INTERNATIONAL STANDARD

ISO 11393-1

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Protective clothing for users of hand-held chain-saws —

Part 1:
Test rig driven by a flywheel for testing resistance to cutting by a chain-saw

Vêtements de protection pour utilisateurs de scies à chaîne tenues à la main —

Partie 1: Banc d'essai à volant d'inertie pour les essais de résistance à la coupure par une scie à chaîne

Reference number
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Contents

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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 3.

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.

International Standard ISO 11393-1 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*.

ISO 11393 consists of the following parts, under the general title *Protective clothing for users of hand-held chain-saws*:

— *Part 1: Test rig driven by a flywheel for testing resistance to cutting by a chain-saw*

— *Part 2: Test methods and performance requirements for leg protectors*

— *Part 3: Test methods for footwear*

— *Part 4: Test methods and performance requirements for protective gloves*

— *Part 5: Test methods and performance requirements for protective gaiters*

— *Part 6: Test methods and performance requirements for jackets with protection against cuts*

Annexes A and B of this part of ISO 11393 are for information only.

Introduction

This part of ISO 11393 forms part of a series concerned with personal protective equipment designed to protect against the risks arising from the use of hand-held chain-saws.

No personal protective equipment can ensure a 100 % protection against cutting from a hand-held chain-saw. Nevertheless, experience has shown that it is possible to design personal protective equipment which offers a certain degree of protection.

Different functional principles may be applied in order to give protection. These include:

a) chain slipping: on contact the chain does not cut the material;

b) clogging: fibres are drawn by the chain into the drive sprocket and block chain movement;

c) chain braking: fibres have a high resistance to cutting and absorb rotational energy, thereby reducing the chain speed.

Often more than one principle is applied.

Protective clothing for users of hand-held chain-saws —

Part 1:
Test rig driven by a flywheel for testing resistence to cutting by a chain-saw

1 Scope

This part of ISO 11393 specifies the test rig to be used to assess the resistance of personal protective equipment to cutting by hand-held chain-saws. It also describes the calibration procedure.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of part of ISO 11393. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 11393 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3386-1, *Polymeric materials, cellular flexible — Determination of stress-strain characteristics in compression — Part 1: Low-density materials.*

ISO 4915:1991, *Textiles — Stitch types — Classification and terminology.*

ISO 11393-2, *Protective clothing for users of hand-held chain-saws — Part 2: Test methods and requirements for leg protectors.*

ISO 11393-3, *Protective clothing for users of hand-held chain-saws — Part 3: Test methods for footwear.*

3 Terms and definitions

For the purposes of this part of ISO 11393, the following terms and definitions apply.

3.1
chain-saw
saw with teeth on an endless chain

3.2
resistance to cutting
general term for the various ways in which a protective material can reject or decelerate the chain of a chain-saw

NOTE It is measured by applying a moving saw chain with a certain chain speed and energy and studying whether the chain cuts through.

3.3
cut-through
term used when a saw chain has penetrated through a sample so that the cut is longer than 10 mm in the layer nearest to the body

3.4
chain stopping time
period of time taken for the saw chain to decelerate from a specified speed to complete rest, when the saw unit is not under power

3.5
free-running stopping time
chain stopping time when the chain is not brought into contact with a test piece

3.6
threshold chain speed
maximum speed which a sample can withstand during testing without cut-through occurring

3.7
chain slipping
protective effect whereby the saw chain slides over the surface of the protective material without cutting it

3.8
clogging
effect whereby fibres, yarns or other materials are drawn by the saw chain into the saw unit, thereby stopping the movement of the saw chain

3.9
chain braking
effect whereby fibres or other materials of the personal protective equipment slow the speed of the saw chain sufficiently to prevent its advancement

3.10
cutting line
tangent to the curve made by teeth of the saw chain at the point where it is in contact with a test specimen

4 Principles

The test rig described in this part of ISO 11393 has been designed to apply a moving saw chain to personal protective equipment in such a way that both the speed of the chain and the amount of kinetic energy available for cutting are controllable.

