
**Exhaust system for multi position
small engine machines — Test
procedures and performance
requirements for spark arrestors**

Système d'échappement pour machines à petit moteur multi-positions — Méthodes d'essai et exigences de performance pour les pare-étincelles

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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.

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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 17, *Manually portable (hand-held) powered lawn and garden equipment and forest machinery*.

This second edition cancels and replaces the first edition (ISO 9467:1993), which has been technically revised.

The main changes are as follows:

- the normative references have been updated;
- multi-position small engine equipment pole pruners, edgers, hedge trimmers and blowers have been added.

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.

Introduction

During dry seasons, forest fires can be ignited by small internal combustion engine-powered equipment such as portable chain-saws, brush-cutters, grass-trimmers, pole-mounted pruners, edgers, hedge trimmers and blowers. The exhaust system of such equipment presents three potential sources of ignition to dry vegetation: hot exhaust gas, hot exhaust system surfaces and the emission of glowing carbon particles. The potential for ignition depends on the specific vegetation involved, environmental factors, equipment usage patterns, the size of carbon particles that can be emitted, and temperatures of the exhaust gas and exhaust system surfaces.

This document highlights the minimum performance and maintenance requirements of spark arrestors for single and multi-position small internal combustion engines used in proximity to grass, brush, timber, and similar cellulose materials. This document provides methods for arrestor performance evaluation, size selection, and determination of application position.

The requirements include:

- maximum temperatures for exhaust gases and exhaust system surfaces;
- maximum opening size for screen-type spark arrestors;
- restriction on debris accumulation.

The test methods include:

- uniform procedures for measuring exhaust gas and exhaust system surface temperatures; and
- a procedure to evaluate opening size for screen-type spark arrestors.

Local laws can govern when and where the use of spark arrestors is required. During periods of very high or extreme fire danger, arrestors meeting the requirements of this document cannot give complete protection against exhaust spark fires. Additional measures, including complete shutdown of operations, can be required during such periods.

Exhaust system for multi position small engine machines — Test procedures and performance requirements for spark arrestors

1 Scope

This document establishes requirements and test procedures for determining the performance of spark arrestor exhaust systems of multi position small engines used in portable applications, such as chain-saws, brush-cutters, grass-trimmers, pole-mounted pruners, edgers and similar shaft-drive machines, hedge trimmers and hand-held and back-pack blowers.

It is not applicable to spark arrestors used in vehicles or stationary equipment.

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 6531, *Machinery for forestry — Portable chain-saws — Vocabulary*

ISO 7112, *Machinery for forestry — Portable brush-cutters and grass-trimmers — Vocabulary*

ISO 7914, *Forestry machinery — Portable chain-saws — Minimum handle clearance and sizes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6531, ISO 7112 and the following 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/>

3.1

contact plane

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

3.2

exhaust gas temperature test

test to determine exhaust gas temperature at the points where the hottest gases impinge a *contact plane* (3.1)

3.3

exhaust gas temperature

temperature of the exhaust gas at any point where it crosses a *contact plane* (3.1)

3.4

exhaust system

device(s) used to contain and direct gas from the cylinder exhaust port to the atmosphere, including spark arrestor and all directly attached shields for hot surface contact prevention

3.5

exposed surface temperature

temperature of the engine *exhaust system* (3.4) at the points where it contacts or intersects the *contact plane* (3.1) surface established by the extremities of the MSE

3.6

maximum power

maximum corrected brake power, as applicable

3.7

maximum power speed

engine speed at which maximum corrected brake power is obtained, in accordance with ISO 7293 or ISO 8893, as applicable

3.8

multi position small engine machine

MSE

hand-held, hand-guided, or back-pack mounted machine having an internal combustion engine operable in more than one position

3.9

power unit

MSE (3.8) exclusive of extensions which are not integral to the operation of the engine, or which can be removed without tools

3.10

spark arrestor

device through which the exhaust gases pass, intended to stop smouldering/burning particles

4 Test equipment

4.1 Calibrated loading device

An apparatus designed to test multi position small engine machines (MSEs) at given loads and speeds, which displays torque or power and is compatible with a multipoint recorder or data logger. A calibrated loading device is required in a 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 $\pm 5\%$ of tachometer reading) of an MSE. It may be separate or integrated with the calibrated loading device or multipoint recorder or data logging device.

