INTERNATIONAL STANDARD

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Protective clothing for use in welding and allied processes

Vêtements de protection utilisés pendant le soudage et les techniques connexes

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11611 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 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).

ISO 11611 cancels and replaces EN 470-1:1995 and EN 470-1:1995/A1:1998, which have been technically revised to:

a) include additional clothing in the scope;

b) specify two classes of protective clothing;

c) include additional terms and definitions;

d) specify ageing due to washing (maximum number of cleaning procedures as indicated by the manufacturer);

e) specify additional tests for heat transfer (radiation) and electrical resistance;

f) specify requirements for inoccuousness;

g) modify requirements for dimensional change on washing to include requirements for knitted fabrics;

h) delete test method for the thickness of leather;

i) modify requirements for tensile strength and tear strength;

j) specify requirements for burst strength and seam strength;

k) include test procedure for the flame testing of seams and hemmed edges;

l) modify the information to be supplied by the manufacturer;

m) specify requirements for care and maintenance;

n) include annex for the selection of welders' clothing;

o) include annex regarding information on UV radiation hazards;

p) include annex for uncertainty of measurement.

Protective clothing for use in welding and allied processes

1 Scope

This International Standard specifies minimum basic safety requirements and test methods for protective clothing including hoods, aprons, sleeves and gaiters that are designed to protect the wearer's body including head (hoods) and feet (gaiters) and that are to be worn during welding and allied processes with comparable risks. For the protection of the wearer's head and feet, this International Standard is only applicable to hoods and gaiters. This International Standard does not cover requirements for hand protection.

This type of protective clothing is intended to protect the wearer against spatter (small splashes of molten metal), short contact time with flame, radiant heat from the arc, and minimizes the possibility of electrical shock by short-term, accidental contact with live electrical conductors at voltages up to approximately 100 V d.c. in normal conditions of welding. Sweat, soiling or other contaminants can affect the level of protection provided against short-term accidental contact with live electric conductors at these voltages.

This International Standard specifies two classes with specific performance requirements (see Annex A), i.e. Class 1 being the lower level and Class 2 the higher level.

— Class 1 is protection against less hazardous welding techniques and situations, causing lower levels of spatter and radiant heat.

— Class 2 is protection against more hazardous welding techniques and situations, causing higher levels of spatter and radiant heat.

Details are given in Table 1 and Annex B.

For adequate overall protection against the risks to which welders are likely to be exposed, personal protective equipment (PPE) covered by other standards should additionally be worn to protect the head, face, hands and feet.

2 Normative references

The following referenced documents are indispensable for the application 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 3071:2005, *Textiles — Determination of pH of aqueous extract*

ISO 3376:2002, *Leather — Physical and mechanical tests — Determination of tensile strength and percentage extension*

ISO 3377-1:2002, *Leather — Physical and mechanical tests — Determination of tear load — Part 1: Single edge tear*

ISO 4045:1977, *Leather — Determination of pH*

ISO 4048:1977, *Leather — Determination of matter soluble in dichloromethane*

ISO 5077:2007, *Textiles — Determination of dimensional change in washing and drying*

ISO 6942:2002, *Protective clothing — Protection against heat and fire — Method of test: Evaluation of materials and material assemblies when exposed to a source of radiant heat*

ISO 9150:1988, *Protective clothing — Determination of behaviour of materials on impact of small splashes of molten metal*

ISO 13688, *Protective clothing — General requirements*

ISO 13934-1:1999, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 13935-2:1999, *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 13937-2:2000, *Textiles — Tear properties of fabrics — Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method)*

ISO 13938-1, *Textiles — Bursting properties of fabrics — Part 1: Hydraulic method for determination of bursting strength and bursting distension*

ISO 15025:2000, *Protective clothing — Protection against heat and flame — Method of test for limited flame spread*

ISO 17075, *Leather — Chemical tests — Determination of chromium VI content*

EN 1149-2:1997, *Protective clothing — Electrostatic properties — Part 2: Test method for measurement of the electrical resistance through a material (vertical resistance)*

