



**International
Standard**

ISO 11611

**Protective clothing for use in
welding and allied processes**

*Vêtements de protection utilisés pendant le soudage et les
techniques connexes*

**Third edition
2024-06**

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document 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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 162, *Protective clothing including hand and arm protection and lifejackets in collaboration*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 11611:2015) which has been technically revised.

The main changes are as follows:

- a) an introduction has been included;
- b) the clause on sampling requirements has been modified;
- c) the clause for ageing due to washing (maximum number of cleaning procedures as indicated by the manufacturer) has been modified;
- d) a new requirement for measuring the property value for rating and classification has been included;
- e) the clause for the manufacturer's instructions and information has been modified;
- f) a new [Annex G](#) for measuring property value for rating and classification has been included;
- g) a procedure for sampling and testing the protective effect of fabrics, garments and gloves for use in welding against UV radiation (UV-A, UV-B, UV-C), taking into account representative manual welding processes, has been included;
- h) [Annex A](#) comprising general explanations for UV protective characteristics of protective clothing for use in welding, has been included. All other annexes have been renumbered accordingly;
- i) [Annex B](#) has been complemented by a three-step UV protection classification system ([Table B.2](#)) for clothing for use in welding;

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- j) [Annex C](#) with the testing procedure for the protective effect against UV radiation emitted by welding processes, has been included;
- k) [Annex D](#) with instructions for calculating the effectively transmitted total irradiance and the resulting maximum time of use related to the exposure limit value by using the determined worst-case UV transmission spectra of fabrics for welding protective garments, has been included;
- l) [Annex E](#) with the spectral distribution and maximum effectively emitted total irradiance of the selected representative welding processes, has been included;
- m) [Annex F](#) with the spectral weighing function $s_{\text{eff}}(\lambda)$ for use in [Annex D](#), has been included;
- n) the previous [Annex C](#) has become [Annex G](#);
- o) the previous [Annex D](#) has become [Annex H](#) and has been revised;
- p) [Annex I](#) with the summary of conducted Round Robin tests in the development of the UV transmission test procedure, has been included.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The purpose of this document is to provide minimum performance requirements for clothing for use in welding and allied processes.

For complete protection against exposure to heat and flame, it will be necessary to protect the head, face, hands, and/or feet with suitable personal protective equipment (PPE) and in some cases, appropriate respiratory protection might also be considered necessary.

Attention is drawn to ISO/TR 2801:2007^[2], which sets out guidelines for selection, use, care, and maintenance of protective clothing against heat and flame.

Nothing in this document is intended to restrict any jurisdiction, purchaser, or manufacturer from exceeding these minimum requirements.

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Protective clothing for use in welding and allied processes

1 Scope

This document specifies minimum 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 document is only applicable to hoods and gaiters. This document does not cover requirements for feet, hand, face, and/or eye protectors.

This type of protective clothing is intended to protect the wearer against the following hazards:

- spatter (small splashes of molten metal) in 2 risk levels, short contact time with flame, radiant heat from an electric arc used for welding and allied processes,
- harmful artificial optical radiation (UV-A, UV-B and especially UV-C) in 3 risk levels generated during welding and allied processes 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.

The main manual welding processes are exemplified and are classified into process groups according to the maximum effectively emitted total irradiance, which has been determined and evaluated by measurement^[15] for these types of welding processes.

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.

This document is not applicable for laser welding processes (coherent, monochromatic radiation sources).

Guidance for the selection of protective clothing for different welding activities is detailed in [Annex B](#).

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 3376:2020, *Leather — Physical and mechanical tests — Determination of tensile strength and percentage elongation*

ISO 3377-1:2011, *Leather — Physical and mechanical tests — Determination of tear load — Part 1: Single edge tear*

ISO 4048:2018, *Leather — Chemical tests — Determination of matter soluble in dichloromethane and free fatty acid content*

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

ISO 6942:2022, *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 13688:2013 + Amd.1:2021, *Protective clothing — General requirements*

ISO 13934-1:2013, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method*

ISO 13935-2:2014, *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 13938-1:2019, *Textiles — Bursting properties of fabrics — Part 1: Hydraulic method for determination of bursting strength and bursting distension*

ISO 13938-2:2019, *Textiles — Bursting properties of fabrics — Part 2: Pneumatic method for determination of bursting strength and bursting distension*

ISO 15025:2016, *Protective clothing — Protection against flame — Method of test for limited flame spread*

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

EN 410:2011, *Glass in building – Determination of luminous and solar characteristics of glazing*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 ageing

changing of the product performance over time during use or storage

Note 1 to entry: Ageing is caused by a combination of several factors, such as the following:

- cleaning, maintenance, or disinfecting process;
- exposure to visible and/or ultraviolet 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

EXAMPLE Cutting, arc air gouging, and hot spraying.

3.3

artificial optical radiation

optical radiation from artificial sources of light/radiation within a broad range of wave lengths over the total electromagnetic spectrum from deep ultraviolet (UV) to the visible spectrum (VIS), and far into the infrared (IR) range

Note 1 to entry: Classification is made into coherent radiation sources (narrowband 'monochromatic' radiation from lasers) and incoherent radiation (broadband 'polychromatic' radiation from all other artificial light sources, except for lasers).

3.4

cleaning

process by which an item of PPE is again made serviceable and/or hygienically wearable by removing any dirt or contamination

Note 1 to entry: A cleaning cycle is typically a washing plus drying or a dry cleaning treatment followed, if required, by ironing, or other finishing.

3.5

clothing assembly

series of garments arranged in the order as worn

Note 1 to entry: They may contain multilayer materials, material combinations or a series of separate garments in single layers.

3.6

component assembly

combination of all materials and hardware presented exactly as the finished garment construction

3.7

conditioning

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

3.8

gaiter

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

3.9

hardware

non-fabric items forming part of or optional extras in a garment

EXAMPLE Metal or plastic buttons or zippers and touch and close fasteners or hook and loop fasteners.

3.10

hole

opening, break, or discontinuity of any size in the original structure of the test specimen's fabric caused by application of the test flame

[SOURCE: ISO 15025:2016, 3.9]

3.11

hood

item of PPE made from material which covers the head and neck and can also cover the shoulders

3.12

innermost lining

innermost face of a *component assembly* (3.6) closest to the wearer's skin

Note 1 to entry: Where the innermost lining forms part of a material combination, the material combination is regarded as the innermost lining.

3.13

interlining

layer between the outermost layer and the *innermost lining* (3.12) in a multilayer garment

3.14

material

substances excluding *hardware* (3.9), of which an item of clothing is made

3.15

material assembly

combination of all *materials* (3.14) of a multi-layer garment presented exactly as the finished garment construction

3.16

material combination

material produced from a series of separate layers, fixed together during the garment manufacturing stage

3.17

multilayer material

material consisting of different layers intimately combined prior to the garment manufacturing stage

EXAMPLE

The combining process includes weaving, quilting, coating, or gluing.

3.18

outer material

outermost *material* (3.14) of which the item of clothing is made

3.19

patch pocket

pocket located on the exterior of a protective garment, which is stitched as a patch over the outer layer of the protective garment

3.20

pre-treatment

standard way of preparing the samples before testing

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

3.21

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

3.22

protective garment

individual item of *protective clothing* (3.21) the wearing of which provides protection against specified hazards to the part of the body that it covers

EXAMPLE

Protective coat, apron, trousers, *gaiters* (3.8), *hoods* (3.11), boiler suit, or coverall.

