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ISO 22867

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

Machines forestières — 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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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 22867 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 17, *Manually portable forest machinery*.

This first edition cancels and replaces ISO 7505:1986 and ISO 7916:1989, of which it constitutes a technical revision.

Introduction

The determination of vibration characteristics is primarily used for

— manufacturer's declarations,

— comparing the data between machines in the 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 will ensure reproducibility of the determination of the vibration characteristics.

The 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 $< 80\ cm^3$ are used for various operations, including felling, bucking and delimbing;

b) chain-saws with an engine displacement of $\geqslant 80\ cm^3$ are normally used for felling and bucking.

Delimbing will cause the saw to run at racing speed; therefore, racing is included only for saws with a $< 80\ cm^3$ engine.

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

For trimmers, the full load and the racing modes are integrated in one single mode due to the loading effect of the flexible line.

For brush-cutters, it is not possible to simulate the full load mode in a feasible way since there are no constant load conditions comparable to chain-saws. Since the operating mode “racing” is anyhow the worst case, it is used as representative.

In either case, transport and other tasks between operations will cause the machine to run at idling. Experience has lead to the conclusion that equal duration for the different working modes is a good estimation of daily exposure.

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

CAUTION — Some of the tests specified in this International Standard involve processes that could lead to a hazardous situation. Any person performing tests in accordance with this International Standard shall be appropriately trained in the type of work to be carried out. All national regulatory conditions and health and safety requirements shall be followed.

1 Scope

This International Standard 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 forestry machines such as chain-saws, brush-cutters and grass-trimmers. The code is applicable to manufacturer's product controls as well as type tests. It is intended that the results obtained will be able to be used to compare different machines or different models of the same type of machine. 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.

2 Normative references

The following referenced documents are indispensable for the application 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 5347 (all parts), *Methods for the calibration of vibration and shock pick-ups*

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

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

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

ISO 8041, *Human response to vibration — Measuring instrumentation*

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

ISO 16063 (all parts), *Methods for the calibration of vibration and shock transducers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6531, ISO 7112 and ISO 8041 apply.

4 Quantities to be measured and determined

The quantities to be measured are the weighted accelerations in the three perpendicular directions, a_{hwx}, a_{hwy} and a_{hwz}.

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 Annexes A and B.

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_{hwx}, a_{hwy}, a_{hwz}.

5 Instrumentation

5.1 General

The vibration measurement system including frequency weighting for hand–arm shall be in accordance with ISO 8041.

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 sensitive element intended to pick up the vibration and to convert it into electrical signals is an accelerometer. A tri-axial accelerometer will permit measurements in the x, y and z axes, simultaneously.

5.3 Fastening of accelerometer

The accelerometer and the mechanical filter, if used, shall be mounted firmly on the handle by means of a fastening device. Guidance is given in ISO 5348 and ISO 5349-2.

For measurement on handles with resilient covers (for example, a cushioned handle), it is permissible to use a suitable adaptor for the accelerometer. The adaptor shall consist of a suitable, formed, light, rigid plate with a suitable mounting arrangement for the accelerometer used. Care shall be taken that the mass, size and shape of the adaptor do not significantly influence the signal from the accelerometer in the frequency range of interest. For more information, see ISO 5349-2:2001, 6.1.4.2.

5.4 Calibration

The whole measuring chain, including the accelerometer, shall be checked before and after use and — when necessary — to ensure accuracy during any sequence of measurements, in accordance with ISO 8041.The accelerometers shall be calibrated in accordance with ISO 5347 and ISO 16063.

5.5 Speed indicator

The rotational frequency of the engine shall be measured with an accuracy of ± 1,5 % of the reading. The speed indicator and its engagement with the machine shall not affect the operation during the test.

6 Measurement direction and location

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

The centre of gravity of the accelerometers shall be positioned at a maximum distance of 20 mm from the handle contour. One of the axis of the accelerometer shall be parallel to the axis of the handle.

NOTE The specific conditions for the particular types of machines covered by this International Standard are given in Annexes A and B.

