
Protective clothing for users of hand-held chainsaws —

**Part 2:
Performance requirements and test
methods for leg protectors**

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

Partie 2: Exigences de performance et méthodes d'essai pour protège-jambes



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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 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 11393-2:1999), which has been technically revised. The main changes compared to the previous edition are as follows:

- in the Introduction, the term “hand-held chainsaws primarily constructed for cutting wood” has been added;
- the normative references have been updated;
- the terms and definitions [3.1](#), [3.2](#), [3.3](#), [3.4](#), [3.5](#), [3.6](#), [3.7](#), [3.9](#), [3.10](#), [3.12](#), [3.14](#) and [3.17](#) have been added;
- in [Clause 4](#), subclauses have been added, PPE for users of left-handed chainsaws has been added, the previous “design B” has been deleted, a new “design B” has been added to describe chaps, the definition for trousers has been specified and a definition valid for chaps has been added;
- in [Clause 5](#), the definition has been specified;
- in [Clause 6](#), the clause has been completely revised, pre-treatment regulation for testing has been changed; the definitions in [6.2](#), [6.3](#), [6.5](#) and [6.7](#) have been specified, a definition valid for chaps has been added, cuts of the smallest and largest sizes have been added, measuring of chaps has been added, a test method ergonomic testing has been added;
- in [Clause 7](#), marking requirements have been revised;
- in [Clause 9](#), information requirements have been revised;
- in [Clause 9](#), the definition has been specified.

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.

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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.

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.

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Protective clothing for users of hand-held chainsaws —

Part 2:

Performance requirements and test methods for leg protectors

1 Scope

This document specifies the performance requirements, test methods, design requirements, identification and marking information for leg protectors that offer protection against cutting by hand-held chainsaws.

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 5077, *Textiles — Determination of dimensional change in washing and drying*

ISO 7000, *Graphical symbols for use on equipment — Registered symbols*

ISO 11393-1:2018, *Protective clothing for users of hand-held chainsaws — Part 1: Test rig for testing resistance to cutting by a chainsaw*

ISO 13688:2013, *Protective clothing — General requirements*

ISO 13935-2, *Textiles — Seam tensile properties of fabrics and made-up textile articles — Part 2: Determination of maximum force to seam rupture using the grab method*

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

ISO 20345, *Personal protective equipment — Safety footwear*

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

attachment

connection (usually stitching) between the protective insert and the outer or lining fabric

3.2

attachment force

force that the connection between the protective insert and any structural fabric can withstand, independent of the way the protective insert is attached to the outer fabric

3.3

chaps

leg protectors (3.11) that cover the front of a leg and fasten around the waist and the back of the leg

3.4

crotch

point between the legs where the two side *seams* (3.17), which run up the inside of each leg, meet

Note 1 to entry: In cases where the side seams do not lie along the edge of the trousers when they are flattened out, the theoretical crotch point effectively becomes the point where the two edges of the trousers converge.

3.5

cut-through

any visible change on the underside of the innermost layer of the test sample caused by the saw chain

3.6

damage

<pre-treatment> condition where some yarns of the protective fabric lose their position in the structure due to a broken ladder during the *pre-treatment* (3.12) cycle

Note 1 to entry: The broken ladder is often caused by a broken knitting yarn.

3.7

fly

fastening in the *front* (3.8) of a pair of trousers

3.8

front

<leg protector> forward 50 % of the leg circumference

3.9

joins

place or line where two or more parts of the *protective insert* (3.14) are connected or fastened together, e.g. by *seams* (3.17) or zippers

3.10

leggings

seat-less trousers

3.11

leg protectors

any type of protective garment that protects at least the *specified protective area* (3.18) to a specified level of resistance for the leg

3.12

pre-treatment

standard way of preparing the samples before testing

Note 1 to entry: This might include a number of cleaning cycles, submitting the sample to heat, mechanical action or any other relevant exposure, and is finished by conditioning.

3.13

protective coverage

area of the garment that is covered by *protective material* (3.15)

3.14

protective insert

fabric, usually placed between the outer fabric and the lining of a garment, that is able to stop the chain by clogging, braking or repelling the chain

3.15**protective material**

material that is designed to protect the wearer against the cutting effect of a hand-held chainsaw

Note 1 to entry: The protective material may include the outer fabric of the garment.

3.16**rear**

<leg protector> backwards 50 % of the leg circumference

Note 1 to entry: Depending upon the design and construction, and due to many layers of clogging material, it can be difficult to establish the *front* (3.8) and the rear of a leg protector. It is nevertheless of great importance to establish the front and the rear before *pre-treatment* (3.12) and testing.

3.17**seam**

join where two or more layers of fabric, leather or other materials are held together with stitches

3.18**specified protective area**

minimum required *protective coverage* (3.13)

4 Requirements**4.1 General**

General requirements not specifically covered in this document shall be in accordance with ISO 13688.

Tested samples shall conform to all the requirements of this document.

4.2 Innocuousness

Leg protectors shall not adversely affect the health or hygiene of the user. The materials shall not release or degrade to release substances generally known to be toxic, carcinogenic, mutagenic, toxic to reproduction or otherwise harmful in the foreseeable conditions of normal use. The specific innocuousness requirements of ISO 13688:2013, 4.2, shall be met.

4.3 Sizing

Leg protectors shall be marked with their size in accordance with ISO 13688.

4.4 Ergonomics

The leg protectors shall be designed to minimize discomfort and any impediment to movement while wearing them. When tested according to 6.6.2, the average score shall be 2 or less. The construction around the crotch shall facilitate lunges. When tested according to 6.6.2, all adjustment systems shall not become incorrectly adjusted without the user's knowledge.