3 Terms and definitions

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

3.1
ageing
changing of the product performance over time during use or storage

NOTE Ageing is caused by a combination of several factors, such as:

— cleaning, maintenance or disinfecting process;

— exposure to visible and/or ultra-violet radiation;

— exposure to high or low temperatures or to changing temperatures;

— exposure to chemicals including humidity;

— exposure to biological agents such as bacteria, fungi, insects or other pests;

— exposure to mechanical action such as abrasion, flexing, pressure and strain;

— exposure to contaminants such as dirt, oil, splashes of molten metal, etc.;

— exposure to wear and tear.

3.2
allied processes
processes having similar types and levels of risk as welding, cutting, arc air gouging and spraying

3.3
cleaning
process by which a PPE is again made serviceable and/or hygienically wearable by removing any dirt or contamination

NOTE A cleaning cycle is typically a washing plus drying or a dry cleaning treatment followed, if required, by ironing or other finishing.

3.4
conditioning
keeping of the samples under standard conditions of temperature and relative humidity for a minimum period of time

3.5
gaiter
removable covering intended to protect the part of the leg below the knee and can also cover the upper surface of shoes

3.6
hood
item of PPE made from flexible material which covers the head and neck

NOTE Certain hood styles also cover the shoulders.

3.7
material assembly
combination of all materials of a multi-layer garment presented exactly as the finished garment construction

3.8
pre-treatment
standard way of preparing the samples before testing

NOTE This can include e.g. a number of cleaning cycles, submitting the sample to heat, mechanical action or any other relevant exposure and is finished by conditioning.

3.9
protective clothing
clothing which covers or replaces personal clothing and which is designed to provide protection for the wearer's upper and lower torso, neck, arms and legs

3.10
protective garment
individual item of protective clothing the wearing of which provides protection against specified hazards to the part of the body that it covers

EXAMPLE Protective coat, apron, trousers, gaiters, hoods, boiler suit or overall.

3.11
side seam
seam that runs laterally along the garment when it is placed flat on a surface, with the front uppermost

3.12
sleeve
removable covering intended to protect part or all of the arm and the wrist

3.13
welding
process used in joining metal components involving local melting of metal

4 Design

4.1 General

General requirements which are not specifically covered in this International Standard shall be in accordance with ISO 13688.

Welders' protective clothing shall be designed without electrical conduction from the outside to the inside, e.g. by metal fasteners. Conformity shall be checked by visual inspection.

4.1.1 Protective clothing

Welders' protective suits shall completely cover the upper and lower torso, neck, arms and legs. Suits shall consist of:

a) a single garment, e.g. an overall or boiler suit;

b) or a two-piece garment, consisting of a jacket and a pair of trousers.

The jacket of a two-piece suit shall provide a minimum overlap of 20 cm between the jacket and the top of the trousers. This minimum overlap shall be maintained in all positions and in movements encountered during welding.

Conformity shall be checked by visual inspection and practical testing, such as physical measurement of the overlap in all positions and movements normally encountered during welding.

4.1.2 Additional protective clothing

Welder’s protective garments may be designed to provide extra protection for specific areas of the body when worn in addition to a suit according to 4.1.1, e.g. neck curtain, hoods, sleeves, apron and gaiters.

Performance testing of partial protective garments shall be carried out on the complete assembly. Additional protective clothing such as hoods, sleeves, apron and gaiters shall cover the intended areas if worn with a suit of appropriate size and shall also meet the requirements of this International Standard.

4.2 Sizes

Garment sizes shall be in accordance with the requirements of ISO 13688.

Conformity shall be checked by visual inspection including an assessment of fit and physical measuring when the appropriate size of clothing is donned by a wearer.

