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Building construction machinery and equipment — Portable, hand-held, internal combustion engine-driven abrasive cutting machines —

Part 1: Safety requirements for cut-off machines for centre-mounted rotating abrasive wheels

Machines et matériels pour la construction des bâtiments — Machines de coupe par abrasion, portatives, à moteur à combustion interne —

Partie 1: Exigences de sécurité des tronçonneuses à disque abrasif monté au centre

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

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

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

This document was prepared by Technical Committee ISO/TC 195, *Building construction machinery and equipment*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 151, *Construction equipment and building material machines - Safety*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 19432-1 cancels and replaces ISO 19432:2012, which has been technically revised.

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

— update of normative references;

— update/revision of terms and definitions;

— revision of handle requirements;

— update of figures;

— revision of requirements for fuel tanks, oil tanks and fuel lines;

— revision of Clause 5, information for use;

— revision of requirements for labels.

A list of all parts in the ISO 19432 series can be found on the ISO website.

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

Introduction

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 -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.

Building construction machinery and equipment — Portable, hand-held, internal combustion engine-driven abrasive cutting machines —

Part 1: Safety requirements for cut-off machines for centre-mounted rotating abrasive wheels

1 Scope

This document specifies safety requirements and measures for their verification for the design and construction of portable, hand-held, internal combustion engine-driven cut-off machines intended to be used by a single operator in the cutting of construction materials, such as asphalt, concrete, stone and metal. It is applicable only to those machines designed purposely for use with a rotating, bonded-abrasive and/or super-abrasive (for example diamond) cut-off wheel having a maximum outer diameter of 430 mm, centre-mounted on and driven by a spindle shaft where the top of the wheel rotates away from the operator (see Figure 1).

This document deals with all significant hazards, hazardous situations or hazardous events significant to these machines when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer. See Annex F for a list of significant hazards.

This document specifies methods for the elimination or reduction of hazards arising from their use, as well as the type of information on safe working practices to be provided with the machines.

Cut-off wheel specifications are not considered in this document. Cut-off wheels are deemed to comply to existing cut-off wheel standards.

NOTE For example see Bibliography.

All through the document, portable, hand-held, internal combustion engine-driven cut-off machines are called “cut-off machines”.

This document is not applicable to machines manufactured before the date of its publication.

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 3744:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane*

ISO 4871:1996, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

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 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 11201:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

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

ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 14982:1998, *Agricultural and forestry machinery — Electromagnetic compatibility — Test methods and acceptance criteria*

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

ISO 20643:2005, *Mechanical vibration — Hand-held and hand-guided machinery — Principles for evaluation of vibration emission*

IEC 60745-1:2006, *Hand-held motor-operated electric tools — Safety — Part 1: General requirements*

IEC 61672-1:2013, *Electroacoustics — Sound level meters — Part 1: Specifications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100, ISO 20643 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp;

— IEC Electropedia: available at http://www.electropedia.org/.

3.1
cut-off wheel
wheel designed to be fitted to a hand-held portable cut-off machine and whose peripheral edge cuts material such as asphalt, concrete, stone and metal

3.1.1
bonded-abrasive wheel
cut-off wheel (3.1) entirely made of abrasive particles bonded together with synthetic resin and reinforced with glass fibre matting

3.1.2
superabrasive wheel
cut-off wheel (3.1) with diamond grains set into segments secured around the circumference of a steel core disc (the wheel body)

3.2
arbor hole
centre hole of the *cut-off wheel* (3.1) used for mounting the cut-off wheel on the machine *spindle* (3.19)

3.3
blotter
washer made from compressible material (e.g. paper, card or similar), attached to each side of the *cut-off wheel* (3.1)

Note 1 to entry: The function of the blotter is to smooth imperfections in the cut-off wheel and to allow a limited degree of slip when the wheel stalls in use.

3.4
clutch
device for connecting and disconnecting the driven member to and from a rotating source of power

3.5
cut-off wheel guard
partial enclosure intended to deflect cutting debris as well as pieces of the *cut-off wheel* (3.1) in the event that the wheel is broken in operation and to reduce the risk of unintentional contact with the cut-off wheel

3.6
engine-stopping device
device by which the stopping of the engine is initiated

3.7
flange contact surface
area between the inner and outer circumference on the flange which forms the contact surface between the flange and the *cut-off wheel* (3.1)

3.8
flange assembly
device provided to clamp and drive the *cut-off wheel* (3.1)

3.9
handle
device designed to facilitate safe and easy control of the machine

3.9.1
front handle
handle (3.9) located at or towards the front of the engine housing

3.9.2
rear handle
handle (3.9) located at or towards the rear of the engine housing

3.10
idle speed
speed at which the engine runs with no load and *throttle trigger* (3.21) released and the *cut-off wheel* (3.1) does not rotate

3.11
reactive force
force generated in a direction opposite to that in which the wheel is moving at the point of contact when the spinning *cut-off wheel* (3.1) is slowed or stopped by frictional contact with any solid object, including the workpiece, or when it is pinched or bound in the cut

Note 1 to entry: 3.11.1, 3.11.2, and 3.11.3, which further describe these reactions, are based on an abrasive cut-off wheel rotation with the top of the wheel rotating away from the operator.

3.11.1
rotational force
kickback
attempt of the wheel to move back and up towards the operator when the spinning *cut-off wheel* (3.1) is slowed or stopped by frictional contact with any solid object in its upper quadrant, so that if it is abruptly slowed or stopped by a pinch or binding in the upper quadrant, the wheel can be thrown back and up towards the operator in a rotational kickback motion

3.11.2
climbing
attempt of the wheel to climb the object being cut when the spinning *cut-off wheel* (3.1) is slowed or stopped by frictional contact with any solid object or by a pinch or binding at the front of the wheel

3.11.3
pulling
pull-away
attempt of the wheel to pull away from the operator when the spinning *cut-off wheel* (3.1) is slowed or stopped by frictional contact with any solid object or by a pinch or binding at the bottom of the wheel

3.12
gyroscopic force
force caused by the rapid spinning of the *cut-off wheel* (3.1) that results in opposition to a directional change of the cut-off machine

3.13
reducing bushing
insert or device used to reduce the hole size in a grinding wheel so that it can be mounted on a smaller diameter *spindle* (3.19)

3.14
maximum depth of cut
t
distance to which *the cut-off wheel* (3.1) can enter the workpiece as measured from the outer diameter of the wheel to the outside diameter of the flange

3.15
maximum cut-off wheel speed
maximum permitted speed of a new *cut-off wheel* (3.1) marked on the cut-off wheel

3.16
maximum spindle speed
maximum speed at which the *spindle* (3.19) rotates with a fully open throttle and no load

3.17
muffler
device for reducing engine exhaust noise and directing the exhaust gases

3.18
rated engine speed
rated speed
engine speed at which maximum power occurs as determined by the manufacturer

3.19
spindle
shaft of the cut-off machine which supports, retains and drives the *cut-off wheel* (3.1) in connection with the flanges

3.20
spindle sleeve
device used to increase the *spindle* (3.19) shaft diameter at the contact area of the abrasive wheel for mounting an abrasive wheel with a larger diameter *arbor hole* (3.2)

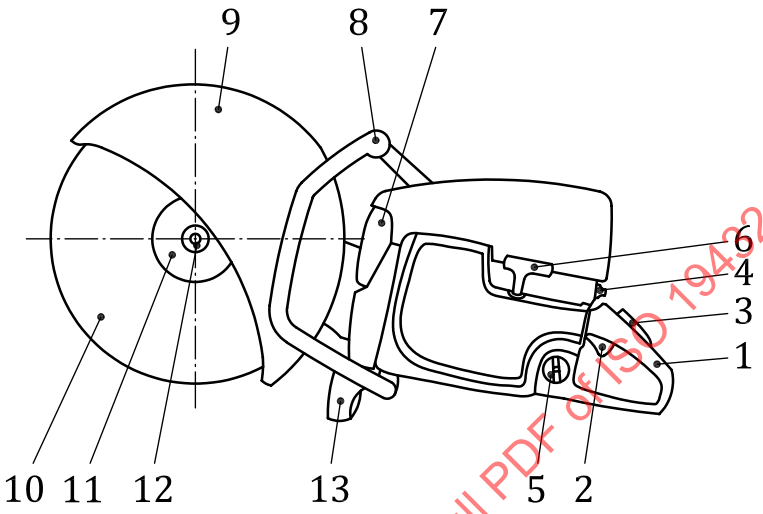
3.21
throttle trigger
device for controlling the engine speed

3.22
throttle lock
device for setting the throttle in a partially open position to aid starting

3.23
throttle trigger lock-out
device that prevents the unintentional operation of the *throttle trigger* (3.21) until manually released

3.24
throttle control linkage
mechanism which transmits motion from the *throttle trigger* (3.21) to the throttle control valve

3.25
transmission cover
device between the engine and the cutting equipment designed to prevent unintentional contact with the transmission



Key

1	*rear handle* (3.9.2)	8	*front handle* (3.9.1)
2	throttle trigger (3.21)	9	*cut-off wheel guard* (3.5)
3	throttle trigger lock-out (3.23)	10	*cut-off wheel* (3.1)
4	engine stopping device	11	*flange assembly* (3.8)
5	fuel tank/fuel tank cap	12	spindle
6	starter	13	foot/standing base
7	*muffler* (3.17)		

Figure 1 — Example of a cut-off machine

4 Safety requirements and verification

4.1 General

Machinery shall comply with the safety requirements and/or protective measures of this clause. In addition, the machine shall be designed according to the principles of ISO 12100 for relevant but not significant hazards which are not dealt with by this document.

The safe operation of cut-off machines depends on both complying with the safety requirements of this clause and using safe working practices. The use of appropriate personal protection equipment (PPE), such as gloves, leg protection, boots, eye, hearing, dust protection mask and head protection equipment, are an integral part of safe working practices (see 5.1).

Cut-off machines shall be marked in accordance with 5.2. Cut-off machines shall carry warnings in accordance with 5.3.

An instruction handbook shall be provided with the machine and shall comply with the requirements of 5.1.

For protection from contact with moving parts, except the cut-off wheel, any opening shall have a safety distance to the moving part that meets the requirements of ISO 13857:2008, 4.2.4.1 and 4.2.4.3.

