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Protective clothing — Body armour —

Part 3: Knife stab resistance — Requirements and test methods

Vêtements de protection — Protection corporelle —

Partie 3: Résistance contre les coups de couteaux — Exigences et méthodes d'essai

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ISO/CEN PARALLEL PROCESSING

This final draft International Standard is a draft European Standard developed within the European Committee for Standardization (CEN) in accordance with subclause 5.2 of the Vienna Agreement. Following parallel ISO member body voting and CEN enquiry on the DIS, this final draft, established on the basis of comments received, has been transmitted by CEN to ISO for circulation for a parallel two-month FDIS vote in ISO and formal vote in CEN.

Positive votes shall not be accompanied by comments.

Negative votes shall be accompanied by the relevant technical reasons.

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 14876 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14876-3 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

ISO 14876 consists of the following parts, under the general title *Protective clothing — Body armour*:

— *Part 1: General requirements*

— *Part 2: Bullet resistance — Requirements and test methods*

— *Part 3: Knife stab resistance — Requirements and test methods*

— *Part 4: Needle and spike stab resistance — Requirements and test methods*

Annexes A and ZZ form a normative part of this part of ISO 14876. Annexes B and ZA are for information only.

Annex ZZ provides a list of corresponding International and European Standards for which equivalents are not given in the text.

Contents

Foreword

This document (prEN ISO 14876-3:2002) 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 document is currently submitted to the parallel Formal Vote.

This document 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 document.

Annex A is normative.

Annex B is informative.

This European Standard consists of the following Parts:

prEN ISO 14876-1 *Protective clothing — Body armour — Part 1: General requirements (ISO/FDIS 14876-1:2001).*

prEN ISO 14876-2 *Protective clothing — Body armour — Part 2: Bullet resistance — Requirements and test methods (ISO/FDIS 14876-2:2001).*

prEN ISO 14876-3 *Protective clothing — Body armour — Part 3: Knife stab resistance — Requirements and test methods (ISO/FDIS 14876-3:2001).*

prEN ISO 14876-4 *Protective clothing — Body armour — Part 4: Needle and spike stab resistance — Requirements and test methods (ISO/DIS 14876-4:2001)*

Introduction

In this Part of prEN ISO 14876 testing of the performance of body armour against knife stabs is described. Three levels of performance against a specified design and construction of test blade are specified. The results from tests with this blade are intended to provide comparative information about the knife stab resistance of different body armour. The operational performance of body armour in attacks should be recorded and related to the test data so that the laboratory derived performance levels can be equated to protection against particular types of attack. The level of threat posed by assailants in different situations using particular weapons of their choice, can only be determined by users and by the organisations providing them with body armour. This risk assessment should be used to specify the Performance level and type of body armour as defined in Part 1 of this standard that should be worn. In most designs of body armour a higher level of protection is associated with increased weight and bulk, and by increased discomfort and ergonomic cost for the wearer. Because the exact conditions of a stabbing attack cannot be known before it occurs it should be realised that increasing the performance specification of body armour only increases the probability that injuries will be prevented; there is no certainty that they will not occur.

Compliance with this Part of prEN ISO 14876 does not imply that the body armour provides protection from ballistic threats or stabs by needles or spikes. Testing according to Parts 2 and Part 4 of this standard is necessary to provide this information.

1 Scope

This European Standard specifies the performance requirements and test methods for determining the resistance of body armour to knife stabs.

2 Normative references

This European Standard incorporates by dated or undated reference provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 388, *Protective gloves against mechanical risks.*

EN 1082-3, *Protective clothing — Gloves and arm guards protecting against cuts and stabs by hand knives — Part 3: Impact cut test for fabric, leather and other materials*.

EN ISO 13998, *Protective clothing — Aprons, trousers and vests protecting against cuts and stabs by hand knives (ISO 13998:2001).*

prEN ISO 14876-1:2001, *Protective clothing — Body armour — Part 1: General requirements (ISO/FDIS 14876-1:2001).*

prEN ISO 14876-2:2001, *Protective clothing — Body armour — Part 2: Bullet resistance — Requirements and test methods (ISO/FDIS 14876-2:2001).*

prEN ISO 14876-4, *Protective clothing — Body armour — Part 4: Needle and spike stab resistance – Requirements and test methods (ISO/DIS 14876-4:2001).*

3 Terms and definitions

For the purposes of this European Standard the terms and definitions given in prEN ISO 14876-1 apply.

