INTERNATIONAL STANDARD

ISO 11393-6

Second edition
2018-09

Corrected version
2019-10

Protective clothing for users of hand-held chainsaws —

Part 6: Performance requirements and test methods for upper body protectors

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

Partie 6: Exigences de performance et méthodes d'essai pour protecteurs du haut du corps

Reference number
ISO 11393-6:2018(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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 11393-6:2007), 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 term and definition 3.1 has been added;

— Clause 4 has been revised, design B jackets have been added in 4.5 and an evaluation of the protective insert after pre-treatment with 60 °C and spin-drying has been added in 4.6;

— in Clause 6, the pre-treatment procedure has been revised;

— in Clause 8, the definition has been specified;

— in 9.7, the cut test at the sleeve has been changed;

— in Clause 10, descriptions have been specified and the test procedure has been revised;

— in Clause 11, the test procedure has been revised and a test procedure has been added in 11.3;

— Clauses 12, 13 and 14 have been specified;

— Clause 15 has been revised;

— in Annex A, the definition has been revised.

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.

This corrected version of ISO 11393-6:2018 incorporates the following corrections:

— The arrows on Figures 5 and 6 have been corrected and the colour of shading improved on Figures 1 to 6 and Figure 9 for more readability.

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.

Accidents occur due to a number of complex reasons, but a common factor is incorrect use of the chainsaw. The importance of correct training and proper use of a chainsaw in preventing accidents cannot be underestimated.

All parts of the upper body have been shown to be at risk when using a chainsaw. In this document, specifications for the protective coverage and performance of the upper body protectors are given.

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 in chainsaw protective clothing. Upper body protectors in accordance with this document are meant to be used while working off the ground, and where risk assessment shows that there is a significant risk of being cut by the moving chain on the upper part of the body, such as when working from a sky lift and carrying out tree surgery.

Protective clothing for users of hand-held chainsaws —

Part 6:
Performance requirements and test methods for upper body protectors

1 Scope

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

It also specifies procedures for sampling and pre-treatment of upper body protectors, the measurement of the protective coverage, the apparatus and test methods for assessing resistance to cutting, and the practical performance test for evaluating ergonomic properties.

Guidance on chainsaw use and the selection of appropriate upper body protectors is given in Annex A.

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 driven by a flywheel for testing resistance to cutting by a chainsaw*

ISO 11393-3:2018, *Protective clothing for users of hand-held chainsaws — Part 3: Test methods for footwear*

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*

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

3.2
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 cycle

Note 1 to entry: The broken ladder is often caused by a broken cross binder.

3.3
front
part of a garment covering the forward half of the upper body circumference

3.4
joins
place or line where two or more parts of the protective insert are connected or fastened together, e.g. by seams or zippers

3.5
protective coverage
area of the garment that is covered by *protective material* (3.6)

3.6
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 cloth of the garment.

3.7
rear
part of a garment covering the backside half of the upper body circumference

Note 1 to entry: Depending upon design and construction, and due to many layers of *protective material* (3.6), it can be difficult to establish the division between the *front* (3.3) and the rear of an *upper body protector* (3.11). It is nevertheless of great importance to establish this before pre-treatment and testing.

3.8
specified protective area
minimum required *protective coverage* (3.5)

3.9
top of shoulder
uppermost line of the shoulder of the *upper body protector* (3.11)

Note 1 to entry: The top of the shoulder is shown in Figure 1.

3.10
unit of protective material
cut-out piece or panel of *protective material* (3.6) consisting of all the fabric or other layers that constitute the protective material that goes into the construction of a garment without any joins within it

Note 1 to entry: Units can be joined together to provide the complete *protective coverage* (3.5) required, before insertion and attachment to garments, but such units retain their individuality for testing purposes.

3.11
upper body protector
any type of protective garment that protects, at least, the specified area to the level of resistance against cutting by a chainsaw as specified for the upper part of the body

EXAMPLE Jacket.

4 Performance 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

Upper body 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

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

4.4 Ergonomic requirements

When tested according to 11.2, the upper body protector shall be free of rough surfaces, sharp edges, sharp points, etc., which could cause excessive irritation or injuries.

The protective garments shall be designed to minimize discomfort and restriction while wearing them. When tested according to 11.3, the average score of all series and all movements shall be 2 or less. The design shall be without appendages, which can become entangled in machinery or the undergrowth.