NOTE Lunges means to take a long step forward keeping the trailing foot still while bending the knee of the leading leg.

When tested according to 6.6.3, the design shall be without any appendages below the knee region, which can become entangled in machinery or the undergrowth. The only possible exceptions to this requirement are the fastening points of chaps (design B). The leg protector shall be free of rough surfaces, sharp edges, sharp points, etc., which could cause excessive irritation or injuries.

4.5 Dimensional and other changes

4.5.1 Dimensional change

After cleaning according to the manufacturer's instructions, the dimensional change when measured according to [6.2](#) shall be not more than 6 % in any direction.

4.5.2 Other changes as a consequence of cleaning

After cleaning according to the manufacturer's instructions, and after cleaning one sample according to [6.1.2](#) at 60 °C and spin-drying, and examining according to [6.4.5.4](#), there shall be no damage in the protective material due to cleaning.

4.6 Protective coverage

4.6.1 General designs of leg protectors

This document defines three designs: design A and design C for trousers and leggings, and design B for chaps. Design A, design B and design C have different specified protective areas as stated in [4.6.2](#), [4.6.3](#), [4.6.4](#), respectively. The protective coverage shall be assessed according to [6.3](#).

Guidance on selecting design A, design B or design C is given in [Annex A](#).

Between the crotch and the fly, a gap of not more than 10 mm wide is permitted. It is recommended to keep this gap as small as possible. For zippers, buttons, etc., an opening gap in the centre front of not more than 10 mm is allowed. Peripheral openings at the right side at the waist region may be up to 30 mm.

Each layer of the protective insert of one garment shall be continuous from the top to the bottom. There shall be no joins in the protective material within the specified protective area. Designs incorporating joins down the legs of design C are acceptable according to [4.6.4](#) c) and e).

The two halves of leggings and chaps shall be joined together from the top of the waistband down to the point of the crotch at the front.

Braces and belts shall have a minimum width of 30 mm.

4.6.2 Design A

The specified protective area for design A is described under a), b), c), d), and e) and is shown in [Figure 1](#). It is measured according to [6.3.2](#).

