# SLOVENSKI STANDARD
# SIST EN ISO 13995:2001

**01-december-2001**

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**Varovalna obleka - Mehanske lastnosti - Preskusna metoda za ugotavljanje odpornosti proti prebadanju in dinamiļ nemu trganju materiala (ISO 13995:2000)**

Protective clothing - Mechanical properties - Test method for the determination of the resistance to puncture and dynamic tearing of materials (ISO 13995:2000)

Schutzkleidung - Mechanische Eigenschaften - Prüfverfahren zur Bestimmung des Widerstandes gegen Durchstoßen und dynamisches Weiterreißen von Materialien (ISO 13995:2000)



Vetements de protection - Propriétés mécaniques - Méthode d'essai pour la détermination de la résistance a la perforation et au dynamique des matériaux (ISO 13995:2000)



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13.340.10 Varovalna obleka Protective clothing

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EUROPEAN STANDARD

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# EN ISO 13995

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English version

# Protective clothing - Mechanical properties - Test method for the determination of the resistance to puncture and dynamic tearing of materials (ISO 13995:2000)

Vêtements de protection - Propriétés mécaniques - Méthode d'essai pour la détermination de la résistance à la perforation et au dynamique des matériaux (ISO 13995:2000)

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This European Standard was approved by CEN on 8 April 2000.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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# Contents

## Foreword

The text of EN ISO 13995:2000 has been prepared by Technical Committee CEN/TC 162 "Protective clothing including hand and arm protection and lifejackets", the secretariat of which is held by DIN, in collaboration with Technical Committee ISO/TC 94 "Personal safety - Protective clothing and equipment".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2001, and conflicting national standards shall be withdrawn at the latest by June 2001.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

## Introduction

This European Standard test method is based on ASTM D 2582-90, "Standard test method for puncture-propagation tear resistance of plastic film and thin sheeting". The test has been modified to make it applicable to strong woven and knitted fabrics, coated fabrics and leather. The test is designed to assess the resistance to snagging and tearing of materials used for protective clothing. It is important to know the puncture and dynamic tear resistance of material used for protective clothing that is intended to be used in hazardous situations where the clothing forms a barrier between the wearer and the hazard, and breaching of the barrier can result in harm and the level of risk of harm is related to the size of hole resulting from the puncture and tear. Such clothing includes chemical and biological barrier clothing, spray suits, foul weather clothing and firefighting clothing.

Dynamic tearing of materials following puncture by a spike is a complex process. The test given in this European Standard has been devised to provide standard conditions under which materials can be compared. Experience with materials of known resistance will enable product standards writers and clothing designers to specify appropriate performance levels for particular end-uses. The standard provides for four performance levels.

It has been assumed in the drafting of this European Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people, for whose guidance it has been prepared. The apparatus described should only be used by competent persons and requires safeguards to prevent, as far as is reasonably practicable, injury to the operator and other persons.

# 1 Scope

This European Standard specifies a test method for the determination of the resistance to puncture and dynamic tearing of protective clothing materials which are used in situations where snagging and tearing could result in unacceptable damage to the clothing or danger to the wearer through loss of integrity of a barrier. It is intended that the performance levels determined will be of use in specifying materials for use in situations where the risk of harm is related to the size of puncture and tear that may occur in accidents.

# 2 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply:

## 2.1 Test specimen mounting block

A solid block of metal or plastic to which the test specimen is clamped for testing.

## 2.2 Tearing blade

A blunt blade projecting from the falling mass which punctures and tears the test specimen.

**NOTE:** The hard steel tearing blade has a ground wedge shaped end that has a radius of curvature so that it is not sharp, but will puncture test materials. The main body of the blade is 3 mm thick and the lower surface is half round. This lower surface causes the blunt tear in the test specimen that is measured in the test. This blade performs the same function as the spike in ASTM D 2582-90, but it is more rigid so is capable of withstanding greater forces.