4.5 Specified minimum protective area for upper body protectors

4.5.1 General

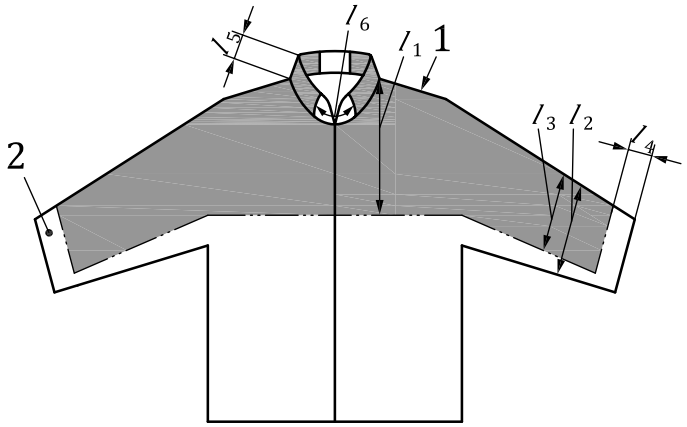
The protective coverage shall be measured in accordance with Clause 8 and shall fulfil the requirements to the dimension of the protective area of 4.5.3, 4.5.4, 4.5.5 and 4.5.7. The requirements of 4.5.6 are optional.

4.5.2 Designs of jackets

Two different designs of jackets may be manufactured. Design A jackets protect at the shoulder and the arms. Design B jackets additionally protect the front of the torso.

4.5.3 Front design A

The specified protective area shall cover the front of the garment from the top of the shoulder downwards for a distance equivalent to at least 25 % of the chest girth of the largest intended user of the tested sample as given in the marking. The protective area shall include the upper 80 % of the surface of the front of the sleeve down to within 70 mm of the lower edge of the cuff of the sleeve. See Figure 1.



Key

1 top of shoulder

2 cuff

l_1 height of protective coverage at the front of the garment (minimum 25 % of the chest girth of the largest intended user of the tested sample)

l_2 width of sleeve

l_3 width of protective coverage on the front of the sleeve (minimum 80 % of l_2)

l_4 unprotected length including cuff less than 70 mm

l_5 height of protective coverage in collar, minimum of 30 mm

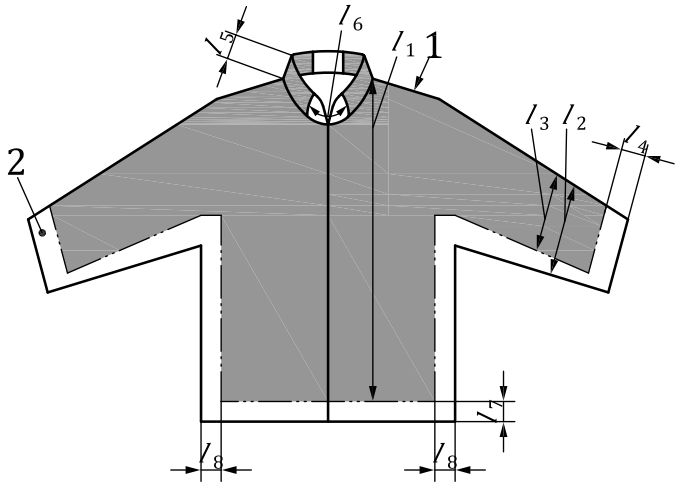
l_6 gap in the protective coverage in the collar, maximum of 80 mm

shaded area is protective material

Figure 1 — Specified protective area of design A, front of garment

4.5.4 Front design B

The specified protective area shall cover the front of the garment from the top of the shoulder downwards to a distance of within 50 mm or less to the bottom of the hem. It shall cover the front half of the circumference of the jacket minus 50 mm on the left and right sides. The protective area shall include the upper 80 % of the surface of the front of the sleeve down to within 70 mm of the lower edge of the cuff of the sleeve. See Figure 2.



Key

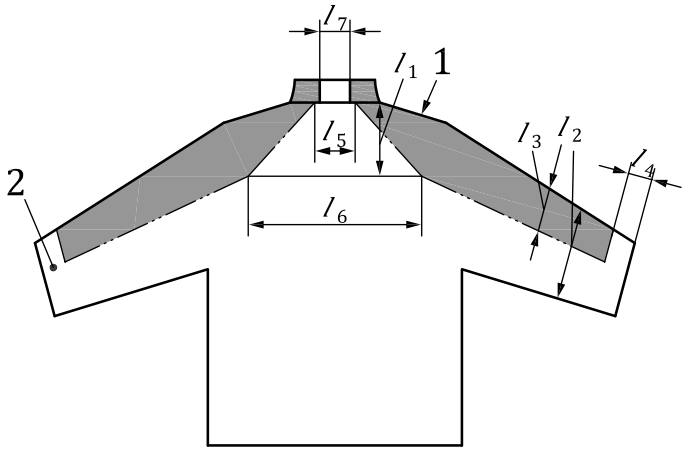
1 top of shoulder
2 cuff
l_1 height of protective coverage at the front of the garment
l_2 width of sleeve
l_3 width of protective coverage on the front of the sleeve (minimum 80 % of l_2)
l_4 unprotected length including cuff less than 70 mm
l_5 height of protective coverage in collar, minimum of 30 mm
l_6 gap in the protective coverage in the collar, maximum of 80 mm
l_7 unprotected waist, length less than 50 mm
l_8 unprotected width less than 50 mm
shaded area is protective material