This standardization is achieved by ensuring that the chain is not under power at the moment of test. Instead the chain is moving solely under the influence of its own momentum, together with that of a flywheel of known inertia to which it is coupled.

In order to conduct a test, the chain is first driven up to the required speed by means of any convenient motor. At the moment of test, the motor is then physically disconnected from the chain and flywheel. Simultaneously the chain is allowed to pivot down from a minimal height onto the test sample. The chain subsequently continues to move (and under normal circumstances, to cut into the sample) until all of its kinetic energy has been dissipated.

The result of the test is then reported as to whether or not the sample shows a cut-through at the test speed.

5 Apparatus

5.1 Test rig

The test rig consists of the following major components:

— a power unit and a connecting device that transfers rotational energy to the saw unit;

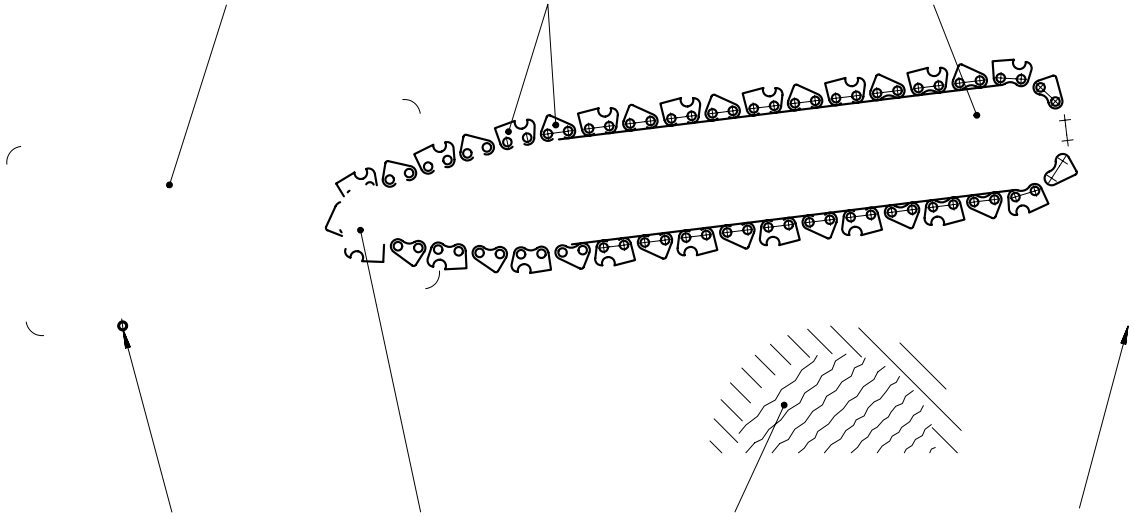
— a saw unit with a defined moment of inertia including shaft, flywheel, sprocket, chain and bar;

— fixture for saw unit;

— test piece mounts for samples;

— instrumentation.

The general arrangement of the test rig is shown in Figure 1.



Key
1 Mounting for sprocket bar
2 Chain
3 Guide bar
4 Sample mount
5 Sprocket
6 Pivot
7 Horizontal plane

Figure 1 — General arrangement of test rig

5.2 Power unit and connecting device

The power unit shall be able to drive the saw chain at the required range of chain speed.

For calibration purposes the test rig shall be able to drive the chain with speeds of between 19 m/s and 21 m/s.

For testing purposes, the test rig shall also be able to drive the chain with speeds as required in ISO 11393-2 and ISO 11393-3. Future parts of ISO 11393 are under preparation.

NOTE For future development, a higher speed possibility is recommended.

It shall be possible to disconnect the power unit from the saw unit.

5.3 Saw unit

The saw unit shall be able to turn freely in the vertical plane around the horizontal pivot at least in the range

— up 20 mm,
— down 100 mm,

measured 360 mm from the pivot.

NOTE It is allowed to include certain stops in order to prevent the saw chain damaging the test piece mount.

The moment of inertia of the saw unit around the pivot shall be $(0,30 \pm 0,05)$ kg·m^2.