When the machine is placed in its normal resting position (see Figure 2) on a flat horizontal surface, the cut-off wheel or the guard shall not touch the horizontal surface and the machine shall remain stable.

The requirements for the normal resting position shall be verified by inspection.

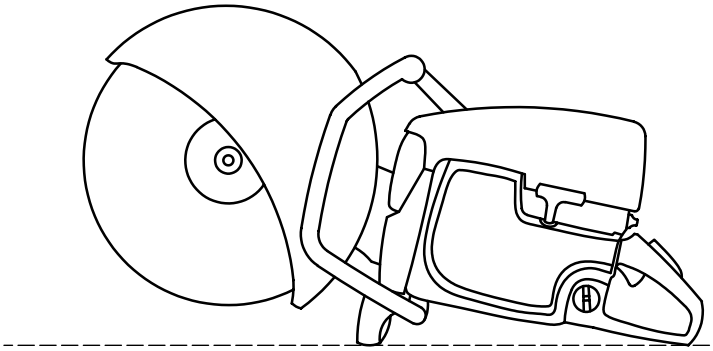


Figure 2 — Example of cut-off machine placed in a normal position on a flat surface

A method of verification is established for each requirement in the following clauses.

WARNING — Some of the tests specified in this document involve processes that could lead to a hazardous situation. Any person performing tests in accordance with this document should be appropriately trained in the type of work to be carried out. All national regulatory conditions and health and safety requirements shall be taken into consideration.

4.2 Handles

4.2.1 Requirements

Cut-off machines shall have a handle for each hand. These handles shall be designed so that they

— can be fully gripped by an operator when wearing protective gloves;

— provide the necessary sureness of grip by their shape and surface; and

— conform to the dimensions and clearances according to Table 1.

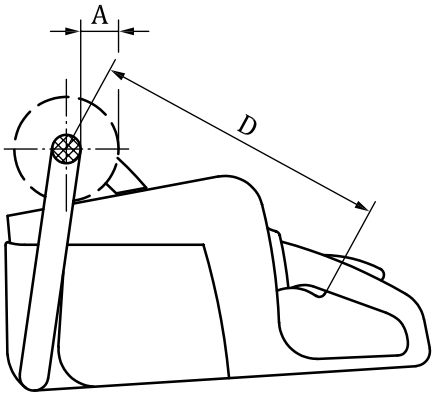
Cut-off machines with a system to isolate the machine vibration from the handles shall be designed so that the operator is able to stop the engine in a controlled manner with the engine-stopping device, even in the event of partial or full failure of the vibration isolators.

Table 1 — Handle requirements

Handles	Description	Dimension	Figure	Minimum size
Front	Finger clearance in the grip area	A	3	35 mm
Front and rear	Perimeter of the cross-section of the handle	H	4	65 mm
	Distance from the rear side of the throttle trigger to the centre of the front handle at the top	D	3	225 mm
Rear[a]	Finger clearance at the released throttle trigger	E	5	30 mm
	Clearance below the released throttle trigger	F	6	25 mm
	Clearance behind the released throttle trigger	G	7	25 mm × 3[b]

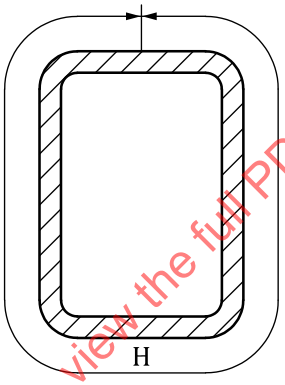
[a] The dimensions shall be gauged free of play, i.e. with a slight initial pressure on the throttle trigger.

[b] 3 represents the number of circles.



NOTE Refer to Table 1 for the A and D dimensions.

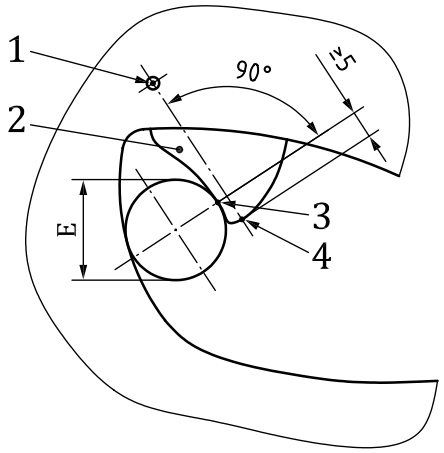
Figure 3 — Clearance and distance between front and rear handles for rear handle machines



NOTE Refer to Table 1 for the H dimension.

Figure 4 — Perimeter of handles cross section

Dimensions in millimetres



Key

1	pivot point	3	contact point
2	throttle trigger	4	intersection point

NOTE Refer to Table 1 for the E dimension.

Figure 5 — Finger clearance at released throttle trigger

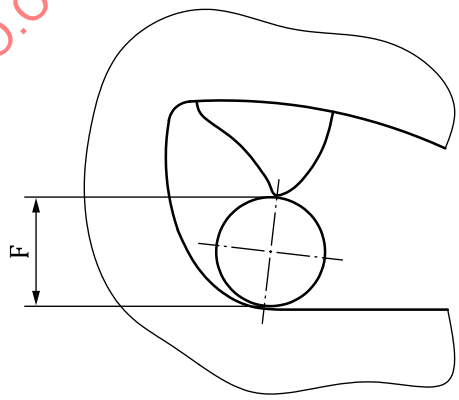
The conformity of the E dimension shall be verified as follows:

— step 1: put gauge E to the uppermost position between housing and throttle trigger;

— step 2: define contact point with throttle trigger;

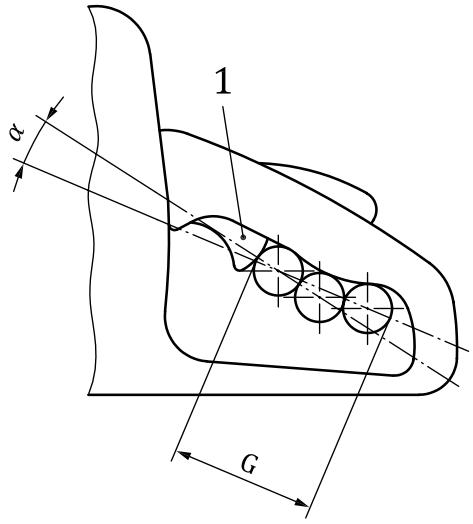
— step 3: connect a line between the centre of the gauge and the contact point and extend into the direction of the throttle trigger;

— step 4: add a perpendicular line to this line which intersects the pivot point of the throttle trigger.



NOTE Refer to Table 1 for the F dimension.

Figure 6 — Finger clearance below the released throttle trigger



Key

1 throttle trigger

α = ±15°

NOTE 1 Angle α shows the maximum allowed deviation of the lower outline of the handle grip.

NOTE 2 Refer to Table 1 for the G dimension.

Figure 7 — Finger clearance at released throttle trigger

4.2.2 Verification

Dimensions shall be verified by measurements. The ability to control the machine if a failure occurs in the vibration isolators shall be verified by inspection of the design and function test with a simulated failure.

4.3 Spindle speed

4.3.1 Requirement

Engine speed shall be limited so that it is not possible to accelerate the engine beyond the specified maximum spindle speed (see 5.1).

4.3.2 Verification

The spindle speed shall be measured at the spindle with fully open throttle and no load. The maximum allowed inaccuracy is 5 r/min.

Simple calculations using the engine speed and the transmission ratio cannot be permitted due to the potential for slippage in the energy transmission from the engine to the shaft.

4.4 Engine-starting device

4.4.1 Requirements

The engine-starting device shall be an electric starter or a manual starter. The actuator for the manual starter shall be permanently attached to the machine.

The cut-off machine with a manual starter shall have a recoil device for the rope.

To activate the electrical starting device, two or more separate and dissimilar actions shall be required. This also applies to manual starting devices with stored energy.

4.4.2 Verification

The means to start the cut-off machine shall be verified by inspection and a functional test.

4.5 Engine-stopping device

4.5.1 Requirements

The machine shall be fitted with an engine-stopping device by which the engine can be brought to a final stop and which does not depend on sustained manual effort for its operation. The control for this device shall be so positioned that it can be operated by the operator's hand while holding the rear handle and wearing protective gloves.

The colour of the control shall contrast clearly with the background of the engine-stopping device.

4.5.2 Verification

Correct operation and location of the engine-stopping device shall be verified by inspection and functional test while the machine is being operated. The colour of the engine-stopping device shall be verified by inspection.

4.6 Throttle control system

4.6.1 Dimensions

4.6.1.1 Requirements

The throttle trigger shall be positioned so that it can be pressed and released with a gloved hand while holding the rear handle by fulfilling the dimensional requirements for clearance around and behind the throttle trigger, as shown in Table 1 and Figures 5, 6, 7.

4.6.1.2 Verification

The dimensions shall be verified by measurement.

4.6.2 Operation

4.6.2.1 Requirements

The cut-off machine shall be provided with a throttle trigger that, when released, automatically reverts to the idling position unless a throttle lock to aid starting is engaged (see 4.6.3). The throttle trigger shall be retained in the idling position by the automatic engagement of a throttle trigger lock-out.

After the starting procedure has finished, activation of the throttle trigger, to increase the engine speed to a point where the cut-off wheel starts to move, shall only be possible after the throttle trigger lock-out has been disengaged.

The starting procedure is finished when the operator disengages the throttle lock and the engine returns to idling speed.

Unintentional movement of the cut-off wheel shall be minimized by a throttle control linkage, so designed that a force applied to the rear handle with the throttle trigger lock-out engaged will not increase the engine speed to a point where the clutch engages and cut-off wheel movement begins.

4.6.2.2 Verification

The function of the throttle trigger and throttle trigger lock-out shall be verified by inspection while operating the machine. The throttle control linkage design shall be verified by applying a force in any direction related to the plane of the cut-off wheel, on the centre of the rear handle grip and with the machine body secured. The force shall be equal to three times the weight of the cut-off machine unit with empty tanks, without accessories and without the cut-off wheel.