Figure 2 — Specified protective area of design B, front of garment

4.5.5 Rear design A and B

The protective area shall cover the top of the shoulders plus the superior 40 % of the surface of the rear of the sleeve down to within 70 mm of the lower edge of the cuff of the sleeve. See Figure 3.

A gap is permitted in the protective material in the centre of the rear. The dimensions of the gap, l_5 and l_6, are shown in Figure 3. l_5 shall be less than 9 % of the chest girth of the smallest intended user of this tested sample, as given in the marking, and l_6 shall be less than 35 % of the chest girth of the smallest intended user of this tested sample.



Key

1 top of shoulder

2 cuff

l_1 minimum height of protective coverage at the rear of the garment (top of the shoulders plus the superior 40 % of the surface of the rear of the sleeve)

l_2 width of sleeve

l_3 width of protective coverage on the rear of the sleeve (minimum 40 % of l_2)

l_4 unprotected length including cuff less than 70 mm

l_5 gap in protective coverage at the level of the top of the shoulders beneath the collar

l_6 gap in protective coverage at a distance of l_1 below the top of the shoulders

l_7 gap in the protective coverage in the collar, maximum of 80 mm

shaded area is protective material

Figure 3 — Specified protective area, rear of garment

4.5.6 Collar (optional)

If a protective collar is fitted, the protective area shall cover a minimum length of 100 mm on each side of the neck. A gap in the protective material at the centre front of a maximum of 80 mm is permitted and a gap in the protective material at the centre rear of a maximum of 80 mm is also permitted. The height of the protective material shall be a minimum of 30 mm. See Figures 1, 2 and 3.

4.5.7 Fastenings and joins

The garment may have a closure down the centre front to facilitate donning and doffing. When the garment is fastened, the gap between the edges of the protective material shall be no more than 30 mm. The gap in the protective material at the join between the main body of the garment and the collar shall be less than 8 mm.

4.6 Dimensional change and other changes

4.6.1 Dimensional change

After cleaning according to the manufacturer's instructions, the dimensional change when measured according to Clause 7 shall be less than 6 %.

4.6.2 Other changes as a consequence of cleaning

After cleaning according to the manufacturer's instructions, and after cleaning one sample according to 6.2.2 at 60 °C and spin-drying, and examining according to 6.5, there shall be no damage in the protective material due to cleaning, except for the damage caused by the cut test.

4.7 Resistance to chainsaw cutting

When tested according to Clause 9, no cut-through is allowed in any test specimen.

4.8 Requirements for the attachment of protective padding and the strength of closures

The protective material shall be permanently attached to the garment. Attachment shall be continuous along all the edges of the protective material, except around the cuff. When tested according to Clause 10, the attachment shall resist at least a force of 150 N for each test specimen.

5 Classification according to chain speed

Testing in accordance with this document shall be carried out at one of the following four speeds with classes assigned as follows:

a) class 0 (16,0 ± 0,2) m/s;

b) class 1 (20,0 ± 0,2) m/s;

c) class 2 (24,0 ± 0,2) m/s;

d) class 3 (28,0 ± 0,2) m/s.

6 Test methods

6.1 General

Measuring instruments, unless otherwise specified, shall be accurate to ±2 % of the pass/fail level of the characteristic being measured.

For each of the required sequences of measurements performed in accordance with this document, a corresponding estimate of the uncertainty of the final result shall be determined. This uncertainty, U_m, shall be given in the test report in the form $U_m = \pm X$. It shall be used in determining whether a pass performance has been achieved. If the final result minus U_m is below the pass level when the requirement that a certain value shall be exceeded, the sample shall be deemed to have failed.