# 3 Requirements

## 3.1 Use of this standard

This European Standard describes a method for determining the resistance to puncture and dynamic tearing of materials. When it is cited as a test method in a specific product standard that standard shall contain the necessary information to permit the application of this European Standard to the particular products. The standard citing this European Standard shall include at least the following:

a) Normative reference to this European Standard;

b) A description of the samples to be tested, their origin in sheet materials or finished PPE (Personal Protective Equipment) products, their method of preparation and pre-treatment, if any, and the permitted size range of the samples;

c) Details of any additions to, or deviations from the method described in this European Standard;

- Details of any specific clamping and stretching methods to be used with the test specimens ;

- The energy(s) and velocity(s) of impacts to be used in the test;

- The orientation of the impacts relative to a specified axis of the test specimens ;

- The number of tests to be performed:

- Details of any specific techniques to be used in measuring tear lengths in particular materials or in materials for particular applications;

d) Additional contents of the test report to be provided:

- The performance requirements for the product, and associated "levels". The performance required shall be given as either a performance level as defined in this European Standard, or as "a mean tear length not more than xx mm and a largest single value of not more than yy mm when tested according to zz";

- The area of the product that is to meet the requirements.

Information and guidance on using this European Standard in a product standard are given in the informative Annex A.

# 4 Test apparatus and procedures

## 4.1 Principle of the puncture and dynamic tear test

A test specimen of fabric or leather is clamped securely to a solid block that is shaped so that the main part of the test specimen is vertical. The upper part of the block is machined to be a quadrant so that the test specimen lies back on it and presents a curved face upwards towards the tearing blade attached to a falling mass that is dropped onto the test specimen. The tearing blade is sharpened on its end so that it punctures the curved part of the test specimen. The rounded lower surface of the blade tears downwards into the vertical part of the test specimen until the energy in the falling mass is dissipated. The vertical face of the block has a slot machined into it so that the end of the blade is in the block and the middle part of the blade causes the tearing.

It is found on very strong materials that the puncturing process by the sharpened end of the blade contributes less than 5 mm to the total tear length. With weak materials the effect is less. Choosing an end point or pass/fail value of 40 mm ensures that the main property measured is the dynamic tear resistance of the punctured material. The tear length is the vertical dimension of the hole made by the blade. It may be appropriate to specify a lower tear length for assessing materials to be used where tearing of products would expose the wearers to hazards, see Annex A.

## 4.2 Types of tear and their measurement

The following types of tear are commonly caused:

a) A vertical slit tear in which the blade breaks horizontal fibres in the test specimen;

b) A "V" tear which has two legs diverging from the puncture point. In woven fabrics the legs may proceed at 90° to the warp and weft fibres giving an angle between the legs of 90°. In leather, composite materials and unsupported plastics the angle between the legs is often about 30°;

c) A horizontal tear in which a tear propagates horizontally from the puncture point along a line of weakness. This is found sometimes in one orientation of testing of coated knitted fabrics. When test specimens of such material are cut at 90° to the orientation giving this type of tear, the result is usually a very long vertical slit tear.

d) Complex tears combining various properties of the above tears. Some warp knits give V tears with one vertical and one 45° leg, or one vertical and one horizontal leg.

For all types of tear the tear length is the vertical dimension of the hole made by the blade. The hole is measured with the blade in situ if the hole is long enough. This ensures the dynamic rolling up of the material in V tears is consistently treated. Similarly the stretching effect of the mass of the block on the test specimen will be consistent for each falling mass. If the tear is shorter than the vertical height of the blade, the blade is lifted out and the hole measured while the test specimen is still clamped. In materials with unusual responses and a particular weakness in one orientation, test samples should be prepared that permit the "worst case" tear to be produced and measured.



The final falling mass position is not a reliable indicator of tear length in all materials as very elastic fabrics stretch during the test, and the upper edge of the hole will be drawn downwards. The hole length would be over estimated by comparing the position of the falling mass when it first contacts the test specimen and its final position. The falling mass resting in the tear will increase its measured length in compliant materials and this should be considered when citing this European Standard.

## 4.3 Performance levels

The performance level reached by a material is determined as described below. It is based on the mean value of the tear lengths in all orientations of test, if these are similar, or on the mean value of the tear lengths at the worst orientation if this value is more than 50% greater than the value from the orientation giving the smallest tear length.

