INTERNATIONAL STANDARD

ISO 11393-1

Second edition
2018-09

Protective clothing for users of hand-held chainsaws —

Part 1: Test rig for testing resistance to cutting by a chainsaw

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

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Foreword

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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).

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets*, in collaboration with ISO Technical Committee TC 94, *Personal safety — Personal protective equipment*, Subcommittee SC 13, *Protective clothing*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 11393-1:1998), which has been technically revised. The main changes compared to the previous edition are as follows:

— the figures have been redrawn;

— measurement tolerances have been added;

— in the Introduction, the term "hand-held chainsaws primarily constructed for cutting wood" has been added;

— in the Scope, the definition has been specified;

— the normative references have been updated;

— the terms and definitions have been revised and updated;

— in Clause 4, the description has been revised;

— in 5.2, the definition has been specified;

— in 5.3, the definition has been specified, a method for measuring the chain tension is added, the description of the saw chain has been updated and the definition of the release system has been revised;

— in 5.4, the description has been specified and the description of the foam has been updated;

— in 7.5, the description has been specified and the definition of the chain has been updated;

— in Annex A, the description has been revised;

— the previous Annex B has been removed and replaced with a new Annex B;

— a new Annex C has been added.

A list of all parts in the ISO 11393 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 forms part of a series concerned with personal protective equipment (PPE) designed to protect against the risks arising from the use of hand-held chainsaws primarily constructed for cutting wood.

The portable hand-held powered chainsaws are normally operated by electric or internal combustion engines. Experience has shown that the specification of the fuel operated engine is difficult. In order to be able to control the testing parameters, these problems have been eliminated by selecting the flywheel method described in this document.

No PPE can ensure a 100 % protection against cutting from a hand-held chainsaw. Nevertheless, experience has shown that it is possible to design PPE that 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 chainsaws —

Part 1:
Test rig for testing resistance to cutting by a chainsaw

1 Scope

This document specifies the test rig for assessing the resistance to cutting of protective clothing, footwear and gloves by hand-held chainsaws. It also describes the calibration procedure.

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 1302, *Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation*

ISO 2060, *Textiles — Yarn from packages — Determination of linear density (mass per unit length) by the skein method*

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

ISO 3801, *Textiles — Woven fabrics — Determination of mass per unit length and mass per unit area*

ISO 4915, *Textiles — Stitch types — Classification and terminology*

ISO 7211-2, *Textiles — Woven fabrics — Construction — Methods of analysis — Part 2: Determination of number of threads per unit length*

ISO 11393-2, *Protective clothing for users of hand-held chainsaws — Part 2: Performance requirements and test methods for leg protectors*

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

ISO 11393-4, *Protective clothing for users of hand-held chainsaws — Part 4: Performance requirements and test methods for protective gloves*

ISO 11393-5, *Protective clothing for users of hand-held chainsaws — Part 5: Performance requirements and test methods for protective gaiters*

ISO 11393-6, *Protective clothing for users of hand-held chainsaws — Part 6: Performance requirements and test methods for upper body protectors*

ISO 17249, *Safety footwear with resistance to chain saw cutting*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
chain braking
effect whereby fibres or other materials of the personal protective equipment slow down the speed of the saw chain

3.2
chain slipping
protective effect whereby the saw chain slides over the surface of the protective material without cutting it

3.3
chain stopping time
period of time taken for the saw chain to decelerate from a specified speed to a complete stop once the power has been disconnected

3.4
chainsaw
portable powered saw with teeth on a saw chain

3.5
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

3.6
cut-through
any visible change on the underside of the innermost layer of the test sample caused by the saw chain

3.7
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

3.8
free-running stopping time
time for the flywheel to come to a complete stop once the power has been disconnected when there is no chain fitted to the guide bar

3.9
resistance to cutting
various ways in which protective material prevents cutting or decelerate the chain of a *chainsaw* (3.4)

Note 1 to entry: It is measured by applying a moving saw chain with a certain chain speed and energy and studying whether the chain cuts through.

