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**Forestry and gardening machinery —  
Vibration test code for portable  
hand-held machines with internal  
combustion engine — Vibration at the  
handles**

*Machines forestières et machines de jardin — Code d'essai des  
vibrations pour machines portatives tenues à la main à moteur à  
combustion interne — Vibrations au niveau des poignées*

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Published in Switzerland

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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 forest machinery*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 144, *Tractors and machinery for agriculture and forestry*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 22867:2011), which has been technically revised.

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

- the scope has been expanded to include hand-held edgers;
- [Clause 9](#) (Information to be reported) has been amended to include “method used for in situ check of the instrumentation system”;
- the accelerometer position for pole-mounted powered pruners and long-reach hedge trimmers has been newly defined to better reflect handling of the machine in use;
- the engine speed tolerance for the operation mode “full load” for chain-saws has been broadened from  $3,5 \text{ s}^{-1}$  to  $4,5 \text{ s}^{-1}$ , to account for feasibility when cutting wood;
- hand-held edgers have been included in [Annex B](#);
- the definition of the position of the accelerometer on the front handle of pole mounted pruners in [Annex C](#) has been improved and [Figure C.1](#) has been modified accordingly;
- the definition of the position of the accelerometer on the front handle of long reach hedge trimmers in [Annex D](#) has been improved and [Figure D.3](#) has been modified accordingly.

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](http://www.iso.org/members.html).

## Introduction

This document is a type-C standard as stated in ISO 12100:2010.

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 -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.

The vibration test code specified in this document is based on ISO 20643:2008, which gives general specifications for the measurement of the vibration emission of hand-held machinery. It differs from ISO 20643:2008 in the number of operators required to be involved in the test, with ISO 20643:2008 requiring at least three operators and this document only one. Another difference is that this document primarily positions the transducers next to the hand in the area between the thumb and the index finger, where they present the least disturbance to the operator gripping the machine.

The determination of vibration characteristics is primarily used for

- manufacturer's declarations,
- comparing data between machines in the machine family concerned,
- development work at the design stage, and
- the estimation of the vibration risk considering the specific conditions (parameters).

The use of this vibration test code ensures reproducibility of the determination of the vibration characteristics. Measurements made during particular operating modes are of interest for assessment of the vibration exposure, for example, over a typical working day.

The work cycles chosen for this test code are based on the following considerations of application:

- a) chain-saws with an engine displacement of  $< 80 \text{ cm}^3$  are used for various operations, including felling, bucking and delimiting;
- b) chain-saws with an engine displacement of  $\geq 80 \text{ cm}^3$  are normally used for felling and bucking.

Delimiting causes the saw to run at racing speed; therefore, racing is included only for saws with an engine displacement  $< 80 \text{ cm}^3$ .

For brush-cutters, grass-trimmers, hedge-trimmers and pole-mounted powered pruners, the cutting mode (full load) is estimated to be valid only for short periods, and racing and idling are the two dominant modes. Moreover, the cutting mode has also been found to be diverse and not able to be performed under repeatable conditions.

For grass-trimmers, the full-load and racing modes are integrated into a single mode, owing to the loading effect of the flexible line.

For brush-cutters, hedge-trimmers, edgers and pole-mounted powered pruners, it is not possible to simulate the full-load mode in a feasible way, since there are no constant load conditions comparable to those of chain-saws. Since the operating mode “racing” is the worst case, it is taken as being representative.

For garden-blowers, full load and idling are the two dominant modes.

In either of these cases, transport and other tasks between operations cause the machine to run at idling. Experience has led to the conclusion that equal duration for the different working modes is a good estimation of daily exposure. The values obtained are values intended to be representative of the average of typical vibration magnitudes in real-world use of the machines. However, the actual magnitudes varies considerably from time to time and depends on many factors, including operator, task and cutting attachment. The state of maintenance of the machine itself might also be of importance.

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# Forestry and gardening machinery — Vibration test code for portable hand-held machines with internal combustion engine — Vibration at the handles

**CAUTION** — Some of the test procedures specified in this document involve processes which could lead to a hazardous situation. Any person performing tests in accordance with this document shall be appropriately trained in the type of work to be carried out.

## 1 Scope

This document specifies a vibration test code for determining, efficiently and under standardized conditions, the magnitude of vibration at the handles of portable hand-held, internal-combustion-engine-powered forest and garden machinery, including chain-saws, brush-cutters, grass-trimmers, edgers, pole-mounted powered pruners, hedge-trimmers and garden-blowers.

Although the magnitudes measured are obtained in an artificial operation, they nevertheless give an indication of the values to be found in a real work situation.

Vibration test codes, as described in this document, enable the manufacturer to verify the effort regarding low vibration design.

## 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 5349-2:2001, *Mechanical vibration — Measurement and evaluation of human exposure to hand-transmitted vibration — Part 2: Practical guidance for measurement at the workplace*

ISO 6531:2017, *Machinery for forestry — Portable chain-saws — Vocabulary*

ISO 7112:2018, *Machinery for forestry — Portable brush-cutters and grass-trimmers — Vocabulary*

ISO 7293:1997, *Forestry machinery — Portable chain saws — Engine performance and fuel consumption*

ISO 8041-1:2017, *Human response to vibration — Measuring instrumentation — Part 1: General purpose vibration meters*

ISO 8893:1997, *Forestry machinery — Portable brush-cutters and grass-trimmers — Engine performance and fuel consumption*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 16063-1:1998, *Methods for the calibration of vibration and shock transducers — Part 1: Basic concepts*

ISO 20643:2008, *Mechanical vibration — Hand-held and hand-guided machinery — Principles for evaluation of vibration emission*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6531:2017, ISO 7112:2018, ISO 12100:2010 and ISO 20643:2008 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 Vibration quantities to be measured and determined

The quantities to be measured are the frequency-weighted accelerations in the three perpendicular directions,  $a_{hw_x}$ ,  $a_{hw_y}$  and  $a_{hw_z}$ .

The quantities to be determined are the vibration total values,  $a_{hv}$ , and the equivalent vibration total values,  $a_{hv,eq}$ , for each handle. See the calculations in [Annexes A](#) to [E](#).

NOTE Mathematically,  $a_{hv}$  is the root sum of the squares of the three root-mean-square (r.m.s.) single-axis acceleration values of the frequency-weighted hand transmitted vibration values  $a_{hw_x}$ ,  $a_{hw_y}$  and  $a_{hw_z}$ .

## 5 Instrumentation

### 5.1 General

The vibration measurement system shall be in accordance with ISO 8041-1:2017.

### 5.2 Accelerometer

The total mass of the vibration accelerometer giving the acceleration in the three directions at each measuring position shall be as low as possible, and shall not in any case exceed 25 g, including the mounting but excluding the cable. For further information, see ISO 5349-2:2001, 6.1.5.

NOTE The accelerometer is a sensitive element intended to pick up the vibration and to convert it into electrical signals. A tri-axial accelerometer permits simultaneous measurements in the x, y and z axes.

### 5.3 Fastening of accelerometer

The accelerometer shall be mounted firmly on the handle by means of a fastening device, in accordance with ISO 5349-2:2001.