3.23

seam

any method of permanent fastening between two or more pieces of *material* (3.14)

3.23.1

side seam

seam (3.23) that runs laterally along the garment when it is placed flat on a surface, with the front uppermost

3.23.2

structural seam

seam (3.23) that is necessary for the integrity of the garment

3.24

sleeve

removable covering intended to protect part or all of the arm and the wrist in addition to sleeves in a jacket or overall

3.25

welding

process used in joining metal components involving local melting of metal

3.26

welding time

effective time during which the arc is burning during the *welding* (3.25) process (“active arc time”) in which persons are within the operational range of the burning arc (“time of exposure”)

4 General and design requirements

4.1 General

General requirements which are not specifically covered in this document shall be in accordance with ISO 13688:2013 + Amd.1:2021.

Welders’ protective clothing shall be designed to prevent electrical conduction from the outside to the inside, e.g. by metal fasteners. Conformity shall be checked by visual inspection.

4.2 Protective clothing

Welders’ protective suits shall completely cover the upper and lower torso, neck, arms to the wrist, and legs to the ankle. Suits shall consist of the following:

- a) a single garment, e.g. a coverall or boiler suit;
- b) a two-piece garment, consisting of a jacket and a pair of trousers.

Pleats in the exterior surface of the garment can act as trapping points for hot/molten materials. If pleats are present in the garment, the bottoms of the pleats shall incorporate a means whereby entrapment of molten metal can be prevented, for example by incorporating diagonal stitches or some other feature. Conformity shall be checked by visual inspection.

4.3 Size designation and fit

Garment sizes shall be in accordance with the requirements of ISO 13688:2013 + Amd.1:2021.

Where protection to the requirements of this document is provided by an outer two-piece suit, it shall be determined that, when correctly sized for the wearer, an overlap between the jacket and trousers remains when one standing wearer firstly fully extends both arms above the head and then bends over until the fingertips touch the ground.

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.

In addition, the wrists, lower arms, and ankles shall also remain covered in an upright and raised arms overhead position. This shall also apply to one-piece suits.

4.4 Additional protective garments

Welder’s protective garments can be designed to provide extra protection against heat and flame aspects, harmful UV radiation and electrical shock for specific areas of the body when worn in addition to a suit according to 4.2, e.g. neck curtain, hoods, sleeves, apron, and gaiters. Aprons shall cover the front body of the user at least from side seam to side seam.

In the case of hoods, manufacturers shall identify the specific visor(s) to be incorporated into the hood.

Performance testing of additional protective garments shall be carried out on the assembly, comprising the suit plus the additional protective garment. Additional protective garments such as sleeves, apron, and gaiters shall cover the intended areas when worn with a suit of appropriate size and the additional item alone shall also meet the requirements of this document.

4.5 Pockets and flap closures

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

- a) pockets with external openings, including patch pockets shall be made of material(s) conforming to [6.7](#) and [6.8](#);
- b) external opening pockets including pass-through openings shall have a covering flap 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, and
- c) all flaps shall be at least 20 mm wider than the opening (at least 10 mm on each side) to prevent the flap from being tucked into the pocket. They shall be stitched down on each side or capable of covering the pocket opening by fastening. Flap materials shall conform to [6.7](#) and [6.8](#).

Conformity shall be checked by visual inspection and physical measurement.

4.6 Closures and seams

Closures shall be designed with a protective cover flap on the outside of the garment. The maximum distance between buttonholes/press studs shall be 150 mm. If zippers are used, they shall be designed in such a way that they completely close the opening and the slide fastener shall be designed to lock when completely closed. Cuffs can be provided with closures to reduce their width. The closure and any fold which it creates shall point downwards when the garment is worn. Cuffs shall not have turn-ups. Neck openings shall be provided with closures.

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

Conformity shall be checked by visual inspection.

4.7 Hardware

Hardware penetrating the outer material of a welders' protective garment or garment assembly shall not be exposed to the innermost surface of the garment or the garment assembly.

Conformity shall be checked by visual inspection.

5 Sampling and pre-treatment

5.1 Sampling

5.1.1 General

The samples shall be taken from fabrics and/or other materials being representative for the component assembly or of the garment or from the finished garment.

The samples for testing the UV protection during welding operations shall be taken in accordance with [5.1.2](#).

NOTE The sampling process in [5.1.2](#) ensures that the variation of the fabric is taken into account.

For testing UV radiation, outer material representing the areas which will be exposed to UV radiation shall be sampled. In case the garment is made with more than one outer material (e.g. body/legs different, body/back different), all materials need to be tested, excluding accessories that are attached additionally to the garment on top of the outer material.

5.1.2 Sampling procedure on fabric materials for the UV transmission measurement

5.1.2.1 Fluorescence

The fluorescence of the (textile) materials has an impact on the UV transmission measurement results.

NOTE Fluorescence can occur intentionally (high-visibility colours) or unintentionally (for example caused by fluorescent nuancing dyestuffs of non-fluorescent colours, additives or finish agents).

In any case, the UV transmission measurement of fluorescent material generate erratic data resulting in lower protection times due to the emission of fluorescence radiation, which is recorded in addition to the actual transmitted radiation by the detector of the spectrophotometer. This is based on the laws of physics and cannot be solved with the existing spectrophotometric equipment. Therefore, the test samples shall be checked for fluorescence prior to the measurement.

5.1.2.2 Sampling process

To take this into account and not to underrate the protection time, a test specimen representing the final protective garment but without fluorescence shall be selected. The fluorescence shall be checked e.g. using a spectroscopic long pass filter with the following properties:

- cut-off range 200 nm to 390 nm, 5 optical densities;
- transmission range: 440 nm to 800 nm, 90 % transmission;
- slope range: cut-off edge (420 ± 5) nm.

NOTE The fluorescence can alternatively be checked with any other technical comparable procedures leading to the same result.

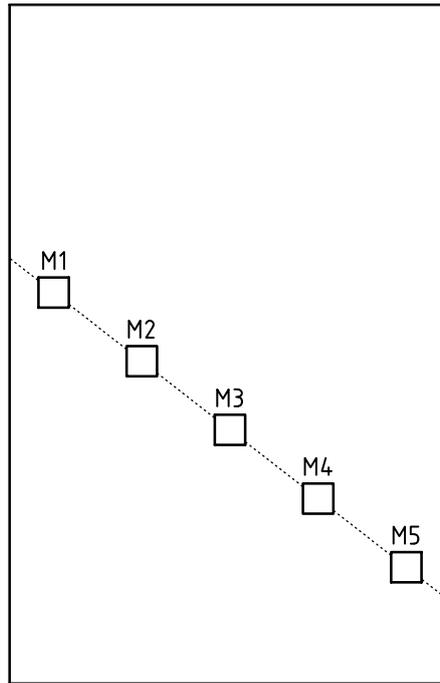
The basic construction parameters (polymer type, yarn construction, weave/knit, mass, density) of the fabric are the major factors for providing the protective function against UV radiation of welding processes.

In addition, the colour of the (textile) material has also – but minor – an impact on the UV transmission measurement results. Therefore, a screening of coloured test samples shall be performed prior to the measurement and the sample with the highest UV transmission (worst case scenario: Lowest protection time) shall be selected to represent the existing colour range for the UV transmission measurement.

To obtain the most realistic number for the protection time against the UV radiation of the relevant welding process, an undyed (blind-dyed) test specimen without fluorescence is highly recommended, but not mandatory.