4.6.3 Throttle lock

4.6.3.1 Requirement

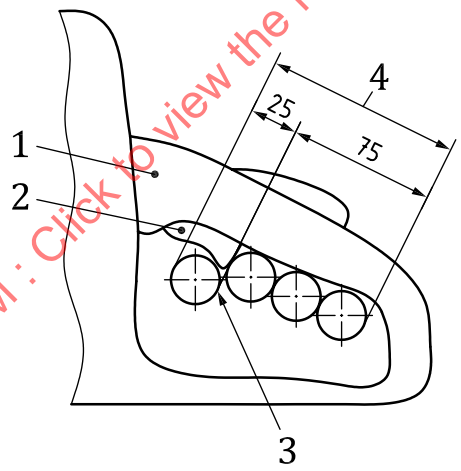
If a throttle lock is provided to aid starting and its engagement will result in a movement of the cut-off wheel during starting, it shall be such that it has to be engaged manually and shall be automatically released when the throttle trigger is operated. Releasing the throttle lock, both with and without operation of the throttle trigger lock-out, is acceptable.

To prevent risk of unintentional operation, the throttle lock shall be located outside the gripping area of the handle and require at least two independent motions to engage the throttle lock.

The gripping area of the handle is defined to extend from 25 mm in front of the rear part of the throttle trigger to 75 mm behind the rear part of the throttle trigger (see Figure 8).

The operational force on the throttle trigger for releasing the throttle lock shall not exceed 25 N.

Dimensions in millimetres



Key

1 rear handle
2 throttle trigger
3 intersection between rear handle and throttle trigger
4 gripping area

Figure 8 — Handle gripping area

4.6.3.2 Verification

The function of the throttle lock shall be verified by inspection and measurement. The force to release the throttle lock shall be applied within 1 s and measured (5 ± 1) mm in front of the rear part of the throttle trigger and in the direction of the trigger movement (perpendicular to the rotation radius of the trigger).

4.7 Clutch

4.7.1 Requirements

The cut-off machine shall have a clutch so designed that the cut-off wheel does not move when the engine rotates at any speed less than 1,25 times the idling speed.

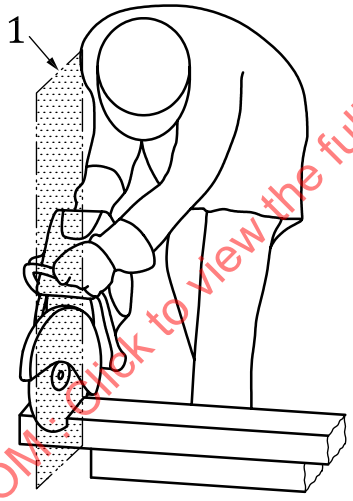
4.7.2 Verification

The function of the clutch shall be verified by running the engine with any speed up to 1,25 times the idling speed. If a range is specified in the instruction handbook, the verification shall be done based on the highest idling speed.

4.8 Exhaust gases

4.8.1 Requirements

The exhaust outlet shall be designed so that the exhaust gases are directed away from the operator when the machine is held in a typical cutting position, as shown in Figure 9.



Key

1 wheel plane

Figure 9 — Example of cut-off machine held in typical cutting position

4.8.2 Verification

The location and direction of the exhaust outlet shall be verified by inspection and functional test during operation of the cut-off machine.

4.9 Cutting-debris discharge

4.9.1 Requirements

The cut-off machine shall be designed so that the main stream of cutting debris from the cut-off wheel is directed away from the operator's face or upper body when holding the machine in a typical cutting position, as shown in Figure 9 (see also 4.14.1).

See 5.1 for required information about instructions for the wheel guard.

4.9.2 Verification

The direction of the opening of the wheel guard and respectively the direction of the cutting debris shall be verified by inspection.

4.10 Fuel tanks, oil tanks and fuel lines

4.10.1 Tank filler location and identification

The fuel tank filler opening and, if provided, the oil tank filler opening, shall be located so that access to the filler opening(s) is not unduly obstructed by other machine components. Each cap or opening shall be clearly and durably identified. If only the caps are identified, they shall not be interchangeable.

4.10.2 Tank filler openings

The minimum diameter of the fuel tank filler hole shall be 20 mm. The minimum diameter of the oil tank filler hole, if provided, shall be 15 mm. The design of the caps shall be such that no leakage occurs while the unit is being used at normal operating temperature, in all working positions, and while being transported. Each cap shall have a retainer that prevents separation from the machine.

Tanks and fuel lines shall be integrated in the cut-off saw so that they withstand, without any visible leakage, the shock that occurs when the complete machine is impacted onto the ground in accordance with 4.10.3.2.

4.10.3 Verification

4.10.3.1 General

The fuel cap retainer, opening dimensions and the possibility of using a funnel shall be verified by inspection and measurement. The tightness of the caps shall be verified by inspection while turning the cut-off machine in any direction. Seepage from fuel tank ventilation systems is not regarded as leakage.

4.10.3.2 Drop test

The cut-off machine shall be impacted onto a concrete surface by dropping it twice, once with the largest diameter cut-off wheel, as specified in the instruction handbook, and once without the cut-off wheel, at (−5 ± 2) °C.

Before the drop test, install the cut-off wheel and fill the fuel tank and oil tank half full with a mixture of 50 % glycol and 50 % water (by volume) and condition the cut-off machine at the test temperature for at least 6 h.

Within 60 s of coming out from the conditioning environment, the cut-off machine shall be dropped onto a concrete surface.

The drop shall be done with the cut-off machine initially suspended by means of a string attached to the front handle so that the cut-off wheel plane is vertical and the lowest point of the front handle where it is suspended is 775 mm ± 5 mm above the concrete surface.

Repeat the test without the cut-off wheel after reconditioning at (−5 ± 2) °C for a minimum of 1 h.

Inspect for visible leakage while holding the machine for (30 ± 2) s in each of the positions a) to f) specified in Figure D.1.

4.11 Protection against contact with parts under high voltage

4.11.1 Requirements

All high-voltage parts of the circuit, including spark-plug terminals, shall be located, insulated or guarded so that the operator cannot make unintentional contact with them.

Ignition interruption or short-circuiting shall be provided and shall be fitted on the low-voltage side.

4.11.2 Verification

The location and insulation of the parts under high voltage shall be verified by inspection and using a standard test finger, in accordance with IEC 60745-1:2006, Figure 1.

The ignition interruption or short-circuiting shall be verified by inspection and functional test.

4.12 Transmission cover(s)

4.12.1 Requirements

The moving transmission shall be covered to prevent contact during operation.

Covers whose only function is to guard from unintentional contact shall be fixed guards, only detachable by means of tools.

Fixed guards shall have their fixing system permanently attached to the guard and/or the machine when the guard is removed.

4.12.2 Verification

The design of fixed guards shall be verified by inspection.

4.13 Protection against contact with hot parts

4.13.1 Requirements

The cylinder or parts in direct contact with the cylinder or muffler shall be protected to avoid unintentional contact during normal operation of the machine. This applies to parts which are less than 120 mm away from the far side of the front handle above the machine (see Figure 10) and less than 80 mm from the far side of the front handle at the sides of the machine (see Figure 11).

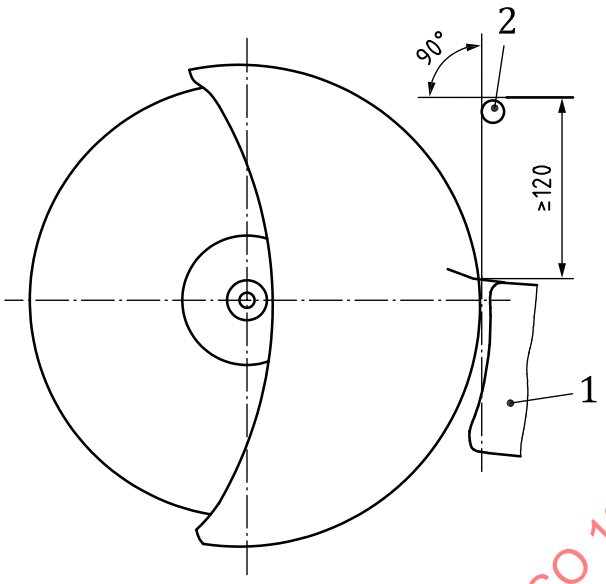
It also applies to the area of the muffler which can be contacted by a tangential line between the outer side of the front handle above the machine and the outer edge of the housing over the muffler, with a length of 120 mm from the front handle (dimension ≥0 in Figure 12).

The protection shall ensure that the area contactable by the cone, as described in 4.13.2, does not exceed 10 cm^2. The temperature for the parts of the machine as defined above, as well as the protection against contact with the cylinder, shall not be more than 80 °C for metallic surfaces or 94 °C for plastic surfaces.

Mufflers other than those mounted at the front of the machine shall be provided with protection against contact — verified with the cone described in 4.13.2 — so that the accessible area does not exceed 10 cm^2.

NOTE For further information, see ISO 13732-1:2006, Annex E.

Dimensions in millimetres

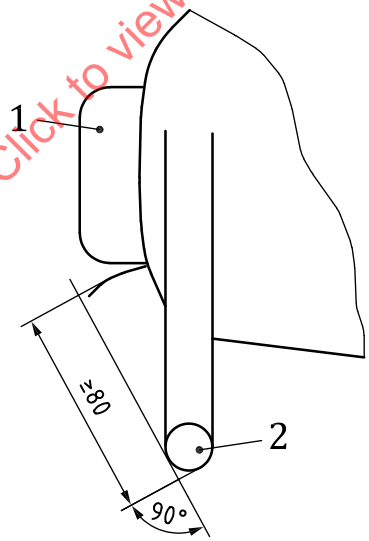


Key

1 muffler
2 front handle

Figure 10 — Required distance between front handle and unprotected hot part

Dimensions in millimetres

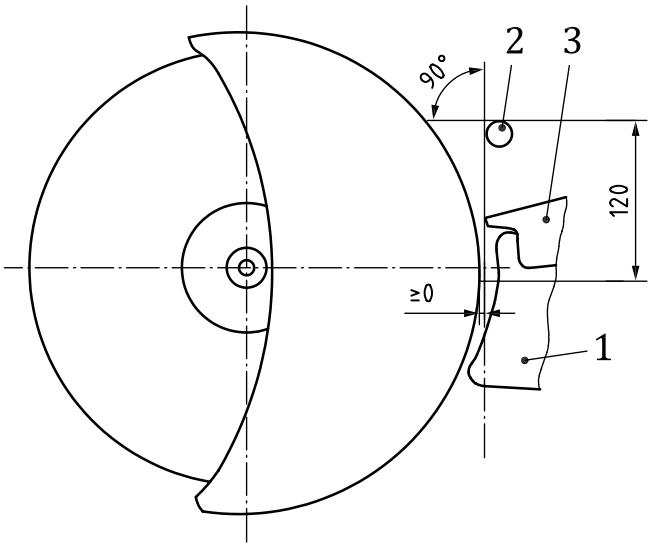


Key

1 muffler
2 front handle

Figure 11 — Required lateral distance between front handle and unprotected hot parts — Plan view

Dimensions in millimetres



Key

1 muffler
2 front handle
3 housing

Figure 12 — Protection against contact with hot parts

4.13.2 Verification

Protection against contact with the cylinder or muffler shall be verified by measuring the required distances. Protection for the muffler shall be verified by determining the contactable area, by applying the test cone as shown in Figure 13 with a force of $\left(10^{\ 0}_{-1}\right)$ N in any direction.