7 Operating conditions, test procedure and presentation of results

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

NOTE The specific conditions for the particular types of machines covered by this International Standard are given in Annexes A and B.

The measured vibration of the machine can be influenced by the operator. The operator shall therefore be skilled and able to operate the machine properly.

The measurement shall be continued until the validity requirement given in Clause 8 is fulfilled.

The total vibration for each handle shall be calculated in accordance with Annex A or B, as appropriate.

8 Validity test

The validity is assured for every combination of handle and operating mode, when either the coefficient of variation, C_v, of the consecutive weighted values is less than 0,4 or the standard deviation, s_{n-1}, is less than 0,4 m/s^2.

If the measured values for a combination of handle and operating mode exceed 0,4 for both coefficient of variation and standard deviation, only the non-complying combination shall be repeated until the criterion of 0,4 is met.

For the purposes of this document, the coefficient of variation, C_v, of a test series is defined as the ratio between the standard deviation, s_{n-1}, of a series of measurement values and the mean value, $\bar{x}$, of the series:

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

where

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

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

where

x_i is the i-th value measured;

n is the number of measurement values.

9 Measurements and calculations

The measurements and calculations are generally done in the following sequence, as illustrated in Figure 1.

a) 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).

b) Calculate the root sum of squares of accelerations $a_{hv,J}$ of the three directions x, y and z for the operating mode selected.

c) Repeat a) and b) at least three times.

d) Calculate the arithmetic mean of the operating mode $\overline{a}_{hv,J}$.

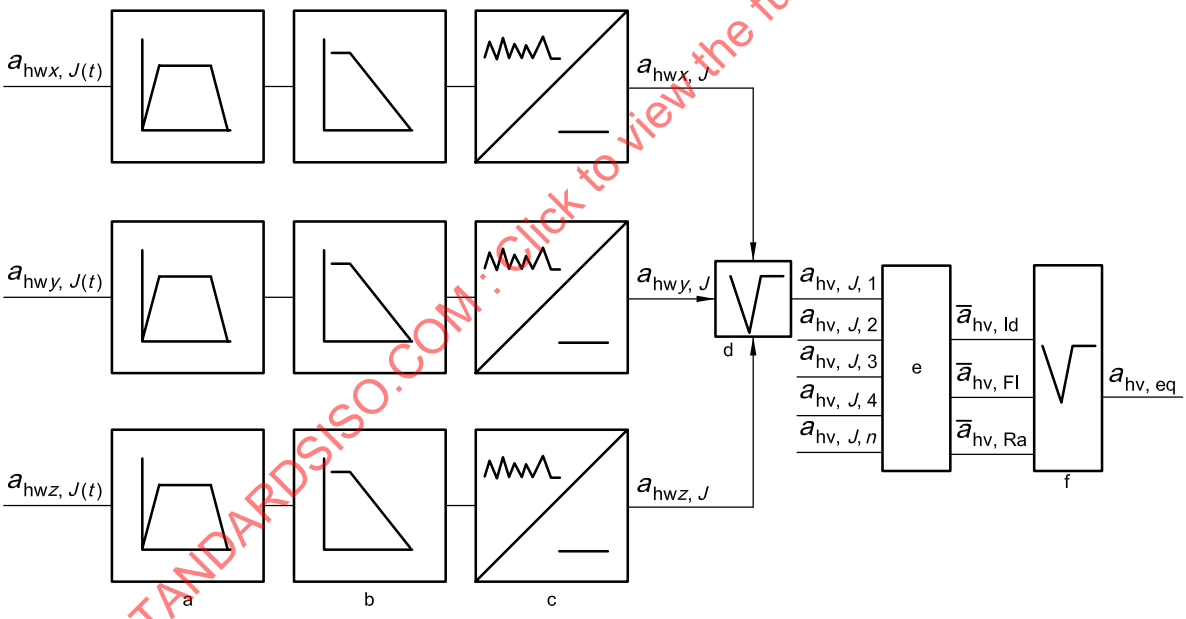
e) Repeat a), b) and d) as many times as necessary, depending on the coefficient of variation C_v and the standard deviation s_{n-1} (see Clause 8).

f) Perform a) to e) for the remaining operating modes.

g) Calculate the equivalent vibration total value $a_{hv,eq}$ for each handle according to A.4.2 and B.4.2.

h) Determine the declared value.