For determining the UV transmission properties of welding protection garments, a representative fabric for the component assembly shall be used. The test specimens shall be preferably taken from the plain fabric following this procedure:

Cut 5 specimens in $(7 \pm 0,1)$ cm \times $(7 \pm 0,1)$ cm size (M1 to M5) in $(45 \pm 1)^\circ$ angle from left to right selvedge (warp/longitudinal direction) with an even distance between each of the 5 specimens and leave at least 12 cm gap to each selvedge (see [Figure 1](#)).

**Key**

M1 to M5 specimen 1 to 5

Figure 1 — Sample location on fabric materials for the UV transmission measurement

NOTE Textiles are not homogeneous materials like plastic or metal but to a certain extent inhomogeneous instead. This inhomogeneity results in varying UV-transmission results over the area of a fabric. Therefore, this adapted sampling procedure was developed in one of the UV-transmission round robin trials to take this inhomogeneity into account.

5.2 Pre-treatment of material

Before each test specified in 6.2 to 6.10, the test materials and test specimens shall be pre-treated by cleaning. If the manufacturer's instructions indicate that cleaning is not allowed, i.e. single use garments, then testing will be carried out on new material. In addition, 6.7 requires that the limited flame spread tests shall be carried out both before the pre-treatment and after the pre-treatment.

The cleaning shall be in line with the manufacturer's instructions, on the basis of standardized processes. If the number of cleaning cycles is not specified, the tests shall be carried out after five cleaning cycles (a cleaning cycle is one wash and one dry cycle). This shall be reflected in the information supplied by the manufacturer. If the garment can be washed and dry-cleaned, it shall only be washed. If only dry-cleaning is allowed, the garment shall be dry-cleaned in accordance with the manufacturer's instructions.

Leather materials shall be tested in accordance with 6.11 in the new state, except if the manufacturer indicates that cleaning is allowed. In that case, cleaning shall be carried out according to the manufacturer's instructions.

The test specified in 6.12 shall be carried out in the new state (as received).

NOTE 1 The manufacturer's instructions typically indicate one or several of the various methods and processes of ISO 6330^[9], ISO 15797^[10], ISO 3175-2^[11] or equivalent as standardized processes for cleaning.

NOTE 2 In the BGHM research project^[15] it was shown that the UV transmission of fabric decreases (respectively the UV protection increases) after washing due to occurring shrinkage. Therefore, the new state (as received) provides the least protection and thus represents the worst case scenario.

5.3 Ageing

In the case that the garment should be submitted to some treatment to maintain its limited flame spread property as specified in [6.7](#), the manufacturer shall indicate the maximum number of cleaning cycles that can be carried out before applying the treatment indicated to maintain the garment protective performance. Limited flame spread test according to [6.7](#) shall be carried out after the last cleaning cycles before any treatment as indicated by the manufacturer, in both cases, the garment shall comply with the requirement.

5.4 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 in an atmosphere having a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) %.

Samples for electrical resistance testing specified in [6.10](#) shall be conditioned at least 24 h (other than leather) or 48 h (leather) and tested in an atmosphere having a relative humidity of (85 ± 5) % and a temperature of (20 ± 2) °C.

6 General performance requirements

6.1 Classification

This document specifies two protection classes with specific performance requirements with regard to all properties but the UV protection (see [Table B.1](#)), i.e. Class 1 being the lower risk level and Class 2 the higher risk level.

- Class 1 is protection against less hazardous welding techniques and situations, causing lower risk levels of spatter and radiant heat.
- Class 2 is protection against more hazardous welding techniques and situations, causing higher risk levels of spatter and radiant heat.

Both protection classes are complemented by a UV protection classification system for specification of the maximum exposure time of the wearer against three representative welding process groups (see [Table B.2](#)), with group 'A' representing a low, group 'B' a medium, and group 'C' a high risk level respectively effectively emitted total UV irradiance, E_{eff} welding process.

- Group 'A' (low risk level/effectively emitted total UV irradiance welding process): $E_{\text{eff}} \leq 6 \text{ W/m}^2$;
- Group 'B' (medium risk level/effectively emitted total UV irradiance welding process): $6 \text{ W/m}^2 < E_{\text{eff}} \leq 16 \text{ W/m}^2$;
- Group 'C' (high risk level/effectively emitted total UV irradiance welding process): $16 \text{ W/m}^2 < E_{\text{eff}} \leq 170 \text{ W/m}^2$.

Further details are given in [Table B.2](#).

Wherever in [Clause 6](#) the requirements for a property value are expressed in terms of a minimum or maximum value and wherever a minimum or maximum value is to determine a Level or Class for that property, the resultant property value shall be determined according to [Annex G](#). All tests in [Clause 6](#) should be evaluated according to [Annex H](#).

6.2 Tensile strength

Sampling procedure shall be in accordance with [5.1.1](#), and 10 (5 lengthwise and 5 crosswise) samples shall be tested.

When tested in accordance with ISO 13934-1:2013, woven outer materials shall have a minimum tensile strength of 400 N in both the machine and cross directions.

When tested in accordance with ISO 3376:2020, leather outer materials shall have a minimum tensile strength of 80 N in two directions at right angles when the standard test specimen specified in ISO 3376:2020, Table 1, is used.

6.3 Tear strength

Sampling procedure shall be in accordance with [5.1.1](#), and 10 (5 lengthwise and 5 crosswise) samples shall be tested.

When tested in accordance with ISO 13937-2:2000, woven outer materials shall have a minimum tear strength of 15 N in both the machine and cross directions for Class 1 welders garments and 20 N in both the machine and cross directions for Class 2 welders garments. When tested in accordance with ISO 3377-1:2011, leather outer materials shall have a minimum tear strength of 15 N in two directions at right angles in the plane of the material for Class 1 welders garments and 20 N in two directions at right angles in the plane of the material for Class 2 welders garments.

6.4 Burst strength of knitted materials and seams

Sampling procedure shall be in accordance with [5.1.1](#), and 5 samples shall be tested.

When tested in accordance with ISO 13938-1:2019 or ISO 13938-2:2019, the burst strength of knitted materials and structural seams in knitted materials, shall have a minimum strength of 200 kPa using a 7,3 cm² test area, or shall have a minimum strength of 100 kPa using a 50 cm² test area.

6.5 Seam strength

Sampling procedure shall be in accordance with [5.1.1](#), and 5 samples shall be tested.

When tested in accordance with ISO 13935-2:2014, structural seams of woven outer materials and leather materials of the clothing assembly shall have a minimum seam strength of 225 N.

6.6 Dimensional change of textile materials

Sampling procedure shall be in accordance with ISO 3759 (referred to in ISO 5077:2007) and 1 sample shall be tested in accordance with the fabric procedure as specified in ISO 3759.

The dimensional change shall be determined from the difference in dimensions between the new state and after five cleaning cycles according to [5.2](#).

The dimensional change of woven, non-woven, and sheet materials shall not exceed ± 3 % in either length or width direction when measured in accordance with ISO 5077:2007.

The dimensional change of knitted materials shall not exceed ± 5 % when measured in accordance with ISO 5077:2007.

The dimensional change shall be measured after the specimen has been uncreased and flattened on a plane surface.

The requirements for dimensional change do not apply to single use garments.

6.7 Limited flame spread

6.7.1 General

Testing of materials and seams shall take place in accordance with ISO 15025:2016, Procedure A (code letter A1) and optionally Procedure B (code letter A2). This test shall be carried out both before and after the pre-treatment specified in [5.2](#).