6.2 Pre-treatment

6.2.1 Cleaning

Before testing, 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, the number of samples indicated in 6.3 for dry cleaning shall be dry-cleaned and the number of samples indicated in 6.3 for washing shall be washed. If only dry-cleaning is allowed, the number of samples indicated in 6.3 for that case shall be dry-cleaned. If only washing is allowed, the number of samples indicated in 6.3 for that case shall be washed.

After each cleaning, the upper body protectors shall be reshaped by hand, but not by ironing.

Line drying after washing shall be carried out in an environment maintained at a temperature of (30 ± 15) °C and at a relative humidity of (30 to 70) % RH.

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 6.3.

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.

6.2.2 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 6.5 and Clause 9, 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 6.3.

6.3 Number of test specimens

A set of upper body protectors shall be taken that is sufficient to complete all the tests. Note that if two types of pre-treatments are specified, the testing and the numbers of upper body protectors are effectively doubled and two sets are required. Upper body protectors that have been used to assess dimensional stability, protective coverage and ergonomic requirements may be used for cut testing if it has not been necessary to cut them up for these measurements.

The number of garments required for cut testing depends on the number of units of protective material present within them and whether there are any joins or seams between different protective material units, such as between the body and the sleeve. Only one test cut shall be carried out on each unit of protective material. Therefore, at least three garments are required for cut testing if the design includes a fastening down the centre front of the garment, but no seams between the protective material on the body and in the sleeve. For a design incorporating only one unit of protective material, six garments are required for cut testing. Additional samples in different sizes can be required to perform the ergonomic assessment.

6.4 Sizes of test specimens

Whenever possible, test specimens shall represent the smallest, medium and largest sizes.

6.5 Examination of protective material

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

7 Testing for dimensional change

One upper body protector shall be tested by each pre-treatment applicable according to 6.2.1.

The dimensions of the protective material coverage shall be measured before the first pre-treatment cycle and on completion of the last cycle of the pre-treatment procedure. The dimensional change shall be determined from the percentage difference between the measurements made before the pre-treatment and the measurements made after the pre-treatment.

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 which

incorporates protective material. Measuring shall be carried out in an environment maintained at a temperature of (22 ± 4) °C and relative humidity of (30 to 70) % RH.

Measurements shall be carried out in two directions, at right angles to the other. It is suggested that one measurement should be the length of the protective material from cuff to cuff, or cuff to the centre of the garment. The other measurement is then, appropriately, the length of the protective material from the bottom edge near the centre front, up to the top edge at the collar and similarly on the rear.

While measuring the dimensions the garment shall be stretched with a force of (20 ± 2) N in the direction of the dimension being measured. Clamps may be attached to the part of the garment to which the protective material is attached, except at the cuff where the clamps shall be attached to the protective material.

8 Checking of protective coverage

The coverage shall be measured on the cleaned test specimen used for the testing of dimensional change.

Lay the garment out flat, front side uppermost on a flat surface, such as a table top. Smooth out any wrinkles and creases and ensure that any fastenings lie down the centre of the garment. On the outer material, mark a line along the top of the shoulder and top and bottom of the sleeve. If there is no front fastening, mark a line down the centre front of the garment. Carefully, and with minimal disturbance of the garment, mark lines on the inside surface of the protective material or lining of the garment, corresponding to the top of shoulder and the top and bottom of the sleeves.

Take the garment and turn it inside out. Mark lines at the edges or contour of the protective insert after visual or manual detection, if needed.

Measure the dimensions of the protective material and check that the requirements given in Clause 4 are fulfilled.

Additional features in some cases shall be removed if they make the measurement impossible.

9 Testing of resistance to cutting

9.1 Purpose of testing

The purpose of this test is to assess the resistance of the upper body protector to cutting by a chainsaw under such conditions that the garment is restrained from twisting when contacted by the moving chain.

9.2 Test specimens

The number of upper body protectors required for cut testing depends on the design of the protective material units constituting the required protective coverage, and the positions of seams between units of protective material (see 6.3). The whole upper body protector is the test specimen.

All cut upper body protectors shall be pre-treated according to 6.2.1 and 6.2.2.

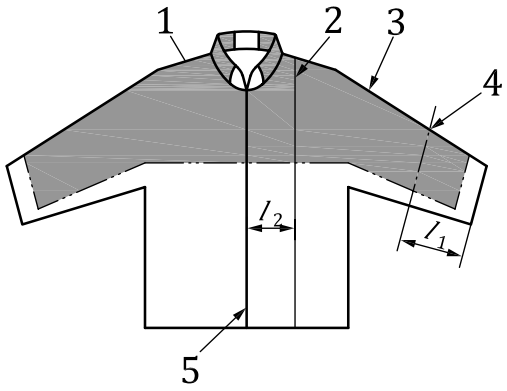
Where the garments are marked as suitable for both washing and dry cleaning, two sets of garments shall be tested.