Dimensions in millimetres

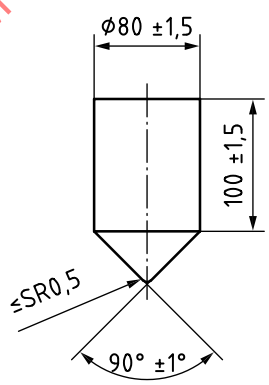
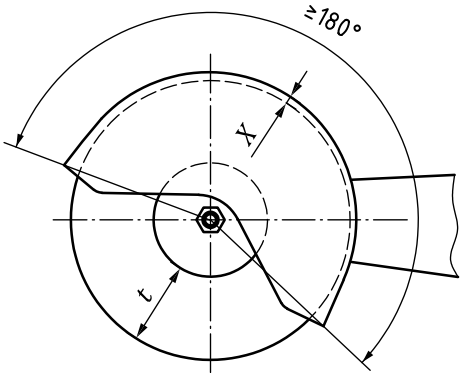


Figure 13 — Test cone

4.14 Cut-off wheel guard

4.14.1 Requirements

The machine shall have a cut-off wheel guard that requires the use of a tool for attachment or removal. The cut-off wheel guard shall cover continuously at least 180° of the circumference of the intended wheels (see Figure 14). Each side of the guard shall cover at least 60 % of the surface area of the 180° circumference covered by the guard. The guard shall remain in its position during normal operation.



Key

t maximum depth of cut

X radial clearance

Figure 14 — Cut-off wheel guard dimensions and maximum depth of cut

If the guard is designed to rotate around the wheel centre, tools shall not be required to perform the adjustment.

The cut-off wheel shall be replaceable without the need to dismount the guard.

The radial clearance (see Figure 14) between the guard and a cut-off wheel with the maximum outer diameter (see 5.1) shall not be more than 15 mm, to avoid the possibility of mounting an oversized cut-off wheel. The radial clearance does not need to be respected along the whole periphery of the guard.

The strength of the cut-off wheel guard shall comply with Annex A and remain functionally intact after the tests. Minor deformations and superficial damage are accepted. Any fixing devices, such as screws, shall remain intact.

The design of the machine shall incorporate a provision for dust reduction resulting from the cutting process which allows the operator to attach the provision to, for example, water injection or a vacuum to enable its effective operation.

4.14.2 Verification

The attachment of the guard and the enclosure of the wheel shall be verified by inspection and measurement and a functional test. The strength requirements shall be verified by functional testing in accordance with Annex A. The provisions to reduce the emission of dust shall be verified by inspection and a functional test.

4.15 Flange locking device

4.15.1 Requirements

The flanges shall have positive locking to the spindle to prevent flange rotation on the spindle. The fastening of the flanges and the cut-off wheel to the spindle shall not be loosened by rotational forces or torque from the spindle. When applying a torque, *M*, as specified in 4.15.2, there shall be no movement between the cut-off wheel and the flanges and the spindle.

4.15.2 Verification

The locking of the flanges to the spindle shall be verified by inspection and the following tests.

a) Attach the cut-off wheel and flanges to the spindle with the specified wheel-fastener tightening torque (see 5.1.2).

b) Lock the spindle and apply to the cut-off wheel a rotational torque M, in newton metres (Nm), calculated as follows:

$$M = 0{,}4 \times V \times k$$

where

V is the engine displacement in cubic centimetres (cm^3);

k is the gear ratio (engine/spindle speed).

c) Repeat the test five times in the normal rotational direction, then five times in the opposite direction of rotation. Observe for any movement.

4.16 Flange assembly

4.16.1 Requirements

The machine shall be equipped with two flanges (see Figure 15) made of steel or another material having comparable physical properties and which complies with the dimensions given in Table 2 for all types of cut-off wheels and Table 3 for superabrasive cut-off wheels only. Both flanges shall have the same outer diameter and the same contact surface.

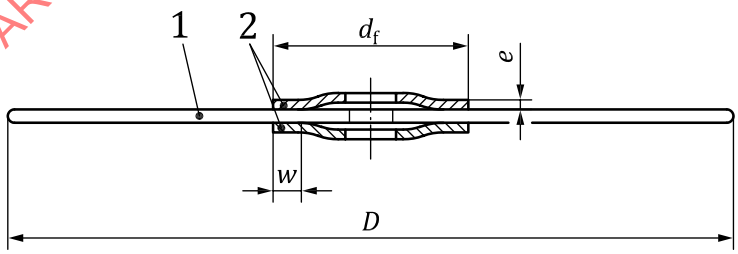
Flanges according to Table 2 shall always be provided with the machine. Optionally, flanges with dimensions according to Table 3 may be provided and shall be marked "For superabrasive cut-off wheels only".

Flanges will be considered suitable if they are mounted as shown in Figure 15 and loaded with the specified wheel-fastener tightening torque. The contact surface, w, of the flange shall be flat after the loading.

See also 5.1.2 for required information on the correct combination of flanges and cut-off wheel.

4.16.2 Verification

The dimensions and radial width of the flanges shall be verified by measurement. After applying the specified wheel-fastener tightening torque, the flatness of the flanges and the contact with the cut-off wheel shall be verified by inspection and gauging with a 0,05 mm thick gauge. It shall not be possible to insert the gauge at any point around the flange circumference between the flange contact surface and the surface of the cut-off wheel. Blotters shall not be used during the test.



Key

1 cut-off wheel

2 flange

Figure 15 — Cut-off wheel and flange dimensions

Table 2 — Cut-off wheel and flange dimensions — Abrasive and superabrasive wheels

Dimensions in millimetres

Cut-off wheel	Flange assembly		
Nominal outer diameter D	Minimum outside diameter d_f	Minimum radial width of contact surface w	Minimum recess e
≤250	63,5	7,9	1,5
>250; ≤300	75	13	1,5
>300; ≤350	87,5	15	1,5
>350; ≤400	100	17	1,5

Table 3 — Cut-off wheel and flange dimensions — Superabrasive wheels only

Dimensions in millimetres

Cut-off wheel	Flange assembly		
Nominal outer diameter D	Minimum outside diameter d_f	Minimum radial width of contact surface w	Minimum recess e
≤250	37,5	6	1,5
>250; ≤300	45	7,2	1,5
>300; ≤350	52,5	8,4	1,5
>350; ≤400	60	9,6	1,5

4.17 Spindle diameter

4.17.1 Requirements

The nominal diameter for the spindle shall be equal to the arbor hole diameter of the cut-off wheel as specified in the instruction handbook, with a tolerance of 0 mm to −0,06 mm.

4.17.2 Verification

The requirement shall be verified by measurement.

4.18 Special tools

4.18.1 Requirements

If special tools are needed for mounting and removal of the cut-off wheel and for adjusting the idle speed, they shall be provided with the machine.

4.18.2 Verification

This requirement shall be verified by inspection.

4.19 Noise

4.19.1 Reduction by design at source and by protective measures

Noise reduction shall be an integral part of the design process, thus specifically taking into account measures at source. The success of the applied noise reduction measures is assessed on the basis of the actual noise emission values. The main sources causing and influencing noise are generally the air intake system, engine cooling system, engine exhaust system, cutting system, and vibrating surfaces.

ISO/TR 11688-1 gives general technical information and guidance for the design of low-noise machines. Special care shall be taken in the acoustical design of cut-off machines.

NOTE ISO/TR 11688-2 gives useful information on noise generation mechanisms in machinery and ISO 14163 gives guidelines for noise control by mufflers. ISO 11691 and ISO 11820 can be used for the testing of the muffler.

4.19.2 Noise measurement

The A-weighted emission sound pressure level at the operator's position and the A-weighted sound power level shall be measured and calculated in accordance with Annex B.

4.20 Vibration

4.20.1 Reduction by design at source and by protective measures

Vibration reduction shall be an integral part of the design process, thus specifically taking into account measures at source. The vibration total values measured for each handle indicate the success of the applied vibration-reduction measures. The main sources causing and influencing vibration are generally the dynamic forces from engine, cut-off wheel, unbalanced moving parts, impact in gear sprockets, bearings and other mechanisms and the interaction between operator, machine and material being worked.

Besides measures to reduce vibration at source, technical measures such as isolators and resonating masses shall be used to isolate, when appropriate, the vibration source from the handles.

NOTE 1 CR 1030-1 gives general technical information on widely recognized technical rules and means and can be used as a guideline for the design of reduced hand-arm-vibration machines.

NOTE 2 Annex E provides useful information about round-robin data on vibration levels.

4.20.2 Vibration measurement

The vibration shall be measured and the equivalent-vibration total value shall be calculated for each handle in accordance with Annex C.

NOTE The equivalent-vibration total value, $a_{hv,eq}$, can be used to determine the daily vibration exposure according to ISO 5349-1 and ISO 5349-2, taking into account the local conditions of use for the time of exposure and type of work to be executed.

4.21 Electromagnetic immunity

4.21.1 Requirements

All electronic components used in the systems to control the machine shall meet the acceptance criteria of ISO 14982:1998, 6.3 and 6.6, concerning electromagnetic immunity of the machine.

4.21.2 Verification

The electromagnetic immunity shall be verified by testing as specified in ISO 14982.

5 Information for use

5.1 Instruction handbook

5.1.1 General

For information to be provided to the user, the content of this clause, together with ISO 12100:2010, 6.4, shall apply.

5.1.2 Technical data

The instruction handbook shall give the following technical information for each operating condition.

a) Mass

— Dry weight of machine without cut-off wheel and accessories and with empty tank, in kilograms (kg).

b) Volume

— Fuel tank, in litres (l).

c) Cut-off wheel

— Maximum outer diameter, in millimetres (mm).