Dimensions in millimetres

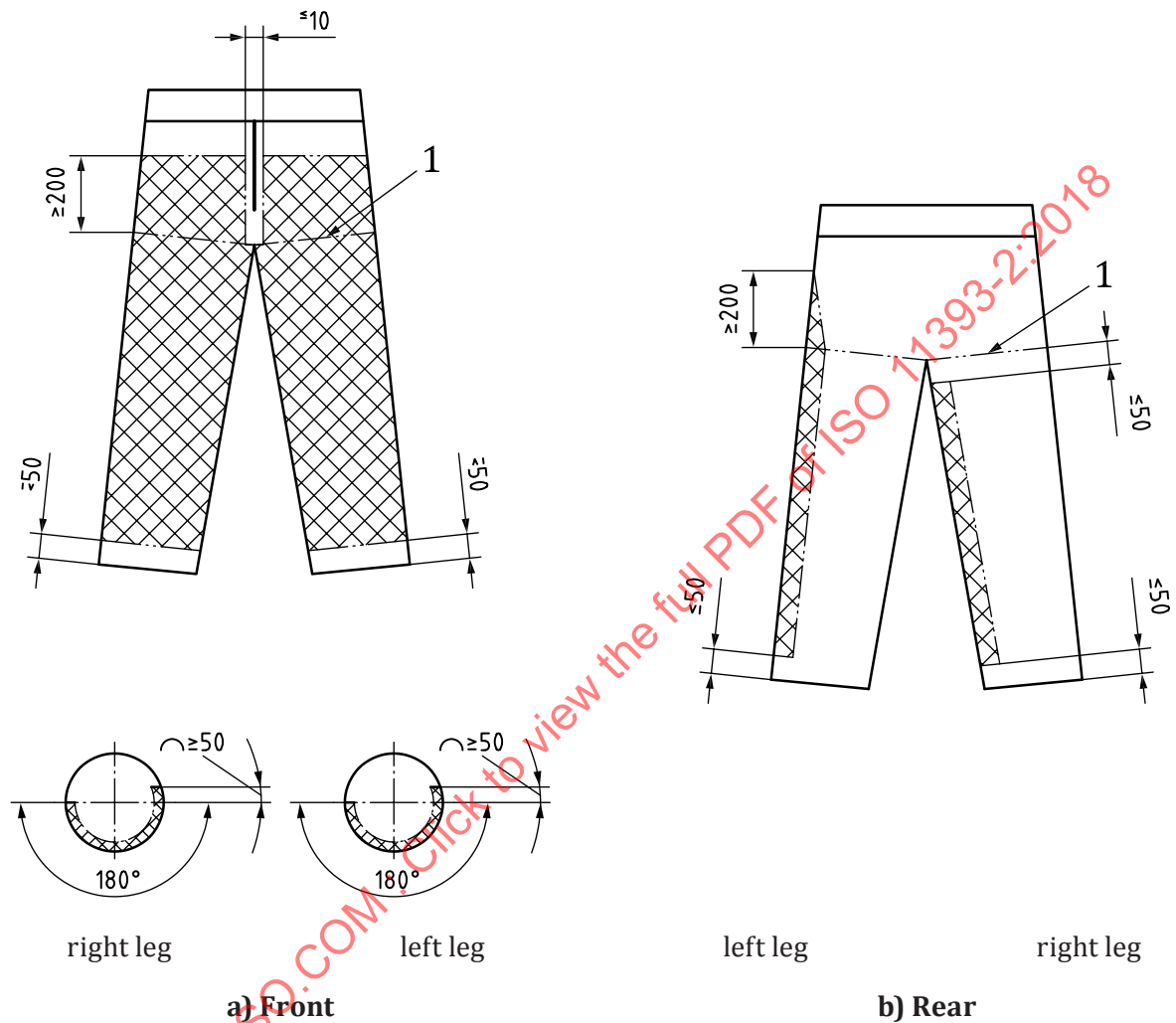


Figure 1 — Specified protective area, design A

- a) Front: the specified protective area fully covers the front of the garment from a maximum of 50 mm above the lower end of the legs to a minimum of 200 mm above the crotch. It is permitted to leave out protective material at the fly. For sizes of leg protectors intended for wearers who have a waist size smaller than 92 cm, the specified protective area only needs to be a minimum of 160 mm above the crotch.
- b) Rear, left leg: the specified protective area covers, on the outer side of the leg, at least a 50 mm extension. It begins no more than 50 mm from the bottom of the leg and ends not more than 200 mm below the crotch, and then tapers to zero at a height of a minimum of 200 mm above the crotch or 160 mm for smaller sizes as described in a).
- c) Rear, right leg: the specified protective area covers, on the inner side, an at least 50 mm-wide extension. It begins no more than 50 mm from the bottom of the leg and ends not more than 50 mm below the crotch.
- d) The gap in the protective insert at the fly shall be not more than 10 mm, measured when the zipper is closed. Underneath the zipper, the protective material can also have a gap and it shall be not more than 10 mm.
- e) The bottom end of the leg of each garment shall be designed to facilitate easy overlap of protective material with safety footwear worn by the user.

Design A leg protectors intended for users of left-handed chainsaws shall additionally include the 50 mm-wide strip specified in b) and c) on the rear right-hand side of each leg. This design supports the use of left-handed chainsaws.

4.6.3 Design B (chaps)

The specified protective area for design B is described under a), b), c), d) and e) and is shown in [Figure 2](#). It is measured according to [6.3.3](#).

Dimensions in millimetres

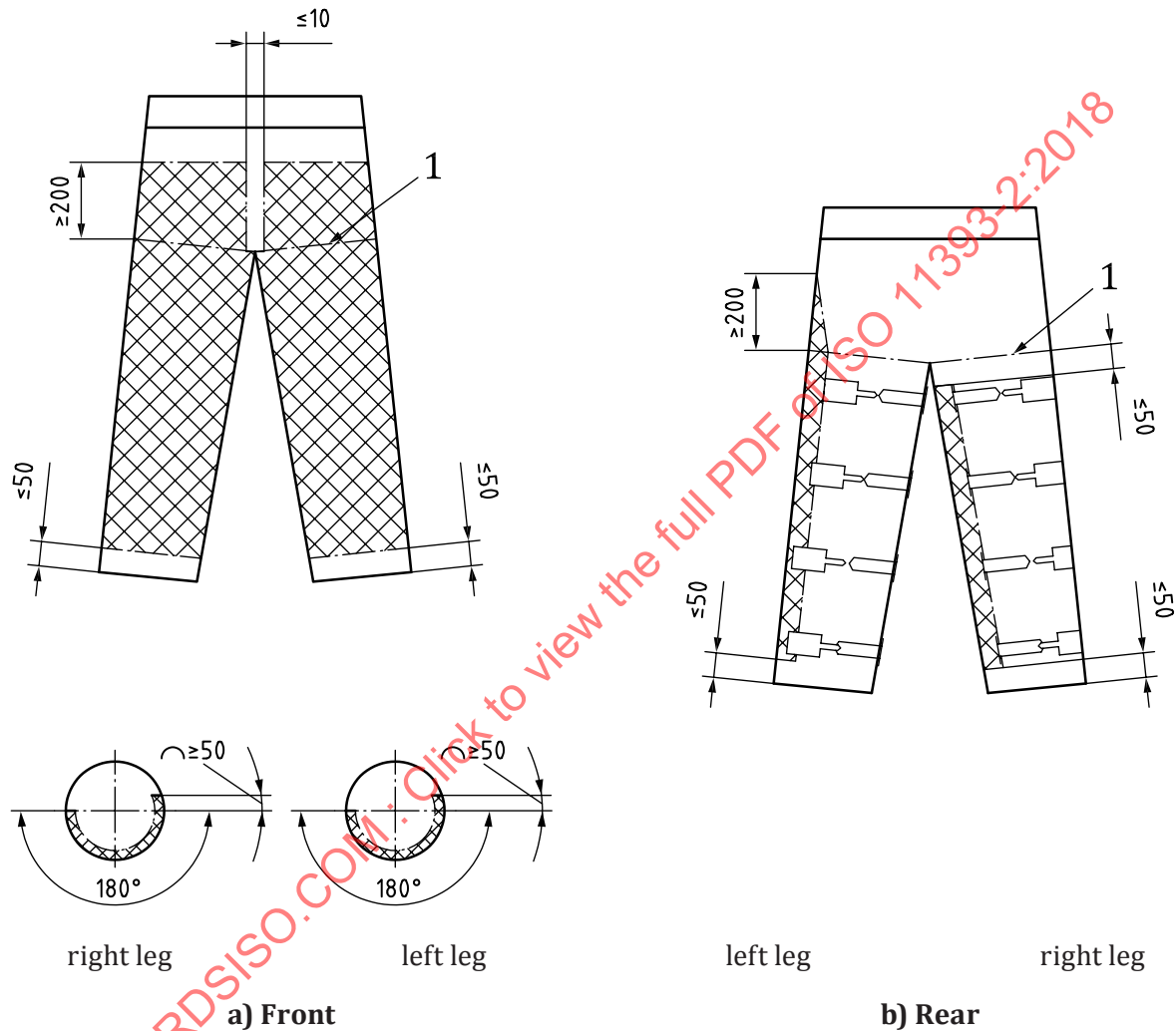


Figure 2 — Specified protective area, design B

Key

- 1 level of crotch
- shaded area is protective material
- picture shows trousers in regular position, not turned inside out

