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**Forestry machinery — Portable chain-  
saws — Engine performance and fuel  
consumption**

*Machines forestières — Scies à chaîne portatives — Puissance et  
consommation de carburant du moteur*

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# Contents

	Page
Foreword.....	iv
Introduction.....	v
<b>1 Scope.....</b>	<b>1</b>
<b>2 Normative references.....</b>	<b>1</b>
<b>3 Terms and definitions.....</b>	<b>1</b>
<b>4 Accuracy of measurements.....</b>	<b>1</b>
<b>5 Power correction factors.....</b>	<b>2</b>
5.1 Definition.....	2
5.2 Reference atmospheric conditions.....	2
5.3 Test atmospheric conditions.....	2
5.4 Determination of correction factor $\alpha$ .....	2
<b>6 Conditions of measurement.....</b>	<b>3</b>
<b>7 Operating method.....</b>	<b>3</b>
7.1 General.....	3
7.2 Procedure.....	4
7.2.1 Determination of the peak power and peak torque engine speed.....	4
7.2.2 Determination of the power curve and fuel consumption curve.....	4
<b>8 Test report.....</b>	<b>4</b>

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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](http://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](http://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](http://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 third edition cancels and replaces the second edition (ISO 7293:1997), which has been technically revised.

The main changes compared to the previous edition are as follows:

- the normative references have been updated;
- the mandatory terms and definitions clause has been inserted and subsequent clauses have been renumbered;
- the "Apparatus" clause has been replaced with "Accuracy of measurements";
- the "Test conditions" clause has been replaced with "Power correction factors";
- the conditions of measurement have been revised;
- the operating method has been revised;
- a new [Table 1](#), Sample test data record sheet, has been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete list of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

This document is a type-C standard as stated in ISO 12100.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organisations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, e. g. for maintenance (small, medium and large enterprises);
- consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the scope of this document.

When requirements of this type-C standard are different from those which are stated in type A or type B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type C standard.

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# Forestry machinery — Portable chain-saws — 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 portable chain-saws.

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

ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100 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 <http://www.electropedia.org/>

## 4 Accuracy of measurements

**4.1 Torque:**  $\pm 2$  % of measured torque. The torque measuring system shall be calibrated to take friction losses into account.

**4.2 Engine speed:**  $\pm 2$  % of measured speed.

**4.3 Fuel consumption:**  $\pm 2$  % of measured consumption.

**4.4 Fuel temperature:**  $\pm 2$  °C.

**4.5 Engine inlet air temperature:**  $\pm 2$  °C.

**4.6 Barometric pressure:**  $\pm 100$  Pa.

## 5 Power correction factors

### 5.1 Definition

The power correction factor is the coefficient to determine the engine power under the reference atmospheric conditions specified in 5.2. It can be calculated using [Formula \(1\)](#):

$$P_o = \alpha P \quad (1)$$

where

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

$\alpha$  is the correction factor;

$P$  is the measured power (test power).

### 5.2 Reference atmospheric conditions

5.2.1 Temperature ( $T_o$ ): 25 °C

5.2.2 Dry pressure ( $P_{s0}$ ): 99 kPa

The dry pressure is based on a total pressure of 100 kPa and a water vapour pressure of 1 kPa.

### 5.3 Test atmospheric conditions

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

5.3.2 Pressure ( $P_s$ ): 90 kPa <  $P_s$  < 110 kPa

### 5.4 Determination of correction factor $\alpha$

The correction factor  $\alpha$  is obtained by applying [Formula \(2\)](#):

$$\alpha = \left[ \frac{99}{P_s} \right]^{1,2} \times \left[ \frac{T + 237,15}{298} \right]^{0,6} \quad (2)$$

where

$P_s$  is the total 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

- 6.1** Measurements shall be carried out on a chain-saw with its standard equipment.
- 6.2** The machine shall be complete (except saw chain and guide bar) with all standard production auxiliaries for its operation (filter, silencer, cooling system, etc.).
- 6.3** 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 according adjustment to achieve the maximum possible power is allowed.
- 6.4** Power-consuming auxiliaries (for example, electrical handle heating) shall be turned off.
- 6.5** No extra cooling on the engine or air supply is allowed.
- 6.6** The fixture used to mount the engine to the dynamometer should be verified that it does not influence the performance on the unit compared to an "in-use" condition.
- 6.7** The engine shall be coupled to the brake power test bench 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.
- 6.8** 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.
- 6.9** The fuel shall consist of petrol with a minimum octane (R+M)/2 of 87, measured according to ISO 5164, 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<sup>3</sup> to 790 kg/m<sup>3</sup> at 15 °C.

## 7 Operating method

### 7.1 General

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

Take the readings during the 10 s interval after the temperature has stabilized at each step, [Table 1](#) shows an example of how to record the data at each step. The engine temperature is stable when the engine coolant, block or head absolute temperature has settled within  $\pm 3$  °C for at least 30 s.

Take the readings at least over a rotational frequency range limited by the rotational frequency for maximum torque minus 900 r/min, and the rotational frequency for maximum power plus 900 r/min.

If the engine speed is limited below the speed of maximum power plus 900 r/min, measure 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 achievable speed.

## 7.2 Procedure

### 7.2.1 Determination of the peak power and peak torque engine speed

**7.2.1.1** 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 operating the engine at any speed and at approximately 75 % of its expected maximum power. Continue the warm-up until the engine-stabilized temperature has been achieved.

**7.2.1.2** Run the engine at fully open throttle on the dynamometer bench and determine the engine speed at which the engine makes peak torque and the speed at which it makes peak power. If an adjustment of the fuel/air mixture by the operator is foreseen in the operator's instructions, adjustment to achieve the peak power is allowed.

**7.2.1.3** Record these speeds, as they will be used in determining the power curve in [7.2.2](#).

### 7.2.2 Determination of the power curve and fuel consumption curve

**7.2.2.1** Prior to the test, record the ambient air temperature (°C) and air pressure (kPa) in [Table 1](#).

**7.2.2.2** Run the engine with fully open throttle at the engine speed of peak power plus 900 rpm until engine-stabilized temperature has been achieved.

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

**7.2.2.4** Repeat [7.2.2.2](#) by decreasing the engine rpm in steps of 300 r/min until the last step is 900 r/min below the engine speed at peak torque as determined in [7.2.1](#), and record the information outlined in [7.2.2.3](#) 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) a reference to this document, i.e. ISO 7293:2021;
  - 2) date and place of measurement;
  - 3) names of the petitioner and the issuer of the report;
- b) description of the machine including:
  - 1) the 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 (RON);
  - 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 off the data in [Table 1](#):
- 1) peak power, in kilowatts;
  - 2) engine speed at peak power, in r/min;
  - 3) peak torque, in newton metres;
  - 4) fuel consumption at peak power, in grams per hour;
  - 5) specific fuel consumption, in grams per kilowatt-hour.

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