4 Principles

The test rig described in this document has been designed to apply a moving saw chain to a test sample in such a way that both the speed of the chain and the amount of kinetic energy available for cutting are controlled.

This is achieved by ensuring that the chain is not under power at the moment of test. The equipment is designed such that the chain is moving solely under the influence of its own momentum, together with that of a flywheel and rotating parts of known inertia to which it is coupled.

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

5 Test rig

5.1 General

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 guide bar;

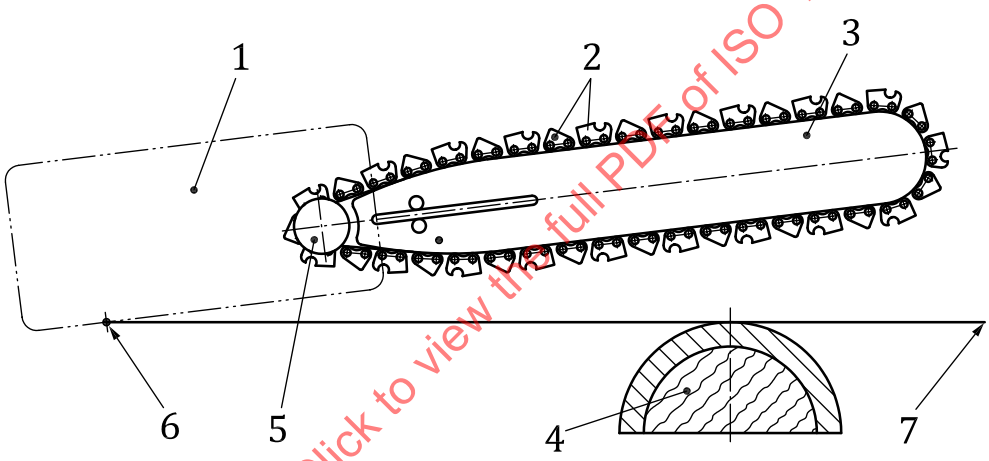
— fixture for saw unit;

— test piece mounts for samples;

— instrumentation.

Fit guards to protect users from flying debris and broken chains.

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 up to a chain speed of at least 21 m/s. For testing class 2 products, the power unit shall be capable of driving the saw chain at a speed of at least 24 m/s. For class 3 products, the power unit shall be capable of driving the saw chain at a speed of at least 28 m/s.

For testing purposes, it is convenient that the test rig shall also be able to drive the chain at speeds as required by ISO 11393-2, ISO 11393-3, ISO 11393-4, ISO 11393-5, ISO 11393-6 and ISO 17249. Currently, the maximum speed specified in the ISO 11393-series and in ISO 17249 is 28 m/s (class 3).

It shall be possible to separate the power from the saw unit, see Clause 4. The separation of the powered drive unit from the saw unit shall not affect the moment of inertia of the sprocket/flywheel assembly and the moving chain and it shall not affect the falling action around the pivot.

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 separated from the chain and flywheel or the

power is disconnected from the rotating parts of the saw unit excluding the sprocket. The moment of inertia shall still fulfil the requirements of 5.3.2.3. 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 and the chain stops.

5.3 Saw unit

5.3.1 General

The saw unit shall be able to turn freely in the vertical plane around the horizontal pivot at least in the range 20 mm upward and 100 mm downward, measured at 360 mm from the pivot.

Certain stops may be included in order to prevent the saw chain damaging the test piece mount.

The moment of inertia of the saw unit, which means all parts turning around the pivot, shall be (0,30 ± 0,05) kgm^2. The moment of inertia shall be calculated from the construction programme or measured. A measuring method is described in Annex C. Ensure that no other rotating parts around the output shaft than the defined rotating inertia will affect the falling action around pivot.

5.3.2 Components of saw unit

5.3.2.1 Guide bar

The guide bar is symmetrical 11-tooth sprocket nosed, with a nominal groove width of 1,50 mm and a nominal length of 330 mm (13")[1)].