### 4.4 Test apparatus

The test apparatus shall consist of a rigid heavy base on which a test specimen mounting block and a falling mass guidance system are mounted, see figure 1. The guidance system shall consist of two vertical polished steel rods at least 15 mm in diameter with their centres (100 ± 2) mm apart. The steel rods shall be sufficiently long to accommodate a drop height of 750 mm between the base of the tearing blade and the puncture point on the test specimen. A dropping mechanism shall be provided such as an electromagnet to hold the falling mass in its initial position. Its height shall be adjustable so that the energy loses due to friction may be allowed for and the appropriate energy of impact achieved. A means of measuring the impact velocity of the falling mass and blade shall be provided.

### 4.5 Falling mass - blade holding block

The proportions and dimensions of the falling mass blade holding block are shown in figure 2. Four blocks should be provided that with the tearing blade fitted have the following masses:

| | |
|---|---|
| No 1 | (250 ± 10) g |
| No 2 | (500 ± 10) g |
| No 3 | (1000 ± 20) g |
| No 4 | (2000 ± 40) g |

The blade holding block may be constructed of any convenient rigid material. Higher mass blocks may be provided by adding weights to lighter ones provided the block remains within the dimensions given in figure 2.

The blocks shall be provided with low friction guides. Plastic tubes running through the block, or slides of at least 20 mm length in the top and bottom of the block, may be used. The clearance on the guidance rods shall be (1 ± 0,5) mm. Systems using linear bearings or wheels have been found to absorb significant amounts of energy during the tearing action because of the moment between the block and the guidance rods. A system of plastic tubes and a light oil on the guidance rods has been found to give consistent results.

### 4.6 The tearing blade

The position and overall dimensions of the tearing blade in relation to the holding block are shown in figure 2. The blade shall be made of steel. It shall preferably have a hardness of 58 HRC (Rockwell hardness scale C). It shall be rigidly attached to the holding block. Its lower edge shall be horizontal, and shall have a radius of (1,5 ± 0,1) mm, and level with the lower edge of the blade holding block, see figure 2. The blade height shall be (10 ± 0,1) mm for the end 10 mm. The top surface shall be flat and parallel to the lower surface. The vertical end of the blade shall be ground to an angle of (60 ± 3)° and radiused at (0,2 ± 0,1) mm.

## 4.7 The test specimen mounting block and clamps

The test specimen mounting block shall be made of metal or a hard plastic. The clamps shall be made of steel and the bolts and fixings shall be hardened steel. The block and clamps are designed to accept material samples 110 mm wide and 180 mm to 200 mm long. The test specimens are clamped across the top and down the sides.

The test specimen mounting block shall be provided with a means of fixing it firmly to the base of the apparatus. The fixing system shall allow the block to be positioned accurately with respect to the tearing blade. The blade shall enter the slot in the block by (10 ± 0,5) mm and shall be central in the slot ± 0,5 mm.

### 4.7.1 Dimensions of the test specimen mounting block

The test specimen mounting block is shown in figure 3. It shall be (250 ± 10) mm high, at least 200 mm wide, and at least 100 mm front to back. The top of the front face shall be machined to be a quadrant of (100 ± 1) mm radius. A slot (8 ± 0,5) mm wide and (15 ± 1) mm deep shall be machined in the centre of the front face.

### 4.7.2 The test specimen clamping system

The clamping system is shown in figure 4. Five steel clamps shall be provided that can be drawn onto the test specimen mounting block by 14 bolts as shown in the figure. The clamps shall have five parallel ridges with angles of (60 ± 3)° and a pitch (separation) of (3 ± 0,05) mm. These ridges shall be machined to stand out from the inner clamp faces. The ridges shall fit into matching grooves machined into the front face of the test specimen mounting block. The positions of these grooves are shown in figure 3. The surface of the test specimen mounting block beneath the upper transverse clamp may be machined flat to accept a flat clamp more easily. This is shown in figure 4. Set screws shall be provided to permit adjustment of the clamps for materials of different thickness. The remaining normative dimensions of the clamping system are given in the legend to figure 4.

## 4.8 Preparing the apparatus

The test specimen mounting block shall be bolted to the base in the appropriate position (4.7). An appropriate blade holding block shall be put on the guidance system and its free running checked. Test drops shall be made and the velocity of the block measured at the point the end of the tearing blade begins to enter the slot on the test specimen mounting block. The dropping height shall be adjusted so that the mean velocity in five consecutive drops is such that the block and blade have a kinetic energy within the required range, below, taking into account the exact mass of the block.