5.3.1 Components[1] of saw unit

5.3.1.1 Bar, such as the Sandvik symmetrical 11-tooth sprocket nosed, nominal groove width 1,50 mm, nominal length 330 mm (13").

The lateral stiffness of the guide bar, measured by the centre of the nose wheel, shall be less than 10,0 mm at a lateral force of 50 N.

The chain tension shall be adjustable.

5.3.1.2 Chain drive sprocket, such as the Oregon 7-tooth rim sprocket.

The dimensions of the sprocket surround shall be as indicated in Figure 2.

The machine shall not be fitted with a chain drive sprocket cover.

This requirement does not preclude a guard to protect the operator. Such a guard shall not interfere with the testing.

5.3.1.3 Flywheel

Moment of inertia of rotating parts around output shaft, including shaft, flywheel and all retaining devices but excluding chain and sprocket, shall be $0,47 \times 10^{-3}$ kg·m^2, with a tolerance of ±1 %.

The free-running stop time without chain shall exceed 25 s.

5.3.1.4 Saw chain, such as the Oregon 8,25 mm (0,325") pitch, 21 LP, 56 chain links.

Chains shall be conditioned according to 7.5.1.

5.3.1.5 Clutch

5.3.1.6 Lubricating system, comprising a device providing a continuous stream of oil to the guide bar and saw chain.

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1) Sandvik and Oregon are examples of suitable products available commercially. This information is given for the convenience of users of this part of ISO 11393 and does not constitute an endorsement by ISO of these products.

Dimensions in millimetres

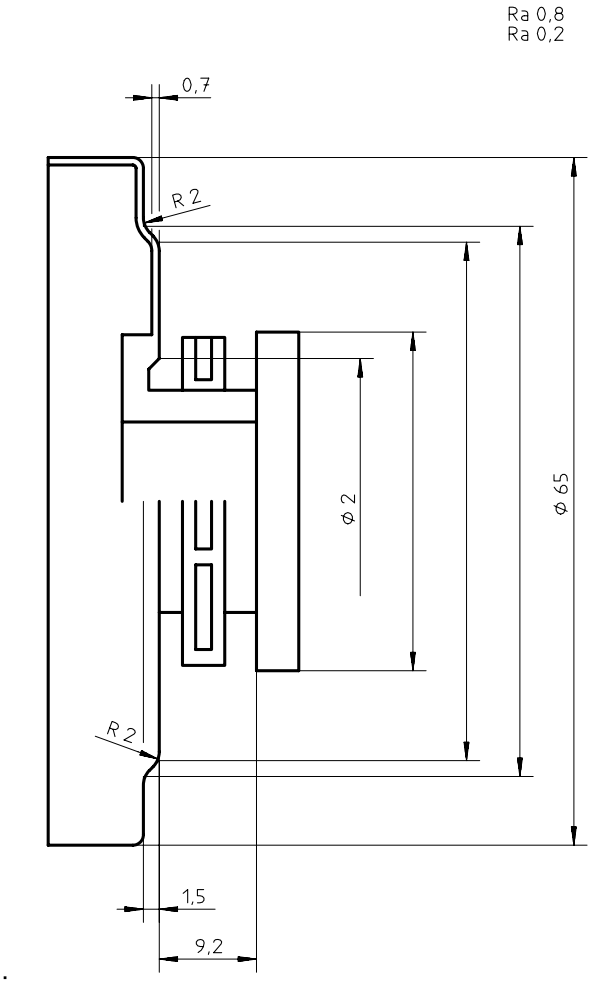

Figure 2 — Dimensions of sprocket surround

The rate of application shall be (2 ± 0,5) ml/min.

Oil type:	White oil
Viscosity at 40 °C:	155 mm^2/s
Viscosity at 100 °C:	15,5 mm^2/s
Density at 15 °C:	880 kg/m^3

5.3.2 Release system, comprising a device allowing disconnection of the power from the saw unit at the same moment as, or momentarily before, the saw unit is released and allowed to pivot downwards.