4.3 Temperature thermocouple

Temperature thermocouple composed of Standard J or K type thermocouple wire with a grounded junction and a probe sheath diameter of 3,2 mm or smaller, used to measure exhaust gas and surface temperatures.

4.4 Graduated cylinders

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

4.5 Wire plug gauge

A round wire gauge of 0,61 mm diameter with precision ground squared ends used to evaluate the geometry of the spark arrestor screen and associated housing openings. Replace if any rounding > 0,03 mm is noted.

5 Performance requirements for multi-position small engine machines

5.1 Marking and identification

The power unit shall be identified by the manufacturer name or trademark and model number.

The exhaust system shall be identified by the manufacturer name or trademark and model number. Due to space limitations in these exhaust systems, partial marking is acceptable provided the marking uniquely identifies the exhaust system.

Acceptable methods of identification are metal stamping, etching, dot peening, or durable labels.

5.2 Mounting and installation

The spark arrestor screen of exhaust systems shall be easily removable for inspection, cleaning or replacement, without major disassembly of the power unit or removal of the exhaust system from the power unit.

5.3 Screen material

The spark arrestor screen used with the engine exhaust system shall be resistant to the high temperatures and corrosive materials present in the engine exhaust gas.

5.4 Screen geometry

Spark arresting screens shall have no screen or housing openings allowing the 0,61 mm diameter wire plug gauge to penetrate any opening when tested in accordance to [Clause 6](#).

5.5 Exposed surface temperature

The maximum exposed exhaust system surface temperature, obtained when tested according to [Clause 9](#), shall not exceed 288 °C.

5.6 Exhaust gas temperature

The maximum exhaust gas temperature in any contact plane, obtained when tested according to [Clause 9](#), shall not exceed 246 °C.

5.7 External pockets

The exhaust system shall be designed so that there are no external pockets in the area surrounding the exhaust system, where flammable material can accumulate.

5.8 Internal pockets

An area on the outer surface area of the exhaust system forming an internal pocket shall be either closed or the surface temperature inside the internal pocket shall not exceed 288 °C. This applies only to front mounted chain-saw exhaust systems.

6 Screen test

6.1 General

The screen test shall be performed using the wire plug gauge on all MSEs with removable (serviceable) screen-type spark arrestors.

6.2 Screen housing seal

With the screen installed in the exhaust system, probe the entire periphery of the screen for any gaps in the mounting structure. When gauging, do not exceed 0,56 N of force.

6.3 Screen openings

Remove the screen from the exhaust system and randomly probe the screen at least 20 times. Especially pay attention to any bends, moulding, or edges. When gauging, do not exceed 0,56 N of force.

6.4 Screen housing seal after reassembly

Install the screen in the exhaust system and repeat [6.2](#).

6.5 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.

7 Contact plane determination

7.1 General

Determine the configuration of the MSE to be tested in accordance with [7.2](#) through [7.5](#).

Place the MSE power unit on the 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. (Refer to [Figure 1](#) for chain-saws, [Figure 2](#) for brush cutters, grass trimmers, pole pruners, edgers and similar shaft-drive machines, [Figure 3](#) for hedge trimmers, and [Figures 4](#) and [5](#) for hand-held and back-pack blowers). 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 [Figures 1](#) to [3](#). These shall be used to provide more accurate thermocouple probe alignment during the test.

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.

7.2 Chain-saw

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

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

Fit a spacer, having the same thickness as the guide bar, between the sprocket cover and body and reinstall the sprocket cover. The spacer shall not protrude beyond the body of the chain-saw.

Secure the hand guard in the position specified by the minimum handle clearance of 35 mm in accordance with ISO 7914.

Determine the contact planes per 7.1.