— Arbor hole diameter, in millimetres (mm).

— Minimum flange outside diameter, d_f, in millimetres (mm).

— Wheel-fastener tightening torque, in newton metres (Nm).

— Maximum cut-off wheel speed, in revolutions per minute (min^{-1}).

— Wheel-type limitation, including correct combination of flanges and cut-off wheel, as well as tightening torque (if applicable).

d) Spindle

— Spindle diameter, in millimetres (mm).

— Maximum spindle speed, in revolutions per minute (min^{-1}).

e) Engine

— Engine displacement, in cubic centimetres (cm^3).

— Rated engine power at rated engine speed (in accordance with ISO 7293), in kilowatts (kW).

— Idle speed (id), in revolutions per minute (min^{-1}).

— Rated engine speed (in accordance with ISO 7293), in revolutions per minute (min^{-1}).

f) Noise and vibration

— Values for A-weighted emission sound pressure level at the operator position and its uncertainty, determined in accordance with Annex B, in decibels (dB).

— Values for A-weighted sound power level and its uncertainty, determined in accordance with Annex B, in decibels (dB).

— Values for equivalent-vibration total value and its uncertainty for each handle, determined in accordance with Annex C, in metres per second squared (m/s^2).

The declared values given in the instruction handbook shall be given together with a reference to this document.

If sales literature contains information on health and safety requirements, it shall not deviate from those given in the instruction handbook. If sales literature contains information on emissions, it shall contain the same information as described in the instruction handbook.

5.1.3 Other information

The instruction handbook shall contain, in accordance with ISO 12100:2010, 6.4.5, comprehensive instructions and information on all aspects of operator/user maintenance and the safe use of the cut-off machine, including type and use of personal protective equipment (PPE), suitable clothing and the need for training in all manual machine operations. The instructions shall take into account the use of a machine by a first-time and/or inexperienced operator.

The importance of reading the instruction handbook thoroughly before using the cut-off machine shall be stressed on the front of the instruction handbook.

The instruction handbook shall at least cover information relating to the following.

a) Transport, handling and storage of the cut-off machine, including

   — recommendation to dismount the cut-off wheel during transport; and

   — recommendations for storage of the machine, including cleaning and maintenance.

b) Commissioning of the cut-off machine, including

   — assembly instructions, initial adjustments and checks;

   — information regarding starting and stopping, with particular reference to safety;

   — information regarding pre-operating measures and daily maintenance techniques, including instructions for adjustment of idling speed;

   — information about the importance of only using cut-off wheels designed for use on hand-held cut-off machines and a warning of the possible consequences of using a cut-off wheel not intended for hand-held cut-off machines;

   — selection and mounting of the correct cut-off wheel for the type of work to be carried out;

   — information regarding correct positioning and fixing of the cut-off wheel guard, including use of blotters, choice of flanges and tightening torque, and if a special tool is needed, this has also to be described;

   — fuelling and refuelling, especially concerning fire precautions and the risk of smoking during refuelling procedures, and that of fuel spillage and fire ignition by sparks when cutting metal;

   — information about the existence of cut-off wheel standards and advise to only use cut-off wheels which comply to a cut-off wheel standard and warn about possible risks to use non-compliant cut-off wheels;

     NOTE Specific national or regional standards/regulations, for example EN 13236 or EN 12413 or ANSI B7.1 can be available.

   — warning against the use of reducing bushings and spindle sleeve if not allowed by the manufacturer of the machine; if allowed by the manufacturer of the machine, the manufacturer shall provide information on the correct use of reducing bushings and spindle sleeves.

c) Information regarding the cut-off machine, including

   — description, identification and nomenclature of principal parts, including the safety devices of the machine, and an explanation of its function;

- explanation of symbols and warnings;
- information to use only wheels which are in compliance with national or regional standards/ regulations, for example EN 13236 or EN 12413 or ANSI B7.1;
- information that it is prohibited to use any other type of cutting attachment, i.e. circular saw blades;
- information about the selection of wheels with regards to the intended use, checking if the wheel is designed to cut the material, ensuring that the maximum wheel operating speed is not exceeded by the machine and that the wheel is within date;
- information on spindle diameter and the use of adjustment rings;
- in addition to the declared values of the A-weighted emission sound pressure level at the operator's position and of the A-weighted sound power level (see 5.1.2 f)), include a warning about the risks and measures to be taken to minimize those risks; an octave band analysis shall be supplied upon request to enable the selection of correct hearing protection; and
- equivalent vibration, including warning about the risks and measures to be taken to minimize those risks (including an explanation of white-finger risks and means for the users to protect themselves).

d) Use of the cut-off machine, including the following:

- operating instructions and instructions for common cutting tasks, including proper positioning of the machine and advice to use the machine only with both hands, having a firm grip on both handles, prohibited operations and warning against the use of the unit while tired, ill or under the influence of alcohol or other drugs;
- if the cut-off wheel guard is designed to rotate around the centre of the wheel, provide instructions how to adjust the guard to direct the cutting debris away from the operator;
- advice to organize the work to be undertaken, paying special attention to surveying the site in order to note any hazards, such as electrical cables and flammable substances, to the use of warning signs, and to safe working distance from other persons;
- instructions to inspect the cut-off wheel for cracks, distortion of shape or unbalance and to reject any such cut-off wheel that does not meet this requirement;
- a warning not to leave the engine running while unattended;
- a warning not to carry the machine when the engine is running and the wheel rotating, e.g. when moving from one workplace to another;
- a warning not to place the machine on the ground while the wheel is rotating; always wait until the wheel has come to a complete stop;
- instructions for the use of PPE, which shall include recommendations for the appropriate type of equipment to be used;
- a warning that the machine shall not be used where flammable substances and gases are present, emphasizing the need for sufficient ventilation;
- a warning that the machine produces exhaust fumes, which include hydrocarbons and benzene, when running emphasizing the need for sufficient ventilation, not only if used indoors but also when working in trenches, hollows or other confined locations;
- instructions regarding exposure to noise: selection and use of hearing protection, including recommendations for limiting the duration of operation, if appropriate;

- instructions regarding exposure to vibration with an explanation of white-finger risks and means for users to protect themselves and, if appropriate, recommendations for limiting the duration of operation;
- a warning about hazards which may be encountered, such as movements caused by reactive forces (i.e. climbing, pulling, pinching and especially rotational reactions) and gyroscopic forces, while using the machine and how to avoid them;
- instructions on the need to control the dust emission at the source;
- instructions to cut wet (with the use of water) with superabrasive wheels whenever feasible;
- a warning not to use water with bonded-abrasive wheels unless otherwise specified by the wheel manufacturer;
- warning not to cut asbestos materials.

e) Maintenance instructions, including

- instructions on servicing and replacement tasks for the user, including the need to keep the machine in good working condition;
- specifications of the spare parts to be used, when these affect the health and safety of operators;
- drawings or diagrams to explain user performed maintenance and troubleshooting tasks;
- provision of sufficient information to enable the user to maintain the safety system throughout the life of the product with an explanation of the consequences of improper maintenance, use of non-conforming replacement components, or the removal or modification of safety components.

5.2 Markings

All cut-off machines shall be marked with the following information as a minimum:

- business name and full address of manufacturer and, where applicable, his authorized representative;

  NOTE 1 The term *'full address'* means a postal address that is sufficient to enable a letter to reach the manufacturer. The name of the country or town alone is not sufficient.

- designation of series or type;
- designation of machinery;

  The designation of machinery is to allow the technical identification of the product and this can be achieved by a combination of letters and/or numbers. In this case, the explicit designation shall be given in the instruction handbook:

- serial number, if any;
- direction of rotation of the spindle for the cut-off wheel;
- year of construction, i.e. the year in which the manufacturing process is completed.

In addition, the machine shall bear the following additional information:

- maximum spindle speed;
- operator controls/interfaces, for example:
  - run and stop controls;
  - fuel cap;
  - carburettor adjustments.

NOTE 2 Identification is preferably in accordance with ISO 3767-5.

If symbols are used, they shall be explained in the instruction handbook.

When symbols are used, they shall, except if they are cast, embossed or stamped, be in contrast to their background. Embossed features shall be at least 0,3 mm in height. The information and/or instructions provided by the symbols shall be clearly legible when viewed by the naked eye from a distance of not less than 500 mm.

The markings shall be located in a readily visible position and shall resist the anticipated service conditions, e.g. the effects of temperature, moisture, petrol, oil, abrasion and weathering exposure.

5.3 Warnings

All cut-off machines shall be marked with the following warnings:

— a sign indicating “WARNING: SEE INSTRUCTION HANDBOOK”;

— symbol(s) indicating that head, eye, hearing protection and dust protection, are necessary;

— a warning for reactive movement of the machine during use;

— a warning for sparks (fire risk);

— a warning of inhalation of exhaust gases;

— a statement that the use of a damaged cut-off wheel is prohibited;

— a statement that the use of a saw blade is prohibited.

All text can be replaced by symbols or pictorials.

NOTE Guidelines for the design of pictorials are also given in ISO 11684.

If symbols or pictorials are used, they shall be explained in the instruction handbook.

The warnings shall be located in a readily visible position on the cut-off machine and shall resist the anticipated service conditions, e.g. the effects of temperature, moisture, petrol, oil, abrasion and weathering exposure.

When symbols are used, they shall, except if they are cast, embossed or stamped, be in contrast to their background. Embossed features shall be at least 0,3 mm in height. The information and/or instructions provided by the symbols shall be clearly legible when viewed by the naked eye from a distance of not less than 500 mm.

5.4 Test of labels

5.4.1 General

If labels are used to fulfil the requirements of 5.2 for marking and 5.3 for warnings, they shall be prepared in accordance with 5.4.2 and tested in accordance with 5.4.3, after which they shall undergo a visual inspection and be compared against an untested, new control specimen. No significant indications of indentation, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material, and/or no significant deterioration of print, shall be detected.

The labels shall also be prepared in accordance to 5.4.2 and tested in accordance with 5.4.4, after which the non-adhesion distance shall be a maximum of 1 mm from the specimen edge and the adhesive properties shall be at least 0,09w, in newtons, where w is the test specimen width, in millimetres.