NOTE The information to be reported is specified in Annexes A and B.



Key

a Pass band.
b Weighting filter.
c Root mean square (r.m.s).
d See Note to Clause 4.
e Average value for each operating mode.
f See A.4.2 and B.4.2.

Figure 1 — Sequence of measurement and calculation of vibration data

10 Measurement uncertainties and declaration of vibration values

Vibration declaration is the responsibility of the manufacturer. If undertaken, it shall be done so that it is possible to verify the declared values.

The declaration shall include a reference to this vibration test code and to the basic standard used. Deviations, if any, from this test code and/or the basic standard shall also be indicated.

Calculated equivalent vibration values for the work cycles (see A.4.2 and B.4.2) shall be declared. The average vibration value for idling, full load and racing (if applicable) shall be provided by the manufacturer on request.

The uncertainties associated with the measurements shall be taken into account when deciding on the values to be declared.

NOTE The methodology used for taking uncertainty into account needs to be based on the use of measured values and measured values and uncertainties. The latter are the uncertainty associated to the measurement procedure (which is determined by the grade of accuracy of the measurement method used) and the production uncertainty (variation of vibration emission from one machine to another of the same type made by the same manufacturer). One method for the calculation of uncertainty is given in EN 12096.

Annex A
(normative)

Specific conditions for chain-saws

A.1 Measurement direction and location

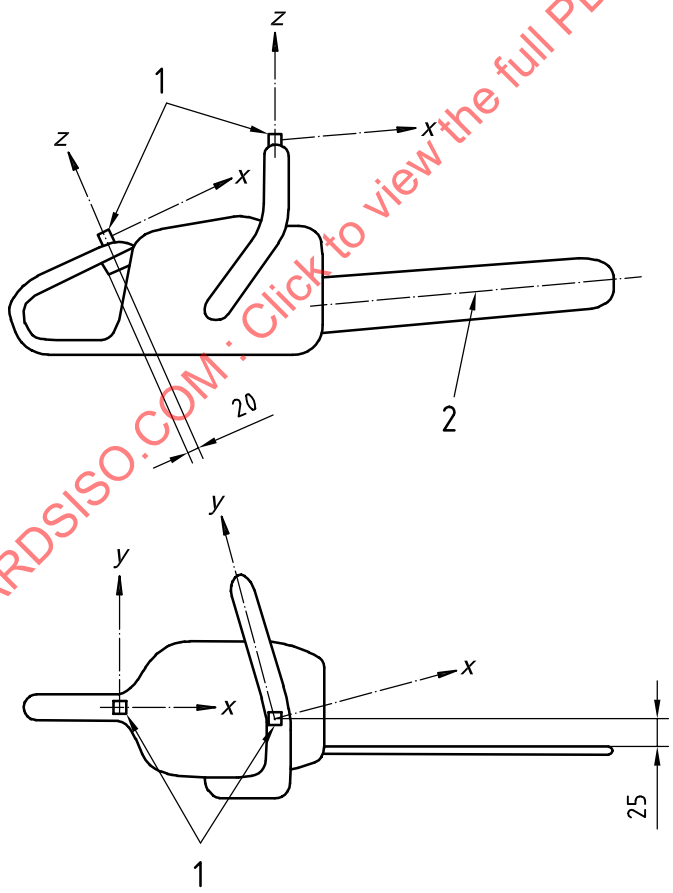
The orientation and location of the accelerometers shall be as given in Figure A.1.

The accelerometers shall be positioned as near as possible to the hand without obstructing the normal grip.

For the front handle, if the measurement of 25 mm according to Figure A.1 cannot be obtained, the accelerometer shall be placed at the right end of that portion of the handle intended to be grasped.