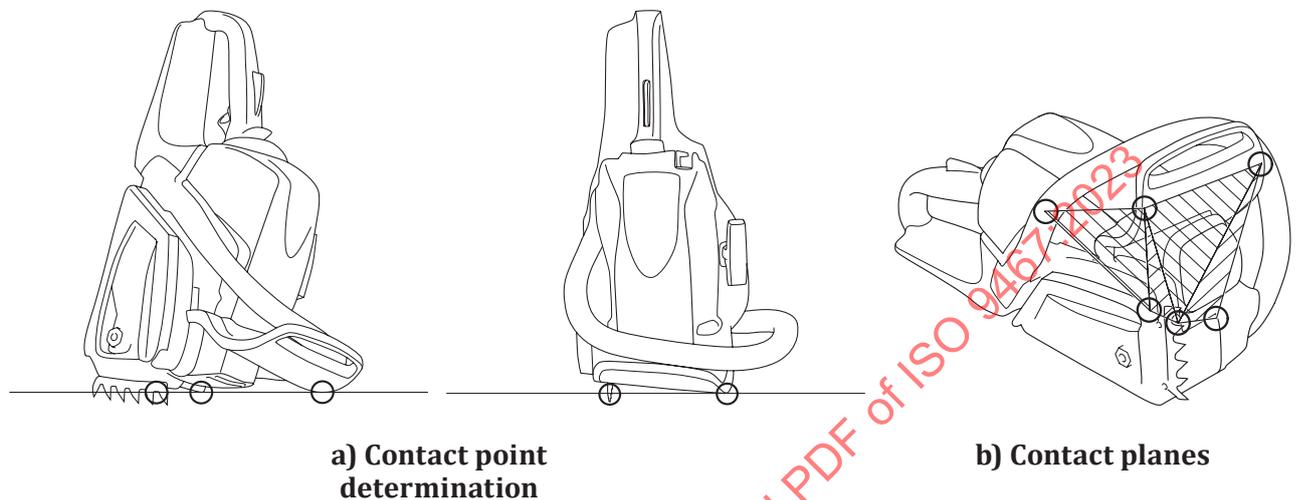


Figure 1 — Chain-saw — Contact plane determination

7.3 Brush cutter, grass trimmer, pole pruner, edger and similar shaft-drive machines

Determine the contact planes per 7.1 using the power unit and lower end shaft.

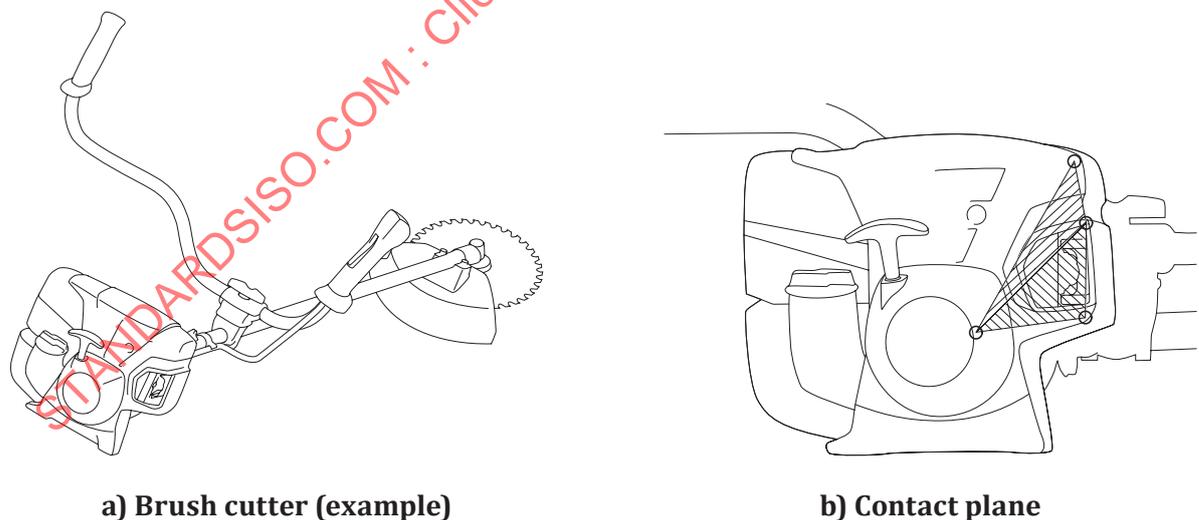


Figure 2 — Brush cutter, grass trimmer, pole pruner, edger and similar shaft-drive machines — Contact plane determination

7.4 Hedge trimmer

Determine the contact planes per 7.1, with cutting attachment installed.