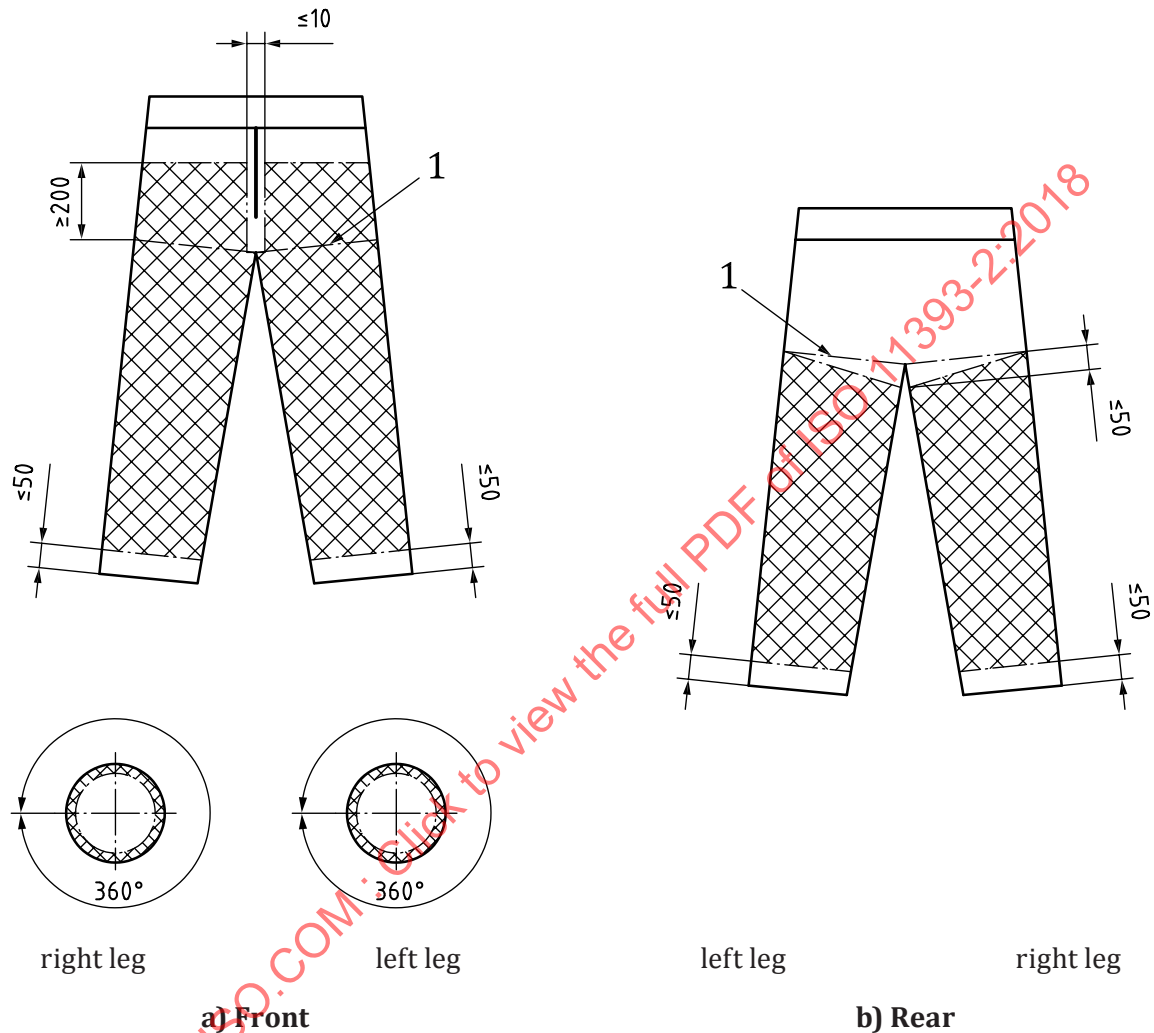
- a) Front: the specified protective area fully covers the front of the garment from a maximum of 50 mm above the lower end of the legs to a minimum of 200 mm above the crotch. The chaps shall be sewn together at the front in the fly region, a gap inside the protective area of maximum 10 mm is allowed. For sizes of leg protectors intended for wearers who have a waist size smaller than 92 cm, the specified protective area only needs to be a minimum of 160 mm above the crotch.
- b) Rear, left leg: the specified protective area covers, on the outer side of the leg, at least a 50 mm extension. It begins no more than 50 mm from the bottom of the leg and ends not more than 200 mm below the crotch, and then tapers to zero at a height of a minimum of 200 mm above the crotch or 160 mm for smaller sizes as described in a).
- c) Rear, right leg: the specified protective area covers, on the inner side, at least a 50 mm-wide extension. It begins no more than 50 mm from the bottom of the leg and ends not more than 50 mm below the crotch.
- d) There shall be at least four fastening points around the back of each leg (see [Figure 2](#)). The straps shall not be attached directly to the protective insert.
- e) Each fastening shall have a stop at the end determining the maximum length of fastening. It shall prevent excessive loosening of the fastening.
- f) The bottom end of the leg of each garment shall be designed to facilitate easy overlap of protective material with safety footwear worn by the user.