6.7.2 Testing in accordance with ISO 15025:2016, Procedure A (code letter A1)

6.7.2.1 When tested in accordance with ISO 15025:2016, Procedure A, specimens from single layer garments shall meet the following requirements.

Table 1 — Limited flame spread performance requirements ISO 15025:2016, Procedure A (code letter A1)

Properties	Requirement
Flame spread	No specimen shall permit any part of the lowest boundary of any flame to reach the upper or either vertical edge.
Flaming debris	No specimen shall give flaming or molten debris.
Hole formation	No specimen shall give hole formation of 5 mm or greater in any direction, except for an interlining that is used for specific protection other than heat and flame protection.
Afterglow	Afterglow time shall be ≤ 2 s. A glowing inside the charred area is defined in ISO 15025:2016 as afterglow without combustion and for the purpose of this clause is not regarded as afterglow.
Afterflame	Afterflame time shall be ≤ 2 s.

For seams, three specimens containing a structural seam shall be tested in accordance with ISO 15025:2016, Procedure A. Specimens shall be oriented with the seam running up the centreline of outer surface of the test specimen so that the burner flame impinges directly upon the seam. Seams shall not separate. Except for leather, seams shall be tested only after pre-treatment according to 5.2.

6.7.2.2 If the garment is a multilayer material and/or a material combination, specimens of the material assembly including seams, except the innermost seams, shall be tested both by applying the flame to the surface of the outer material of the garment and to the innermost lining of the garment and shall meet the requirements of 6.7.2.1, including that no specimen shall give hole formation except for an interlining that is used for specific protection other than heat protection, for example liquid penetration.

6.7.2.3 Hardware, whether it is exposed or covered when all closure systems in the garment are in the closed position, shall be tested separately, using ISO 15025:2016, Procedure A, after the pre-treatment specified in 5.2. Samples shall be taken in combination with the garment layer(s) to make it possible to have samples with the dimensions as indicated in ISO 15025:2016, Procedure A. Three specimens containing the hardware shall be tested.

When the hardware is covered, the flame shall be applied to the outer surface of the component assembly containing hardware exactly as designed in the garment so that the burner flame impinges directly upon the place where the hardware is located. When the hardware is directly exposed, the flame shall be applied directly upon the hardware.

When the hardware is covered when all closure systems in the garment are in the closed position, the assembly shall meet the requirements of 6.7.2.1. At least 5 min after completion of the test, it shall be verified that the closure system can be opened at least once.

When the hardware is directly exposed, it shall comply with the following requirements:

- no specimen shall melt or give flaming or molten debris;
- the afterglow time shall be ≤ 2 s
- the afterflame time shall be ≤ 2 s;
- at least 5 min after completion of the test, it shall be verified that the closure system can be opened at least once.

6.7.2.4 Labels, badges, retro-reflective materials, transfers, etc., which are applied to the outermost surface of the garment, shall be tested only after pre-treatment according to 5.2. in combination with

the outer layer to make it possible to take samples with the dimensions as indicated in ISO 15025:2016, Procedure A. Three specimens containing the item shall be tested. The items shall be oriented with the longer dimensions running up the centreline of the test specimen so that the burner flame impinges directly upon the middle surface of the item, not the edge. The combination with the outermost layer of the garment shall meet the requirements of 6.7.2.1. This requirement is not applicable for labels, embroideries, or other added decorations with a surface area of less than 10 cm².

6.7.3 Testing in accordance with ISO 15025:2016, Procedure B (code letter A2)

6.7.3.1 When tested in accordance with ISO 15025:2016, Procedure B, hemmed specimens from single layer garments, shall meet the requirements in Table 2.

Table 2 — Limited flame spread performance requirements ISO 15025:2016, Procedure B (code letter A2)

Properties	Requirement
Flame spread	No specimen shall permit any part of the lowest boundary of any flame to reach the upper or either vertical edge.
Flaming debris	No specimen shall give flaming or molten debris.
Afterglow	Afterglow time shall be ≤2 s. A glowing inside the charred area is defined in ISO 15025:2016 as afterglow without combustion and for the purpose of this Clause is not regarded as afterglow.
Afterflame	Afterflame time shall be ≤2 s.

For seams, three specimens containing a structural seam shall be tested in accordance with ISO 15025:2016, 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 the seam. Seams shall not separate. Except for leather, seams shall be tested only after pre-treatment according to 5.2.

6.7.3.2 The hemmed fabric specimen shall be representative of and in conformity with the garment and shall be prepared by the manufacturer in the same manner as used in the construction of the clothing.

6.7.3.3 If the garment is multilayer, hemmed specimens of the material assembly including seams shall be tested by applying the flame to the edge of the multilayer assembly and shall meet the requirements of 6.7.3.1.

6.8 Impact of spatter (small splashes of molten metal)

Sampling procedure shall be in accordance with 5.1.1. and 10 samples shall be tested.

When tested according to ISO 9150:1988, the outer material or material assembly shall require

- at least 15 drops of molten metal to raise the temperature behind the test specimen by 40 K for Class 1, and
- at least 25 drops of molten metal to raise the temperature behind the test specimen by 40 K for Class 2.

Material and material assemblies which ignite during the test do not meet this requirement.

6.9 Heat transfer (radiation)

Sampling procedure shall be in accordance with 5.1.1 and 3 samples shall be tested.

When tested in accordance with ISO 6942:2022, Method B, at a heat flux density of 20 kW/m², single layer or multilayer garments, and/or clothing assemblies shall meet a radiant heat transfer index (RHTI for 24 °C) of

- for Class 1: RHTI 24 ≥ 7,0 s, and
- for Class 2: RHTI 24 ≥ 16,0 s.

If the garment is multi-layered, the test shall be carried out on the complete material assembly with the innermost layer facing the calorimeter and the outermost layer facing the energy source.

6.10 Electrical resistance

Conditioning period and testing of the samples shall be carried out in an atmosphere according to 5.4. When the material assembly is tested in accordance with the test method specified in EN 1149-2:1997 and under an applied potential of (100 ± 5) V, the electrical resistance shall be greater than $10^5 \Omega$ (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 Fat content of leather

Sampling procedure shall be in accordance with ISO 2418 and ISO 4044 and 3 samples shall be tested.

When tested according to ISO 4048:2011, the fat content of leather shall not exceed 15 %.

6.12 Protection against UV radiation

Sampling procedure and number of samples shall be in accordance with 5.1.2.

The test for protection against UV radiation shall be performed as specified in Annex C and Annex D (normative).

The test results shall be evaluated according to Table B.2 and Table 4.

NOTE General information related to the UV protective characteristics of welders' protective clothing and to the measuring methods used are given in Annex A.

6.13 Performance requirements

The performance requirements are summarized in Table 3 and the UV protection requirements in Table 4.

Table 3 — Summary of performance requirements

Subclause	Requirement	Class 1	Class 2
6.2	Tensile strength		
	— woven outer textile material	400 N	400 N
	— leather	80 N	80 N
6.3	Tear strength		
	— woven outer textile material	15 N	20 N
	— leather	15 N	20 N
6.4	Burst strength		
	Test area of 7,3 cm ²	200 kPa	200 kPa
	Test area of 50 cm ²	100 kPa	100 kPa
6.5	Seam strength		
	— textile material	225 N	225 N
	— leather	225 N	225 N

^a For ISO 15025:2016, Procedure B, this requirement is not applicable.