4 Requirements

4.1 General

Knife stab resistant body armour shall meet the general requirements and requirements for labelling and the provision of information given in Part 1 of this standard.

4.2 Test blade impact resistance

When tested according to the procedures in clause 6 at the impact energies in Table 1, the mean penetration depth and the largest individual penetration depth of body armour test specimens shall not exceed the values in Table 1 in accepted test sequences.

Table 1 - Impact energies and maximum mean penetration depths and largest individual penetration depths for different performance levels

Performance level	Impact energy J	Mean penetration depth mm	Largest individual penetration depth mm
1	15	< 5	< 10
	25	< 20	< 30
2	25	< 5	< 10
	40	< 20	< 30
3	40	< 5	< 10
	65	< 20	< 30

4.3 Resistance to penetration by a test blade applied by hand

Body armour marked for penetration testing with a hand held test blade inserted between hard units of the body armour in the examination made according to 6.5 of prEN ISO 14876-1:2001 shall meet this requirement. Other body armour is exempt from this requirement.

When tested with the test device described in 5.8 according to 6.8 the test blade shall not pass through the gap or interstice under examination when the specified forces are applied.

5 Test apparatus

5.1 General

Unless otherwise specified below the tolerances on dimensions of apparatus shall be ± 2%. Measuring instruments unless otherwise specified shall have an error limit of ± 2% of the pass/fail level of the characteristic being measured.

For each of the required sequences of measurements performed in accordance with this standard 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.

5.2 Principle of the stab resistance test

The knife stab resistance of whole body armour is evaluated using prepared test blades of uniform dimensions. The test blades are held in assemblies of specified masses. The assemblies are dropped from various heights in an apparatus that controls the orientation and position of impact of the test blade on the body armour. The body armour is supported on a backing material as in ballistic testing. The test measurement is the depth of blade penetration into the backing material at specified energies of impact.

5.3 Dropping apparatus

5.3.1 Apparatus performance requirements

The apparatus shall permit individual impact energies to be within 3% of those specified in Table 1 and the mean impact energies of ten impacts in normal test sequences to be within 1% of those specified in Table 1. The velocity of the test blade or the block holding it, shall be measured to a tolerance of 0,02 ms^{-1} when the blade tip is within

100 mm of the strike face of the body armour. In determining the required velocity of impact to provide impacts of the specified energy the remaining distance below the point of velocity measurement shall be allowed for.

The apparatus shall constrain the movement of the blade holding block so that the blade enters the body armour in a vertical direction and continues in this direction. When the test blade and block are in a position in the apparatus equivalent to a 20 mm penetration of typical body armour, the shape traced by the tip of the blade under a lateral force of (50 ± 5) N applied sequentially through 360° shall not be more than 5 mm in diameter in any direction. The design of the apparatus should ensure that virtually all the kinetic energy of the falling assembly and test blade is dissipated as work done against the test specimen, and that loss of energy to the guidance system is minimised.

5.3.2 Dropping tower apparatus – A possible design

The following details of a design of the framework of a dropping tower apparatus are provided for information. As illustrated in Figure 1, a rigid framework of metal tubing 4 m high with an internal space at least 0,8 m × 0,8 m built on a steel base plate on top of a concrete block weighing over 1 000 kg, has been found to be suitable.

5.3.3 Requirements for the falling mass guidance system

Two polished steel guide rods (25 ± 0,1) mm in diameter and at least 3 m long, shall be supported vertically in the centre of the dropping tower framework. The centres of the rods shall be (250 ± 1) mm apart. The lower ends of the rods shall be supported by a framework with a clear space below it with a depth of more than 150 mm above the steel base plate of the apparatus, see Figure 2. This space permits the test specimen on a box of backing material to be moved freely into place, and for the box to be raised on steel spacer sheet(s) to bring the test specimen into an appropriate position. The rods shall be secured in place on the framework. The position of the base of at least one of the rods shall be adjustable. The top ends of the rods shall be supported in close fitting rings with centres (250 ± 1) mm apart. The rods shall be free to slide vertically in these rings. The rods shall be straight and parallel with a maximum deviation of 1,0 mm when fixed in the dropping tower. The rods shall be wiped clean and sprayed with light oil before use on each day of testing.