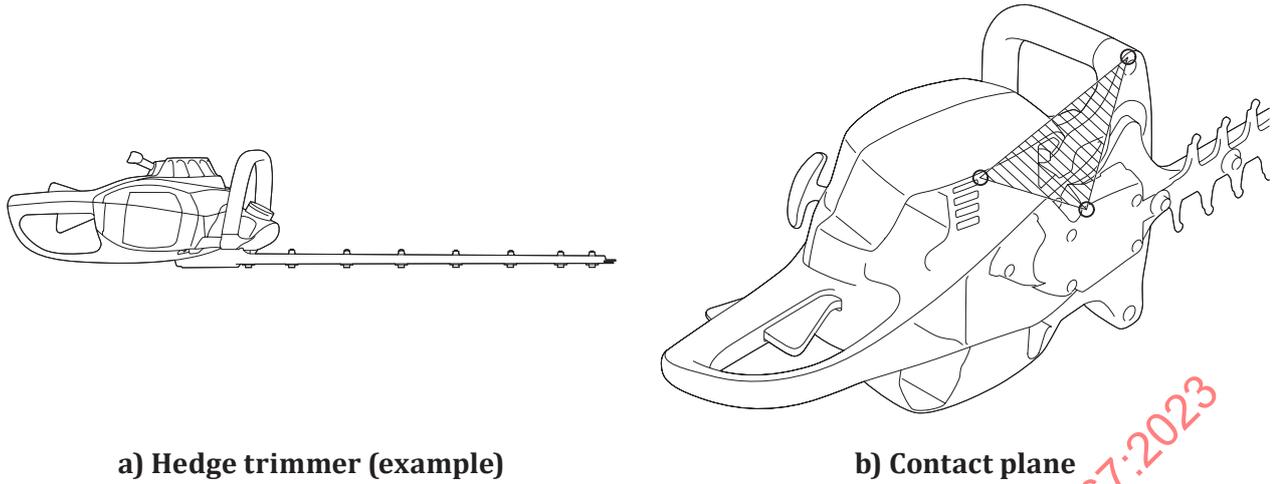


Figure 3 — Hedge trimmer — Contact plane determination

7.5 Blower

Determine the contact planes per 7.1, 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.