For measurement on handles with resilient covers (e.g. cushioned handle), mount the accelerometer in accordance with ISO 5349-2:2001, 6.1.4.2, and perform one or the other of the following actions:

- remove the resilient material from the area beneath the transducers;
- fix the transducers using a force which fully compresses the resilient material.

Mountings shall be in accordance with ISO 5349-2:2001, D.2.2 and D.2.3. The method given in ISO 5349-2:2001, D.2.4, shall not be used.

### 5.4 Calibration

The accelerometer shall be calibrated in accordance with ISO 16063-1:1998.

The whole measuring chain, including the accelerometer, shall be checked before and after a sequence of measurements using a calibrator which produces known accelerations at a known frequency. These in-situ checks shall be carried out in accordance with ISO 8041-1:2017.

## 5.5 Speed indicator

The rotational frequency of the engine shall be measured with an accuracy of  $\pm 1,0$  % of the reading. The speed indicator and its engagement with the machine shall not affect the operation of the machine under test.

## 6 Measurement direction and location

Measurements shall be made at each hand-grip at which the operator normally holds the machine. Measurements shall be made simultaneously in the three directions  $x$ ,  $y$  and  $z$ .

The centre of gravity of the accelerometer shall be positioned as close as possible to, but at a maximum distance of 20 mm from the handle contour. One of the axes of the accelerometer shall be parallel to the axis of the handle.

The position of the accelerometer shall be as near as possible to the hand without obstructing normal grip.

NOTE The specific conditions for each type of machine are given in [Annexes A to E](#).

## 7 Test and operating conditions of machine

Measurements shall be carried out on a new machine, featuring standard equipment as provided by the manufacturer, and with the fuel and oil tank(s) at least half-filled.

The engine shall be run-in prior to the test according to the manufacturer's recommendations. The engine shall be at a stable normal operating temperature before the test is commenced.

The carburettor shall be set, where applicable, according to the instructions of the manufacturer.

Unless otherwise specified, the engine speed for all test modes shall be kept constant to within  $\pm 3,5$  s<sup>-1</sup> during testing. No alteration to the initial settings is permitted once measurements have commenced. If adjustment becomes necessary, the test shall be restarted after the adjustment.

The measured vibration of the machine is influenced by the operator. The operator shall therefore be skilled and able to operate the machine properly. The machine shall be held in a manner consistent with day-long use of the machine. Hand-held machines, except those suspended by harness, shall be held so that there is no contact with the operator's body during measurements.

A test to obtain the required data for a given operating mode shall consist of a minimum of four measurements, with a short break and a significant change of engine speed (to idling or racing speed, as applicable) between measurements. Stable speed conditions (constant to within  $\pm 3,5$  s<sup>-1</sup>) shall be obtained before testing is continued.

At least four separate periods of vibration data shall be obtained, totalling at least 20 s.

Each signal duration used shall be at least 2 s, during which the engine speed shall be maintained within  $\pm 3,5$  s<sup>-1</sup> (unless otherwise specified).

The measurements shall be continued until the validity requirements given in [Clause 8](#) are fulfilled.

The collection of data for the different operating modes need not be carried out in any particular sequence.

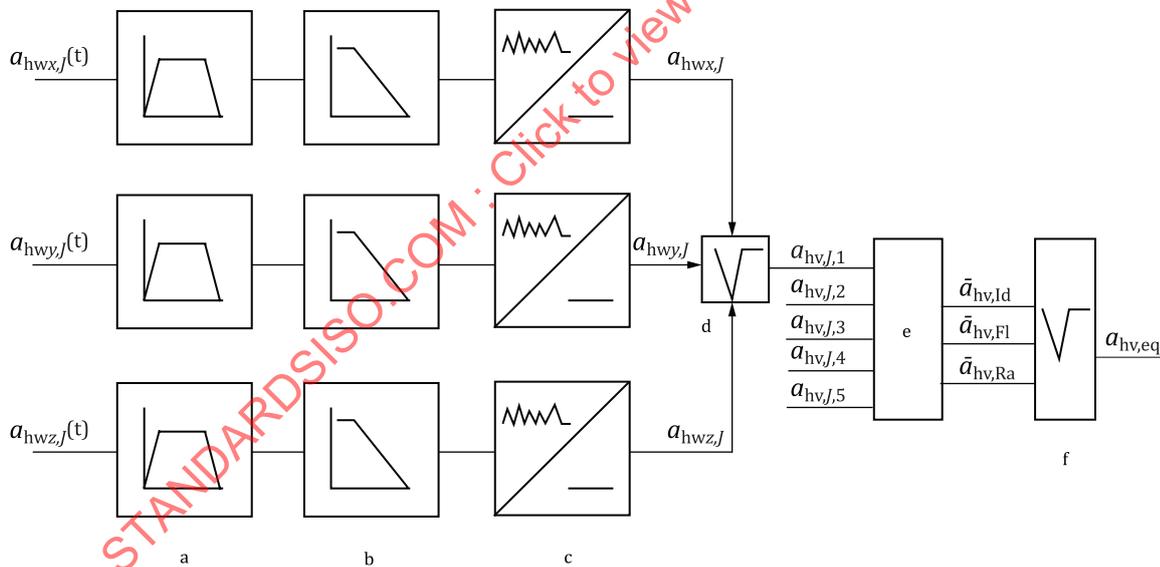
NOTE The specific conditions for each type of machine are given in [Annexes A to E](#).

## 8 Measurement and calculation

### 8.1 General

The following measurements and calculations shall be made and are generally performed in the sequence given here and as illustrated by [Figure 1](#).

- Measure the weighted acceleration of an operating mode in the three directions,  $a_{hwx,J}$ ,  $a_{hwy,J}$  and  $a_{hwz,J}$ , for the left and right handles, where  $J$  is the operating mode idling (Id), full load (Fl) or racing (Ra).
- Calculate the root sum of squares of accelerations  $a_{hvJ}$  of the three directions  $x$ ,  $y$  and  $z$  for the operating mode selected.
- Repeat a) and b) at least three more times.
- Calculate the arithmetic mean of the operating mode,  $\bar{a}_{hvJ}$ .
- Repeat a), b) and d) until the coefficient of variation  $C_v$  and the standard deviation  $s_{n-1}$  conform with the requirements of [8.2](#).
- Perform a) to e) for the remaining operating modes in accordance with the annex applicable to the type of machine.
- Calculate the equivalent vibration total value,  $a_{hv,eq}$  for each handle in accordance with the annex applicable to the type of machine.
- Determine the declared value according to [Clause 10](#).



#### Key

- Band pass filter.
- Frequency weighting filter.
- Root mean square (r.m.s).
- See Note to [Clause 4](#).
- Arithmetic mean for each operating mode.
- See [Annexes A](#) to [E](#) for calculation of  $a_{hv,eq}$ .

**Figure 1 — Sequence of measurement and calculation of vibration data from the applicable operating modes**

## 8.2 Validity of measured data

The measured data for every combination of handle and operating mode shall be considered valid when either

- a) the coefficient of variation,  $C_v$ , of the consecutive weighted values is less than 0,3, or
- b) the standard deviation,  $s_{n-1}$ , is less than 0,4 m/s<sup>2</sup>.

