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Manually portable (hand-held) powered lawn and garden equipment and forest machinery — Engine performance and fuel consumption

Matériel pour jardins et pelouses et matériel forestier portatifs à main à moteur — Performance du moteur et consommation de carburant

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Foreword

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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 document 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).

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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 first edition of ISO 20599 cancels and replaces ISO 7293:2021 and ISO 8893:2021, which have been technically revised.

The main changes are as follows:

— the requirements have been combined into a single International Standard.

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.

Manually portable (hand-held) powered lawn and garden equipment and forest machinery — Engine performance and fuel consumption

1 Scope

This document specifies a method for testing the performance and fuel consumption of internal combustion engines used to power manually portable (hand-held) powered lawn and garden equipment and forest machinery, for example, chain-saws, hedge trimmers, brush-cutters, grass-trimmers, pole-mounted pruners, and edgers.

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 5163, *Petroleum products — Determination of knock characteristics of motor and aviation fuels — Motor method*

ISO 5164, *Petroleum products — Determination of knock characteristics of motor fuels — Research method*

ISO 10517, *Powered hand-held hedge trimmers — Safety*

ISO 11680-1, *Machinery for forestry — Safety requirements and testing for pole-mounted powered pruners — Part 1: Machines fitted with an integral combustion engine*

ISO 11681-1, *Machinery for forestry — Portable chain-saw safety requirements and testing — Part 1: Chain-saws for forest service*

ISO 11789, *Powered edgers with rigid cutting means — Definitions, safety requirements and test procedures*

ISO 11806-1, *Agricultural and forestry machinery — Safety requirements and testing for portable, hand-held, powered brush-cutters and grass-trimmers — Part 1: Machines fitted with an integral combustion engine*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6531, ISO 7112, ISO 10517, ISO 11680-1, ISO 11681-1, ISO 11789 and ISO 11806-1 apply.

ISO and IEC maintain terminological 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/

4 Accuracy of measurements

The following accuracy of measurements apply:

a) Torque: ±2 % of measured torque. The torque measuring system shall be calibrated to take friction losses into account.

b) Engine speed: ±2 % of measured speed.

c) Fuel consumption: ±2 % of measured consumption.

d) Fuel temperature: ±2 °C.

e) Engine inlet air temperature: ±2 °C.

f) Barometric pressure: ±100 Pa.

5 Correction factors

5.1 General

An engine's torque, power and fuel consumption will vary based on ambient temperature and pressure conditions. To address test variances, this clause prescribes allowable test atmospheric conditions and establishes a correction factor coefficient. This correction factor coefficient correlates the test atmospheric conditions to reference atmospheric conditions. The test atmospheric conditions are specified in 5.2. The reference atmospheric conditions and the calculation of the correction factor are specified in 5.3.

The corrected torque can be calculated using Formula (1):

$$T_o = \alpha T \tag{1}$$

where

α is the correction factor;

T_o is the corrected torque (i.e. power under reference atmospheric conditions);

T is the measured torque (test torque).

The corrected power can be calculated using Formula (2):

$$P_o = \alpha P \tag{2}$$

where

P_o is the corrected power (i.e. power under reference atmospheric conditions);

α is the correction factor;

P is the power calculated from the measured torque (test power).

The corrected specific fuel consumption may be calculated using Formula (3):

$$F_{SCo} = F_C / P_o \tag{3}$$

where

F_{SCo} is the corrected specific fuel consumption (i.e. specific fuel consumption under reference atmospheric conditions);

F_C is the measured fuel consumption (test fuel consumption);

5.2 Test atmospheric conditions

The following atmospheric conditions shall be maintained throughout the test:

a) Temperature (T): 14,85 °C ≤ T ≤ 34,85 °C

b) Dry atmospheric pressure (P_s): 90 kPa < P_s < 110 kPa

5.3 Determination of correction factor α

The test atmospheric conditions shall be corrected to a temperature of 298 K and a dry pressure of 99 kPa. The dry pressure is based on a total pressure of 100 kPa and a water vapour pressure of 1 kPa. The correction factor α is obtained by applying Formula (4):

$$\alpha = \left[\frac{99}{P_s}\right]^{1,2} \times \left[\frac{T + 273,15}{298}\right]^{0,6} \quad (4)$$

where

P_s is the dry atmospheric pressure in kilopascals (kPa), i.e. the total barometric pressure minus water vapour pressure;

T is the absolute temperature in degree Celsius (°C) of the air drawn in by the engine.

Conditions are complied with in the laboratory.

For a test to be valid, the correction factor shall be such that:

$$0,93 \leq \alpha \leq 1,07$$

If these limits are exceeded, the corrected value obtained shall be given and the test conditions (temperature and pressure) precisely stated in the test report.