Design B leg protectors intended for users of left-handed chainsaws shall additionally include the 50 mm-wide strip specified in b) and c) on the rear right-hand side of each leg. This design supports the use of left-handed chainsaws.

4.6.4 Design C

The specified protective area for design C is described under a), b), c), d) and e) and is shown in [Figure 3](#). It is measured according to [6.3.2](#).

Dimensions in millimetres



Key

- 1 level of crotch
- shaded area is protective material
- picture shows trousers in regular position, not pulled inside out

Figure 3 — Specified protective area, design C

- a) Front: the specified protective area fully covers the front of the garment from no more than 50 mm above the lower end of the legs to at least 200 mm above the crotch. It is permitted to leave out protective material at the fly. The gap at the fly shall be not more than 10 mm. Underneath the fly, the protective material can have a gap and it shall be not more than 10 mm. For sizes of leg protectors intended for wearers who have a waist size smaller than 92 cm, the specified protective area only needs to be at least 160 mm above the crotch.
- b) Rear: the specified protective area fully covers the rear of the garment from no more than 50 mm above the lower end of the legs up to not more than 50 mm below the crotch on the inner side of each leg and to the level of the crotch on the outside of each leg.
- c) Designs incorporating zippers down the leg are acceptable, provided that they are positioned outside the protective area covered by design A trousers. A gap in protection at the zipper shall be not more than 4 mm. The strength of the zipper shall be at least 150 N when tested across the zipper according to 6.5.4. The zipper slider shall be designed to lock when completely closed to prevent unintentional opening of the zipper.
- d) The bottom end of the leg of each garment shall be designed to facilitate easy overlap of protective material with safety footwear worn by the user.
- e) It is acceptable to incorporate one join down each leg, provided that it is positioned outside the protective area covered by design A trousers and the gap in protection at the join is not more than 4 mm. The strength of the join shall be at least 150 N when tested across the join according to 6.5.4.

4.7 Resistance to cutting by a chainsaw

4.7.1 Classification according to chain speed

Testing in accordance with this document shall be made at one of the following three speeds with classes designated as follows:

- class 1: 20 m/s $\pm$ 0,2 m/s;
- class 2: 24 m/s $\pm$ 0,2 m/s; and
- class 3: 28 m/s $\pm$ 0,2 m/s.

4.7.2 Requirements for cut resistance

When tested according to 6.4, no cut-through is allowed in any tested specimen. Any damage caused by the cutting chain to last layer next to the skin shall be considered as cut-through.

4.8 Requirements for strength of attachment of protective insert of trousers, chaps and strap attachment for chaps

4.8.1 Trousers and leggings

The protective material shall be permanently attached to the garment in such a way that the protective function is not impaired. The attachment shall be a line of continuous stitching or groups of stitches no further apart than 5 cm. When tested according to 6.5.4, the attachment of the protective insert to the outer fabric shall resist at least a force of 150 N for each test specimen, independent if the protective insert is fixed directly to the outer fabric or with a lining between. The minimum result of the three tests according to 6.5.4 shall be used.

For designs C seams joining the protective material in design C leg protectors are subjected to the seam strength tests according to 6.5.4. If the trouser leg of design C-trousers can be opened by zippers, the strength of the connection between both sides of the protective insert shall be at least 150 N when tested across the zipper. The minimum result of the three tests according to 6.5.4 shall be used.

Hook and loop type fasteners are not allowed for leggings.

4.8.2 Chaps

Chaps shall stay in place during use when tested according to 6.6.2. Straps shall be at least 30 mm wide.

Fastenings shall ensure that the clothing remains in an effective functional position. Fastenings with hooks and loops are not allowed for chaps and leggings. Fasteners shall be of quick release type and stay fastened unless deliberately unfastened by the wearer, as tested according to 6.6.2.

The attachment strength between the strap and the chap material shall be no less than 150 N, tested according to 6.5.4. The minimum result of the three tests according to 6.5.4 shall be used.

Straps shall be positioned immediately underneath the crotch, at the bottom of the leg and intermediate straps shall be positioned so that the distance between any two straps is not more than 200 mm.

5 Test specimens for cut testing

The numbers of test specimens for cut testing are as follows and shall include the smallest, the largest and medium sizes.

a) Designs A and B:

- 1) if only cleaned by washing: three pairs of complete leg protectors;
- 2) if only cleaned by dry-cleaning: three pairs of complete leg protectors;
- 3) if cleaned both by washing and dry-cleaning: six pairs of complete leg protectors.

It is permitted to use the test specimens used for testing dimensional change for the cut testing.

b) Design C:

- 1) if only cleaned by washing: five pairs of complete leg protectors;
- 2) if only cleaned by dry-cleaning: five pairs of complete leg protectors;
- 3) if cleaned both by washing and dry-cleaning: ten pairs of complete leg protectors.

It is permitted to use the test specimens used for testing dimensional change for the cut testing.