5.3.4 Carriage and blade holding block

A metal carriage shall be mounted on the vertical guide rods. (See Figure 2). Except were specified, aluminium alloy has been found satisfactory for its construction. The carriage shall consist of a central metal plate approximately 215 mm wide and 150 mm high. Tubes shall be welded to the vertical sides of the plate with their centres (250 ± 1) mm apart. The tubes shall be fitted with (20 ± 5) mm long sleeves made of polytetrafluoroethylene or similar material inserted in their ends. These plastic sleeves shall have a clearance of approximately 1 mm on the rods. A horizontal steel disc shall be provided at the centre of the top of the plate for the electromagnetic release mechanism that shall be used for releasing the carriage. The lower edge of the carriage shall be provided with a centrally placed metal blade holding block approximately 50 mm high, 90 mm wide and 25 mm thick. A vertical slot in the block shall be provided so that it will accept test blades directly, or steel insert plates which can accept the test blades or can de adapted for any other blades, impactors or spikes and needles, such as those specified in prEN ISO 14876-4.

Steel insert plates approximately 70 mm long, 30 mm high, and 5 mm thick have been found convenient. The slot for such plates should be at least 75 mm long to permit fine adjustment of the positions of the insert plates. Steel clamping screws shall be provided to hold the insert plates in place. If insert plates are used, one or more shall be provided with a central slot large enough to accept a test blade.

The end of the slot for the test blade in the blade holding block or in an insert plate, that will be in contact with the back of the blade shall be vertical and at (90 ± 5)º to the base of the slot. One or more steel screws shall be provided to clamp the test blade or the test blade and insert plate, in the appropriate place in the slot in the blade holding block on the carriage. It is convenient if provision is made for the screw(s) clamping the test blade in place, to be easily loosened after an impact to leave the test blade in the test specimen when the carriage and blade holding block are lifted clear.

The total mass of the carriage, insert and any particular test blade, needle, spike, or impactor, shall be adjustable to (2 500 ± 25) g by weights bolted onto the carriage above the blade holding block.

Before use the clearance of the plastic sleeves on the rods shall be checked. The carriage shall be free to move horizontally in every direction by at least 0,5 mm. When dropped from any height up to 2,8 m the carriage should fall silently and the measured velocity just prior to impact should indicate minimal energy loss due to friction.

5.3.5 Test blade position

The blade holding block, or block with inserts, shall securely hold the test blade with the back of the blade vertical so that at least 50 mm of blade is exposed. The tip shall be positioned so that it is offset (4 ± 1) mm from the vertical axis through the centre of mass of the blade holding block and carriage as illustrated in Figure 3. The shape of the lower surface of the blade holding block shall permit at least 30 mm of test blade penetration through a typical body armour held down by the heavy flexible ring (5.6). The centre of mass of the entire blade holding block and carriage shall be less than 200 mm above the level of the tip of the test blade.

5.3.6 Carriage dropping height

The complete carriage, blade holding block and test blade shall be weighed. The impact velocities to provide impact energies within the specified ranges shall be calculated. Trials shall be used to determine the dropping heights necessary to achieve these velocities.

5.3.7 Verification of apparatus performance

5.3.7.1 Background and principle

It is possible to calculate accurately the energy of impact of the test blade, blade holding block and carriage at the moment of impact on a test specimen. It is not possible however to predict thereafter how much of the energy will be expended in penetration of the specimen and how much will be lost through friction in the apparatus and various dynamic events. The specification of the apparatus above is intended to minimise unintended losses of energy. However comparative trials of different apparatus suggest that this is not sufficient and that verification of apparatus performance is necessary. This requires measuring test blade penetration of a 'standard' material, and achieving a particular performance. This requires the existence of a 'standard' material that will be available in a consistent form for a long time. Such material is not known. An alternative system is proposed wherein the same material is tested in two or more apparatus at the same time and the results are compared.

5.3.7.2 Recommended procedure

One or more test houses shall act as a reference and maintain apparatus conforming to this standard and shown in comparative testing with other test houses to give high penetration values on a 'standard' material such as a high fabric fibre paper. At the same impact energy the highest penetration indicates the lowest energy loss to friction etc. The performance of the apparatus on the then current reference material with the same batch of test blades shall be determined under conditions specified by the reference test house[1]) when either a new apparatus is to be brought into service, or when an existing apparatus is modified, and at least annually for all apparatus used for testing to this Standard.