5.4.2 Preparation of test specimens and control specimens

5.4.2.1 General

New test specimens shall be prepared for each of the tests given in 5.4.3 and 5.4.4. New control specimens shall also be prepared for any test that involves a visual inspection.

5.4.2.2 Test panel

Test panels shall be made with a surface and material equal to that on which the sign shall be mounted.

The test panels shall be carefully cleaned with an appropriate solvent in order to remove all traces of adhesive, grease, oil and water, and then dried for at least 2 h.

5.4.2.3 Test specimens

The number of test specimens and control specimens prepared for each test shall be a minimum of three.

The test specimens and control specimens shall be the complete label wherever possible, except where the physical limitations of the test equipment do not allow for testing of an entire label or when the graphical content of the label has no effect on the result of the test. The minimum dimension of the test specimen shall be 13 mm width and 25 mm length.

The protective layer for the adhesive side shall be completely removed for the wipe resistance test (see 5.4.3). For the adhesion test (see 5.4.4), it shall be removed over a length of at least 15 mm, but leaving the protected end long enough to be attached to the pulling machine. The specimens shall then be applied to the test panel symmetrically. The applied specimens shall be rolled over five times using a steel roller with a rubber coating having a width at least 2 mm wider than the test specimen and a diameter of 30 mm to 60 mm; the roller shall be applied with a force of 50 N and a rolling speed of approximately 200 mm/s shall be maintained.

After being applied to the test panels, the test specimens shall be conditioned at a temperature of 23 °C ± 5 °C with a relative humidity of 50 % ± 20 % for at least 24 h prior to testing.

5.4.3 Wipe resistance test

Three test specimens shall be mounted on test panels in accordance with 5.4.2 and then immersed in the test liquid for 300 s ± 3 s.

After having removed it from the test liquid, wipe the test specimen with a force of 10 N and 1 cycle per second, using an unbleached cotton cloth soaked in the test liquid for 30 s ± 3 s. After the wiping test has been completed, a visual inspection of the test specimens shall be carried out.

The test liquids shall be

a) water; and

b) a mixture by volume of 50 % isooctane and 50 % toluene.

5.4.4 Adhesion test

Three test specimens shall be mounted on test panels in accordance with 5.4.2 and immersed in the test liquid (50 % isooctane and 50 % toluene) for 30 min ± 1 min.

After removing the test specimens from the test liquid, inspect and measure any non-adhesion distances from the specimen edge.

Then, attach the test panel to a holder and the free end of the test specimens, still covered by a protective layer for the adhesive side, to a pulling machine. Apply a pulling force upwards at an angle of 90° to the test panel and at a speed of (60 ± 6) mm/min. Measure the tensile force required for this

over a distance of at least 15 mm. The average value of the tensile force, expressed in newtons, shall be calculated and recorded. If the test distance of 15 mm is not achievable because the test specimens tear, the test specimens shall be reinforced with a second layer on the label being tested.

Annex A
(normative)

Strength test of cut-off wheel guard

A.1 General

This test shall be used to analyse the strength of the guard. It is not intended to examine the protection of the operator in case of a wheel failure.

The test shall be performed inside a fully protected enclosure that can contain all of the cut-off wheel fragments and other debris.

This test creates flying debris and wheel fragments and should only be carried out in a properly constructed and equipped test facility.

A.2 Principle

In this test of the cut-off wheel guard, a non-reinforced wheel of the maximum size and thickness possible for appropriate mounting on the machine and running at the maximum spindle speed is burst. The fragments of the broken wheel hit the guard and transfer kinetic energy to the outer edge and the inner surface of the guard. In a subsequent examination, it is revealed whether or not the guard is significantly damaged.

A.3 Test setup

The test shall be performed inside a fully protected enclosure able to contain all of the cut-off wheel fragments and other debris. In this enclosure, the cut-off machine shall be suspended horizontally on ropes affixed to the front and rear handle, as shown in Figure A.1. If necessary, the cut-off machine may be stabilized in the lateral direction with two ropes fixed to a rod on the front handle.

As an alternative to the use of ropes, the test may be carried out with the cut-off machine mounted on a base.

The projectile used in this test shall have sufficient energy to burst the cut-off wheel (i.e. a steel ball or pin).

A.4 Test object

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

A.5 Preparation

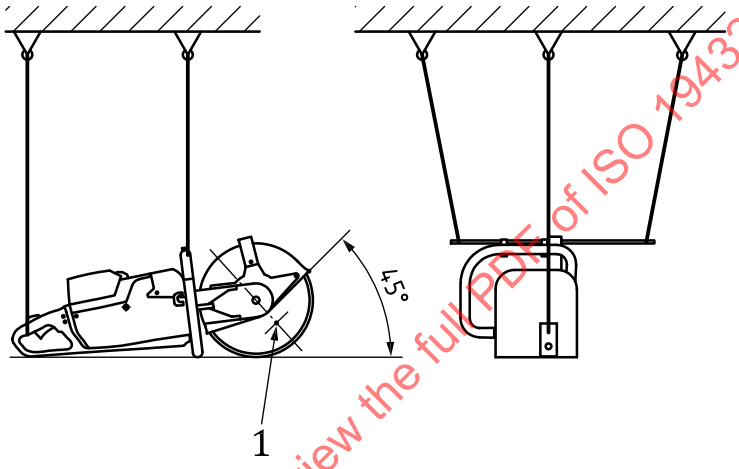
If the guard is adjustable, adjust the guard so that the exposed section of the wheel is at an angle of 45° to the horizontal as shown at Figure A.1. If the guard is not adjustable, perform the test with the guard set as given by the manufacturer.

A.6 Test procedure

The cut-off machine with a non-reinforced wheel of the maximum size and thickness possible for appropriate mounting on the machine and running at the maximum spindle speed shall be burst, while the machine is hanging horizontally on ropes affixed to the front and rear handles (see Figure A.1). The burst shall be caused by a projectile fired at the wheel or by another suitable method. The projectile shall hit the wheel in the middle of dimension t ± 25 mm (see 3.14 and Figure 14). The test shall be carried out until three separate wheel bursts are accomplished using the same guard.

A.7 Test result

After three consecutive tests, the guard shall be inspected. It shall have maintained its structural integrity such that the guard can furthermore be used for all applicable operations.



Key

1 impact point

Figure A.1 — Test setup for cut-off wheel — Burst test

Annex B
(normative)

Noise test code — Engineering method (grade 2 of accuracy)

B.1 General

The noise test code specified in this annex gives the information necessary for determining, efficiently and under standardized conditions, the noise emission characteristics of portable, hand-held, internal combustion engine-driven cut-off machines.

Noise emission characteristics include the A-weighted emission sound pressure level at the operator's position and the A-weighted sound power level.

The determination of these quantities is necessary for

— manufacturers, to declare the noise emitted;

— comparing the noise emitted by machines in the family concerned; and

— purposes of noise control at the source at the design stage.

Although the noise emission values determined are obtained in an artificial operation, they are representative of noise emission in a real work situation.

NOTE These quantities can also be used as an indicator for the evaluation of the daily exposure level and for the estimation of environmental noise.

The use of this noise test code enables reproducibility of the determination of the noise emission characteristics within specified limits determined by the grade of accuracy of the basic noise measurement method used. Noise measurement methods allowed by this annex are engineering methods (grade 2).

B.2 Quantities to be measured and quantities to be determined

Quantities to be measured are defined in ISO 3744 and ISO 11201. These are time-averaged sound pressure levels: A-weighted and, if required, in frequency bands.

Quantities to be determined are sound power levels and emission sound pressure levels: A-weighted and, if required, in frequency bands.

B.3 A-weighted sound power level determination

B.3.1 For the determination of the A-weighted sound power level, ISO 3744 shall be used, subject to the modifications or additions given in B.3.2 to B.3.5.

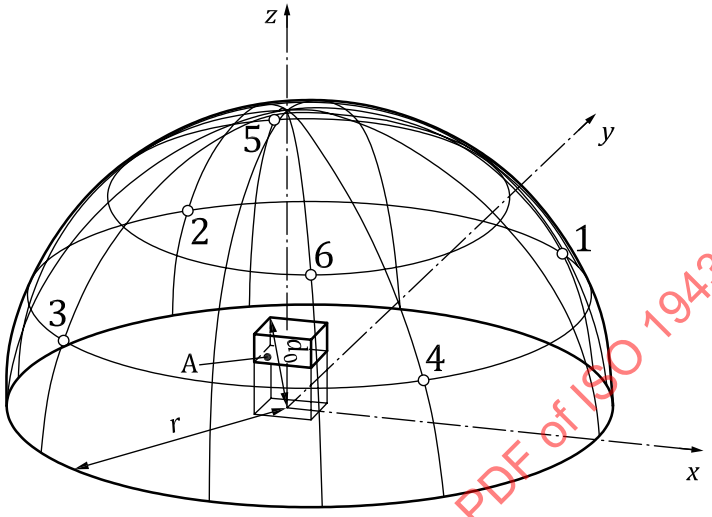
B.3.2 The microphone array shall be six microphone positions in accordance with Figure B.1 and Table B.1.

NOTE Experimental data has shown that use of this array does not yield results that differ significantly from those obtained with the 10-microphone array specified in ISO 3744.

The measurement surface shall be a hemisphere with a radius, r, of 4 m. Dimension d_0 is determined by the reference box and its defined location above ground (see Figure B.1). A smaller radius is permitted if

it is demonstrated that the results are within 0,5 dB, compared with measurements with a hemisphere of r = 4 m. If a smaller radius, r, is used, it shall not be less than $2d_0$, where d_0 is defined by the reference box enclosing the machine.

A smaller radius is permitted if it is demonstrated that the results are within 0,5 dB, compared with measurements with a hemisphere of r = 4 m (e.g. in an anechoic room where a radius of 4 m cannot be provided).



Key

A reference box

d_0 characteristic source dimension

r hemisphere radius ≥$2d_0$

NOTE For position numbers 1 to 6, see Table B.1.

Figure B.1 — Microphone positions on the hemisphere

Table B.1 — Coordinates of microphone positions

Position No.	X	Y	Z
1	+0,65r	+0,65r	0,38r
2	−0,65r	+0,65r	0,38r
3	−0,65r	−0,65r	0,38r
4	+0,65r	−0,65r	0,38r
5	−0,28r	+0,65r	0,71r
6	+0,28r	−0,65r	0,71r

B.3.3 Environmental conditions shall be within the limits specified by the manufacturers of the measuring equipment. The ambient air temperature shall be in the range from −10 °C to 30 °C and the wind speed shall be less than 5 m/s. A microphone windscreen shall be used each time the wind speed exceeds 1 m/s.