6 Test methods

6.1 Pre-treatment

6.1.1 Cleaning

Before testing according to 6.2, 6.3, 6.4 and 6.5, the test specimens shall be pre-treated by cleaning. The cleaning shall be in accordance with the manufacturer's instructions, on the basis of standardized processes. If the total number of cleaning cycles is not specified in the manufacturer's instructions, five cleaning cycles shall be performed. This shall be reflected in the information supplied by the manufacturer. If the manufacturer includes instructions for washing and dry-cleaning, both shall be applied. If only dry-cleaning is allowed, the number of samples indicated in Clause 5 for that case shall be dry-cleaned. If only washing is allowed, the number of samples indicated in Clause 5 for that case shall be washed.

After each pre-treatment cycle, the leg protectors shall be re-shaped by hand, but not by ironing.

Line drying after washing shall be carried out at $(30 \pm 15) ^\circ\text{C}$ and at a humidity of (30 to 70) %.

If tumble-drying is permitted by the manufacturer's care instructions, the garment shall be tumble-dried after each washing cycle.

If the manufacturer doesn't give an indication to wash the garment before first use, the test laboratory shall test one sample unwashed. This sample shall be in addition to the samples specified in [Clause 5](#).

NOTE Manufacturers typically indicate one or more of the methods given in ISO 6330, ISO 3175-2, ISO 3175-3, ISO 3175-4, ISO 15797 or an equivalent standardized processes for cleaning.

6.1.2 Pre-treatment for testing the effect of temperature and spinning on the structure of the protective insert

Where washing is allowed by the manufacturer's care instructions, before testing according to [6.4](#), one of the specimens shall be washed five times according to the manufacturer's instructions, except that the washing temperature shall be 60 °C and the specimens spin-dried at (500 ± 20) r/min. This sample shall be selected from the samples specified in [Clause 5](#).

6.2 Measurement of dimensional change

All measurements of protective coverage and dimensional change that are not specifically pointed out assume a tolerance of measurement of not more than ± 5 mm.

One pair of leg protectors for each cleaning procedure specified in the manufacturer's instructions or the care label shall be measured.

Dimensional change shall be assessed in accordance with ISO 5077 after five cleaning cycles according to the manufacturer's instructions. The measurements shall be made at a part of the garment that incorporates protective material. Measuring shall be carried out at (22 ± 4) °C and at a humidity of (30 to 70) %.

During measurement of distances representing length, L , and width, W , the leg protectors shall be stretched with a force of 20 N. This can be done with a line load. The line load of 20 N shall be applied between the waist and bottom of the leg protectors' leg and for measurement of the width at both sides of the trouser leg. It shall be applied through at least three clamps in each end, whereby the load is distributed. Clamping shall be on both sides, including the protective insert.

6.3 Measurement of protective coverage

6.3.1 General

One pair of leg protectors for each cleaning procedure specified in the manufacturer's instructions or in the care label shall be measured after cleaning.

6.3.2 Procedure for trousers and leggings

For trousers and leggings, the following procedure shall be applied.

Take the garment and turn it inside out. Establish the front and the rear of the leg protector. Lay the trousers on a table, stretch them out with the fly and crotch central, and make a mark at the edge of trousers along the inner and outer sides of the leg. Also mark the front lines, which are the lines in the middle of the legs in front, and the rear lines, which are the lines of the legs in the middle of the rear from top to bottom.

Record the dimensions of the area that is covered with protective material and check that the requirements given in [4.6.2](#) or [4.6.4](#) are fulfilled.

Additional features in some cases (e.g. inside gaiters) shall be removed if they make the measurement impossible.

6.3.3 Procedure for chaps

For chaps, the following procedure shall be applied.

Before measuring the protective coverage according to [6.3.2](#), close the fastenings in the position of maximum width.

If the straps are made from stretchy materials, apply a force of 20 N to each strap according to [6.2](#).

For the measurement, the chaps shall not be turned inside out.

Record the dimension of the area that is covered with protective material and check that the requirements given in [4.6.3](#) are fulfilled.

6.4 Testing of resistance to cutting

6.4.1 Purpose of testing

The purpose of this test is to assess the resistance of the leg protector to cutting by a chainsaw. During these tests, the leg protectors are mounted in such a way as to prevent twisting of the garment leg when contacted by the moving chain.

6.4.2 Test specimens

The number of test specimens required for each design as defined in [4.6.2](#), [4.6.3](#) and [4.6.4](#) are as indicated in [Clause 5](#).

All pairs of protective garments shall be pre-treated according to [6.1.1](#) before testing. If a leg protector is washed according [6.1.2](#), that pair shall be tested as well.

6.4.3 Apparatus

The test rig described in ISO 11393-1 shall be used.

The calibration pad mount and calibration pad fixture device described in ISO 11393-1:2018, 5.4 and 5.5, shall be used.

6.4.4 Mounting of test specimens

The test specimen is mounted on the calibration pad mount in such a way that the contact point with the saw chain shall be on the middle line of the front or the middle line of the rear.

It is fixed using the calibration pad fixture device. Remove three of the spikes, one in line with the contact point and the next nearest on each side. Ensure that the spikes penetrate the protective material.

A linear loading of (50 ± 3) N/m is applied under test inside the trouser leg. When testing alongside opened trouser legs, such as chaps, the load used for calibration pads in accordance with ISO 11393-1:2018, 7.5.2, shall be used.

6.4.5 Test procedure

6.4.5.1 Positions

The test cuts are performed either on the front of the leg and on the rear of the leg for leg protectors of design C or only at the front of the leg for leg protectors of design A and B.