6 Conditions of measurement

The following conditions of measurements apply.

a) Measurements shall be carried out on a machine with its standard equipment.

b) The machine shall be complete, except as noted in this clause, with all standard production auxiliaries for its operation (filter, silencer, cooling system, etc.).

c) Chain-saws shall be tested without the cutting attachment.

d) Hedge trimmers shall be tested without the cutting attachment.

e) Shaft-driven machines, including hedge trimmers (where applicable), grass trimmers, brushcutters, edgers, and pole-mounted pruners shall be tested without the cutting attachment, drive shaft, and drive shaft tube.

f) The engine shall be adjusted according to the manufacturer's recommendations as stated in the operator's instructions for normal operating conditions. If an adjustment of the fuel/air mixture by the operator is foreseen in the instructions, an adjustment to achieve the maximum power is allowed.

g) Power-consuming auxiliaries (for example, a chain-saw electrical handle heating) shall be turned off.

h) No extra cooling on the engine or air supply is allowed.

i) The fixture used to mount the engine to the brake power test bench (dynamometer) should be verified that it does not influence the performance on the unit compared to an “in-use” condition.

j) The engine shall be coupled to the brake power test bench (dynamometer) in such a manner that the engine crankshaft is aligned with the brake shaft and connected to it with a flexible coupling. The use of the engine clutch is optional.

k) A new engine shall be run in, in accordance with the manufacturer's instructions. If the engine was previously run in, this operation shall be omitted.

l) The fuel shall consist of petrol with a minimum octane (R+M)/2 of 87, measured according to ISO 5164 and ISO 5163, and, if it is a two-stroke engine, mixed with two-stroke oil according to the manufacturer's recommendation. The density of the fuel shall be 680 kg/m^3 to 790 kg/m^3 at 15 °C.

7 Operating method

7.1 General

With the throttle in the fully open position, record the power, torque and fuel consumption as a function of the rotational frequency in steps of 300 r/min, starting from 900 r/min above maximum power speed and decreasing down to 900 r/min below the maximum torque speed.

Take the readings after the engine temperature has stabilized at each step. Table 1 shows an example of how to record the data at each step. The engine temperature is considered stable when the engine cylinder head or spark plug seat absolute temperature has settled within ±3 °C for at least 30 s.

If the engine speed is limited below the maximum power speed plus 900 r/min, measure the power at the maximum speed achievable. If the engine does not run with a stable speed, carry out the test at the maximum possible stable speed. This speed shall however not be more than 480 r/min below the maximum speed achievable.

7.2 Procedure

7.2.1 General

If an adjustment of the fuel/air mixture by the operator is foreseen in the instructions, an adjustment is permitted in 7.2.2 and 7.2.3 to achieve the maximum power.

7.2.2 Determination of the maximum power speed and maximum torque speeds

Determine the engine maximum power and maximum torque speeds as follows.

a) Prior to mounting the engine on the power test bench, warm up the engine and, if applicable, set the idle-speed adjuster and low-speed mixture adjuster for best idling at the rotational frequency recommended by the manufacturer. It is recommended to operate the engine at any speed and at approximately 75 % of its expected maximum power. Continue the warm-up until the engine temperature(s) has stabilized.

b) Run the engine at fully open throttle on the dynamometer bench and determine the engine speed at which the engine reaches its maximum torque and power. The manufacturers rated speed shall apply if there is a range of rotational frequency over which the power / torque is constant (“plateau”), within the tolerance range of ±50 W / ± 0,05 Nm.

c) Record these speeds, as they will be used in determining the power curve in 7.2.3.

7.2.3 Determination of the power and fuel consumption curves

Determine the power and fuel consumption curves as follows:

a) Prior to the test, record the ambient air temperature (°C) and air pressure (kPa) in Table 1.

b) Run the engine with fully open throttle at the maximum power speed plus 900 r/min until the engine temperature(s) has stabilized.

c) Record the following readings: power (kW), torque (N·m), fuel consumption (g/h), engine-stabilized temperature (°C), and engine speed (r/min).

d) Decrease the engine speed in steps of 300 r/min, allowing the engine temperature(s) to stabilize at each step, until the last step is 900 r/min below the engine speed at maximum engine torque as determined in 7.2.2 b).

e) Record the engine temperature stabilized information outlined in 7.2.3 c) for every step. If the machine is using a clutch, only record at intervals in which the clutch is transferring all of the power generated by the engine.

8 Test report

The test report shall include the following information:

a) basic information specifying:

   1) test standard, i.e. ISO 20599:2024;

   2) date and place of measurement;

   3) names of the petitioner and the issuer of the report;

b) description of the machine including:

   1) manufacturer's name or make or brand name;

   2) model (type);

   3) serial number;

   4) working cycle (for example two stroke);

   5) bore, stroke and swept volume of the engine;

   6) fuel density;

   7) oil mixture ratio;

   8) petrol octane number [(R+M)/2];

   9) measuring equipment;

   10) ambient air temperatures;

   11) ambient air pressures;

c) the following parameters, given as a function of the engine rotational frequency, see Table 1. Power, torque, and fuel consumption curves should be generated based on the data in Table 1:

   1) maximum power, in kilowatts;

   2) maximum power speed, in r/min;

   3) maximum torque, in newton metres;