The lateral stiffness of the saw unit and guide bar shall be measured at the centre of the nose wheel of the bar, mounted in the saw unit of the test rig. Apply a load cell at the centre of the nose wheel and adapt equipment for measuring the movement. Pull the guide bar with the load cell until a force of (50 ± 2) N is reached. The deflection of the guide bar shall be less than 10,0 mm.

The chain tension shall be adjustable. The chain tension shall be measured with every new chain. This measurement shall be done after having reached the chain stopping time of (4 ± 0,2) s.

The method for measuring chain tension is as follows.

a) Position a suitable clamp on the link on the uppermost edge of the guide bar immediately over the cutting point for calibration pads (see 5.3.5). Gently lift the guide bar vertically until its own gravitational force (15 N) is supported entirely by the one link. Measure the vertical deflection of the chain from the edge of the guide bar and record the deflection to the nearest millimetre.

b) Release the force and remove the clamp from the link. Move the chain along by approximately 14 links and repeat step a).

c) Repeat step b) twice more until four measurements of deflection at different parts of the chain have been recorded.

d) The range between the highest and the lowest measurement of deflection should not be more than 2 mm to ensure that the deflection at different parts of the chain is constant.

e) If this test fails, repeat both procedures until the required values are fulfilled. If this is impossible, check the saw unit.

1) A suitable guide bar available on the market is Article no. 138SLBK095 — Blount Oregon. This is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

5.3.2.2 Chain drive sprocket

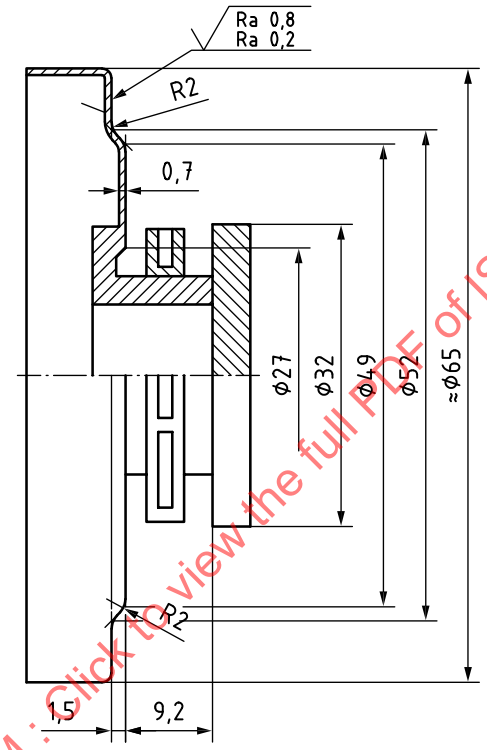
Use a 7-tooth rim sprocket[2)].

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.

Dimensions in millimetres



Key

√ surface roughness in accordance with ISO 1302

Figure 2 — Dimensions of sprocket surround

5.3.2.3 Moment of inertia of rotating parts

The moment of inertia of rotating parts around the output shaft, including the shaft, flywheel and all rotating devices, but excluding the chain and sprocket, shall be [(0,47 ± 0,015) × 10^{-3}] kgm^2. The moment of inertia shall be calculated with the construction programme or a calculation.

The free-running stopping time without a chain shall exceed 25 s at a rotational speed corresponding to a chain speed of 20 m/s.

5.3.2.4 Saw chain

Chains shall be conditioned according to 7.5.1.

2) A suitable sprocket is the Oregon 7-tooth rim sprocket. This is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Use a chain (0,325") pitch, with 56 chain links, that conforms to Figure 3[3].

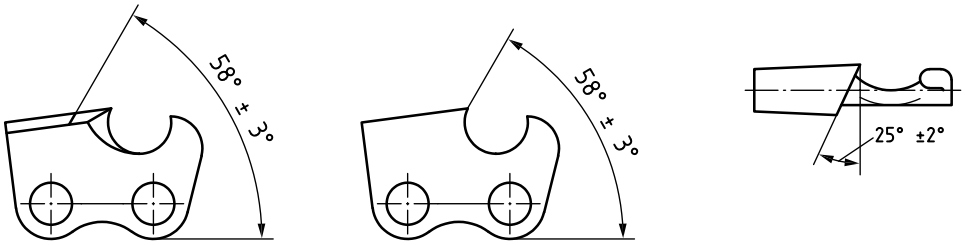


Figure 3 — Chain

5.3.2.5 Lubrication system

The lubrication system comprises a device capable of providing a continuous stream of oil to the guide bar and saw chain at the rate of 1,5 to 3,0 ml/min.