If  $C_v$  is greater than 0,15 or if  $s_{n-1}$  is greater than 0,3 m/s<sup>2</sup>, the measurements shall be checked for error before the data are accepted. See ISO 20643:2005, Annex B, for possible causes of error. If the measured values for a combination of handle and operating mode do not meet either criterion a) or b), then measurements and calculations with the non-complying combination shall be repeated until one or the other of these validity criteria is met [see 8.1 e)].

The coefficient of variation,  $C_v$ , of a test series is the ratio between the standard deviation,  $s_{n-1}$ , of the series of measurement values and the mean value,  $\bar{x}$  of the series, determined by [Formula \(1\)](#):

$$C_v = \frac{s_{n-1}}{\bar{x}} \quad (1)$$

with  $s_{n-1}$  calculated using [Formula \(2\)](#):

$$s_{n-1} = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2} \quad (2)$$

and  $\bar{x}$  calculated using [Formula \(3\)](#):

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i \quad (3)$$

where

- $x_i$  is the  $i$ -th value measured;
- $n$  is the number of measurement values.

## 9 Information to be reported

The following information shall be compiled and reported for all measurements made in accordance with this document.

- a) Machine under test:
  - 1) description of machine, including engine displacement, manufacturer, type and serial number, type of cutting equipment (where applicable);
  - 2) operating conditions, in accordance with [Table 1](#).
- b) Work piece, where applicable.
- c) Instrumentation:
  - 1) equipment used for the measurements, including name, type, serial number and manufacturer;
  - 2) methods used to fasten accelerometers;
  - 3) method used to calibrate the instrumentation system;
  - 4) method used for in situ check of the instrumentation system;

- 5) date and place of most recent calibration of accelerometer calibrator.
- d) Vibration and other data:
  - 1) location of accelerometer positions (a sketch may be included, if necessary);
  - 2) measurement values and arithmetic mean values for each handle and cutting attachment (where applicable) in accordance with [Table 1](#);
  - 3) remarks, if any;
  - 4) air temperature;
  - 5) date and place of measurements.

**Table 1 — Table for reporting determined vibration total values and calculation of their arithmetic means for each handle**

Operating mode	Calculated data and validity criteria	Operating engine speed s <sup>-1</sup>	Specified handle				
			Test no.				
•	•	•	1	2	3	4	n
Idling (Id)	$a_{hv,Id}$ (m/s <sup>2</sup> )						
•	$\bar{a}_{hv,Id}$ (m/s <sup>2</sup> )		—	—	—		
•	$s_{n-1}$ (m/s <sup>2</sup> )			—	—		
•	$C_v$			—	—		
Full load (Fl) <sup>a</sup>	$a_{hv,Fl}$ (m/s <sup>2</sup> )						
•	$\bar{a}_{hv,Fl}$ (m/s <sup>2</sup> )		—	—	—		
•	$s_{n-1}$ (m/s <sup>2</sup> )		—	—	—		
•	$C_v$		—	—	—		
Racing (Ra) <sup>a</sup>	$a_{hv,Ra}$ (m/s <sup>2</sup> )						
•	$\bar{a}_{hv,Ra}$ (m/s <sup>2</sup> )		—	—	—		
•	$s_{n-1}$ (m/s <sup>2</sup> )		—	—	—		
•	$C_v$		—	—	—		

The vibration total values  $a_{hv}$  are determined and recorded, and their arithmetic mean,  $\bar{a}_{hv}$  is calculated until the coefficient of variation,  $C_v$ , is less than 0,3, or the standard deviation,  $s_{n-1}$ , is less than 0,4 m/s<sup>2</sup>.  
 If  $C_v$  is greater than 0,45 or if  $s_{n-1}$  is greater than 0,3 m/s<sup>2</sup>, the measurements shall be checked for error before the data are accepted.  
 The calculation of arithmetic mean  $\bar{a}_{hv}$  is based on at least four determinations of the vibration total value  $a_{hv}$ .  
 The values for the arithmetic mean ( $\bar{a}_{hv,Id}$ ,  $\bar{a}_{hv,Fl}$  and  $\bar{a}_{hv,Ra}$ ) are used to calculate the equivalent vibration total values  $a_{hv,eq}$ .

<sup>a</sup> According to the test procedures for the specific machine type given in [Annexes A to E](#).

## 10 Declaration and verification of vibration values

The declaration shall include a reference to this document. Deviations, if any, shall be indicated.

Equivalent vibration total values,  $a_{hv,eq}$ , calculated according to [Annexes A to E](#), shall be used for the declaration of the vibration emission values. The uncertainty,  $K$ , shall also be given.

The total vibration value for the applicable operating modes (idling, full load and racing) shall be made available on request.

The uncertainty,  $K$ , to be associated with the declared equivalent vibration total value(s) is based on the standard deviation of reproducibility,  $\sigma_R$ , and the standard deviation of production,  $\sigma_p$ , where  $K$  is calculated using [Formula \(4\)](#).

$$K = (\sigma_R^2 + \sigma_p^2)^{1/2} \quad (4)$$

Guidelines on  $\sigma_R$  are given in [Annex F](#); its value shall be determined based on the manufacturer's experience of the production variation.

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## Annex A (normative)

### Chain-saws

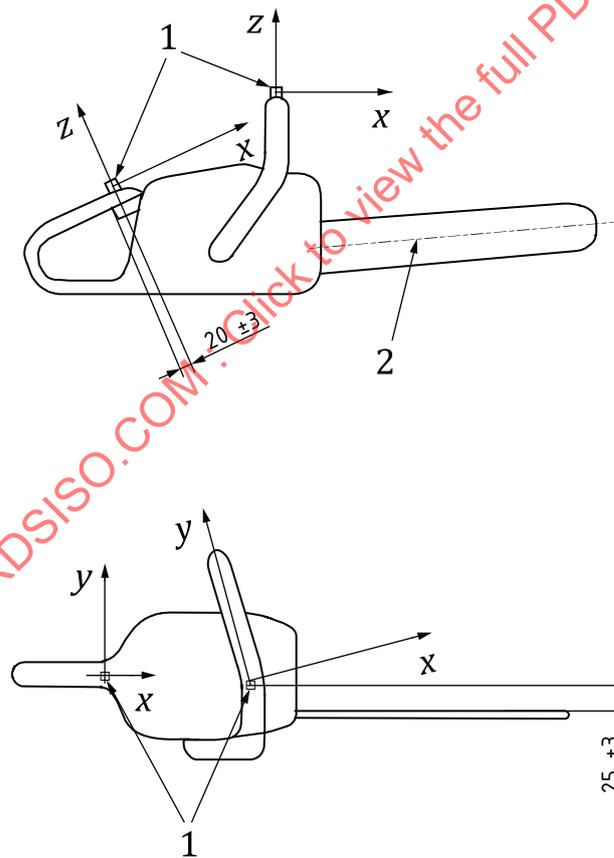
#### A.1 Measurement direction and location

The orientation and location of the accelerometers shall be in accordance with [Figure A.1](#).

The accelerometer on the rear handle shall be located  $20 \text{ mm} \pm 3 \text{ mm}$  in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped.

The accelerometer on the front handle shall be located  $25 \text{ mm} \pm 3 \text{ mm}$  to the left of the guide bar plane. If this distance cannot be obtained, the accelerometer shall be placed at the right end of that portion of the handle intended to be grasped.