4.3 Pockets

Where garments are constructed with pockets, the pockets shall be constructed to the following design:

a) pockets with external openings shall be made of material(s) conforming to 6.7 and 6.8.

b) external opening pockets including pass through openings shall be flapped except for:
   - side pockets below the waist which do not extend more than 10° forward of the side seam;
   - a single rule pocket with an opening not greater than 75 mm placed behind the side seam on one or both legs and measured flat;

c) all flaps shall be stitched down or capable of fastening the pocket closed. They shall be 20 mm wider than the opening (10 mm on each side) to prevent the flap from being tucked into the pocket.

Conformity shall be checked by visual inspection and physical measurement.

4.4 Closures and seams

Closures shall be designed with a protective cover flap on the outside of the garment. The maximum distance between buttonholes shall be 150 mm. If zippers are used, the slide fastener shall be designed to lock when completely closed. Cuffs may be provided with closures to reduce their width. The closure and any fold which it creates shall be on the underside of the cuff. Cuffs shall not have turn-ups.

Neck openings shall be provided with closures.

Trousers or one-piece suits shall not have turn-ups. They may have side slits which shall have a means of closure and the slit and closure shall be covered.

Overlapping seams on the outside of the garment shall be downward facing and overstitched.

Conformity shall be checked by visual inspection.

5 Sampling and pre-treatment

5.1 Sampling

Test samples shall be representative of the material or material assembly as used in the protective clothing to be tested. If possible, all samples shall be taken from the garment. The number and size of the test specimens required shall be in accordance with the relevant test methods.

The tests shall be carried out on the outer material of the garment unless it is mentioned in the appropriate test clause of this International Standard to use the complete material assembly.

5.2 Pre-treatment of material

5.2.1 General

Prior to testing, the protective clothing shall be pre-treated. Leather shall not be pre-treated.

If a manufacturer indicates that the performance of the garment is intended for a single use only, then the tests shall only be carried out on new material.

5.2.2 Cleaning

Before each test specified in 6.1 to 6.10 except 6.6, the cleaning of the protective clothing shall be in line with the manufacturer's instructions, on the basis of standardized processes. If the number of cleaning cycles is not specified, five cleaning cycles shall be performed. Tests specified in 6.6, 6.11.2 and 6.11.3 shall be carried out in the new state (as received).

5.2.3 Ageing

Performance tests specified in 6.7 shall also be executed after the maximum number of cleaning procedures indicated by the manufacturer.

5.3 Conditioning

Specimens other than leather shall be conditioned for at least 24 h in an atmosphere having a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) %. Leather specimens shall be conditioned for at least 48 h in an atmosphere having a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) %. Testing shall be carried out within 5 min of removal from this atmosphere.

Samples for electrical resistance testing specified in 6.10 shall be conditioned and tested in an atmosphere having a relative humidity of (85 ± 5 %).

6 General safety requirements

6.1 Tensile strength

Woven outer textiles shall have a minimum tensile strength of 400 N.

The tensile strength of woven outer textile materials shall be determined in accordance with ISO 13934-1 in both the machine and cross directions.

Leather shall have a minimum tensile strength of 80 N in accordance with ISO 3376 using the standard test piece in two directions at right angles in the plane of the material.

6.2 Tear strength

Woven outer textiles and leather materials shall have a minimum tear strength of 20 N.

The tear strength of woven outer textile materials shall be determined in accordance with ISO 13937-2:2000 in both the machine and cross directions.

The tear strength of leather shall be determined in accordance with ISO 3377-1:2002 in two directions at right angles in the plane of the material.

6.3 Burst strength of knitted materials

When tested in accordance with ISO 13938-1, the burst strength of knitted outer material shall be a minimum of 200 kPa.

6.4 Seam strength

When tested in accordance with ISO 13935-2, the seam strength for textiles shall be at least 225 N for textiles and 110 N for leather.

6.5 Dimensional change of textile materials

The dimensional change of woven textile materials shall not exceed ± 3 % when tested in accordance with ISO 5077 after a pre-treatment specified in 5.2.

The dimensional change of knitted textile materials shall not exceed ± 5 % when tested in accordance with ISO 5077 after a pre-treatment specified in 5.2.