9.3 Marking of positions for cutting

9.3.1 Test position line on shoulder

Mark a line parallel to, and (170 ± 10) mm from, the centre front line, from the shoulder vertically down the front of the garment (see Figure 4).

The contact point to the saw chain is on that line on the front side of the jacket. It is the uppermost point of the garment when the test mount is tilted 30°, as shown in Figure 8.



Key

1 top line of shoulder
2 shoulder test line
3 top line of sleeve
4 cut point on sleeve
5 centre front line
l_1 (300 ± 10) mm on the right sleeve and on the left sleeve as well
l_2 (170 ± 10) mm
shaded area is protective material

Figure 4 — Test positions on shoulder and sleeve units of protective material

9.3.2 Test position on the sleeve

Mark a line at the top of the sleeve. Mark the test line (300 ± 10) mm from the free edge of the cuff at an angle of (90 ± 10)° across the line at the top (see Figure 4). The point where the lines cross is the contact point (cut position) according to 9.7.1.

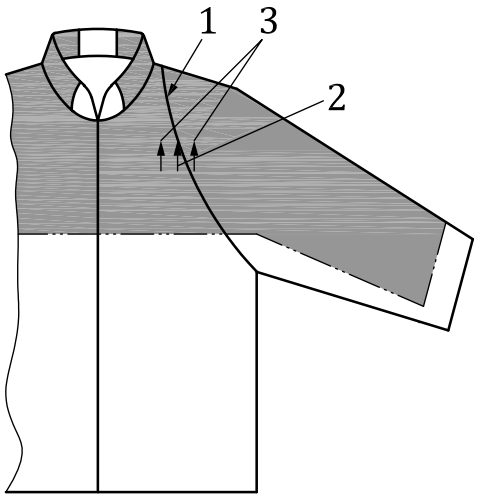
9.3.3 Test positions if there are seams in the protective material

If there are seams between units of protective material, they shall be tested as follows:

— once across the seam at (0 ± 10)° to the vertical axis of the garment in the shoulder region and at (90 ± 10)° to the long axis of the arm on the sleeve (the first point of contact of the chain being on the seam) (position 2 of Figure 5);

— once each side of the seam with the first contact of the chain being (20 ± 5) mm from the seam [the cut directions being determined by the seam position as shown in Figures 5 and 6 (position 3)].

For these cut tests, the jacket shall be positioned on the appropriate mount as specified in either 9.4.1, with the top line of the shoulder of the jacket in line with the top of the mount, or 9.4.2, with the first marked line as specified in 9.3.2 along the top of the sleeve mount. The jacket shall then be moved along the mount until the seam, or the test points 20 mm either side of the seam, are at the point of first contact with the chain.