Dimensions in millimetres



**Key**

- 1 accelerometer
- 2 guide bar centreline

**Figure A.1 — Measurement directions and positioning of accelerometers on chain-saws**

## A.2 Chain-saw conditions and test timber log

### A.2.1 Chain-saw

The chain-saw shall be equipped with a guide bar as specified by the machine manufacturer and shall be of a length in accordance with [Table A.1](#). All saw chains specified by the chain-saw manufacturer shall be tested.

The saw chain shall be new and shall be tensioned according to the instruction handbook.

### A.2.2 Test timber log

For cutting tests, sound timber shall be taken from freshly felled local hardwood. The timber shall not be seasoned or frozen.

NOTE The humidity of the timber has an influence on the vibration emission.

The cut shall be made in a part of the timber free from knots.

The width and shape of the test timber log shall be correlated to the usable cutting length of the guide bar, as shown in [Figure A.2](#) and in accordance with [Table A.1](#).

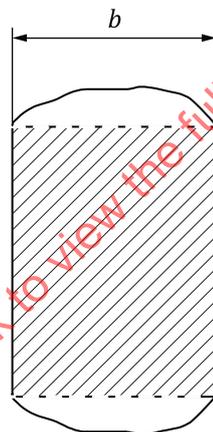


Figure A.2 — Test timber log shape

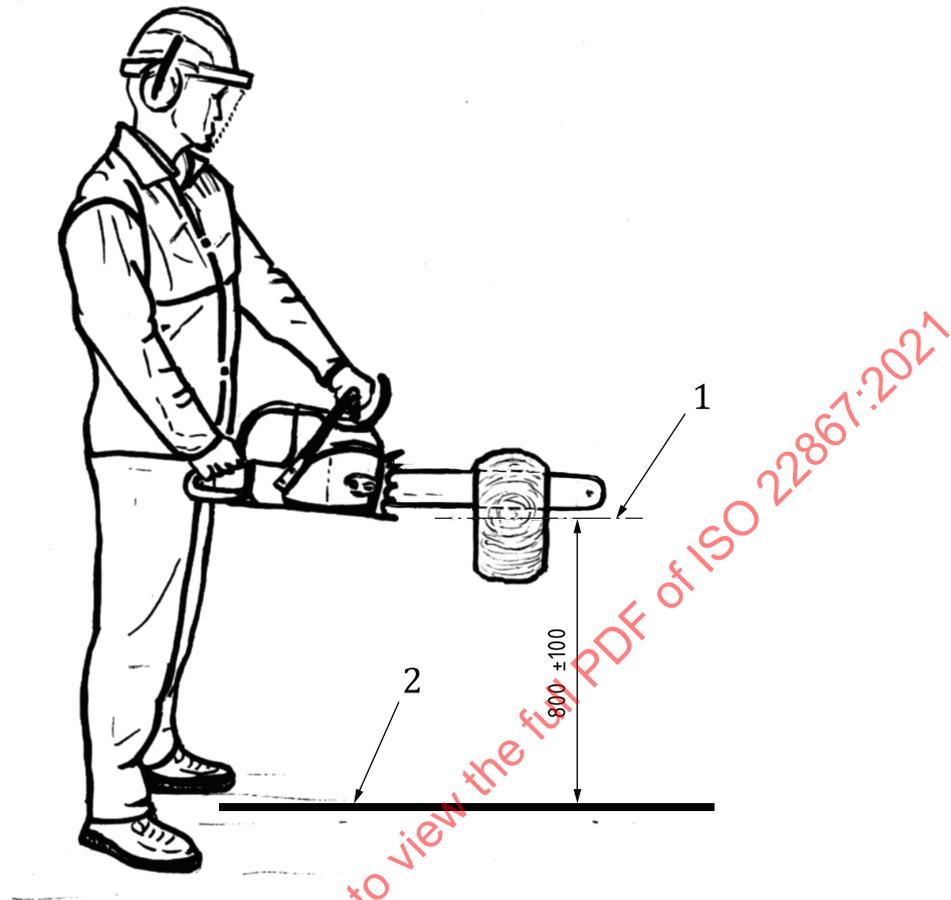
Table A.1 — Width of test timber log and usable cutting length of guide bar

Engine displacement $C$ cm <sup>3</sup>	Usable cutting length of guide bar $L$ m	Width of test timber log $b$
< 45	0,25 to 0,4	(75 ± 5) % of $L$
45 ≤ $C$ < 70	0,30 to 0,5	(75 ± 5) % of $L$
70 ≤ $C$ < 90	0,40 to 0,55	(75 ± 5) % of $L$
≥ 90	> 0,50	$L - (0,1 ± 10) %$ of $L$

### A.2.3 Operating conditions

The machine shall be operated upright and with the guide bar nose protruding outside the test timber log, in accordance with [Figure A.3](#).

The test timber log shall be horizontally and rigidly mounted on a stiff support so that its centreline is (800 ± 100) mm above ground level.

**Key**

- 1 centreline of test timber log
- 2 ground plane

**Figure A.3 — Chain-saw position****A.3 Test procedure****A.3.1 General**

The tests shall be carried out in the following operating modes:

- a) for machines with an engine displacement of  $< 80 \text{ cm}^3$  idling, full load and racing;
- b) for machines with an engine displacement of  $\geq 80 \text{ cm}^3$  idling and full load.

During operation, the chain-saw shall be held with the guide bar centreline horizontal and the guide bar plane vertical.

**A.3.2 Idling**

The idling speed shall be adjusted according to the machine manufacturer's instructions. Perform the measurements with the throttle trigger fully released. The saw chain shall not move during the test.

### A.3.3 Full load

Perform the measurements during crosscutting and with the throttle fully open. The engine speed shall be kept at maximum engine power, determined in accordance with ISO 7293:1997, by controlling the applied feed force on the handles.

The vibration measurements shall be taken in the middle third through the log with the complete bar tip free outside the log. The rotational frequency of the engine shall be maintained within  $\pm 4,5 \text{ s}^{-1}$  by the cutting force. There shall be no contact between the test timber and the engine/motor part of the machine or the spiked bumper, if provided. Only the bar and the saw chain shall come into contact with the test timber.

### A.3.4 Racing

Perform the measurements at an engine speed of 133 % of the speed at maximum engine power, determined in accordance with ISO 7293:1997.

If the engine has a speed limiter set below that speed, measure at the maximum speed achievable. If the engine does not run at a stable speed, carry out the test at the maximum possible stable speed; this speed shall not, however, be more than  $8 \text{ s}^{-1}$  below the maximum speed as determined by the speed limiter. The engine speed shall be controlled with the throttle trigger.

## A.4 Calculation of equivalent vibration total values

### A.4.1 General

The equivalent vibration total values are determined by means of work cycles. These are composed of components of equal time duration where the components for chain-saws with an engine displacement  $< 80 \text{ cm}^3$  are the idling, full load and racing modes and, for chain-saws with an engine displacement  $\geq 80 \text{ cm}^3$ , the idling and full load modes.