The value of the environmental correction K_{2A}, determined in accordance with ISO 3744:2010, Annex A, shall be a maximum of 2 dB.

B.3.4 Measurements shall be made using an integrating-averaging sound level meter as defined in IEC 61672-1.

B.3.5 The positive *x*-axis of the machine shall coincide with the positive *x*-axis of the hemisphere with the front handle vertically above the centre of the hemisphere (see Figure B.1).

The machine shall be mounted in the test stand in accordance with B.5.1.

B.3.6 The uncertainty, *K*, shall be calculated as $K = 1{,}5 \times \sigma_t$, where σ_t shall be calculated using the formula:

$$\sigma_t = \sqrt{\sigma_R^2 + \sigma_P^2}$$

where

σ_R is the standard deviation of reproducibility, where the given values in Annex E shall be used;

σ_P is the standard deviation of production and is calculated as follows:

σ_P is calculated from the measurement results of at least 5 machines. Determine s_P — the standard deviation of the sample — for a sample size of $n \geq 5$ machines. Because the production variation may enlarge under later production conditions, it is recommended to calculate σ_P as follows:

$$\sigma_P = S \times s_P$$

The necessary size of the safety factor, *S*, depends on the relation between s_P and σ_R as well as on the sample size *n*. See Table B.2.

Table B.2 — Values of the safety factor, *S*

n	$s_P \leq \sigma_R$	$s_P > \sigma_R$
5 to 7	1,3	1,5
8 to 12	1,2	1,3
13 to 19	1,0	1,1
≥20	1,0	1,0

The safety factor of 1,5 coincides with a 95 % confidence level when using a sample size of 5 machines.

NOTE σ_P in this standard includes σ_{omc}, which is considered in ISO 3744 and ISO 11201.

B.4 A-weighted emission sound pressure level measurement at the operator position

B.4.1 For the measurement of the A-weighted emission sound pressure level, ISO 11201:2010, accuracy grade 2, shall be applied, subject to the modifications and additions given in B.4.2 to B.4.4.

B.4.2 Environmental conditions shall be within the limits specified by the manufacturer of the measuring equipment. The ambient air temperature shall be in the range from −10 °C to 30 °C, and the wind speed shall be less than 5 m/s. A microphone windscreen shall be used each time the wind speed exceeds 1 m/s.

An octave band analysis shall be supplied upon request to enable the selection of correct hearing protection.

B.4.3 Measurements shall be made using an integrating-averaging sound level meter, as defined in IEC 61672-1.

B.4.4 The location of the microphone relative to the machinery shall be (700 ± 10) mm above the top of the front handle and vertically above the centre line between the outer edge of the rear and front handles. The microphone shall be in the plane of the cut-off wheel (see Figure B.2).

B.4.5 The uncertainty, K, shall be calculated as $K = 1{,}5 \times \sigma_t$, where σ_t shall be calculated using the formula:

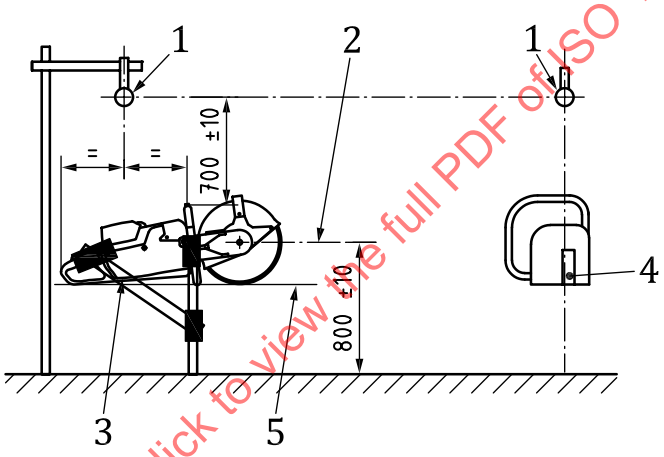
$$\sigma_t = \sqrt{\sigma_R^2 + \sigma_P^2}$$

where

σ_R is the standard deviation of reproducibility, where the given values in Annex F shall be used;

σ_P is the standard deviation of production — see B.3.6.

Dimensions in millimetres



Key

1 position of the microphone (for operator's position)
2 spindle centre
3 test fixture
4 rear handle
5 horizontal plane through the support points of the cut-off machine

Figure B.2 — Test setup and microphone position for the determination of the emission sound pressure level at the operator position

B.5 Mounting and operating conditions

B.5.1 Mounting

The machine shall be mounted on a test stand, as shown in Figure B.2, oriented with its supporting points in a horizontal plane (see Figure B.1) (800 ± 10) mm above the ground. A fixture shall be used which holds the machine in the intended position and which does not cause any reflections. A flexible mount is recommended to avoid any structural resonance.

B.5.2 Operating conditions

Measurements shall be carried out on a new, normal-production machine fitted with standard equipment. The engine and the machine shall be run-in prior to the test in accordance with the

manufacturer's instructions. The engine shall be at a normal stable operating temperature before the test is started.

The carburettor shall be set as marked on the machine (see 5.2).

The engine speed for all test conditions shall be kept constant to within ±3,5 s^{-1}.

An engine speed indicator shall be used to check the speed of the engine. It shall have a measurement uncertainty of ±1,0 % of the reading. The indicator and its engagement with the machine shall not affect the operation during the test.

No alterations to the initial settings are permitted once measurements have commenced.

B.6 Test procedure

B.6.1 General

A-weighted emission sound pressure levels shall be determined for two different operating conditions: idling (B.6.2) and at full load (B.6.3), and an A-weighted sound power level shall be determined for the full-load operating condition (B.6.3).

Perform the test as follows.

a) Carry out a minimum of four measurements with a significant change of speed between the measurements in order to allow the engine to stabilize. Each measurement at idle shall be separated by a short period of running the engine in the range of full-load speed, and the measurement at full-load speed shall be separated by a short period of idling.

b) Obtain at least four separate periods of noise data totalling at least 20 s.

c) Maintain each signal duration used for at least 2 s over which the engine speed shall be within ±3,5 r/s.

The collection of data for the two different operating conditions does not need to be carried out in any fixed sequence.

The range of all values noted for each operating condition shall not be greater than 2 dB. If this range is exceeded, repeat the tests until four consecutive results fall within a range of 2 dB. The final value to be retained for each microphone position is the arithmetical mean of the four successive values satisfying this requirement.

For all the conditions according to B.6.2 and B.6.3, this procedure shall be followed when measuring the A-weighted emission sound pressure levels. When determining the A-weighted sound power level, this procedure shall be applied to the sound pressure levels averaged over the six microphone positions (L'_{pA}).

B.6.2 Idling

Take the measurements with a fully released throttle trigger. The idling speed shall be adjusted in accordance with the machine manufacturer's instructions. The cut-off wheel shall not move.

B.6.3 Full load

Take the measurements during a simulated cutting with the throttle fully open. The engine speed shall be kept at the maximum engine power speed, determined in accordance with ISO 7293, by adjustment of the load applied by the loading device (e.g. water brake) on the spindle.

NOTE An example of a water brake application can be found in ISO 22868.

The loading device attached to the spindle shall be capable of absorbing the energy of the machine. If a water brake is used, the speed of the engine shall be controlled by the water flow inside of the water

brake. The weight, shape or design of the loading device shall be such that there is no influence on the noise readings.

B.7 Information to be recorded and reported

The following information, when applicable, shall be recorded and reported for all measurements made in accordance with the requirements of this annex.

a) Machine under test

   1) Description of the machine (including its engine displacement, manufacturer, type and serial number, and size and type of cut-off wheel);

   2) operating conditions, according to Tables B.4 and B.5 during noise testing.

b) Acoustic environment

   1) Description of the test environment:

      — if outdoors, a sketch showing the location of the machine with respect to the surrounding terrain, including a physical description of the test environment (the nature of the ground plane shall be described);

      — if indoors, a description of the physical treatment of walls, ceiling and floor, with a sketch showing the location of machine and room contents.

   2) Value of K_{2A}.

c) Instrumentation

   1) Equipment used for the measurements, including name, type, serial number and manufacturer.

   2) Method used to calibrate the instrumentation system.

   3) Date and place of the most recent calibration of the acoustical calibrator.

d) Acoustical data

   1) A-weighted sound pressure levels of the background noise at the microphone positions.

   2) Emission sound pressure levels (see Table B.3):

      — A-weighted emission sound pressure level at operator position at full load;

      — A-weighted emission sound pressure level at operator position at idle speed;

      — A-weighted emission sound pressure level at operator position calculated for a work cycle composed of 1/7 idling and 6/7 full-load operating conditions.

      The A-weighted emission sound pressure level at the operator position for the work cycle, $L_{pA,wc}$, in decibels (dB), shall be determined using the formula:

$$L_{pA,wc} = 10\lg\left(\frac{1}{7}10^{0,1L_{pA,Id}} + \frac{6}{7}10^{0,1L_{pA,Fl}}\right)$$

-weighted sound 3) The A where

$L_{pA,Id}$ is the A-weighted emission sound pressure level at the operator position for idling;

$L_{pA,Fl}$ is the A-weighted emission sound pressure level at the operator position for full load.

power level (see Tables B.4 and B.5) for the full-load operating condition, $L_{WA,Fl}$.

e) Air temperature and wind speed

f) Date and place of measurements

Table B.3 — A-weighted emission sound pressure level determination — Recording and reporting measured values, mean values and emission values

Operating conditions	Engine speed s^{-1}	Measured A-weighted sound pressure levels L'_{pA} dB					Arithmetic mean value $\overline{L'_{pA,X}}$ dB	Correction factor K_{1A}	A-weighted emission sound pressure level $L_{pA,X}$ dB
		Test no.							
		1	2	3	4	n			
Idling (Id)									
Full load (Fl)									

NOTE The emission sound pressure level for the respective operating conditions X is calculated from

$$L_{pA,X} = \overline{L'_{pA,X}} - K_{1A}$$

where

K_{1A} is the background noise correction, according to ISO 11201;

X is the operating condition for idling (Id) or full load (Fl).