6.6 Requirements for leather

When tested according to ISO 4048:1977, the fat content of leather shall not exceed 15 %.

6.7 Flame spread

Each material or material assembly and each type of seam used in welders' protective clothing shall be tested in accordance with ISO 15025:2000, using either Procedure A (code letter A1), or Procedure B (code letter A2), or both, in accordance with the existent risk during the foreseen use.

For seams, three specimens containing a structural seam shall be tested in accordance with ISO 15025:2000, Procedure A. Specimens shall be oriented with the seam running up the centreline of the test specimen so that the burner flame impinges directly upon it. Seams shall remain intact.

For seams, three hemmed specimens containing a structural seam shall be tested in accordance with ISO 15025:2000, Procedure B. Specimens shall be oriented with the seam running up the centreline of the test specimen so that the burner flame impinges directly upon it. Seams shall remain intact.

Materials and material assemblies shall meet the following requirements:

a) no specimen shall give flaming to the top or either side edge;

b) no specimen shall give hole formation;

c) no specimen shall give flaming or molten debris;

d) the mean value of afterflame time shall be $\leqslant$ 2 s;

e) the mean value of afterglow time shall be $\leqslant$ 2 s.

NOTE A glowing inside the charred area is defined in ISO 15025 as afterglow without combustion and for the purpose of this clause is not regarded as afterglow.

When testing in accordance with ISO 15025:2000, Procedure B edge ignition requirement b) is not applicable.

6.8 Impact of spatter

When tested according to ISO 9150, each material or material garment assemblies shall require

— at least 15 drops of molten metal to raise the temperature behind the test specimen by 40 K for Class 1, and

— 25 drops of molten metal to raise the temperature behind the test specimen by 40 K for Class 2.

Material which ignites does not fulfil this test.

6.9 Heat transfer (radiation)

When tested in accordance with ISO 6942:2002, at a heat flux density of 20 kW/m^2, the radiant heat transfer index (RHTI for 24 °C) shall be:

— for Class 1: RHTI 24 $\geqslant$ 7 s;

— for Class 2: RHTI 24 $\geqslant$ 16 s.

If the garment is multi-layered, the test shall be carried out on the complete material assembly.

6.10 Electrical resistance

Conditioning and testing of the samples shall be carried out at a temperature of (20 $\pm$ 2) °C and relative humidity of (85 $\pm$ 5) %. When the material assembly is tested in accordance with the test method specified in EN 1149-2 and under an applied potential of (100 $\pm$ 5) V, the electrical resistance shall be greater than 10^5 Ω (corresponds to less than 1 mA leakage current) for all assemblies of the clothing. Seams shall be taken into account when preparing test samples.

6.11 Innocuousness

6.11.1 Possible harmful effect

No component of the clothing shall be known to produce any harmful effect on the wearer. This shall be verified by checking technical safety sheets of the individual materials and components.

6.11.2 pH-value

When tested in accordance with ISO 3071 (for textiles) or ISO 4045 (for leather), the pH-value shall be greater than 3,5 and less than 9,5.

6.11.3 Cr(VI) content

When tested in accordance with the procedure described in ISO 17075, the content of Cr(VI) of leather shall be less than the detection limit.

6.12 Summary of general safety requirements

The general safety requirements are summarized in Table 1. See Annex C for indications concerning uncertainty.