5.3.3 Instrumentation, comprising

a) a tachometer for the measurement of chain speed with an accuracy of 0,1 m/s; it shall be possible to record the speed at the time of release;

b) an instrument for measuring chain stopping time, with an accuracy of 0,1 s.

5.3.4 Fixture for saw unit

The arrangement shall be such that the centre of gravity of the saw unit shall be offset from the pivot of the saw unit in such a way that, at a distance of (360 ± 2) mm from the pivot, the gravitational force shall be (15,0 ± 0,5) N. This

is the contact point. The cutting line shall lie in the same horizontal plane as the centreline of the pivot (see Figure 3).

The horizontal distance from the centre of the pivot to the centre of the sprocket shall be (130 ± 1) mm.

Dimensions in millimetres

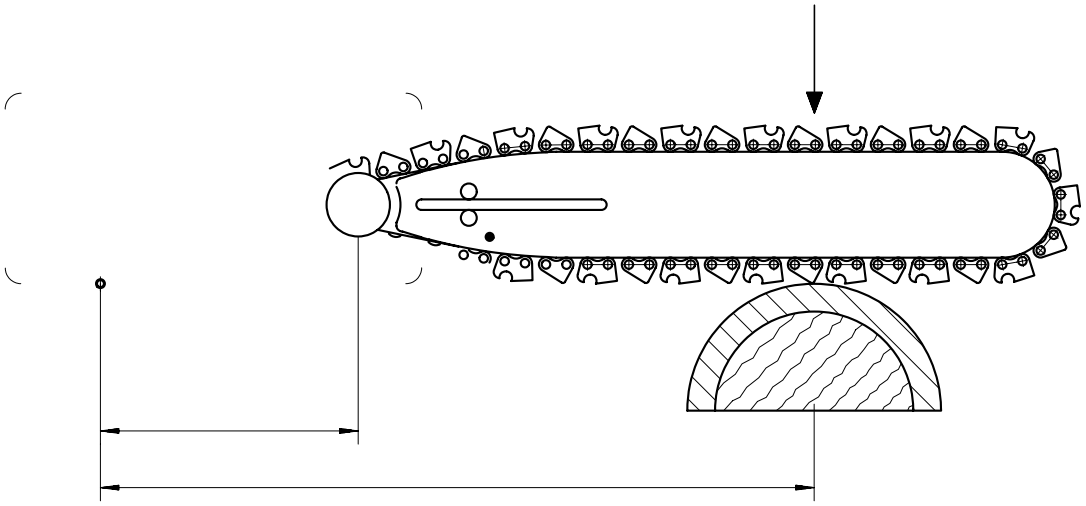

Figure 3 — Arrangement of test rig at time of cutting

5.4 Calibration pad mount

The sample mounts shall be horizontally positioned with a specified angle to the guide bar.

The horizontal distance from the centreline of the pivot to the centreline of the sample mounts shall be (360 ± 2) mm.

The centreline of the pivot and the top of the sample shall be in the same horizontal plane.

Prior to testing, the saw unit shall be tilted about the pivot in such a way that the vertical distance between the lowest surface of the teeth on the saw chain and the surface of the sample at the point of contact is (3 ± 1) mm as shown in Figure 4.

The calibration pad mount shall be made up of a rigid base, covered with a layer of flexible cellular material (see Figure 5).

The upperside shape shall be cylindrical, of diameter (100 ± 2) mm plus the thickness of the covering material.

The base material shall be rigid (e.g hardwood).

The covering material[2)] shall consist of a (14 ± 2) mm thick layer of flexible cellular material of ethylene vinyl acetate copolymer foam, with a specific density of (50 ± 2) kg/m^3 and a compression stress value at 40 % compression (CV 40) of (75 ± 10) kPa, as tested in accordance with ISO 3386-1.

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2) Suitable covering material can be obtained from Fagerdala Industri AB, S-139 00 Varmd Ö, Sweden, with reference No. AZ 450. This information is given for the convenience of users of this part of ISO 11393 and does not constitute an endorsement by ISO of this product.