Table B.4 — A-weighted sound power level determination — Recording and reporting measured A-weighted sound pressure levels

Test	Operating condition	Engine speed r/s	L'_{pA1} dB	L'_{pA2} dB	L'_{pA3} dB	L'_{pA4} dB	L'_{pA5} dB	L'_{pA6} dB	$\overline{L'_{pA}}$ dB
1	Full load (Fl)								
2	Full load (Fl)								
3	Full load (Fl)								
4	Full load (Fl)								
N	Full load (Fl)								
Average sound pressure level $\overline{L'_{pAFI}}$	Full load (Fl)	$\overline{L'_{pAFl}}$ = dB							

Individual values for L'_{pA} shall only be reported if available. The test procedure may include automatic averaging.

NOTE 1 L'_{pA1} to L'_{pA6} are the measured time-averaged sound pressure levels at the corresponding microphone positions.

NOTE 2 $\overline{L'_{pA}}$ is the averaged sound pressure level according to ISO 3744:2010, Formula (4).

NOTE 3 $\overline{L'_{pAFI}}$ is the arithmetic average of the values for $\overline{L'_{pA}}$ for the full-load operating condition.

Table B.5 — A-weighted sound power level determination — Recording and reporting sound power data

Operating condition	Average sound pressure level $\overline{L'}_{pA,Fl}$ dB	Correction factor K_{1A} dB	Surface sound pressure level $\overline{L}_{pA,Fl}$ dB	Surface level L_S dB	Sound power level L_{WAFl} dB
Full load (Fl)					
Environmental correction K_{2A} = dB					

NOTE 1 $\overline{L'}_{pAFl}$ is the arithmetic average of the values for $\overline{L'_{pA}}$ given for the full-load operating condition.

NOTE 2 The surface sound pressure level $\overline{L}_{pA,Fl}$ for the full-load operating condition is calculated from:

$$\overline{L}_{pA,Fl} = \overline{L'}_{pA,Fl} - K_{1A} - K_{2A}$$

where

K_{1A} is the background noise correction according to ISO 3744:2010, 8.3;

K_{2A} is the environmental correction (see B.3.3).

NOTE 3 The sound power level $L_{WA,Fl}$ for the full-load operating condition is calculated from:

$$L_{WA,Fl} = \overline{L}_{pA,Fl} + L_S$$

where

$L_S = 10\lg\frac{S}{S_0}$ is expressed in decibels, with $S_0 = 1\ m^2$;

S is the surface of the hemisphere, expressed in square metres.

B.8 Declaration of noise emission levels

The noise declaration shall provide:

— the dual-number value of the A-weighted emission sound pressure level at the operator position as defined in ISO 4871, i.e. values of A-weighted emission sound pressure level and associated uncertainty given separately, for the work cycle as defined in B.7 e);

— the single-number value of the A-weighted sound power level as defined in ISO 4871, i.e. the value of the sound power level plus the value of the associated uncertainty, for full load.

Noise emission values (A-weighted emission sound pressure level at the operator's position) for applicable operating modes (idling, full load) shall be made available on request.

The noise declaration shall include a reference to this noise test code and to the basic standard used, i.e. ISO 3744 and/or ISO 11201. Deviations, if any, from this test code and/or the basic standards shall also be indicated.

NOTE 1 The uncertainty to be associated with the declared noise level(s) is based on the total standard deviation σ_t which is composed of the standard deviation of reproducibility σ_R and the standard deviation of production σ_p. Results from round-robin tests carried out in 2007 and 2008 concerning σ_R are given in Annex E. The determination of σ_p is done by the manufacturer, based on experience of the production variation.

NOTE 2 Methods for the determination of uncertainty and the verification of declared values are given in ISO 3744, ISO 11201 and ISO 4871.

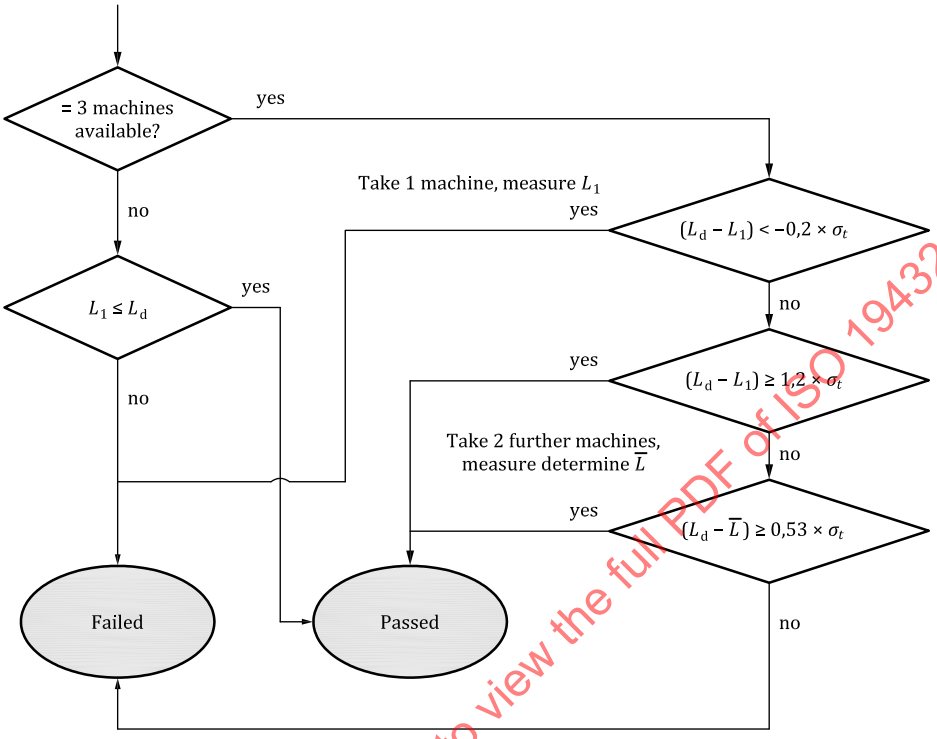
B.9 Verification of the declared sound power level and emission sound pressure level

If a verification is made, the method given below shall be used.

This verification is a double-sample test with sample size n_1 = 1 for the first sample and sample size n_2 = 2 for the second sample as described in ISO 7574-4:1985, 6.3 and Table 2. These sample sizes are the most practical way for verification.

The same σ_t used during declaration shall be used also for verification: $\sigma_R = K/1{,}5$.

The procedure is shown in Figure B.3 as a graphic.



Key sound power

L_1 measured sound power level of sample 1

L_d measured sound power level + K

$\overline{L}$ mean level of measured sound power levels

σ_t total standard deviation

Key sound pressure

L_1 measured emission sound pressure level of sample 1

L_d declared emission sound pressure level + K

$\overline{L}$ mean level of measured emission sound pressure level

σ_t total standard deviation

Figure B.3 — Verification procedure

The procedure for verification described here may fail, if for comparison the whole figure of L_{WAd} which comes from rounding down to get the final declared sound power level or emission sound pressure level, is used. The calculation shall be based on the un-rounded result of $L_{WAm} + K$. This term may be shown in the technical documentation.

Annex C
(normative)

Measurement of vibration values at the handles

C.1 General

The vibration test code specified in this annex gives the information necessary for determining efficiently and under standardized conditions the vibration emission characteristics of portable, hand-held, internal combustion engine-powered cut-off machines.

It presents a test procedure for establishing the magnitude of vibration at the handles of the machine and is suitable for product control as well as type tests.

It is intended that the results obtained be used to compare different machines or different operating conditions 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.

NOTE While these measurements can indicate vibration values experienced in real work situations, it is possible that this is not correct for specific operations.

C.2 Vibration parameters to be measured and determined

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

Quantities to be determined are total-vibration values, a_{hv}, and the equivalent-vibration total value, $a_{hv,eq}$, for each handle.

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}).

C.3 Instrumentation

C.3.1 General

The vibration measurement system and frequency weighting for hand-arm shall be in accordance with ISO 8041-1.

C.3.2 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, according to 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.

C.3.3 Fastening of accelerometer

The accelerometer shall be glued onto the handle according to ISO 5349-2:2001, 6.1.4.

For measurement on handles with resilient covers (e.g. a cushioned handle), the resilient material shall be removed from the area where the accelerometer shall be glued.

C.3.4 Calibration

The whole measuring chain, including the accelerometer, shall be checked before and after use, as well as whenever necessary, to ensure accuracy during any sequence of measurements, in accordance with ISO 8041-1. The accelerometers shall be calibrated in accordance with ISO 16063-1.

C.3.5 Speed indicator

The rotational frequency of the engine shall be measured with an accuracy of ±1,0 %. The speed indicator and its engagement with the machine shall not affect the operation during the test.

C.4 Measurement direction and location

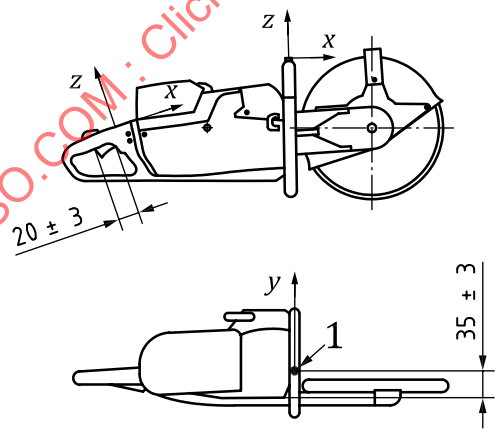
Measurements shall be made at each hand-grip, where the operator normally holds the machine. Measurements shall be made in the three directions *x, y* and *z*.

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

For the front handle, the accelerometer shall be mounted 35 mm ± 3 mm to the right of the point of lateral balance on the front handle with feed force, and with the cut-off wheel centre-mounted (see Figure C.1). If this dimension 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, the accelerometer shall be 20 mm ± 3 mm in front of the throttle-trigger rear end (see Figure C.1). If this cannot be obtained, it shall be placed as close as possible to the hand holding the handle, between the thumb and index finger.

Dimensions in millimetres



Key

1 lateral balance point

Figure C.1 — Position of accelerometers

C.5 Operating conditions, testing and presentation of results

Measurements shall be carried out on a new machine, featuring standard equipment and with the tank(s) at least half full. The cut-off wheel used shall be a superabrasive wheel with the maximum permissible diameter and an unbalance of 250 g · mm to 260 g · mm.