Table 1 — General safety requirements

Subclause	Requirement	Class 1	Class 2
6.1	Tensile strength — woven outer textile material — leather	 400 N 80 N	 400 N 80 N
6.2	Tear strength	20 N	20 N
6.3	Burst strength	200 kPa	200 kPa
6.4	Seam strength — textile material — leather	 225 N 110 N	 225 N 110 N
6.5	Dimensional change of woven textile materials Dimensional change of knitted textile materials	$\leqslant \pm 3$ % $\leqslant \pm 5$ %	$\leqslant \pm 3$ % $\leqslant \pm 5$ %
6.6	Requirements for leather: fat content	$\leqslant$ 15 %	$\leqslant$ 15 %
6.7	Flame spread	ISO 15025:2000, Procedure A (surface ignition) ISO 15025:2000, Procedure B (edge ignition) No flaming to the top or either side edge No hole formation [a] No flaming or molten debris Mean afterflame $\leqslant$ 2 s Mean afterglow $\leqslant$ 2 s	ISO 15025:2000, Procedure A (surface ignition) ISO 15025:2000, Procedure B (edge ignition) No flaming to the top or either side edge No hole formation [a] No flaming or molten debris Mean afterflame $\leqslant$ 2 s Mean afterglow $\leqslant$ 2 s
6.8	Impact of spatter	15 drops	25 drops
6.9	Heat transfer (radiation)	RHTI 24 $\geqslant$ 7 s	RHTI 24 $\geqslant$ 16 s
6.10	Electrical resistance	$> 10^5\ \Omega$	$> 10^5\ \Omega$
6.11	Innocuousness	See 6.11	See 6.11

[a] For ISO 15025:2000, Procedure B, this requirement is not applicable.

7 Marking

Welders' protective clothing, for which compliance with this International Standard is claimed, shall be marked in accordance with ISO 13688 and with the following information:

a) classification:

- Class 1: the number of this International Standard (ISO 11611) followed by the pictogram shown in Figure 1 and the indication "Class 1" and the indication "A1" or "A2" or "A1 + A2" as appropriate;
- Class 2: the number of this International Standard (ISO 11611) followed by the pictogram shown in Figure 1 and the indication "Class 2" and the indication "A1" or "A2" or "A1 + A2" as appropriate;
- where garments contain parts of both classes, these shall be identified as shown above with their classification; any additional protective clothing used shall be identified as shown above with their classification;

b) if the garment is intended for a single use only, the information: "For single use only";

c) instructions for cleaning shall be marked (e.g. on a label).

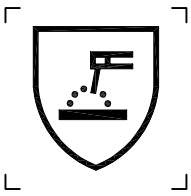

Figure 1 — Pictogram for protection against welding hazards (ISO 7000-2683)

8 Information supplied by the manufacturer

8.1 General

When welders' protective clothing is delivered to the consumer, instructions for use shall be provided in accordance with ISO 13688.

The manufacturer shall give as much information as possible on known factors of durability, especially on durability to cleaning. See ISO 13688 for further details.

In the case that applying a finish can restore the protective properties, the maximum number of cleaning cycles before re-application of the finish shall be clearly indicated in the information notice.

8.2 Intended use

At least the following basic information shall be provided:

a) any guidance on the appropriate choice of class of welders' protective clothing, (see Annexes A and B);

b) any identified hazards against which the clothing is intended to protect (e.g. flames, molten metal spatter, radiant heat and short term, accidental electrical contact);

c) a warning that for operational reasons not all welding voltage carrying parts of arc welding installations can be protected against direct contact;

d) for protective clothing, a warning that additional partial body protection may be required, e.g. for welding overhead;

e) a warning that the garment is only intended to protect against brief inadvertent contact with live parts of an arc welding circuit, and that additional electrical insulation layers will be required where there is an increased risk of electric shock; garments meeting the requirements of 6.10 are designed to provide protection against short term, accidental contact with live electric conductors at voltages up to approximately 100 V d.c.;

f) aprons should cover the front body of the user at least from side seam to side seam;

g) using additional partial protective garments, the basic garment shall meet at least Class 1.

8.3 Improper use

Attention shall be drawn to the hazards of improper use.

a) The level of protection against flame will be reduced if the welders' protective clothing is contaminated with flammable materials.

b) An increase in the oxygen content of the air will reduce considerably the protection of the welders' protective clothing against flame. Care should be taken when welding in confined spaces, e.g. if it is possible that the atmosphere may become enriched with oxygen.

c) The electrical insulation provided by clothing will be reduced when the clothing is wet, dirty or soaked with sweat.

d) For two-piece protective clothing, a warning that both items shall be worn together to provide the specified level of protection.

e) For additional body protection, a warning that the garment is intended for use in addition to protective clothing providing protection against welding hazards.

f) Warnings, regarding other limitations of a garment, as identified by the manufacturer.