Key

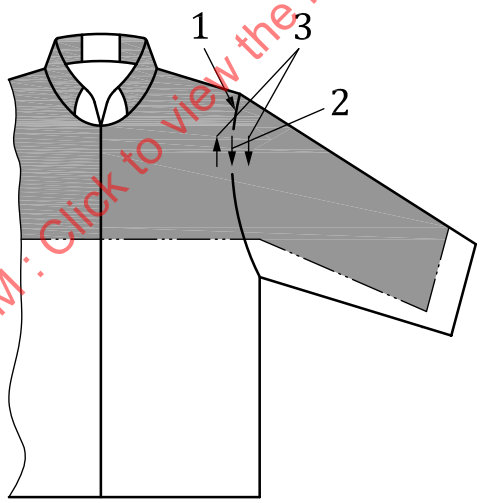
1 seam

2 direction of the cut directly on the seam

3 direction of the cuts (20 ± 5) mm on either side of the seam

shaded area is protective material

Figure 5 — Test positions and cut directions on the seam in the shoulder area



Key

1 seam

2 direction of the cut directly on the seam

3 direction of the cuts (20 ± 5) mm on either side of the seam

shaded area is protective material

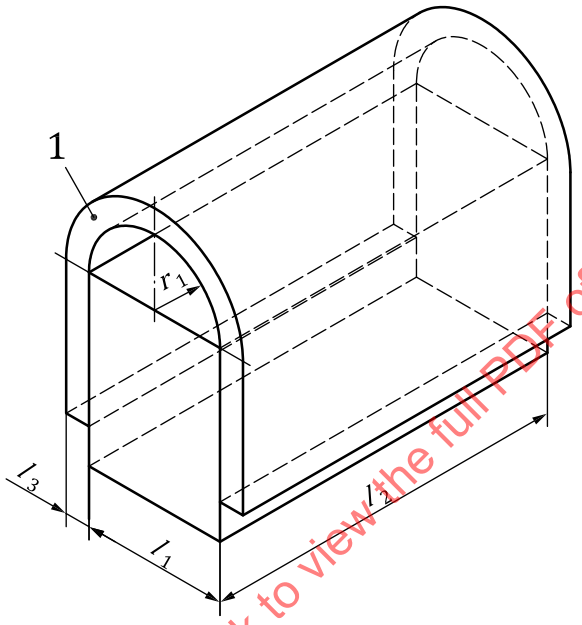
Figure 6 — Test positions and cut directions on seams between protective material on the shoulder and arm

9.4 Test mounts

9.4.1 Shoulder test mount

The shoulder test mount (see Figure 7) shall be made of rigid material, such as wood. The top section shall be a half cylinder at least 200 mm long with a radius of (40 ± 1) mm. The bottom section shall be (80 ± 2) mm wide and at least 200 mm long. It shall be high enough so that the test samples can be mounted satisfactorily according to 9.6.1.

It shall be covered with (14 ± 2) mm thick flexible cellular material in accordance with ISO 11393-1:2018, 5.4.



Key

1 flexible cellular covering
r_1 radius of half cylinder (40 ± 1) mm
l_1 width of block (80 ± 2) mm
l_2 length of block 200 mm minimum
l_3 thickness of flexible cellular foam (14 ± 2) mm

Figure 7 — Shoulder test mount

9.4.2 Sleeve test mount

Use the test mount as described in ISO 11393-3:2018, 6.1.2.2.

9.5 Apparatus

The test rig described in ISO 11393-1:2018, Clause 5, shall be used. It shall be set up so that the horizontal distance from the centre of the drive sprocket to the contact point between the guide bar and the test mount is (300 ± 5) mm. The contact force between the test mount and the guide bar with a chain fitted shall be (15 ± 0,5) N.

Before beginning a series of cut tests on a set of upper body protectors, the test rig and chain shall be calibrated in accordance with ISO 11393-1:2018, Clause 7. For calibration, the test rig shall be set up in accordance with ISO 11393-1:2018, 5.3.5, using the calibration mount specified in ISO 11393-1:2018, 5.4, and standard calibration pads specified in ISO 11393-1:2018, Clause 6.

Measured chain speeds at the point of release shall be as specified with an accuracy of ±0,2 m/s. Between test cuts, the test rig shall be checked in accordance with ISO 11393-1:2018, 7.3. The free-running stopping time shall be (4 ± 0,2) s at a chain speed of (20 ± 0,2) m/s.

9.6 Mounting of test specimens

9.6.1 Shoulder test

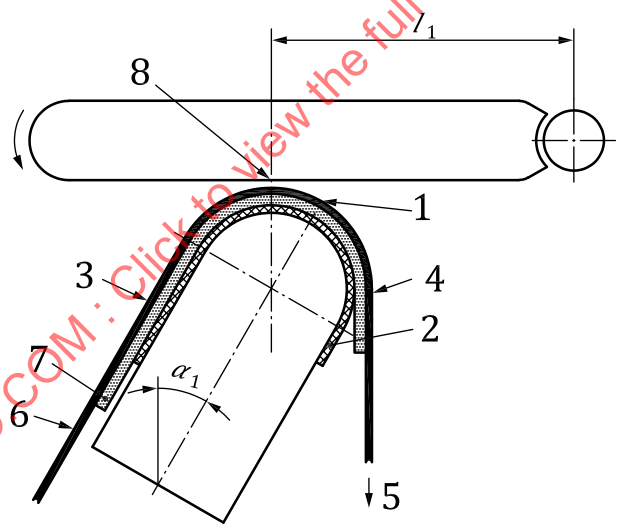
The upper body protector shall be mounted on the shoulder test mount in such a way that the top line of the shoulder follows the centre top line of the shoulder mount. The front part of the upper body protector of design A is then stapled every (50 ± 10) mm to the mount in such a way that the staples do not penetrate the protective material (see Figure 8). Use nails to mount upper body protectors of design B to the shoulder test mount; they may penetrate the protective insert.

Three (1 000 ± 10) g weights shall be attached to the rear of the jacket. The middle weight shall be in line with the chainsaw guide bar ±10 mm. The other weights shall be (100 ± 10) mm on either side.