All cuts are made at an angle of 45° to the sample mount. The contact point shall be at a distance of between 250 mm and 500 mm from the crotch, but not nearer than 250 mm to the bottom end of the trouser. The direction of the cut is as shown in [Figure 4](#).

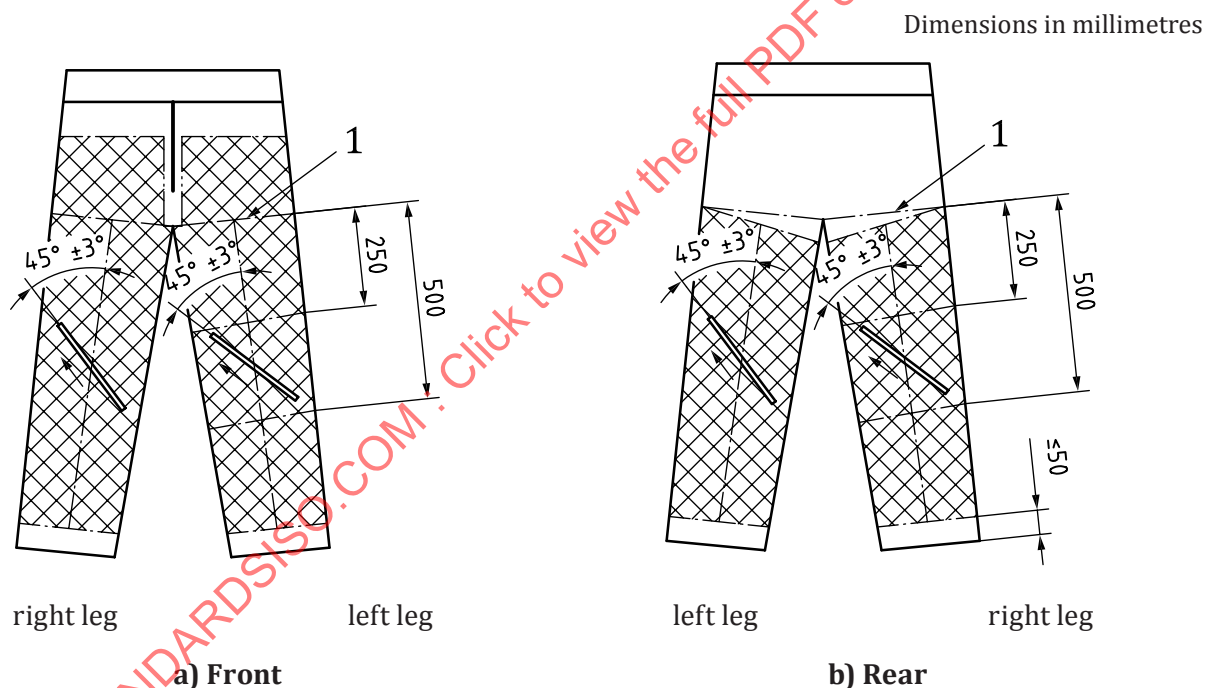
No cutting shall be made at positions where the protective material is folded.

If there are joins in design C protective leg protectors, the following will apply.

- a) If the join is outside the protective area for design A and interferes with the normal testing positions for design C, there is cut testing across such a join. In such cases, one more test specimens for each join or seam is needed.
- b) If the join is outside the protective area for design A and clear of the normal testing position for design C, there is no cut testing over the joins.

Only one cut shall be performed on any one leg of each test specimen. In cases where trousers include extra materials, such as abrasion resistant layers or other reinforcements on the knees of trousers, tests shall be carried out outside the area covered by the extra materials, if possible. If it is not possible, then the cut shall be carried out including the extra materials.

Any damage caused by the cutting chain to the final layer of any type of PPE shall be considered as cut-through.



Key

- 1 level of crotch
- shaded area is protective material
- picture shows trousers in regular position, not turned inside out

NOTE Arrow indicates the direction of the cuts.

Figure 4 — Positions for application and angles of cut

6.4.5.2 Number of cuts

6.4.5.2.1 Design A and design B

For each pre-treatment, six cuts are made, all on the front.

6.4.5.2.2 Design C

For each pre-treatment, eight cuts are made, four on the front and four on the rear.

6.4.5.3 Chain speed

The chain speed shall be one of the speeds specified in [4.7.1](#) as required by the manufacturer.

6.4.5.4 Examination of protective material

Open up the outer fabric and the lining after each cut test to examine any damage to the protective material.

6.5 Measurement of the strength of the protective insert attachment

6.5.1 General

The purpose of this test is to ensure that the protective material is adequately fixed to the garment.

This test is only applied to trousers or similar leg protectors where outer material is provided with protective material giving the chainsaw protective properties. Only the strength of attachments along the left side of both legs shall be measured. If the leg protector is designed for users of left-handed chainsaws the strength of attachments along the right side of both legs shall be tested as well.

Test samples shall be conditioned and tested at $(22 \pm 4) ^\circ\text{C}$ and at a relative humidity of (30 to 70) % RH.

6.5.2 Test specimens

Use one pair of trousers for each cleaning procedure, specified by the manufacturer's user instructions according to [6.1.1](#).