### A.4.2 Chain-saws with an engine displacement $< 80 \text{ cm}^3$

The equivalent vibration total value,  $a_{\text{hv,eq}}$ , shall be determined by [Formula \(A.1\)](#)

$$a_{\text{hv,eq}} = \left[ \frac{1}{3} (\bar{a}_{\text{hv,ld}}^2 + \bar{a}_{\text{hv,Fl}}^2 + \bar{a}_{\text{hv,Ra}}^2) \right]^{1/2} \quad (\text{A.1})$$

### A.4.3 Chain-saws with an engine displacement $\geq 80 \text{ cm}^3$

The equivalent vibration total value,  $a_{\text{hv,eq}}$ , shall be determined by [Formula \(A.2\)](#)

$$a_{\text{hv,eq}} = \left[ \frac{1}{2} (\bar{a}_{\text{hv,ld}}^2 + \bar{a}_{\text{hv,Fl}}^2) \right]^{1/2} \quad (\text{A.2})$$

## Annex B (normative)

### Brush-cutters, grass-trimmers and hand-held edgers

#### B.1 Measurement direction and location

Each accelerometer shall be located on the same side of a handle as the thumb of the hand grasping that handle; the orientation of the accelerometer shall be the same as that of the thumb.

- For machines with bicycle-type handles, the accelerometers shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  outside the centre of the gripping areas, in accordance with [Figure B.1](#).
- For machines with a rear handle and loop-type front handle, the accelerometer on the rear handle shall be located  $20 \text{ mm} \pm 3 \text{ mm}$  in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped. The accelerometer for the front hand shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  to the right of the centre of the gripping area. See [Figure B.2](#).
- For machines with a rear handle and the front handle on the tube, the accelerometer on the rear handle shall be located  $20 \text{ mm} \pm 3 \text{ mm}$  in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped, in accordance with [Figure B.2](#). The accelerometer for the front hand shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  in front of the centre of the gripping area or, if there is no designated gripping area,  $250 \text{ mm} \pm 5 \text{ mm}$  in front of the centre of the rear-handle accelerometer.

#### B.2 Adjustment of machine

The machine shall be equipped with all cutting attachments specified by the machine manufacturer.

The handles, if adjustable, shall be set according to the manufacturer's instructions.

For grass-trimmers with flexible lines, the length of the line shall be adjusted to the maximum length, with the guard in place.

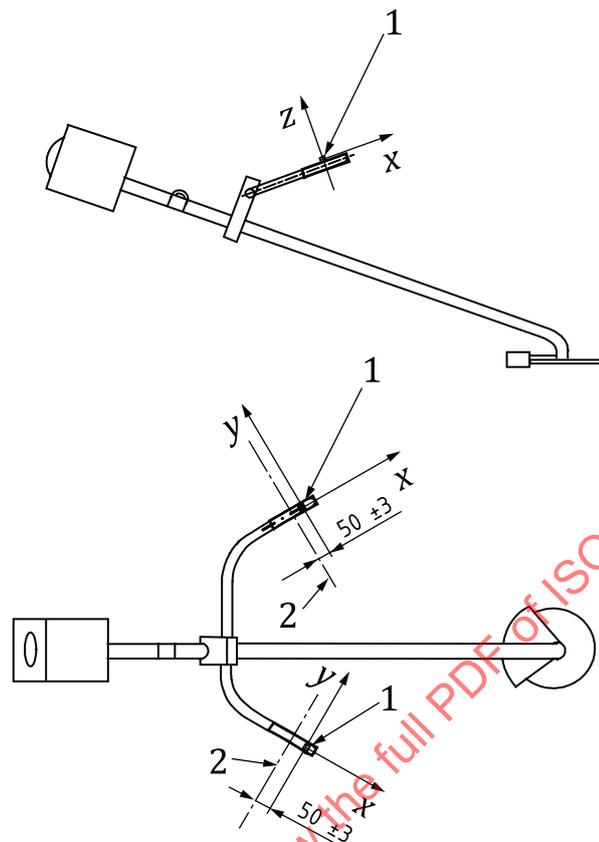
The machine shall be operated upright, as shown in [Figure B.3](#). The machine shall be connected to the harness, if any, and held with both hands in a manner consistent with day-long use of the machine.

Machines with a harness shall have the suspension point adjusted so that it is vertically  $775 \text{ mm} \pm 25 \text{ mm}$  above the ground, and with the nearest point of the cutting attachment, *H*, vertically above the ground in accordance with [Figure B.3](#).

Machines without a harness shall be held so that the rear end of the throttle trigger is vertically  $775 \text{ mm} \pm 25 \text{ mm}$  above the ground and with the nearest point of the cutting attachment, *H*, vertically above the ground in accordance with [Figure B.3](#).

The specified distances shall be met with the tanks half-filled and with all recommended cutting attachments. Any contact between the machine and the ground shall be avoided.

Dimensions in millimetres

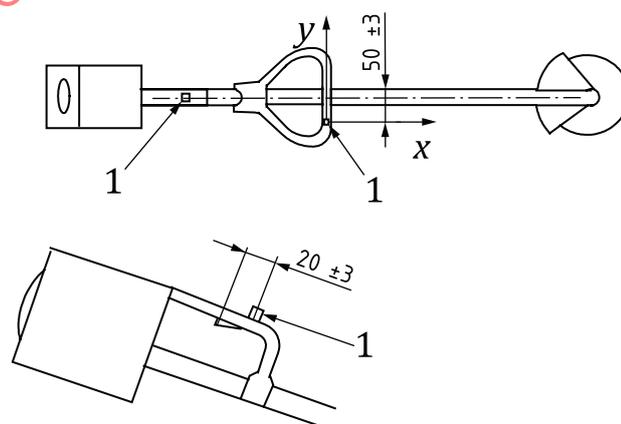


**Key**

- 1 accelerometer
- 2 centre of gripping area

**Figure B.1 — Measurement directions and positioning of accelerometers on machines with right and left handles (bicycle-type handles)**