The shoulder test mount with the jacket shall be mounted at a (90 ± 10)° angle to the direction of the saw chain in such a way that the rear of the jacket is nearest the drive sprocket.

The mount shall then be tilted (30 ± 5)° from the vertical plane (see Figure 8).

The contact point between the saw chain and the test specimen shall be (300 ± 5) mm from the drive sprocket and on the shoulder test line marked according to 9.3.1.



Key

1 top line of shoulders
2 flexible foam covering mount
3 outer material of the front of garment
4 outer material of the rear of garment
5 stretching force on rear of garment
6 position of the line of staples through the front of the garment
7 protective material
8 cut point
α_1 (30 ± 5)°
l_1 (300 ± 5) mm

Figure 8 — Mounting of test specimens on the shoulder test mount

9.6.2 Sleeve test

The sleeve shall be put on the test mount as described in 9.4.2 in such a way that the top line of the sleeve is along the top of the mount. The front side of the sleeve shall be stapled every (60 ± 3) mm along the mount. The staples will usually pass through protective material. A (500 ± 10) g weight on a cord with a clamp shall be attached to the outer material only of the rear of the sleeve near its lower edge as it is mounted on the apparatus, below the position of the intended cut, and so that the fabric in the region of the cut is under tension.

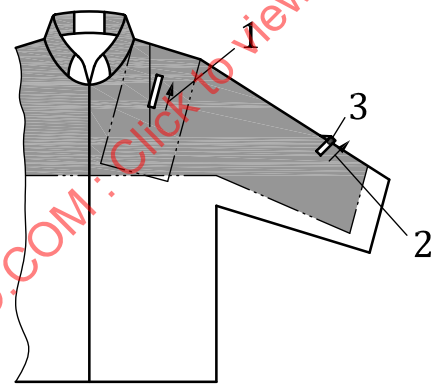
9.7 Test procedure

9.7.1 Positions of cuts

9.7.1.1 On protective material units

Test cuts shall be performed on protective material units on the front of the shoulder and on the top of the sleeve. The cuts on the shoulder shall be made at an angle of (90 ± 5)° to the mount used and on line, which is marked out according to 9.3.1 and shown in Figure 4. The cut position on that line is determined by mounting according to 9.6.1. The cuts on the sleeves shall be made at an angle of (45 ± 5)° to the mount used and on the intersection of the lines, which were marked out according to 9.3.2 and are shown in Figure 4.

The directions of cut (i.e. the movement of the cutting chain relative to the test site) at the shoulder and sleeve test points shall be as shown in Figure 9. Cuts on the shoulder shall be carried out with the test specimen mounted so that the cutting direction is up the garment. The cut on the sleeve shall be carried out with the test specimen mounted so that the cutting direction is across the front of the sleeve away from the body. One test cut shall be made on each unit of protective material.



Key

1 direction of cut on the shoulder for upper body protectors without seams between units of protective material

2 direction of cut on the sleeve

3 cut point

shaded area is protective material

Figure 9 — Direction of cut on units of protective material

9.7.1.2 On seams between protective material units

One test cut shall be carried out on each seam type and one test cut shall be carried out on either side of each seam type. For seams in the shoulder region, as shown in Figure 5, all test cuts shall be carried out using the shoulder mount and the cuts shall be directed upwards. For seams between the shoulder and sleeve, as shown in Figure 6, the test cut on the shoulder side shall be carried out on the shoulder mount in an upwards direction, and the test cuts on the seam itself and on the sleeve shall be carried out on the sleeve mount in a downwards direction.

Any other seams found between units of protective material shall be tested according to the same principles. All tests on the trunk part of the garment shall be carried out on the shoulder mount with the direction of the cuts upwards. All tests on sleeves shall be carried out on the sleeve mount with the direction of the cuts downwards. For seams parallel to the shoulder or sleeve top lines it is normally only possible to do a cut across the seam. However, if there is any doubt about the safety of the design, samples shall be cut to test the cut resistance parallel to the seam and along the seam.

9.7.2 Number of cuts

One test cut only shall be performed on any one unit of protective material or on any seam between two units. If a cut has been performed on a seam, the units either side of a seam shall be considered tested and shall not be used for further test cuts. A total of three test cuts shall be carried out at the shoulder test site, and three test cuts shall be carried out at the sleeve test site described in 9.7.1.1. A total of three test cuts shall be made on each seam type as described in 9.7.1.2.

9.7.3 Chain speed

The chain speed shall be one of the speeds specified in Clause 5 in accordance with the level of protection that the garment is stated as providing. If no information is available, the speed shall be (20 ± 0,2) m/s.