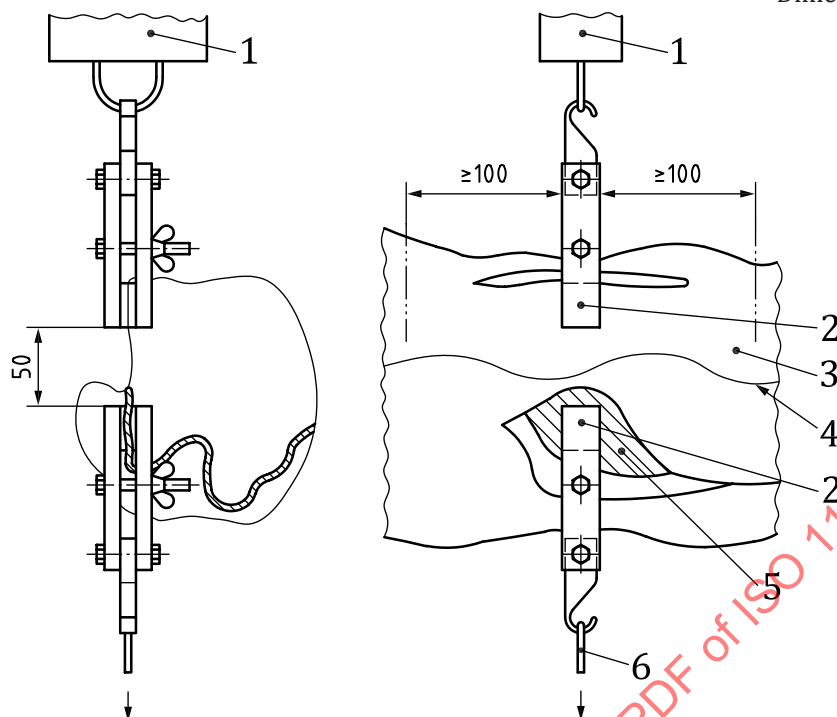
The leg protectors are cut open in the leg length direction at a distance of at least 100 mm from the seam to be tested. Leg protectors earlier tested according to [6.4](#) may be used, provided the attachment has not been affected. Alternatively, cut out two test specimens from the leg protector. The test specimens shall be at least (100 ± 5) mm wide (along the length of the seam or attachment) and (200 ± 5) mm in length (across the seam or attachment) so that there is (100 ± 5) mm of material either side of the seam or attachment.

Three test samples at different places of the seam shall be tested per pre-treatment applied according to [6.1.1](#).

6.5.3 Apparatus

Use tensile testing machine and clamp equipment (see [Figure 5](#)) as specified in ISO 13935-2.

Dimensions in millimetres

**Key**

- 1 fixing
- 2 clamp
- 3 garment

- 4 seam
- 5 protective material
- 6 load

Figure 5 — Clamp equipment example for testing attachment strength

6.5.4 Test procedure

Fix the free end of the protective insert and the opposite free end of the garment to each of the two clamps. When testing trousers of design A, fix the free end of the protective insert and the opposite free end of the outer fabric to each of the two clamps. When testing chaps (design B), fix the free end of the protective insert and the opposite strap to each of the two clamps. When testing trousers of design C, fix the free end of the protective insert and the opposite free end of the protective insert beyond the seam or zipper to each of the two clamps.

The distance from the each clamp to the nearest connection shall be (25 ± 3) mm. This is applicable to every type of connection. No clamp shall be positioned closer than 100 mm to an end or corner of the protective insert. Mount the clamps with the test specimen in a tensile testing machine and pull with a speed of $(1,5 \pm 1)$ mm/s. Test until the specimen breaks or the force exceeds 150 N.

If no tensile testing machine is available, the test may be performed by gently applying loads of 1 kg mass every 5 s to the lower clamp. Continue adding 1 kg masses until the specimen breaks or until the total force exceeds 150 N.

Take the lowest force at break obtained as the result, or, if no break occurs, state "break force exceeds 150 N".

6.6 Ergonomic testing

6.6.1 Ergonomic assessment

The leg protectors shall be examined to determine whether they are ergonomically satisfactory. The sizes, the fit and the ergonomic characteristics of garments shall be determined by an assessor with the help of the two people who wear the garment and perform a number of prescribed actions and answer questions. The test people do not necessarily need to be habitual wearers of these types of protective garments. The test person shall select, according to the instructions supplied by the manufacturer, the appropriate size among all the samples submitted for testing.

6.6.2 Procedures

The test person shall put on the leg protector and adjust it according to the information supplied with the manufacturer's instructions. The test person shall perform the following movements to assess the restriction and discomfort imposed by the leg protector. The movements shall be typical of those made by users of the garments, and shall include:

- a) making one lunge with each leg (the wearer should take a long step forward keeping the trailing foot still while bending the knee of the leading leg);
- b) kneeling on both knees;
- c) walking five metres at a normal walking speed;
- d) opening and closing the fasteners;
- e) using all settings provided to optimize PPE adaptation to user morphology;
- f) putting on chainsaw protective leather boots, design C in accordance with ISO 20345 as customary in the trade and checking for the satisfactory overlap of protective material with this safety footwear;
- g) stepping over a tube of diameter $(60 \pm 5 \text{ cm})$ lying on the ground;
- h) specifically for chaps: checking after each procedure if one or more fasteners opens unintendedly and if the straps are still tight and maintain position.

After performing each movement five times, the test person shall report his or her responses, which shall be scored according to [Table 1](#).

Table 1 — Score of ergonomic response

Score	Response
0	No restriction
1	Slight restriction of movement
2	Restriction of movement
3	More severe restriction of movement
4	Movement very restricted or impossible

After each series of movements, the score of each movement shall be recorded by the test person. It shall be added up for each series and divided by the number of movements performed. For each score of 3 or more, two further test people shall carry out the series. The mean value of the scores shall be calculated.

An average score of all series and all movements is calculated and included in the test report.