Oil type: suitable for food production[4];

Viscosity at 40 °C: (155 ± 5) mm^2/s;

Viscosity at 100 °C: (17 ± 2) mm^2/s;

Density at 15 °C: (860 ± 20) kg/m^3.

5.3.3 Release system

This comprises a device or system in which the powered unit is separated or removed from the driven parts, i.e. the flywheel, sprocket and saw chain. Some current systems use electro-mechanical clutches, while others use toothed gear systems, which mechanically separate upon receiving a signal from the control unit.

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 separated from the chain and flywheel or the power is disconnected from the saw unit. The moment of inertia shall still fulfil the requirements of 5.3.2.3.

5.3.4 Instrumentation

It shall be capable of:

a) measuring the chain speed with an accuracy of 0,2 m/s;

b) recording the chain speed at the time of release;

c) measuring chain stopping time, with an accuracy of 0,1 s.

NOTE Test laboratories could find additional instrumentation useful (e.g. Voltage meter or Ampere meter).

3) A suitable chain is the Oregon, 21 LPX. This is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

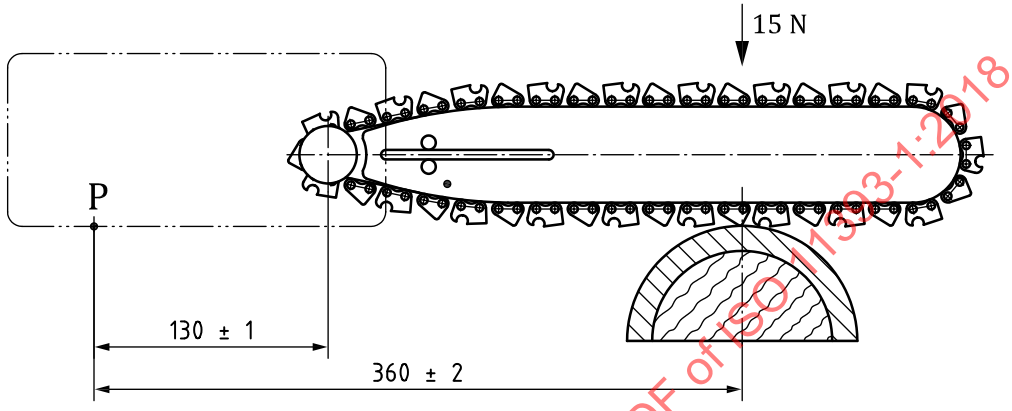
4) A suitable oil is Cassida Chain Oil 150 or MOLYDUVAL Biolube 150. These are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

5.3.5 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 loading 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 4).

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

Dimensions in millimetres



Key

P pivot

Figure 4 — Arrangement of test rig at time of cutting

5.4 Calibration pad mount

The sample mounts shall be horizontally positioned with an angle of 45° 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 shall be (2 ± 1) mm above the top of the sample.

Prior to testing, the saw unit or the sample mount shall be adjusted 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 (2 ± 1) mm, as shown in Figure 5.

The calibration pad mount shall be made up of a rigid base, covered with a layer of flexible cellular material (see Figure 6).

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

The base material shall be a hardwood, such as beech, although other hardwoods are acceptable.

The covering material[5] shall consist of a (14 ± 2) mm thick layer of flexible cellular material of ethylene vinyl acetate copolymer foam, with a specific density of (47 ± 7) kg/m^3 and a compression stress value of (80 ± 10) kPa, when tested in accordance with ISO 3386-1 at 40 % compression (CV 40).

