 30 second period).

8.3.2.2 Increase speed by 1000 rpm above the operational speed found in 8.3.2.1, by partially covering the blower intake or discharge port. Run for at least 3 minutes after temperature has stabilized, simultaneously recording test data. Maintain the cylinder head temperatures below manufacturer's maximum head temperature limit