Table 3 (continued)

Subclause	Requirement	Class 1	Class 2
6.6	Dimensional change of woven textile materials	±3 %	±3 %
	Dimensional change of knitted textile materials	±5 %	±5 %
6.7	Flame spread	ISO 15025:2016, Procedure A (surface ignition)	ISO 15025:2016, Procedure A (surface ignition)
	— Procedure A - mandatory — Procedure B - optional	ISO 15025:2016, Procedure B (edge ignition) No specimen shall permit any part of the lowest boundary of any flame to reach the upper or either vertical edge. No hole formation ^a No flaming or molten debris afterflame ≤2 s afterglow ≤2 s	ISO 15025:2016, Procedure B (edge ignition) No specimen shall permit any part of the lowest boundary of any flame to reach the upper or either vertical edge. No hole formation ^a No flaming or molten debris afterflame ≤2 s afterglow ≤2 s
6.8	Impact of spatter	15 drops	25 drops
6.9	Heat transfer (radiation)	RHTI 24 ≥ 7,0 s	RHTI 24 ≥ 16,0 s
6.10	Electrical resistance	>10 ⁵ Ω	>10 ⁵ Ω
6.11	Fat content of leather	≤15 %	≤15 %

^a For ISO 15025:2016, Procedure B, this requirement is not applicable.

Table 4 — Guideline for garment selection, summary of UV protection requirements

Subclause	UV protection requirement acc. to the extent of listed welding task	Time interval of the welding task h	UV protection period class 'XX' h
6.12 Table B.2	"Full-time" welder (>80 % welding tasks/shift)	6,5 < t ≤ 10	≤10
	"Part-time" welder (<80 % or >1 h welding tasks/shift)	1 ≤ t ≤ 6,5	≤6,5
	"Not suitable for welding tasks"	<1,0	0 or 'no protection'

NOTE The term "welding task" includes the welding process itself and preparation and follow-up work, not solely arc burning time.

7 Marking

7.1 General

Welders' protective garments, for which conformity with this document is claimed, shall be marked in accordance with ISO 13688:2013 + Amd.1:2021 and with the following information:

a) classification according to 6.2 to 6.11:

- Class 1: the number and year of this document (ISO 11611) followed by the graphical symbol shown in Figure 2 and the indication "Class 1" and the indication "A1" or "A1 + A2" as appropriate for limited flame spread;
- Class 2: the number and year of this document (ISO 11611) followed by the graphical symbol shown in Figure 2 and the indication "Class 2" and the indication "A1" or "A1 + A2" as appropriate. Garments conforming to Class 2 shall meet Class 2 for all performance requirements;
- where garments contain parts of both classes, the garment shall be classified in the lower class.

b) classification according to 6.12:

The two protection classes are supplemented by a three-step UV protection classification system for specification of the maximum time of exposure (UV protection period class acc. to Table 4) of the wearer for each of the three representative welding process groups (see Table B.2).

- Group 'A' (low effectively emitted total irradiance welding process): $E_{\text{eff}} \leq 6 \text{ W/m}^2$;
- Group 'B' (medium effectively emitted total irradiance welding process): $6 \text{ W/m}^2 < E_{\text{eff}} \leq 16 \text{ W/m}^2$;
- Group 'C' (high effectively emitted total irradiance welding process): $16 \text{ W/m}^2 < E_{\text{eff}} \leq 170 \text{ W/m}^2$.

c) for garments intended for single use only, the garment marking shall indicate “Do not re-use” (or the equivalent term in the language of the country of destination) and in addition with the graphical symbol according to ISO 7000-1051.

7.2 Procedure and examples of markings:

Step 1: Determine the required protective effect according to 6.2 to 6.11. Options: Class '1' or Class '2' and indication "A1" or "A1+A2"

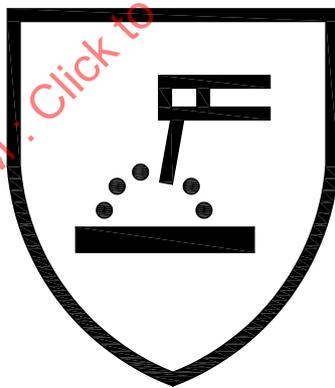
Step 2: Determine the UV protection period class 'XX' according to Table 4 (where 'XX' stands for '≤10', '≤6,5', '0' or 'no protection') for the three representative welding process groups 'A', 'B' and 'C' (see Table B.2):

Options: Group A ≤XX h; B ≤XX h; C ≤XX h.

Step 3: Combine the options chosen from step 1 and step 2 to the final classification:

Protection Class 1 or 2, A1 or A1+A2, Group A ≤XX h; B ≤XX h; C ≤XX h.

If garments are made of a combination of different materials, the UV protections classification codes shall be given for the lowest protection.



Example:

Class 1/2, A1 or A1+A2; Group A ≤XX h; B ≤XX h; C ≤XX h

or

Class	Group
1/2	A ≤XX h
A1 or	B ≤XX h

A1+A2	C ≤XX h
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Where “XX” is the UV protection period class according to [Table 4](#).

Figure 2 — Graphical symbol for protection against welding hazards (ISO 7000-2683)

Example 1 for UV protection period class marking: Group A ≤ 10 h; B ≤ 10 h; C ≤ 10 h;

This means working with welding processes of “group A” allows a welding time of maximum 10 h, those of “group B” a maximum time of 10 h and those of “group C” a maximum time of 10 h.

Example 2 for UV protection period class marking: Group A ≤ 10 h; B ≤ 6,5 h; C 0 h;

This means working with welding processes of “group A” allow a welding time of maximum 10 h and those of “group B” a maximum time of 6,5 h. Welding is not allowed with welding processes of “group C” (due to less than 1 h of protection time according to [Annex D](#)).

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 13688:2013 + Amd.1:2021.

The manufacturer shall give as much information as possible on known factors of durability, especially on durability to cleaning. See ISO 13688:2013 + Amd.1:2021 for further details.

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

8.2 Intended use

At least the following basic information shall be provided

- any guidance on the appropriate choice of class of welders’ protective clothing, (see [Annex B](#));
- any identified hazards against which the clothing is intended to protect (e.g. flames, molten metal spatter, radiant heat, short term accidental electrical contact and UV radiation);
- for protective clothing, a warning that additional partial body protection can be required, e.g. for welding overhead;
- 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.
- Warning of limited UV protection provided by the garment in comparison to a full workday when class marking of ≤10 h for the relevant welding process group (‘A’, ‘B’, or ‘C’)

8.3 Improper use

A warning shall be given about 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 like lubricants and anti-corrosives.
- 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 can 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) A hazard of immediate skin irritation (severe sunburn) and long-term health damage (skin cancer) is present if the declared maximum UV protection period for the applied welding process group is exceeded, or if body parts exposed to UV radiation are not covered.
- g) 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 shall be visually inspected for any sign of damage.

Similarly, users should be advised that if they experience sunburn-like symptoms during or after work, harmful UV radiation is penetrating the garment. In either case, the garment shall immediately be repaired (if practicable) or replaced with a more suitable or new one and consideration given to the use of additional, more resistant, protective layers or overall better performing garment in future.

9 Test report

- a) a reference to this document i.e. ISO 11611:2024;
- b) identification of the sample tested;
- c) required parameters of the test method;
- d) which side of material was tested
- e) test results;
- f) the calculated UV protection time according to [Annex D](#);
- g) any deviation from this document.