Dimensions in millimetres

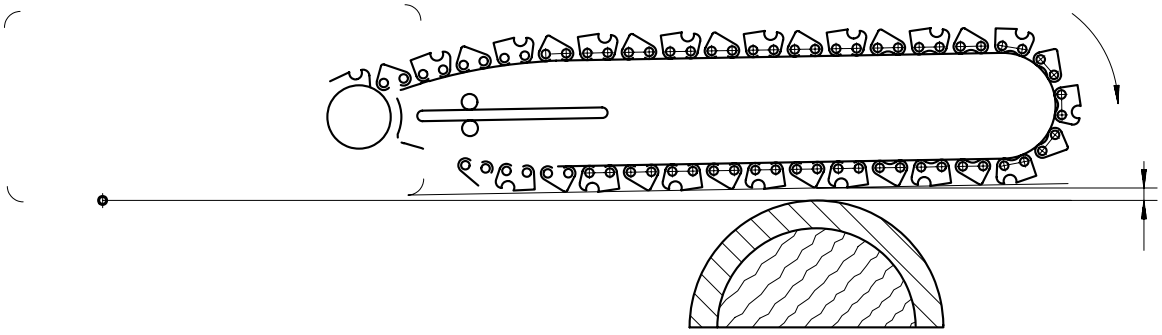

Figure 4 — Arrangement of test rig immediately before testing

5.5 Calibration pad fixture device

The device is fitted to the rigid base material of the calibration pad mount, on the side furthest from the pivot. It consists of:

a) a row, at least 800 mm long, of spikes with a distance of 30 mm between each spike;

b) a row, at least 800 mm long, of holes with a distance of 30 mm between each hole, each hole being large enough to accept a spike.

An example of a fixture device is shown in Figure 5.

Dimensions in millimetres

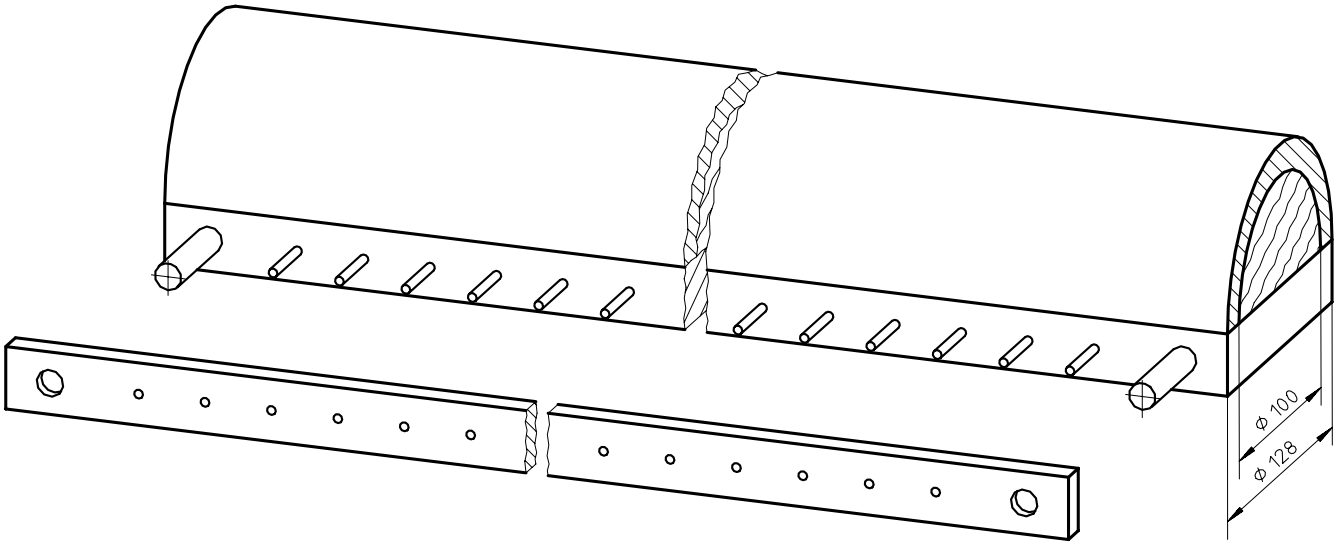

Figure 5 — Example of calibration pad mount and fixture device

6 Calibration materials

6.1 Calibration pads

The calibration pads shall have the dimensions (300 ± 10) mm × (700 ± 10) mm.