5) Suitable covering material can be obtained from Zotefoams plc, 675 Mitcham Road, Croydon, CR9 3AL, United Kingdom, Telephone: +44 (0) 20 8664 1600, Telefax: +44 (0) 20 8664 1616, with reference No. Evazote® EV50. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Dimensions in millimetres

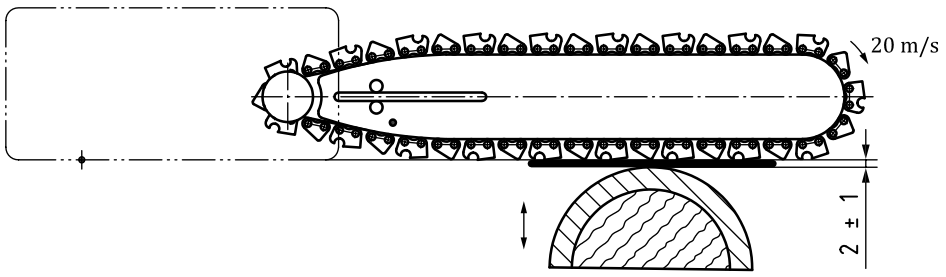


Figure 5 — Arrangement of test rig immediately before testing

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 6.

Dimensions in millimetres

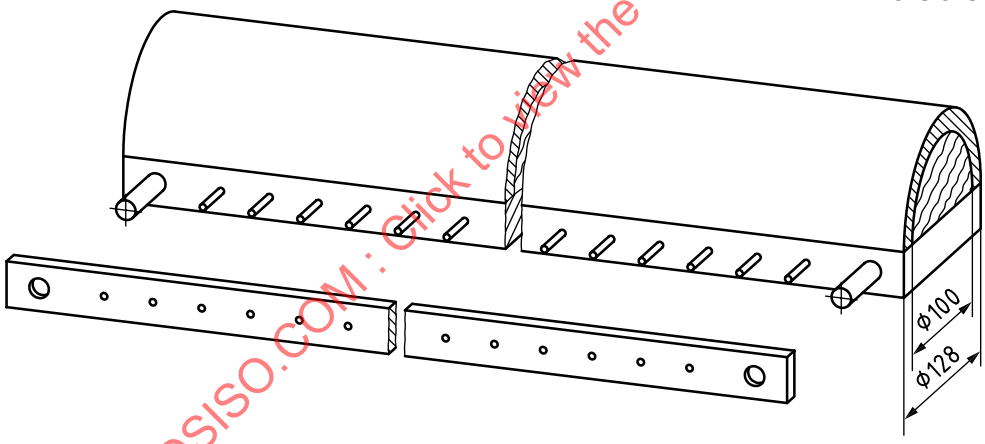


Figure 6 — Example of calibration pad mount and fixture device

6 Calibration materials

To calibrate the sharpness of the chain, calibration pads of the product code 027, from Engtex[6] shall be used. It is necessary to use identical calibration material at all laboratories to guarantee comparable test results. This calibration pad shall conform to the specification given in Annex A.

6) Suitable calibration pads can be obtained from Engtex AB, SE-565 22 Mullsjö, Sweden, info@engtex.se, www.engtex.se, with reference No. 027. This is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

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 ISO 11393-2, ISO 11393-4, ISO 11393-5 and ISO 11393-6), check the chain sharpness by carrying out cut tests into calibration pads (according to Clause 6).

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 20 m/s for (4 ± 2) min. The chain is then warmed up. Check the chain stopping time at the correct chain tension.

Running-in procedure: When using a completely new chain or new guide bar for the first time increase the chain speed to 20 m/s and let it run for (10 ± 5) min.

7.3 Chain stopping time

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

Once the chain stopping time is within the range (4,0 ± 0,2) s, lock the tension adjustment and proceed to carry out the cut test.

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. There should not be any burrs or external damages. Restore the sharpness of the cutting edges, prior to use, using a commercial grinding machine.

Restore the sharpness of the cutting edges by only lightly touching the edges X, Y and Z (see Figure 3) with the grinding wheel of the grinding machine. Do not grind the height of the depth gauges of each cutter link.