10 Testing of the protective material attachment

10.1 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 upper body protectors where the outer material covers the protective material providing the chainsaw protective properties.

Testing shall be carried out in accordance with ISO 13935-2 with deviations as listed below in 10.2, 10.3 and 10.4.

10.2 Test specimens

One upper body protector from each pre-treatment applied shall be tested. To assist in preparation of the test specimens, the sleeves may be cut open along the arm at a distance of at least 100 mm from the seam to be tested. Upper body protectors tested earlier according to Clause 9 can be used, provided the attachment has not been affected.

Examine the upper body protector and identify how many different types of attachment between the outer material and the protective material have been used in its construction. Three test specimens of each type of attachment shall be tested.

10.3 Apparatus

Apparatus in accordance with ISO 13935-2 shall be used. For testing the strength of attachment of protective material, a cross head speed of (1,5 ± 1) mm/s shall be used.

If no tensile testing machine is available, the test can be performed by gently applying individual masses of 1 kg every 5 s without jerks to the lower grab jaw until the attachment breaks.

10.4 Test procedure

Cut out three test specimens from the upper body protector. If different attachment constructions are used to join protective material to the garment material in different parts of garments, then two test specimens shall be taken from each part.

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. Upper body protectors earlier tested according to 9.7 can be used, provided the attachment has not been affected.

Prepare the test specimens as specified in ISO 13935-2, except that the lines shall be drawn on both the outer material, and the facing surface of the protective material. Conditioning shall be carried out at (22 ± 4) °C and at a relative humidity of (30 to 70) % RH.

Mount the test specimens to the apparatus. Fix the free end of the protective insert and the opposite free end of the outer fabric to each of the two clamps. The distance from each clamp to the nearest connection shall be (25 ± 3) mm and no clamp shall be closer than 100 mm to an end or corner of the protective insert. If the distance between the attachment of the protective material to a lining and the attachment from the lining to the outer fabric is more than 100 mm, each attachment shall be tested separately.

Put the moving clamp in motion with a speed of (1,5 ± 1) mm/s. Test until the specimen breaks or the force exceeds 150 N.

If carrying out the test by applying units of 1 kg to the lower clamp jaw in accordance with ISO 13935-2:2014, 9.3, the test may be stopped if breakage has not occurred when the mass hanging from the lower jaw has reached 15 kg.

11 Ergonomic testing

11.1 Ergonomic assessment

The upper body 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 people shall select, according to the instructions supplied by the manufacturer, the appropriate size among all the samples submitted for testing.

11.2 Test for surface conditions

The surface of upper body protectors shall be visually and manually checked for rough surfaces, sharp edges, sharp points, etc., which could cause excessive irritation or injuries.

11.3 Procedures

Each test person shall put on the upper body protector and adjust it according to the information supplied with the manufacturer's instructions. He or she shall perform the movements below to assess the restriction and discomfort imposed by the upper body protectors. The movements shall be typical of those made by users of the garments, and shall include:

— raising the arms forwards to above the head;

— raising the arms sideways to above the head;

— bending the arms forwards and sideways;

— bending the torso forwards with the arms outstretched as if to pick up an object placed about 300 mm above the floor;

— bending forward with the legs flexed to pick up an object from the ground;

— standing with the feet slightly apart and holding a chainsaw without its motor running in front of the body, turning 90° to the left and then 90° to the right;

— holding a chainsaw without its motor running, and moving it as in cutting and de-branching;

— standing in front of a working surface about 800 mm high and bringing the hands together to manipulate small objects;

— checking for appendages that can become entangled in machinery or the undergrowth.

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 ergonometric 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.

12 Test report

The report shall include the following information:

a) a reference to this document and the year, i.e. ISO 11393-6:2018;

b) identification of the test specimens, e.g. manufacturer, style, design, date of manufacture, size; number of layers, type, composition and weight per square metre of protective insert provided by the manufacturer;

c) details of the pre-treatments carried out, dimensional change measurements, protective coverage assessment results, positions of seams identified between protective material units;

d) the protective material attachment strength and, for each type of attachment, the minimum breaking force of the individual tests;

e) the chain speed used in the tests;

f) the test results for resistance to cutting, evaluation of damage, numbers of layers of protective material damaged, and chain-stopping mechanism for all cut tests;

g) the results from ergonomic testing;

h) the results of the assessment of protective coverage of one sample;

i) the mass of a test garment in h);

j) the legibility of the marking after each cleaning procedure applied;

k) any deviations from the procedure;

l) any unusual features observed;.

m) the date of the test.