The pads[3)] are produced for this test method according to the description given in annex A.

Seams shall be as follows:

a) straight seam 10 mm from the edge; the seam shall go around all edges of the pad; thread 100 % polyester NM 80/1; approximately 3 stitches per centimetre; stitch type according to ISO 4915:1991, No. 301;

b) one needle 3 thread overlock around edges; threads 100 % polyester NM 80/1 + 150 dtex; approximately 5 stitches per centimetre; stitch type according to ISO 4915:1991, No. 504.

6.2 Control of calibration pads

Each new batch of calibration pads shall be compared with older batches, and the laboratory shall keep a record of these tests.

6.3 Other calibration methods

Annex B describes an alternative calibration method currently being studied.

7 Calibration of the test rig

7.1 General

The calibration procedure consists of the following steps:

a) before any cut, check the free-running stopping time;

b) before each complete test of a product (see product standard parts), check cutting into calibration pads containing clogging material.

7.2 Starting up the rig

Before starting the rig, make checks to ensure that the guide bar chain and sprocket are clean and free of any fibres or other extraneous material.

Start the motor and increase the chain speed to approximately 20 m/s. The chain is then warmed up. Check the free-running stopping time.

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3) Suitable calibration pads can be obtained from EngTex AB, S-565 00 Mullsjö, Sweden, with reference No. 027/110-5901.This information is given for the convenience of users of this part of ISO 11393 and does not constitute an endorsement by ISO of these products.

7.3 Free-running stopping time

Check the free-running stopping time before each cut. It shall be (4,0 ± 0,2) s at a chain speed of (20,0 ± 0,2) m/s.

7.4 Measurement of chain speed

Measure the speed of the saw chain at release.

7.5 Calibration with clogging material (pads)

7.5.1 Conditioning of the saw chain

Check the cutting edges of each cutter link in the saw chain and restore them, prior to use, using a commercial grinding machine [4] as follows.

Lightly touch the edges X, Y and Z (see Figure 6) to the grinding wheel of the grinding machine.

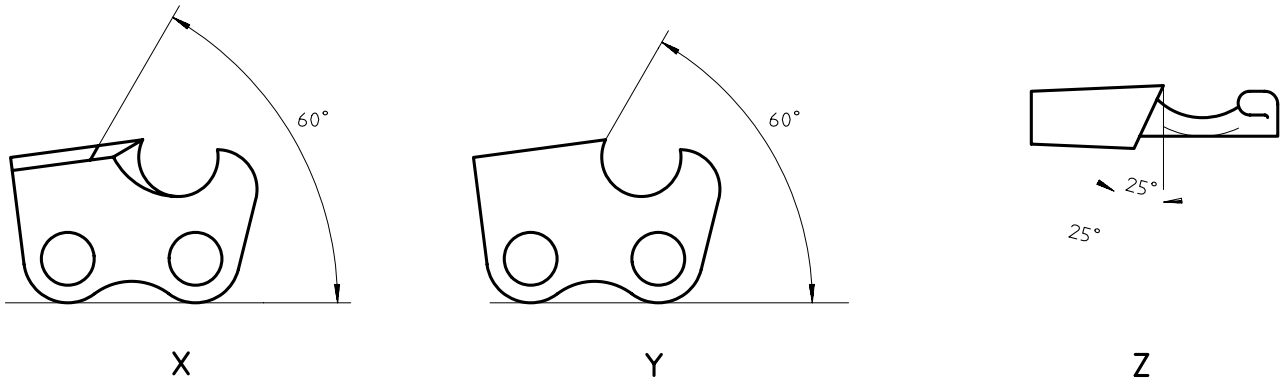

Figure 6 — Conditioning edges of saw chain

The grinding wheel [5] shall meet the following specifications:

— grit type: 60 grade M, structure 5
— radius of profile: 2,4 mm
— nominal thickness of grind wheel: 4,8 mm

4) The following grinding machines are suitable: Model No. Stihl USG 5203, Andreas Stihl, Postfach 1760, D-7050 Waiblingen, Germany; Oregon Chain Grinder Blount UK Ltd., 6 Station Drive, Bredon, Tewkesbury, Gloucestershire, GL20 7HQ, England. This information is given for the convenience of users of this part of ISO 11393 and does not constitute an endorsement by ISO of these products.