5.3.7.3 Requirement

In comparative testing under the same conditions new and existing apparatus shall give mean values of ten penetrations into a reference material within 5% of those obtained on the reference apparatus.

5.4 Test blade

5.4.1 Specification

The test blades shall have the profile and dimensions shown in Figure 4. They shall be made from AISI-01 tool steel hardened to above (58 ± 3) HRC. The blades shall be at least 80 mm long, (20 ± 0,5) mm wide, and (2,5 ± 0,05) mm thick. The edge angle shall be (30 ± 1)°. The included angle of the fine ground edge shall be (30 ± 3)°. All edges shall be fine ground.

The tip of the test blades shall be ground so that an edge at (90 ± 10)° to the back of the blade is created with an included angle of (60 ± 10)° and a length of (1,5 ± 0,1) mm.

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[1]) The names and addresses of the reference test houses may be obtained from the secretariat of CEN TC 162 through the CEN Central Secretariat, rue de Stassart 36, B-1050 Brussels.

5.4.2 Preparation

The dimensions of test blades shall be verified.

Each test blade shall be examined to ensure its long edge is ground or honed so that the ground faces intersect all along its length, and that the tip has been ground to a transverse edge as specified in 5.4.1. A dissecting microscope with adjustable collimated top lighting and providing x100 magnification will be useful for examining blade edges. The edge of each blade should be examined by looking directly down onto it with the flat faces of the blade parallel to the optical axis of the microscope. The angles between the edge and the illuminating light beam, and between the edge and the optical axis of the microscope, should be adjusted so that any reflected light beam will be visible in the microscope. When an edge is imperfect it will reflect light and be visible, whereas a perfectly sharp edge will not reflect the illuminating light beam.

The flatness and straightness of the blade and edge shall be checked. The ground edges shall be free of imperfections such as chips. Any residual whiskers of metal along the edge left by the grinding process may be removed by gentle polishing or sharpening on a fine flat oilstone. The blade should be drawn along the oilstone, edge first, with the whole ground face in contact with the stone. After a small number of passes on each ground face the blade shall be wiped and examined.

The blade is adequately prepared if:

— The oilstone polishing of the edge is continuous on both faces to the intersection of the faces;

— No ”whiskers” are visible;

— The edge does not reflect light;

— The tip is ground as specified in 5.4.1.

A batch of supplied blades shall be examined, prepared and polished as above, and all imperfect blades eliminated. The prepared blades shall then be checked for sharpness according to annex A. At least one in ten prepared blades shall be tested. If they are all satisfactory the batch of prepared blades are ”accepted”. If any fail to give a penetration through the cotton canvas of over 20 mm all the ”prepared” blades shall be tested and only those penetrating more than 20 mm shall be ”accepted”. The remainder may be sharpened on an oilstone until they pass, or they are to be rejected. Advice on sharpening is given in annex B.

5.5 Test specimen support

Test specimens shall be laid across boxes of backing material as specified in 5.6 of prEN ISO 14876-2:2001. The boxes shall be placed on a horizontal solid base of concrete or similar material in the dropping tower apparatus. The boxes shall be filled with backing material as specified in 5.8 of prEN ISO 14876-2:2001. The backing material shall meet the requirements in 5.9 of prEN ISO 14876-2:2001 when tested by the procedure described.

Blocks of suitable material should be available to place beside the backing material box supporting the test specimen so that the test area and the area held down by the heavy flexible ring (5.6) is not distorted by the test specimen draping over the edge of the backing material box. The additional blocks should provide a level area of at least 250 mm radius around the intended knife impact point.

5.6 Heavy flexible ring for test specimen retention

Test specimens shall be held in place during blade impact testing by a mass of (2,5 ± 0,1) kg. The mass shall be flexible so that if conforms to the surface of the test specimen. It shall have a central hole (150 ± 30) mm in diameter such that it will not interfere with the movement of the blade holding block or carriage during testing. If it is in the form of a ring it will be convenient if it can be opened.

NOTE The following have been found satisfactory:

— A fabric tube filled with lead shot;

— A ring of metal blocks with flexible connections;