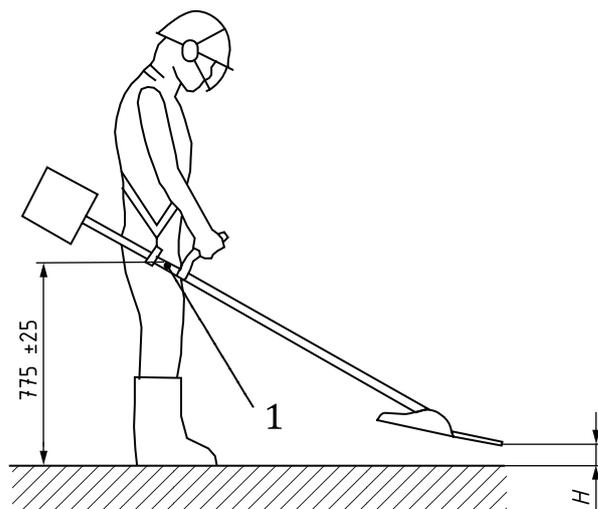
Dimensions in millimetres



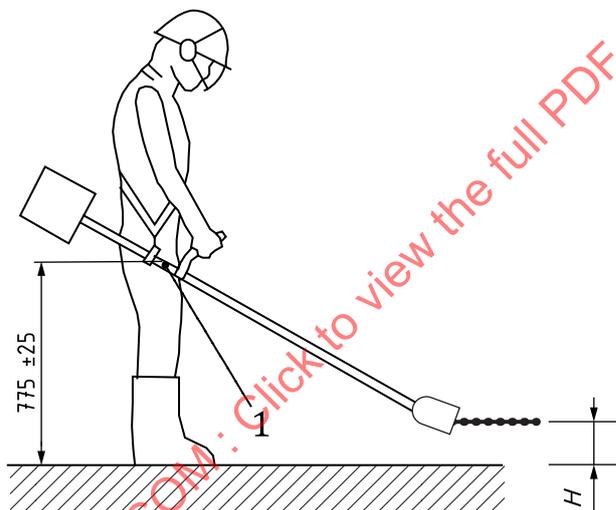
**Key**

- 1 accelerometer

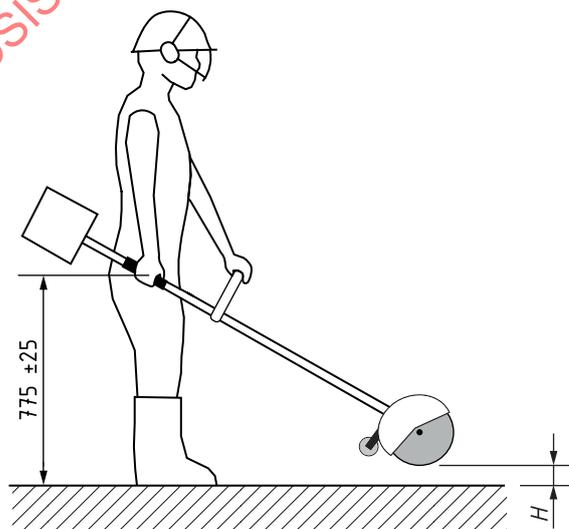
**Figure B.2 — Measurement directions and positioning of accelerometers on machines with rear and front handles (loop-type handle)**



a) Brush-cutter or grass-trimmer with rotating tool



b) Machine with reciprocating tool



c) Hand-held edger

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**Key**

1 suspension point

$H$  shall equal 50 mm ± 25 mm.

**Figure B.3 — Operating positions**

## B.3 Test procedure

### B.3.1 General

The tests shall be carried out in the idling and racing operating modes, as follows.

### B.3.2 Idling

The idling speed shall be adjusted in accordance with the machine manufacturer's instructions. Perform the measurements with the throttle trigger fully released. The cutting attachment shall not move during the test.

### B.3.3 Racing

For brush-cutters and hand-held edgers, perform the measurements at an engine speed of 133 % of the speed at maximum engine power, as determined in accordance with ISO 8893:1997.

For grass-trimmers, perform the measurements with the flexible line adjusted to the full usable length (see B.2) and with full open throttle. If the maximum speed exceeds 133 % of the speed at maximum engine power, the speed shall be controlled so that it is maintained at 133 %.

If the engine has a speed limiter set to below that speed, measure at the maximum speed achievable. If the engine does not run at a stable speed, carry out the test at the maximum possible stable speed; this speed shall not, however, be more than 8 s<sup>-1</sup> below the maximum speed as determined by the speed limiter. The engine speed shall be controlled with the throttle trigger.

### B.3.4 Calculation of equivalent vibration total values

The equivalent vibration total values,  $a_{hv,eq}$ , are based on a work cycle composed of idling and racing with equal duration for each.

The equivalent vibration value,  $a_{hv,eq}$ , shall be determined by [Formula \(B.1\)](#)

$$a_{hv,eq} = \left[ \frac{1}{2} (\bar{a}_{hv,ld}^2 + \bar{a}_{hv,Ra}^2) \right]^{1/2} \quad (B.1)$$

## Annex C (normative)

### Pole-mounted powered pruners

#### C.1 Measurement direction and location

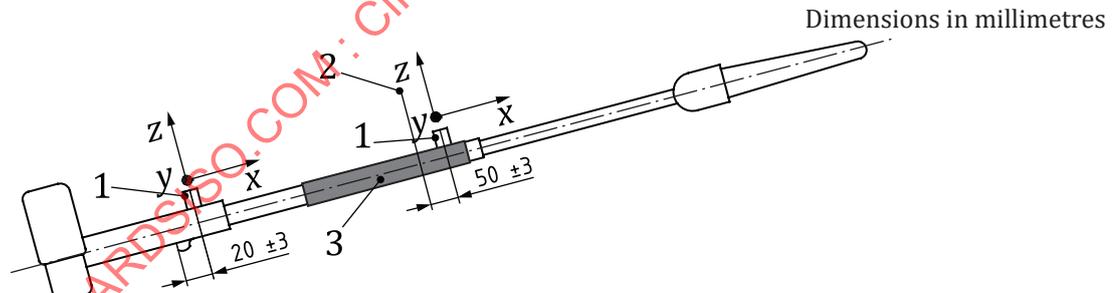
The orientation and location of the accelerometers shall be in accordance with [Figure C.1](#).

The accelerometer on the rear handle shall be located  $20 \text{ mm} \pm 3 \text{ mm}$  in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped.

For machines to be held with the front hand on the tube, the accelerometer for the front handle shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  forward from the machine's centre of gravity, on the designated gripping area and at a distance between 500 mm and 950 mm from the rear accelerometer, see [Figure C.1](#). If this position is not achievable, the accelerometer shall be positioned on the designated gripping area as close as possible to the prescribed position.

For machines without a designated gripping area on the tube, the accelerometer for the front handle shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  forward from the machine's centre of gravity and at a distance between 500 mm and 950 mm from the rear accelerometer. If this position is not achievable, the accelerometer shall be fixed as close as possible to the centre of gravity within the distance of 500 mm to 950 mm from the rear accelerometer.

For machines with a loop-type front handle, the accelerometer shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  to the right of the centre of the gripping area.



**Key**

- 1 accelerometer
- 2 centre of gravity
- 3 designated gripping area

**Figure C.1 — Measurement directions and positioning of accelerometers on pole-mounted powered pruners**

#### C.2 Adjustment of machine

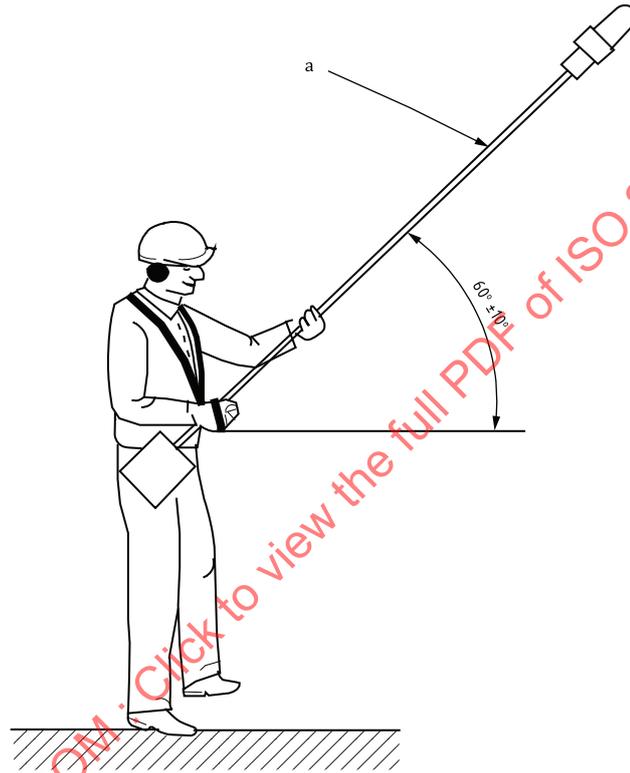
The machine shall be equipped with each type of standard cutting attachment specified by the machine manufacturer.