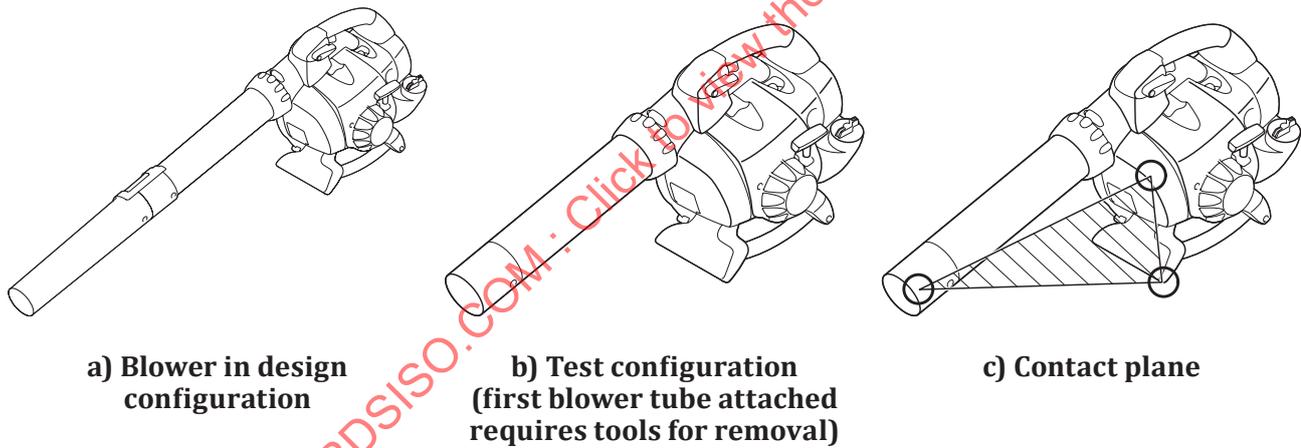


Figure 4 — Hand-held blower — Contact plane determination

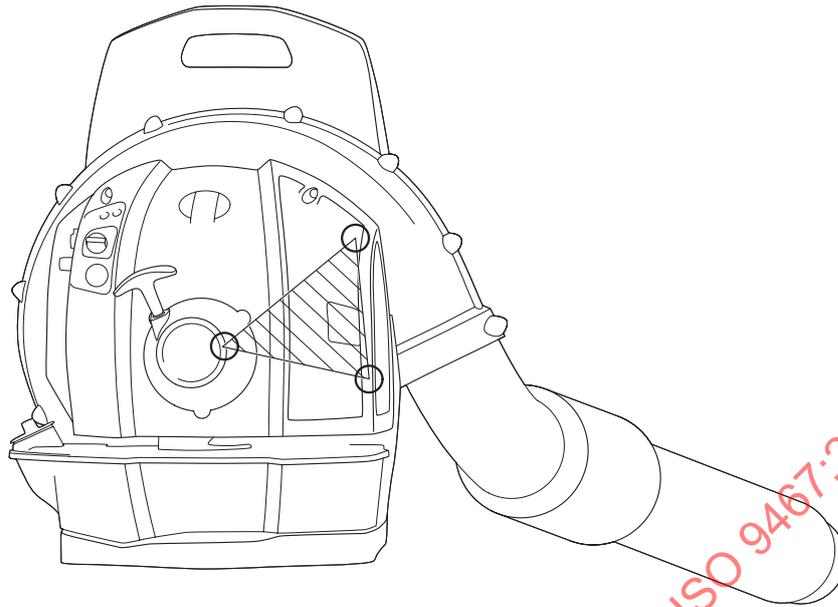


Figure 5 — Back-pack blower — Contact plane determination

8 Temperature tests

8.1 General

- Construct the contact planes as described in [Clause 7](#).
- Set-up the power unit to measure speed and apply the measurement devices to measure the temperatures according to test methods described in [Clause 9](#).
- Document the method of loading (if applicable).
- Prepare a fresh fuel and oil mixture as provided by the manufacturer's recommendations.
- The ambient temperature during test runs shall be between 15 °C and 30 °C.
- Use the temperature test methods described in [Clause 9](#) to test MSE exhaust systems.
- Start data collection prior to first cold start.
- Record the test data according to [Clause 10](#).

8.2 Test apparatus

- Use thermocouples to measure surface temperatures. Thermocouples shall be welded or brazed to all points found by the methods described in [7.1](#) where the test plane touches any part of the exhaust system surface.
- Use a thermocouple to measure the exhaust gas temperature.
- Use a spark plug or cylinder head thermocouple to measure the cylinder head temperature for all tests.
- Use a calibrated loading device (if required).

8.3 Test data

- The test data to be recorded for MSE temperature testing shall include the time, exhaust gas temperature, cylinder head and ambient temperatures, engine speed, torque and the exhaust surface temperature, if required (see [Clause 10](#)).
- 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.

8.4 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 surface established per [7.1](#).

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 shall be measured.

8.5 Exhaust gas temperature test

Measure the exhaust gas temperature at the point where the hottest gases impinge a plane established per [7.1](#).

9 Temperature test methods

9.1 Chain-saws

9.1.1 Preparation

Mount the power unit to the calibrated loading device as recommended by the manufacturer, without interference of the test plane.

Set the loading device for the maximum power speed stated by the manufacturer.

- For carburetors with limited adjustment (limiter cap): adjust the high-speed mixture jet to factory setting (rich stop). Then turn towards lean to achieve maximum torque at maximum power speed and back out as needed to maintain cylinder head temperature below the manufacturers' maximum 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.

Using a portable hand-held thermocouple, crisscross the contact plane surface to find the hottest spot. Mount a thermocouple to measure the exhaust gas temperature during the test at this location.

9.1.2 Test

Run the engine at maximum power speed until a stable cylinder head temperature has been achieved (± 3 °C within a 30 s period). Run the engine for additional 3 min to 4 min, recording the test data according to [8.3](#); the maximum sampling interval shall be 10 s.

- Increase speed to 1 000 r/min above maximum power speed. When the cylinder head temperature has stabilized, run the engine for additional 3 min to 4 min, recording the test data according to [8.3](#); the maximum sampling interval shall be 10 s.

- Decrease speed to 1 000 r/min below maximum power speed. When the cylinder head temperature has stabilized, run the engine for additional 3 min to 4 min, recording the test data according to 8.3; the maximum sampling interval shall be 10 s.
- Increase speed to maximum power speed. When the cylinder head temperature has stabilized, run the engine for additional 3 min to 4 min, recording the test data according to 8.3; the maximum sampling interval shall be 10 s.

9.2 Brush cutters, grass trimmers and pole pruners

9.2.1 Preparation

Run the engine and set the loading device to the maximum power speed as stated by the manufacturer.

- For carburettors with limited adjustment (limiter cap): adjust the high-speed mixture jet adjustment to factory setting (rich). Then turn towards lean to maximum torque at maximum power speed (back it out slightly to allow proper lubrication and to keep the cylinder head temperature below the cylinder head temperature limit indicated by the manufacturer).
- For non-adjustable carburettors: 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.