For the 250 g block the energy range shall be 1,6 J - 1,8 J

For the 500 g block the energy range shall be 3,3 J - 3,5 J

For the 1000 g block the energy range shall be 6,6 J - 7,0 J

For the 2000 g block the energy range shall be 13,4 J - 14,0 J

### 4.9 Preparation of test specimens

Whenever possible test specimens for the assessment of materials shall be cut from rolls of material, whole skins or half hides. The long axis of the roll (machine direction), or the head to tail axis of a skin shall be established. Equal numbers of test specimens orientated along the long axis, across the long axis and at 45° to the long axis shall be cut (110 ± 5) mm wide and (200 ± 20) mm long. The long axis shall be marked in each specimen. If washing or dry cleaning pre-treatments are specified in the product standard citing this European Standard, intact products, or large material specimens shall be pre-treated before test specimens are cut from them.

If finished PPE products are the source of the test specimens, the construction materials should be examined to determine an identifiable axis. If this is impossible an axis related to the product construction shall be chosen and recorded. Test specimens should be taken from a number of PPE items, as required by the product standard.

The test specimens shall be conditioned at (20 ± 2)°C and a relative humidity of (65 ± 5)%, for at least 24 h before testing. Testing shall be carried out in the conditioning environment or within 5 min of withdrawing the specimens from the conditioning environment.

### 4.10 Mounting the test specimens

The clamps of the specimen mounting block shall be loosened off and pushed clear of the block. A specimen is fed under the clamps. The horizontal clamp is held up as the specimen is pushed under it. When the specimen is equally under all the clamps the bolts shall be done up in the order shown in figure 5, except that the order is not normally critical after bolt 8. Light pressure with the finger tips flat on the specimen should be used while doing up bolts 1, 2, 5, 7, and 8, in the directions of the arrows in the figure. Firmer pressure should be used while doing up bolt 6 to ensure even flattening of the specimen.

The specimen should not be stretched during the mounting, but after the clamps are all tightened it should be flat and taught. To ensure even clamping the set screws of the vertical straight and curved clamps should be adjusted to just touch the face of the block when the clamps are firm before the final tightening. The set screws in the horizontal clamping bar should be set to ensure the nuts on the studs pull the clamp evenly onto the test specimen and the ridges engage in the grooves equally. In all cases the thicker the test specimen the longer the protrusion of the set screws should be.

### 4.11 Carrying out a test

The blade holding block shall be released by the electromagnet from the height determined in 4.8, onto a test specimen mounted as described in 4.10. The length of tear shall be measured with callipers accurate to 0,1 mm. For all tears longer than 15 mm, the distance between the top of the tearing blade and the top of the tear is measured while the block and blade are at rest supported by the test specimen. A value of 10 mm is added to the measured value to give the tear length. For tears shorter than 15 mm the blade holding block shall be raised, and the blade disengaged from the test specimen. The whole tear length shall then be measured with the callipers while the test specimen is still clamped in the machine.



The test specimen shall be removed from the clamps and examined. The clamps should have left even marks on the specimen. There should be no evidence of any slippage and no fibres should have pulled partly or completely out of the clamps.



**NOTE 1:** If the specimen shows evidence of slippage the result should normally be rejected. That will be except in the cases of some very strong fabrics such as plain weave monofilament aramid fabrics which show holes or tears of only 10 mm to 20 mm with the 2000 g block. These fabrics have a low compliance so high yarn tensions occur on impact in the test. The slipping fibres are difficult to clamp. Results of 10 mm to 20 mm are well within the highest performance level so the results can be accepted despite some yarn slippage. Slippage should be noted in the test report.

At least two test specimens cut in each orientation shall be tested. The mean tear length in tests in each orientation shall be calculated. If the largest value is more than 1,5 times the smallest value for further test specimens cut in the same orientation as those giving the largest value shall be tested. All the results in this orientation shall be combined to give an overall result. If the largest value is not more than 1,5 times the smallest value, the six results shall be averaged to give the overall result.