For the rear handle, if the measurement of 20 mm according to Figure A.1 cannot be obtained, the accelerometer shall be placed at the front of the portion of the handle intended to be grasped.

Dimensions in millimetres



Key

1 accelerometers
2 guide bar centreline

Figure A.1 — Measurement direction and example of positioning and fastening of accelerometers on chain-saws

A.2 Chain-saw conditions and test timber

A.2.1 Chain-saw

Measurements shall be carried out on a saw with the bar and chain combination recommended by the manufacturer. If no guide bar is recommended, a bar according to Table A.1 shall be used.

The engine and the saw chain shall be run-in prior to the test according to the manufacturer's recommendations. The chain-saw engine shall be at operating temperature before the test is commenced.

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

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

The engine speed for all test modes shall be kept constant to within ± 3,5 r/s. No alterations to the initial settings are permitted once measurements have commenced.

A.2.2 Test timber

For cutting tests, sound timber shall be taken from freshly felled local hardwood. The width of the log shall be correlated to the usable cutting length of the guide bar in accordance with Table A.1.

The timber shall not be seasoned or frozen. The cut shall be made in a part of the timber free from knots.

The shape of the log shall be as shown in Figure A.2 and given in Table A.1.

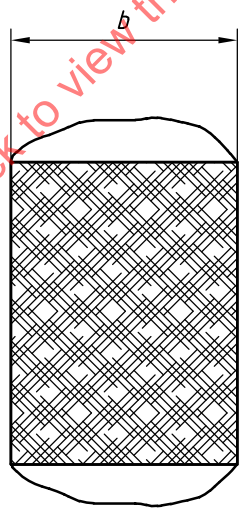


Figure A.2 — Test-log shape

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

Engine displacement C cm^3	Usable cutting length of the guide bar L m	Width of timber b m
< 45	0,25 to 0,35	(75 ± 5) % of L
$45 \leqslant C < 70$	0,30 to 0,40	(75 ± 5) % of L
$70 \leqslant C < 90$	0,40 to 0,50	(75 ± 5) % of L
$\geqslant 90$	$> 0,50$	$L - 0,1$

A.2.3 Operating conditions

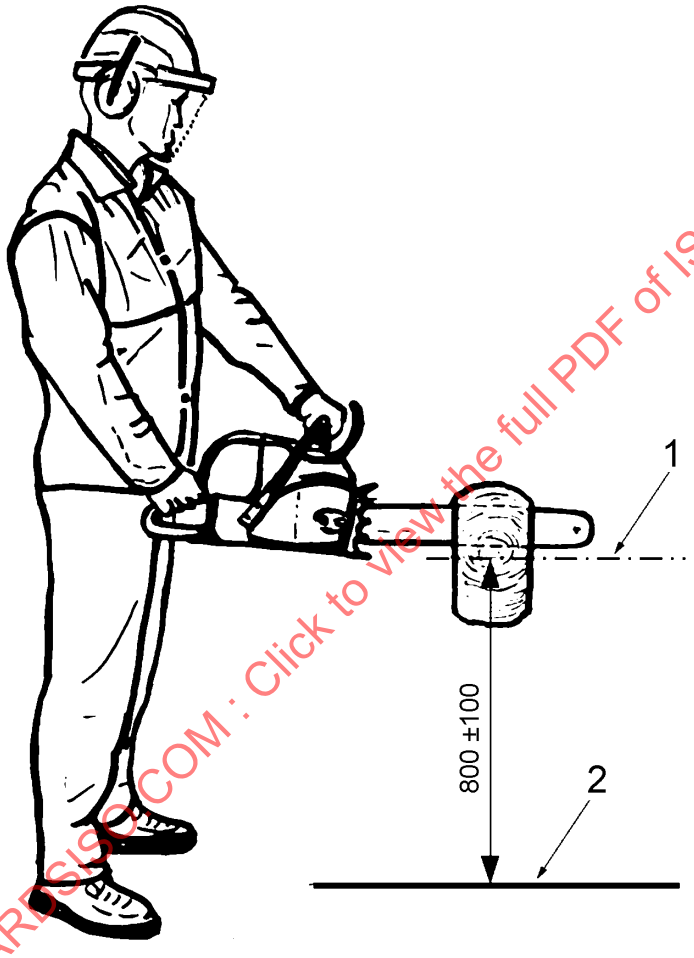
The machine shall be operated upright, in accordance with Figure A.3.