The cutting device shall be lubricated, as applicable, and adjusted for best cutting performance in accordance with the manufacturer's instructions.

The handles, if adjustable, shall be set according to the manufacturer's instructions.

The machine shall be operated at an angle of  $60^\circ \pm 10^\circ$ , as shown in [Figure C.2](#). The machine shall be connected to the harness, if any, and held with both hands in a manner consistent with day-long use of the machine. A harness shall carry no load from the machine during measurements.

Machines with adjustable or different shaft lengths shall be measured at their maximum and minimum shaft lengths.



<sup>a</sup> Pole length adjusted to its shortest or longest position, if applicable.

**Figure C.2 — Operating position**

### C.3 Test procedure

#### C.3.1 General

The tests shall be carried out in the idling and racing operating modes, as follows.

#### C.3.2 Idling

The idling speed shall be adjusted in accordance with the machine manufacturer's instructions. Perform the measurements with the throttle trigger fully released. The cutting attachment shall not move during the test.

#### C.3.3 Racing

Perform the measurements at an engine speed of 133 % of the speed at maximum engine power, as determined in accordance with ISO 8893:1997.

If the engine has a speed limiter set to below that speed, measure at the maximum speed achievable. If the engine does not run at a stable speed, carry out the test at the maximum possible stable speed; this speed shall not, however, be more than  $8 \text{ s}^{-1}$  below the maximum speed, as determined by the speed limiter. The engine speed shall be controlled with the throttle trigger.

#### C.3.4 Calculation of equivalent vibration total values

The equivalent vibration total values,  $a_{\text{hv,eq}}$ , are based on a work cycle composed of idling and racing with equal duration for each.

The equivalent vibration value,  $a_{\text{hv,eq}}$ , shall be determined by [Formula \(C.1\)](#)

$$a_{\text{hv,eq}} = \left[ \frac{1}{2} (\bar{a}_{\text{hv,ld}}^2 + \bar{a}_{\text{hv,Ra}}^2) \right]^{1/2} \quad (\text{C.1})$$

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## Annex D (normative)

### Hedge trimmers

#### D.1 Measurement direction and location

Each accelerometer shall be located on the same side of a handle as the thumb of the hand grasping that handle; the orientation of the accelerometer shall be the same as that of the thumb.

- For machines with a rear handle and a loop-type front handle, the accelerometer on the rear handle shall be located  $20 \text{ mm} \pm 3 \text{ mm}$  in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped. The accelerometer for the front handle shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  to the right of the centre of the gripping area. See [Figure D.1](#).
- For machines with lateral rear and front handles, the accelerometer on the rear handle shall be located  $20 \text{ mm} \pm 3 \text{ mm}$  in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped, in accordance with [Figure D.2](#). The accelerometer for the front handle shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  forward from the centre of the gripping area, as shown in [Figure D.2](#).
- For machines with the rear and the front handle on the tube, the accelerometer on the rear handle shall be located  $20 \text{ mm} \pm 3 \text{ mm}$  in front of the rear of the throttle trigger. If this distance cannot be obtained, the accelerometer shall be placed at the front of that portion of the handle intended to be grasped, in accordance with [Figure D.3](#).

The accelerometer for the front handle shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  forward from the machine's centre of gravity, on the designated gripping area and at a distance between 500 mm and 950 mm from the rear accelerometer, see [Figure D.3](#). If this position is not achievable, the accelerometer shall be positioned on the designated gripping area as close as possible to the prescribed position.

For machines without a designated gripping area on the tube, the accelerometer for the front handle shall be located  $50 \text{ mm} \pm 3 \text{ mm}$  forward from the machine's centre of gravity and at a distance between 500 mm and 950 mm from the rear accelerometer. If this position is not achievable, the accelerometer shall be fixed as close as possible to the centre of gravity within the distance of 500 mm to 950 mm from the rear accelerometer.

#### D.2 Adjustment of machine

The machine shall be equipped with the cutting attachment specified by the machine manufacturer that gives the highest vibration value.

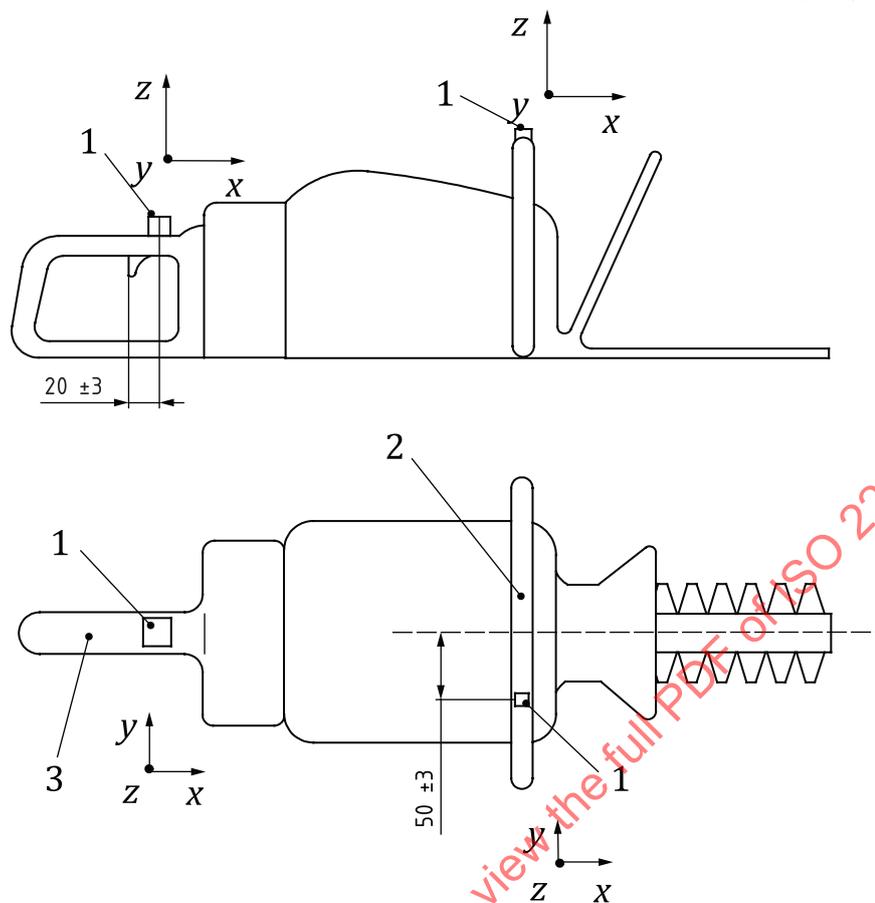
The cutting device shall be lubricated and adjusted for best cutting performance in accordance with the manufacturer's instructions.

Machines with adjustable or different shaft lengths shall be measured at their maximum and minimum shaft lengths.