The grinding wheel[7)] shall meet the following specifications:

— radius of profile: (2,4 ± 0,2) mm;

— nominal thickness of grind wheel: (4,7 ± 0,2) mm.

The length of the teeth shall be a minimum of 8 mm.

Discard chains that fail to meet these requirements.

7) Grinding wheel model, Oregon Part No. 32660P is suitable. It is available from Blount UK Ltd., 6 Station Drive, Bredon, Tewkesbury, Gloucestershire, GL20 7HQ, United Kingdom. This is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

The height of the depth gauges of the cutter link is given in Figure 7.

Dimensions in millimetres

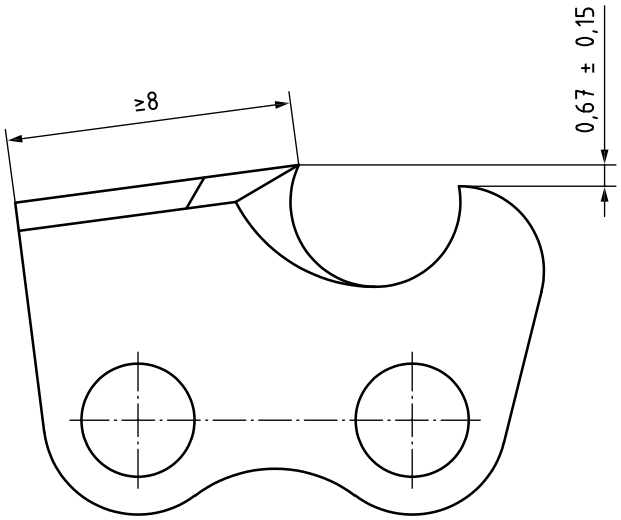


Figure 7 — Height of depth gauges of the cutter link

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 the 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 furthest from the pivot.

7.5.3 Cut test

Only one cut shall be made on each calibration pad. Apply the cut (350 ± 5) 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 a test speed of (19,0 ± 0,2) m/s and a minimum of two calibration pads at a test speed of (21,0 ± 0,2) m/s, according to the following criteria:

— at 19 m/s, no cut-through is allowed; a maximum of two layers is left uncut (including the lining);

— at 21 m/s, cut-through shall occur; the length of cut shall be between 10 mm and 50 mm in the bottom layer (e.g. lining).

The test shall be in accordance with Annex B.

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

Annex A
(normative)

Supplementary information on calibration pads

It is necessary to use identical calibration material in all laboratories to guarantee comparable test results. The calibration pads shall have the dimensions (300 ± 10) mm × (700 ± 10) mm.

Seams shall be as follows.

a) Two straight seams 8 mm from the edge. These seams shall go around all edges of the pad. Thread polyester/cotton NM 80/1. Three stitches per cm (±0,5 stitches/cm) each. Stitch type in accordance with ISO 4915, No. 301.

b) Five thread overlock around edges. Threads polyester/cotton NM 80/1. Three stitches per cm (±0,5 stitches/cm). Stitch type in accordance with ISO 4915, No. 504.

The calibration pads should consist of the following.

a) One-layer, warp knitted fabric, 100 % polyester, Engtex style No. 402, 225 g/m^2 ± 5 g/m^2, measured in accordance with ISO 3801.

b) Ten layers of weft insertion protective material, Engtex style No. 027, (105 ± 3) g/m^2.

   1) Weft: 940 dtex polyamide, measured in accordance with ISO 2060.

   2) Warp 1: 50 dtex polyester, measured in accordance with ISO 2060.

   3) Warp 2: 167 dtex polyester, measured in accordance with ISO 2060.

   4) Yarn ends/cm, in accordance with ISO 7211-2: Warp 8,6 ends/cm, weft 7,2 ends/cm.

c) One-layer, warp knitted fabric, 100 % polyester, Engtex style No. 325, 58 g/m^2 ± 2 g/m^2.

The protective material shall be of unfinished quality.

The weft yarns are in the length direction of the pad.