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

The machine shall be held by the operator in a normal operating manner.

NOTE Gripping forces on the handles will influence the vibration measurements.

Dimensions in millimetres



Key

1 centreline of 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 cm^3 at idling, full load and racing;

b) for machines with an engine displacement of $\geqslant 80$ cm^3 at idling and full load.

A test to obtain the required data for a given operating condition shall consist of a minimum of four measurements with a break to reach stable idling conditions between each measurement.

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 ± 3,5 r/s.

NOTE The collection of data for idling, full load and racing need not be carried out in any fixed sequence.

A.3.2 Idling

At idling, hold the machine with both hands and with the saw in a normal horizontal operating position.

Carry out measurements at the idling engine speed as stated by the manufacturer. The saw chain shall not move.

A.3.3 Full load

At full load, cut slices from the log with the throttle fully open. During the cut, the guide bar shall be kept in a horizontal position and perpendicular to the axis of the log.

The engine speed shall be kept at maximum engine power in accordance with ISO 7293.

The vibration measurements shall be taken in the middle third through the log. The rotational frequency of the engine shall be controlled by the cutting force. Any contact between the test timber and the engine/motor part of the machine or the spiked bumper, if provided, shall be avoided.

A.3.4 Racing

At racing, the saw shall be held with both hands in a normal horizontal operating position. Measurements shall be made at an engine speed of 133 % of the speed at maximum engine power as determined in accordance with ISO 7293.

If the engine has a speed limiter set below that speed, the measurement shall be made at the maximum speed achievable. Tests shall be carried out at the maximum possible stable speed but at least with a speed no more than 8 r/s below the speed stipulated by the manufacturer. The engine speed shall be controlled with the throttle trigger.

A.4 Information to be reported

A.4.1 General

The following information, where applicable, shall be compiled and reported for all measurements made in accordance with the requirements of this International Standard.

a) Saw under test:

   1) description of saw, including engine displacement, manufacturer, type and serial number, type of saw chain and length of guide bar;

   2) operating conditions, in accordance with Table A.2;

   3) width of log.

b) 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) date and place of most recent calibration of accelerometer calibrator.

c) Vibration and other data:

1) location of accelerometer positions (a sketch may be included, if necessary);

2) measurement values and arithmetic mean values in accordance with Table A.2;

3) declared value;

4) remarks, if any;

5) air temperature;

6) date and place of measurements.

Table A.2 — Table for reporting determined vibration total values and calculation of their arithmetic means

Operating mode	Calculated data and validity criteria	Nominal engine speed	Front handle/Rear handle				
			Test No.				
		r/s	1	2	3	4	n
Idling (Id)	$a_{hv,Id}$ (m/s^2)						
	$\overline{a}_{hv,Id}$ (m/s^2)		—	—	—		
	s_{n-1} (m/s^2)		—	—	—		
	C_v		—	—	—		
Full load (Fl)	$a_{hv,Fl}$ (m/s^2)						
	$\overline{a}_{hv,Fl}$ (m/s^2)		—	—	—		
	s_{n-1} (m/s^2)		—	—	—		
	C_v		—	—	—		
Racing (Ra) [a]	$a_{hv,Ra}$ (m/s^2)						
	$\overline{a}_{hv,Ra}$ (m/s^2)		—	—	—		
	s_{n-1} (m/s^2)		—	—	—		
	C_v		—	—	—		
The vibration total values a_{hv} are determined and recorded, and their arithmetic mean $\overline{a}_{hv}$ is calculated until the coefficient of variation C_v or the standard deviation s_{n-1} are less than 0,4. The calculation of arithmetic mean $\overline{a}_{hv}$ is based on at least 4 determinations of the vibration total value a_{hv}. The values for the arithmetic mean ($\overline{a}_{hv,Id}$, $\overline{a}_{hv,Fl}$ and $\overline{a}_{hv,Ra}$) are used to calculate the equivalent vibration total values $a_{hv,eq}$ (see A.4.2).								
[a] Not applicable to chain-saws with engine displacement of $\geqslant$ 80 cm^3.							