Using a portable hand-held thermocouple, crisscross the contact plane surface to find the hottest spot. Mount a thermocouple to measure the exhaust gas temperature during the test at this location.

Alternatively, grass trimmers or brush cutters equipped with a trimmer line cutting attachment may be tested without calibrated loading device by running the engine at full open throttle and adjusting the trimmer line length so that the maximum power speed as stated by the manufacturer is achieved.

9.2.2 Test

Run the engine at maximum power speed until a stable cylinder head temperature has been achieved (± 3 °C within a 30 s period). Run the engine for additional 3 min to 4 min, recording the test data according to 8.3; the maximum sampling interval shall be 10 s.

- Increase speed to 1 000 r/min above maximum power speed. When the cylinder head temperature has stabilized, run the engine for additional 3 min to 4 min, recording the test data according to 8.3; the maximum sampling interval shall be 10 s.
- Decrease speed to 1 000 r/min below maximum power speed. When the cylinder head temperature has stabilized, run the engine for additional 3 min to 4 min, recording the test data according to 8.3; the maximum sampling interval shall be 10 s.
- Increase speed to maximum power speed. When the cylinder head temperature has stabilized, run the engine for additional 3 min to 4 min, recording the test data according to 8.3; the maximum sampling interval shall be 10 s.

9.3 Hedge trimmers and edgers

9.3.1 Preparation

- For carburettors with limited adjustment (limiter cap): adjust the high-speed mixture jet to factory setting (rich stop). Then turn towards lean stop position of the limiter cap and back out as needed to maintain cylinder head temperature below the manufacturers' maximum limit.
- For non-adjustable carburettors: run engine as delivered.

- For engines with electronically controlled fuel-air mixture adjustment (electronic engine management): operate and set up engine according to the manufacturer's instructions.

Using a portable hand-held thermocouple, crisscross the contact plane surface to find the hottest spot. Mount a thermocouple to measure the exhaust gas temperature during the test at this location.

9.3.2 Test

Run the engine at wide open throttle until a stable cylinder head temperature has been achieved (± 3 °C within a 30 s period). Run the engine for additional 3 min to 4 min, recording the test data according to [8.3](#); the maximum sampling interval shall be 10 s.

If the maximum engine speed is limited by a speed governor, run the engine at wide open throttle, and then lower the engine speed with the throttle control just below the speed limiter activation, however not more than 480 r/min below the maximum speed as determined by the speed governor. Then run the engine until stable engine speed and cylinder head temperature has been achieved.

9.4 Blowers

9.4.1 Preparation

Mount the first blower tube as specified by the manufacturer.

- For carburettors with limited adjustment (limiter cap): adjust the high-speed mixture jet to factory setting (rich stop). Then turn towards lean stop position of the limiter cap while maintaining the wide open throttle speed, and back out as needed to maintain cylinder head temperature below the manufacturers' maximum limit.
- For non-adjustable carburettors: run engine as delivered.
- For engines with electronically controlled fuel-air mixture adjustment (electronic engine management): operate and set up engine according to the manufacturer's instructions.

Using a portable, hand-held, thermocouple, crisscross the contact plane surface to find the hottest spot. Mount a thermocouple to measure the exhaust gas temperature during the test at this location.

9.4.2 Test

Run the engine at wide open throttle until a stable cylinder head temperature has been achieved (± 3 °C within a 30 s period). Run the engine for additional 3 min to 4 min, recording the test data according to [8.3](#); the maximum sampling interval shall be 10 s.

- Increase speed to 1 000 r/min above the wide open throttle speed in [9.4.1](#) by partially covering the blower intake or discharge port. Run the engine for additional 3 min to 4 min, recording the test data according to [8.3](#); the maximum sampling interval shall be 10 s.

If the maximum engine speed is limited by a speed governor, run the engine at wide open throttle, and then lower the engine speed with the throttle control just below the speed limiter activation, however not more than 480 r/min below the maximum speed as determined by the speed governor. Then run the engine until stable engine speed and cylinder head temperature has been achieved.

9.5 Other MSE Configurations

Test methods for configurations other than those listed previously (e.g. similar shaft-drive machines) may be developed with respect to the performance requirements stated in [Clauses 5](#) and [6](#). Contact plane determination and temperature test methods as described in [Clauses 7](#) and [9](#) may be considered where appropriate.