5) Grinding wheel model, Oregon Part No. 32660 is suitable. It is available from: Blount UK Ltd., 6 Station Drive, Bredon, Tewkesbury, Gloucestershire, GL20 7HQ, England. This information is given for the convenience of users of this part of ISO 11393 and does not constitute an endorsement by ISO of these products.

Then check the height of the depth gauges of each cutter link. These shall be (0,64 ± 0,05) mm (see Figure 7).

After conditioning, the mass shall be (222 ± 2) g.

Discard chains failing to meet these requirements.

Dimensions in millimetres

Figure 7 — Height of depth gauges of the cutter link

7.5.2 Attachment of calibration pad

Mount the calibration pad with the long edge parallel to the axis of the mount, using the fixture device. Pass the pad over the top of the mount and apply a distributed loading of 25 N/m (250 g every 10 cm starting 5 cm from edge) on the free hanging side. Smooth out the calibration pad by hand. When mounted, the clamping bar shall not compress the calibration pad.

Position the sample mount with the fixed side of the calibration pad on the side opposite from the pivot.

7.5.3 Cutting

Only one cut shall be made on each calibration pad. Apply the cut approximately 350 mm from the end of the pad at an angle of 45° to the calibration pad mount. Measure this angle in the horizontal plane.

Cut a minimum of two calibration pads at (19,0 ± 0,2) m/s and (21,0 ± 0,2) m/s, in accordance with the following criteria:

— at 19 m/s, no cut-through is allowed;
— at 21 m/s, cut-through shall occur.

If these results are not met, the test rig and chain shall be checked and adjusted.

Annex A
(informative)

Supplementary information on calibration pads

The calibration pads should consist of the following.

a) One-layer, warp-knitted outer material, of quality A342, 100 % polyester, approximately 240 g/m^2.

b) Ten layers of weft insertion protective material, of quality Y027, approximately 105 g/m^2:

weft: 940 dtex Polyamide
warp 1: 50 dtex Polyester
warp 2: 167 dtex Polyester

seven courses per centimetre

nine wales per centimetre.

c) One layer of lining material, of quality D650, 100 % polyamide, approximately 50 g/m^2.

The material should be of unfinished quality.

Annex B
(informative)

Calibration method using a plastic bar

The following alternative calibration method may be used.

Take a plastic bar with the following specifications[6]:

— polyethylene PE-HD 250

— density (0,95 ± 0,1) g/cm^3

— yield stress ≥ 24 N/mm^2

— modulus of elasticity ≥ 850 N/mm^2

— notch impact strength ≥ 12 kJ/m^2 (23 °C)

— meltflow index MFI 190/5 < 0,6 g/10 min

— thickness (20 ± 0,68) mm

Mount the bar firmly using a suitable clamping device. Position the plastic bar at an angle of (90 ± 1)° to the guide bar of the saw unit.

Make three cuts at a chain speed of 20 m/s.

Measure the depth and width on the side furthest from the pivot, after cleaning away partly loosened material.

Measure the depth at the deepest point.

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6) A suitable bar is available from: Hüls Troisdorf AG, Kölner Strasse 176, Postfach 1165, D-5210 Troisdorf, Germany. This information is given for the convenience of users of this part of ISO 11393 and does not constitute an endorsement by ISO of this product.

ICS 13.340.10

Descriptors: garments, protective clothing, operator protection, portable equipment, chain saws, protection against mechanical hazards, tests, mechanical tests, test equipment, calibration.

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