A.4.2 Equivalent vibration total values

A.4.2.1 General

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

A.4.2.2 Chain-saws with engine displacement $< 80\ cm^3$

The equivalent vibration total value $a_{hv,eq}$ shall be determined as follows:

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

A.4.2.3 Chain-saws with an engine displacement $\geqslant 80\ cm^3$

The equivalent vibration total value $a_{hv,eq}$ shall be determined as follows:

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

Annex B
(normative)

Specific conditions for brush-cutters and grass-trimmers

B.1 Measurement direction and location

The accelerometer orientation and locations shall be in accordance with Figure B.1 or Figure B.2, depending on handle design.

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

For machines with left and right handles (see Figure B.1), the position shall be opposite to the thumb (the inner side of the handle) when holding the machine in a normal working position.

For machines with a rear and front handle (see Figure B.2), the position at the rear handle shall be 80 mm behind the end of the throttle trigger. If this distance can not be obtained, the accelerometer shall be placed at the rear end of the portion of the handle intended to be grasped. The position at the front handle shall be on the same side as the thumb when holding the machine with the left hand on the front handle in a normal working position.

B.2 Adjustment of machine before test

Measurements shall be carried out on a machine with the cutting attachment provided by the manufacturer.

The engine and the cutting attachment shall be run-in prior to the test according to the manufacturer's recommendations. The machine shall be warmed up until stable conditions are reached before the test is commenced.

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

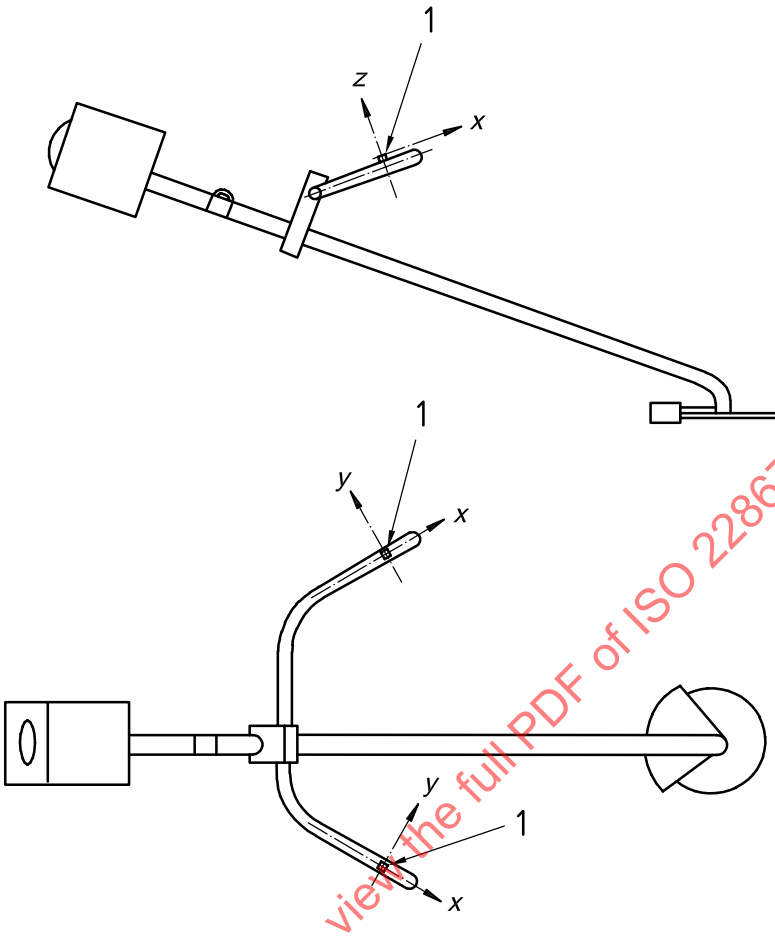
The cutting attachment shall be adjusted for best cutting performance in accordance with the manufacturer's instructions.