Annex A (informative)

General explanations related to the UV protective characteristics of welders' protective clothing and to the measuring methods used

The UV transmittance/transmission of garments is determined according to EN 410:2011 by using wavelength-dependant UV/VIS/NIR (ultraviolet/visible/near-infrared) spectrometers: EN 410:2011 specifies a method to determine the luminous and solar characteristics of glazing in buildings. Furthermore, it is applicable for all light-transmitting materials (including fabrics). In principal, materials having light-scattering properties in case of incident radiation (fabrics) are treated as standard light-transmitting materials, but certain measuring conditions have to be observed (see 6.12). Therefore, EN 410:2011 has been used for a long time for the determination of solar characteristics of sunscreen materials. Even the military refers to EN 410:2011 in the terms of delivery for the solar characteristics of camouflage garments. Thus, EN 410:2011 is appropriate for the testing of the protective effect against UV radiation (UV-A, UV-B, UV-C) of welders' protective clothing for various welding processes.

In prevention, the so-called effective radiation H_{eff} is used for determining the exposure limit values, since it considers the spectral sensibility of both the eyes and the skin. The exposure limit values used for prevention of hazards to the eyes and the skin due to UV radiation at workplaces are indicated by using this parameter.

NOTE For exposure limit values, see e.g. EC Directive 2006/25/EX, Annex I, Table 1.1.^[14] For wavelengths ranging from 400 – 180 nm (UV-A, UV-B, UV-C), EC Directive 2006/25/EX specifies an exposure limit value H_{eff} of 30 J/m² for a daily value of 8 h (or for a period of time of 8 h, corresponding to a regular daily shift).

Annex B (normative)

Classification system of the type of welders' clothing (Class 1/Class 2, UV protection period class for welding process groups 'A', 'B' and 'C')

[Table B.1](#) classifies both the class 1 and class 2 of protective clothing for use in manual welding and for operators of machines and systems, based on the frequently used welding and cutting processes. Thus, clothing can be chosen according to the required protective effect against splatter and drops.

[Table B.2](#) classifies welding processes, for which detailed UV spectra have been measured^[15] according to the effectively emitted total irradiance, into 3 process groups (A, B, C). In addition, other known and frequently used welding and cutting processes have been included in these process groups.

The maximum arc time allowed for not exceeding the daily UV-exposure limit value $H_{\text{eff}} = 30 \text{ J/m}^2$ ^[14] is included in these three process groups.

Table B.1 — Classification of garments for use in welding or allied processes with regard to the protective effect against splatters and drops (reference points)

Type of welders' garments	Selection criteria relating to the process:	Selection criteria relating to the environmental conditions:
Class 1	Manual welding techniques with light formation of splatters and drops, e.g.: <ul style="list-style-type: none"> — gas welding; — TIG welding; — MIG welding (with low current); — micro plasma welding; — brazing; — spot welding; — MMA welding (with rutile-covered electrode). 	Operation of machines, e.g.: <ul style="list-style-type: none"> — oxygen cutting machines; — plasma cutting machines; — resistance welding machines; — machines for thermal spraying; — bench welding.

Table B.1 (continued)

Type of welders' garments	Selection criteria relating to the process:	Selection criteria relating to the environmental conditions:
Class 2	Manual welding techniques with heavy formation of spatters and drops, e.g.: <ul style="list-style-type: none"> — MMA welding (with basic or cellulose-covered electrode); — MAG welding (with CO₂ 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.: <ul style="list-style-type: none"> — in confined spaces; — at overhead welding/cutting or in comparable constrained positions.

Table B.2 — Classification scheme for representative process groups of welding or allied processes with regard to the maximum effectively emitted total irradiance related to representative welding processes

Process groups of welding processes	Classification scheme of welding processes		
	Group	Selected representative spectrum with the highest irradiance	Range of effectively emitted total irradiance E_{eff}
TIG hard soldering gas welding manual flame cutting Laser cutting and welding	A	TIG DC 260 A	$E_{eff} \leq 6 \text{ W/m}^2$
manual electrode welding gouging flame grooving	B	MMA (stick welding) 220 A	$6 \text{ W/m}^2 > E_{eff} \leq 16 \text{ W/m}^2$
MIG MAG plasma arc welding plasma cutting	C	MIG pulse 250 A	$16 \text{ W/m}^2 > E_{eff} \leq 170 \text{ W/m}^2$

NOTE The knowledge and data has been taken from a research project by the German Federal Institute for Occupational Safety and Health (BAuA)^{[15][16]}.

Annex C
(normative)

Test procedure for the protective effect against UV radiation emitted by welding processes

When testing the UV transmission, or the spectral transmission grade $\tau(\lambda)$ of the material or the composition of materials according to the principles of transmission measurement described in EN 410:2011 by using at least an UV/VIS spectrophotometer the following test parameters shall be applied:

The use of an integrating sphere (a so-called Ulbricht's sphere) is mandatory for examining the materials used for the welders' protective clothing (light-scattering materials such as fabrics, as well as leather) in order to capture all scattering light, and to obtain a sufficient averaging of the measuring value in case of an uneven surface structure of the samples.

The mandatory settings of the test apparatus are specified in [Table C.1](#).

Table C.1 — Mandatory settings of the test apparatus

UV/VIS spectrophotometer:	Double beam spectrophotometer with additional integrating sphere supplement "Diffuse Reflectance Accessory", diameter 150 mm (according to CIE "fr: Commission Internationale de l'Éclairage")
Measurement method:	% transmission, transmission is measured at the light inlet of the sphere (transmission port)
Normative reference:	principles of hemispherical transmission measurement in compliance with EN 410:2011
Scan range (nm):	200 to 400
Y mod:	%T
UV-Vis scan rate (nm/min)	≤300,00 (equals an average time of ≥ 0,2 s/nm)
UV-Vis data interval (nm)	1,00
UV-Vis Spectral Bandwidth (nm)	5,000
Reference beam attenuator	1,0 ABS - 1,5 ABS (ABS: absorbance)
Integrating sphere	
Diameter (mm)	150
Inner surface coating	Pressed and sintered PTFE (PTFE: polytetrafluoroethylene) coating with low density
port to surface area relationship	≤1/10
Sample illumination	
Minimum illumination area of irradiance beam	Rectangular beam profile: 6 mm × 15 mm Circular beam profile: 11 mm in diameter
Diverse	Homogenous irradiation of the beam over the total illumination area

Number of replicates and orientation of the test specimens in the spectrophotometer:

The sampling shall be done in accordance with 5.1.2 resulting in five (7 ± 0,1) cm × (7 ± 0,1) cm test specimens [M1 - M5]]. Each specimen shall be fixed relaxed/without stretch and wrinkles in its own plastic frame (specimen holder (7 ± 0,1) cm × (7 ± 0,1) cm with (5 ± 0,1) cm diameter hole, 5 specimens = 5 plastic frames) by double-sided adhesive tape. The preparation of the specimen with the plastic frames have to be done in

Annex D (normative)

Instructions for calculating the effectively transmitted total irradiance E_{eff} and the resulting maximum time of use related to the exposure limit value H_{eff} of 30 J/m², by using the determined worst-case UV transmission spectra of fabrics for welding protective garments

D.1 General

Conversion of the transmission spectra taken from EN 410:2011 to transmission factors (0 to 1), see [Table D.1](#), column B and C.

The effective transmitted spectral irradiance in W/m² below the fabrics or on the skin shall be superimposed with the radiation spectrum of the corresponding welding process listed in [Annex E](#) together with the transmission factors (shown in [Table D.1](#), column D and E).