8.4 Care and maintenance

Instructions shall be given to advise the user on cleaning procedures, the maximum number of cleaning cycles, maintenance, inspection and repair of the garment where practical.

Manufacturers shall include the information that welder's protective clothing be cleaned regularly in accordance with the manufacturer's recommendations. After cleaning, the clothing should be inspected.

Annex A
(informative)

Guidance for the selection of the type of welders' clothing (Class 1/Class 2)

Table A.1 — Selection criteria for welders' clothing (reference points)

Type of welders' clothing	Selection criteria relating to the process:	Selection criteria relating to the environmental conditions:
Class 1	Manual welding techniques with light formation of spatters and drops, e.g.: — gas welding, — TIG welding, — MIG welding, — micro plasma welding, — brazing, — spot welding, — MMA welding (with rutile-covered electrode).	Operation of machines, e.g. of: — oxygen cutting machines, — plasma cutting machines, — resistance welding machines, — machines for thermal spraying, — bench welding.
Class 2	Manual welding techniques with heavy formation of spatters and drops, e.g.: — MMA welding (with basic or cellulose-covered electrode), — MAG welding (with CO_2 or mixed gases), — MIG welding (with high current), — self-shielded flux cored arc welding, — plasma cutting, — gouging, — oxygen cutting, — thermal spraying.	Operation of machines, e.g.: — in confined spaces, — at overhead welding/cutting or in comparable constrained positions.

Annex B
(informative)

Information on UV radiation hazards

This International Standard specifies minimum requirements for clothing which can protect the wearer against the normal hazards associated with welding, when used correctly. These hazards include exposure of skin to ultraviolet (UV) radiation which is produced in all electric arc-welding operations. This UV includes UVA, UVB and UVC radiation in intense bursts.

With use, however, the fabric of the clothing will degrade and may not continue to provide protection. This is especially true when the clothing is used in some electric arc-welding processes (notably MIG/MAG welding), where damage from intense UV, radiant heat, and copious sparks or droplets of molten metal can reduce its effectiveness very quickly. In such situations, use of higher levels of protection such as additional leather sleeves, aprons, etc., will prolong the effectiveness of the garment and assist in protecting the wearer.

Class 2 garments are designed to be more resistant to the degradation caused by these hazards than Class 1 garments, although this cannot be precisely quantified since it will be affected by the welding process, technique of the welder, welding currently used, spatter produced and welding position.

The Personal Protective Equipment Directive (89/656/EEC) requires that the PPE be initially selected after a thorough risk assessment, be regularly examined and be maintained or replaced to ensure continuing protection. Users who are exposed to UV radiation are to be made aware of the risk and the need for regular checking.

A simple check for continued UV protection for this type of clothing (e.g. carried out weekly) is to hold the garment up to the light of a 100 W tungsten bulb at arm's length (approximately 1 m away); if light can be seen through the fabric, UV will penetrate too.

Similarly, users should be advised that if they experience sunburn-like symptoms, UVB is penetrating. In either case, the garment should be repaired (if practicable) or replaced and consideration given to the use of additional, more resistant, protective layers in future.

Annex C
(informative)

Uncertainty of measurement

The uncertainty associated with most of the test methods specified in this International Standard cannot be determined until laboratory trials have been completed and the test methods have been amended appropriately. In this transitional period the results obtained from all tests specified in this International Standard shall be interpreted without taking uncertainty into account.

Bibliography

[1] ISO 2589:2002, *Leather — Physical and mechanical tests — Determination of thickness*

[2] ISO 7000, *Graphical symbols for use on equipment — Index and synopsis*

[3] ISO 17227:2002, *Leather — Physical and mechanical tests — Determination of dry heat resistance of leather*

[4] IEC 60974-1, *Arc welding equipment — Part 1: Welding power sources*

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