The engine speed shall be kept constant to within ± 3,5 r/s for all operating modes. No alterations to the initial settings are permitted once measurements have commenced.

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. If nothing else is stated, the machine shall be operated under the conditions given in B.3.2 and B.3.3.

NOTE Gripping forces on the handles will influence the vibration measurements.

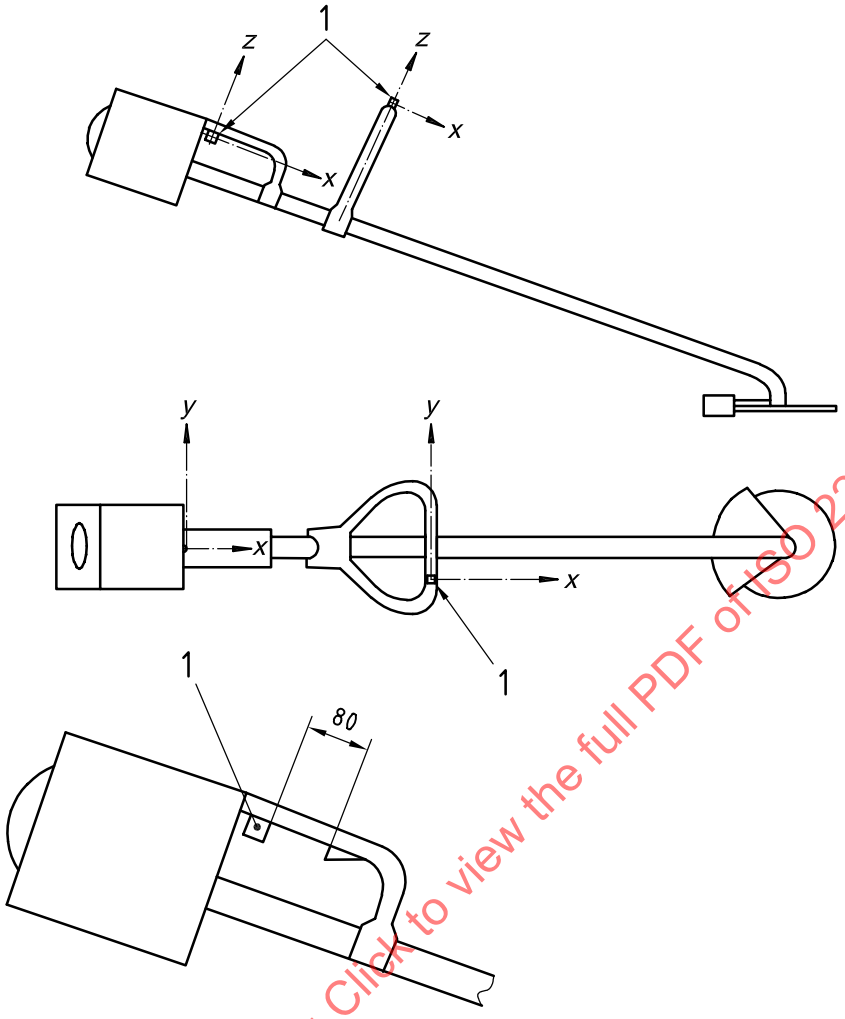


Key

1 accelerometers

Figure B.1 — Measurement direction and example of position and fastening of accelerometers on machines with right and left handles (bicycle-type handles)

Dimensions in millimetres



Key

1 accelerometers

Figure B.2 — Measurement direction and example of position and fastening of accelerometers on machines with rear and front handles (loop-type handle)