Wavelength-depending weighing of the effective transmitted spectral radiance shall be calculated with the spectral weighing function $S_{\text{eff}}^{[13]}$ listed in [Annex F](#) (shown in [Table D.1](#), column E, F, and G).

The effective transmitted total irradiance E_{eff} is the sum of the wavelength-depending weighted effective transmitted spectral radiance over all wavelengths ranging from 200 nm to 400 nm as given by [Formula \(D.1\)](#):

$$E_{\text{eff}} = \sum_{400}^{200} E_{\lambda}(\lambda)_{\text{eff}} \quad (\text{D.1})$$

In the following, two options are outlined how the measured fabric transmission data shall be processed to come to the effective transmitted total irradiance E_{eff} .

Option 1 are the detailed instructions in so to speak laymen terms for an inexperienced user with little to no spectroscopic knowledge and experience.

Option 2 are the instructions for an experienced user with profound spectroscopic knowledge and experience.

Both options lead to the same result, they just differ in the depth and details of guidance provided.

D.1.1 Option 1 “inexperienced user”: Table with examples of calculations on the basis of exemplary values:

Table D.1 — Examples of calculations on the basis of exemplary values

Column A	Column B	Column C	Column D	Column E	Column F	Column G
Measuring range λ nm	Fabric's spectral transmission % ^a	Transmissions-factor τ_λ ^b	Spectral total irradiance of corresponding welding process $E_e(\lambda)$ W/m ² nm ^c	effective transmitted spectral radiance below fabric $E_\lambda(\lambda)$ W/m ² nm ^d	Weighting of effective transmitted spectral radiance $E_\lambda(\lambda)$ with spectral weighing function s_{eff} ^e	Weighted spectral radiance $E_\lambda(\lambda)_{\text{eff}}$ ^f
200	80,3	0,803	0,828	0,664 8	0,430 000	0,285 864
201	80,6	0,806	0,826	0,708 7	0,465 282	0,329 745
202	85,8	0,858	0,819	0,702 7	0,426 582	0,299 759
...	
400	86,6	0,866...	0,023	0,003 3	0,000 030	0,000 015

Option 1 calculations:

^a Averaged %T test result of test specimen in respect of worst-case scenario (see [Annex C](#)).

^b Column C = column B/100.

^c Spectral distribution of the selected representative welding processes acc. to [Table E.1](#).

^d Column E = column D × column C.

^e Reference [13], [Annex F, Table F.1](#).

^f Column G = column E × column F.

D.1.1.1 Maximum time of operation

In radiation prevention, the so-called effective irradiance H_{eff} is used for determining the exposure limit values, since it considers the spectral sensibility of both the eyes and the skin. The exposure limit values used for prevention of hazards to the eyes and the skin due to UV radiation at workplaces are indicated using this unit.

NOTE For exposure limit values, see e.g. EC Directive 2006/25/EC, Annex I, Table 1.1^[14]. For wavelengths ranging from 400 – 180 nm (UV-A, UV-B, UV-C), EC Directive 2006/25/EX specifies an exposure limit value H_{eff} of = 30 J/m² over a daily period of 8 h (or for a period of time of 8 h, corresponding to a standard daily shift).

H_{eff} is defined as per [Formula \(D.2\)](#):

$$H_{\text{eff}} = E_{\text{eff}} \cdot \Delta t \tag{D.2}$$

The resulting exposure limit value for E_{eff} is given by [Formula \(D.3\)](#):

$$E_{\text{eff}} = \frac{H_{\text{eff}}}{\Delta t} = \frac{30 \frac{\text{J}}{\text{m}^2}}{28\,800 \text{ s}} = 0,001\,041\,67 \frac{\text{W}}{\text{m}^2} \tag{D.3}$$

According to the following [Formula \(D.4\)](#), the maximum time of operation in decimal hours is calculated with the values of E_{eff} and $H_{\text{eff}} = 30 \text{ J/m}^2$:

$$\Delta t = \frac{H_{\text{eff}}}{E_{\text{eff}}} \times \frac{1}{3\,600 \times 0,5} \tag{D.4}$$

The factor 0,5 in the above equation takes the 50 % burning arc/flame time into account.

The calculated maximum protection time of operation Δt shall be calculated for each the three specified welding process groups ('A', 'B' and 'C' acc. to [Table B.2](#)), rounded down to the next 0,5 h and classified according to the UV protection period class in [Table 4](#).

Calculated maximum protection times of operation Δt of more than 10 h shall be reported as 10 h (cut-off higher than 10 h).

Calculated maximum protection times of operation Δt of less than 1,0 h shall be reported as '0' or 'no protection' in the marking of the affected welding process group (see [7.2](#), example 2).

Given example for implementation the calculated maximum protection time from [Table 4](#), [Table B.2](#) and the calculated maximum protection time of operation according to [Annex D](#) in the marking:

Calculated maximum protection time of operation: Group A = 12 h; B = 4 h; C = 0,8 h

Marking the UV protection period class: Group A \leq 10 h; B \leq 6,5 h; C \leq 0 h or "no protection"

D.1.2 Option 2 „experienced user“: Table with calculation samples using actually measured values:

Table D.2 — Calculation samples using actually measured values

A	B	C	D	E
Wavelength	Transmission of fabric ^a	Irradiance of welding process ^b (e.g. MAG ST37) in W/m ² nm	Weighing function of the effective radiation	Effective radiation in W/m ² (columns B × C × D) ^c
λ (nm)	$\tau(\lambda)$	$E_e(\lambda)$	$s_{eff}(\lambda)$	$= \tau(\lambda) \times E_e(\lambda) \times s_{eff}(\lambda)$ $E_{eff,\tau}(\lambda)$
200	2,05E-05	5,15E-02	3,00E-02	3,16E-08
201	6,78E-05	5,24E-02	3,34E-02	1,19E-07
202	2,17E-05	4,94E-02	3,71E-02	3,97E-08
203	4,08E-05	4,76E-02	4,12E-02	7,99E-08
204	2,31E-04	4,80E-02	4,59E-02	5,08E-07
205	1,12E-04	4,04E-02	5,10E-02	2,31E-07
...
397	5,61E-04	9,69E-02	3,30E-05	1,79E-09
398	5,71E-04	7,53E-02	3,20E-05	1,38E-09
399	5,81E-04	5,59E-02	3,10E-05	1,01E-09
400	6,00E-04	5,65E-02	3,00E-05	1,02E-09

Option 2 calculations:

a Averaged %T test result of test specimen in respect of worst-case scenario (see [Annex C](#)).

b Spectral distribution of the selected representative welding processes according to [Table E.1](#).