The handles, if adjustable, shall be set according to the manufacturer's instructions.

The machine shall be operated with the operator standing upright, with the machine held with both hands in a manner consistent with day-long use of the machine. Long-reach hedge-trimmers shall be held at an angle of  $45^\circ \pm 10^\circ$  and with the cutting attachment as far as possible in line with the shaft tube, as shown in [Figure D.4](#). Other machines shall be held with the cutting attachment horizontal.

Dimensions in millimetres

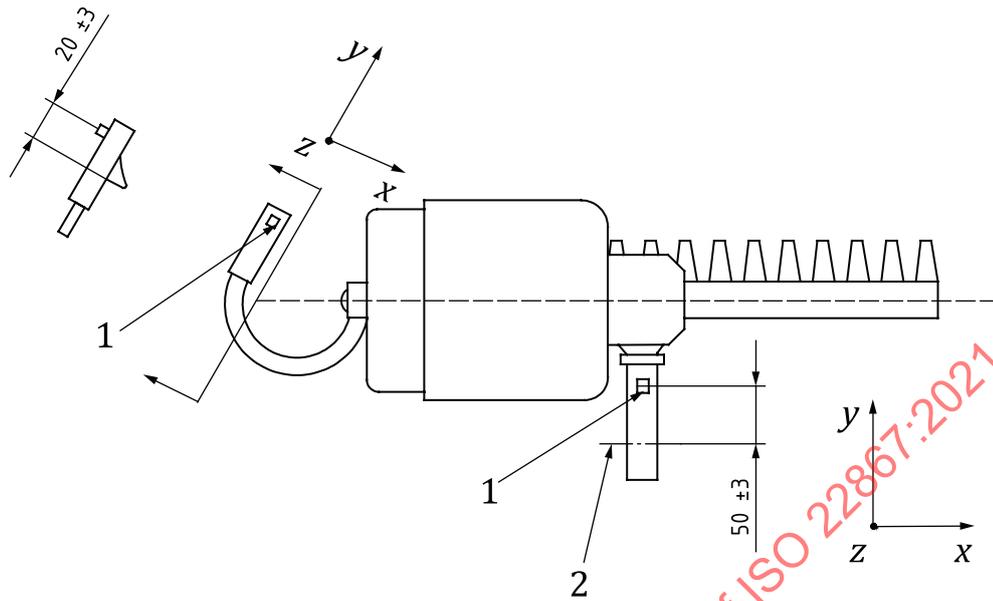


**Key**

- 1 accelerometer
- 2 front handle
- 3 rear handle

**Figure D.1 — Measurement directions and positioning of accelerometers on machines with longitudinal rear handle and loop-type front handle**

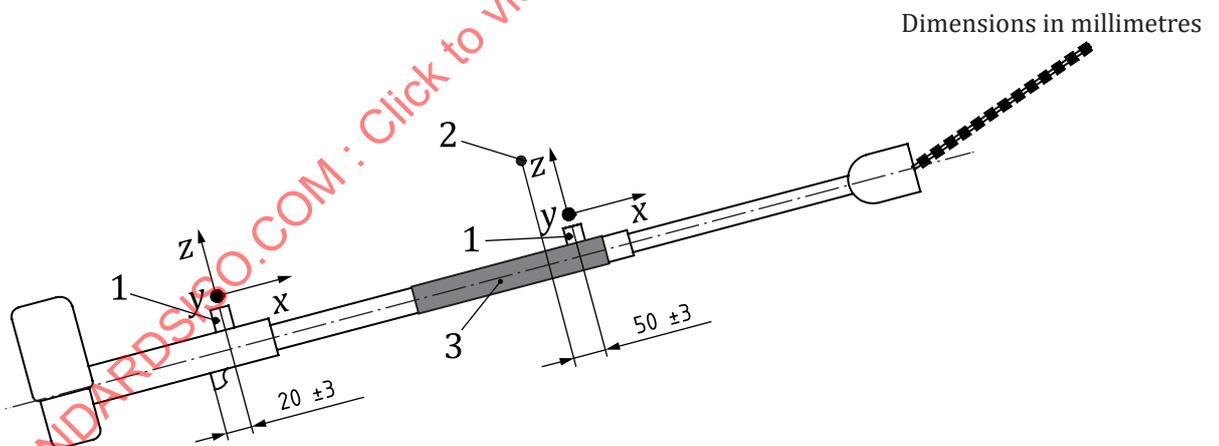
Dimensions in millimetres



**Key**

- 1 accelerometer
- 2 centre of gripping area

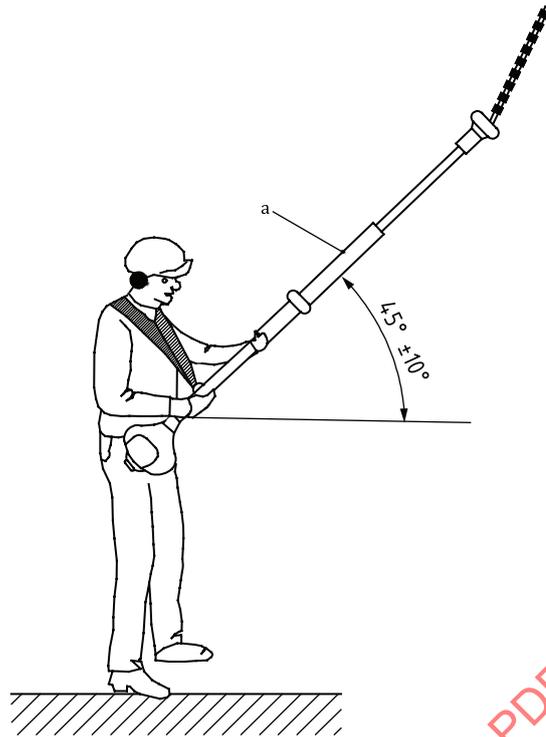
**Figure D.2 — Measurement directions and positioning of accelerometers on machines with lateral rear and front handles**



**Key**

- 1 accelerometer
- 2 centre of gravity
- 3 designated gripping area

**Figure D.3 — Measurement directions and positioning of accelerometers on long-reach hedge trimmers**



a Pole length adjusted to its shortest or longest position, if applicable.

**Figure D.4 — Operator position with long-reach hedge trimmer**

### D.3 Test procedure

#### D.3.1 General

The tests shall be carried out in the idling and racing operating modes, as follows.

#### D.3.2 Idling

The idling speed shall be adjusted in accordance with the machine manufacturer's instructions. Perform the measurements with the throttle trigger fully released. The cutting attachment shall not move during the test.

#### D.3.3 Racing

Perform the measurements at an engine speed of 133 % of the speed at maximum engine power, as determined in accordance with ISO 8893:1997.

If the engine has a speed limiter set to below that speed, measure at the maximum speed achievable. If the engine does not run at a stable speed, carry out the test at the maximum possible stable speed; this speed shall not, however, be more than  $8 \text{ s}^{-1}$  below the maximum speed, as determined by the speed limiter. The engine speed shall be controlled with the throttle trigger.

#### D.3.4 Calculation of equivalent vibration total values

The equivalent vibration total values,  $a_{hv,eq}$ , are based on a work cycle composed of idling and racing with a duration of 1/5 for idling and 4/5 for racing.