Calculations:

c Effective spectral radiation (200 nm – 400 nm) (product of columns B × C × D = column E):

$$E_{eff}(\lambda) = \tau(\lambda) \times E_e(\lambda) \times s_{eff}(\lambda)$$

d Effective total irradiance (200 nm – 400 nm) (sum column E):

$$E_{eff} = \sum_{200}^{400} \tau(\lambda) \times E_e(\lambda) \times s_{eff}(\lambda)$$

e Maximum operation time (Δt) of the fabric in hours in relation to a daily exposure limit value $H_{eff} = 30 \text{ J/m}^2$

$$t = \frac{30}{E_{eff}} \times \frac{1}{3600 \times 0,5}$$

Table D.2 (continued)

A	B	C	D	E
Wavelength	Transmission of fabric ^a	Irradiance of welding process ^b (e.g. MAG ST37) in W/m ² nm	Weighing function of the effective radiation	Effective radiation in W/m ² (columns B × C × D) ^c = $\tau(\lambda) \times E_e(\lambda) \times s_{\text{eff}}(\lambda)$ $E_{\text{eff},\tau}(\lambda)$
λ (nm)	$\tau(\lambda)$	$E_e(\lambda)$	$s_{\text{eff}}(\lambda)$	
E_{eff} (Sum column E):				8,98E-04^d
maximum time of operation in decimal hours per day:				9,28^e
Option 2 calculations:				
^a Averaged %T test result of test specimen in respect of worst-case scenario (see Annex C). ^b Spectral distribution of the selected representative welding processes according to Table E.1 . Calculations: ^c Effective spectral radiation (200 nm – 400 nm) (product of columns B × C × D = column E): $E_{\text{eff}}(\lambda) = \tau(\lambda) \times E_e(\lambda) \times s_{\text{eff}}(\lambda)$ ^d Effective total irradiance (200 nm – 400 nm) (sum column E): $E_{\text{eff}} = \sum_{400}^{200} \tau(\lambda) \times E_e(\lambda) \times s_{\text{eff}}(\lambda)$ ^e Maximum operation time (Δt) of the fabric in hours in relation to a daily exposure limit value $H_{\text{eff}} = 30 \text{ J/m}^2$ $t = \frac{30}{E_{\text{eff}}} \times \frac{1}{3\,600 \times 0,5}$				

The factor 0,5 in the above equation takes the 50 % burning arc/flame time into account.

The calculated maximum protection time of operation Δt is calculated for each the three defined welding process groups ('A', 'B' and 'C' acc. to [Table B.2](#)), rounded down to the next 0,5 h and classified acc. to the UV protection period class in [Table 4](#).

Calculated maximum protection times of operation Δt of more than 10 h shall be reported as 10 h (cut-off higher than 10 h).

Calculated maximum protection times of operation Δt of less than 1,0 h shall be reported as '0' or 'no protection' in the marking of the affected welding process group (see [7.2](#), example 2).

Given example for implementation the calculated maximum protection time from [Table 4](#), [Table B.2](#) and the calculated maximum protection time of operation according to [Annex D](#) in the marking:

Calculated maximum protection time of operation: Group A = 12 h; B = 4 h; C = 0,8 h

Marking the UV protection period class: Group A ≤ 10 h; B ≤ 6,5 h; C ≤ 0 h or "no protection"

Annex E

(normative)

Spectral distribution and maximum effectively emitted total irradiance E_e of the selected representative welding processes in [Table B.2](#)

Table E.1 — Spectral distribution and maximum effectively emitted total irradiance E_e of the selected representative welding processes in [Table B.2](#)

Wavelength λ	Emitted total irradiance E_e [W/(m ² nm)] of the selected representative welding processes		
	Group A TIG DC S235 E_e (260 A)	Group B MMA S235 E_e (220 A)	Group C MIG pulse Al E_e (250 A)
200	0,061 2	0,067 0	2,625 2
201	0,055 4	0,053 6	1,512 4
202	0,069 7	0,045 3	3,386 8
203	0,073 8	0,047 1	3,963 4
204	0,059 5	0,038 3	2,679 5
205	0,071 2	0,049 2	2,450 7
206	0,084 7	0,061 2	2,525 7
207	0,074 9	0,049 3	2,620 8
208	0,063 7	0,050 4	2,565 7
209	0,067 8	0,063 5	2,665 8
210	0,067 4	0,065 7	2,749 4
211	0,066 0	0,070 0	2,817 5
212	0,063 8	0,088 4	2,837 5
213	0,081 5	0,082 0	3,042 7
214	0,087 1	0,063 1	3,207 8
215	0,072 6	0,074 6	3,113 3
216	0,070 6	0,089 9	3,189 4
217	0,100 4	0,086 6	3,336 7
218	0,105 8	0,073 7	3,131 0
219	0,079 7	0,075 9	2,958 6
220	0,070 2	0,085 1	3,714 6
221	0,070 7	0,105 8	4,021 2
222	0,080 1	0,103 9	2,910 5
223	0,081 6	0,074 8	2,227 0
224	0,075 2	0,065 8	2,030 3
225	0,070 2	0,061 5	1,984 5
226	0,068 0	0,084 3	4,891 8
227	0,067 2	0,112 0	5,491 5
228	0,073 1	0,106 2	2,601 3
229	0,074 8	0,105 0	1,507 1
230	0,070 4	0,106 3	1,296 4

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Table E.1 (continued)

	Emitted total irradiance E_e [W/(m ² nm)] of the selected representative welding processes		
Wavelength	Group A	Group B	Group C
lambda	TIG DC S235 E_e (260 A)	MMA S235 E_e (220 A)	MIG pulse Al E_e (250 A)
231	0,078 5	0,084 6	1,625 9
232	0,077 6	0,070 0	1,705 7
233	0,075 8	0,085 1	1,190 7
234	0,079 4	0,122 8	1,152 7
235	0,074 7	0,110 4	0,648 8
236	0,072 4	0,090 1	3,590 3
237	0,074 5	0,113 7	8,230 6
238	0,079 0	0,116 3	4,961 6
239	0,079 6	0,102 8	0,615 0
240	0,082 2	0,115 0	0,803 9
241	0,080 7	0,116 9	0,674 1
242	0,076 1	0,091 3	0,787 8
243	0,081 2	0,159 0	0,834 5
244	0,079 6	0,192 9	0,735 5
245	0,081 8	0,157 8	0,741 5
246	0,078 7	0,179 6	0,869 7
247	0,076 4	0,202 5	0,780 6
248	0,087 0	0,223 5	0,730 3
249	0,084 9	0,233 9	0,830 9
250	0,076 4	0,251 4	0,747 5
251	0,077 4	0,298 7	0,741 9
252	0,082 3	0,317 4	0,799 2
253	0,087 0	0,331 8	0,865 3
254	0,089 9	0,350 4	0,934 7
255	0,098 8	0,259 2	0,768 1
256	0,075 6	0,155 3	1,650 1
257	0,194 4	0,200 9	5,061 7
258	0,216 5	0,247 6	4,082 2
259	0,190 5	0,251 4	1,459 1
260	0,262 5	0,283 9	1,937 4
261	0,164 2	0,269 2	1,363 0
262	0,101 1	0,265 8	1,096 0
263	0,105 7	0,255 2	1,234 5
264	0,090 7	0,231 1	1,060 6
265	0,081 8	0,188 8	2,329 8
266	0,084 0	0,160 8	3,322 9
267	0,089 3	0,169 0	1,815 0
268	0,090 1	0,178 4	0,989 0
269	0,088 4	0,208 8	1,033 2
270	0,103 8	0,196 6	1,176 7
271	0,107 4	0,215 4	1,329 1

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Table E.1 (continued)

	Emitted total irradiance E_e [W/(m ² nm)] of the selected representative welding processes		
Wavelength	Group A	Group B	Group C
lambda	TIG DC S235 E_e (260 A)	MMA S235 E_e (220 A)	MIG pulse Al E_e (250 A)
272	0,091 8	0,277 8	1,359 5
273	0,088 5	0,313 9	1,639 8
274	0,093 6	0,330 5	1,787 7
275	0,097 1	0,316 8	1,730 2
276	0,091 2	0,264 0	1,123 9
277	0,102 4	0,223 6	5,496 3
278	0,064 6	0,233 9	10,160 9
279	0,278 8	0,311 3	34,708 4
280	0,406 8	0,387 5	48,422 7
281	0,143 4	0,299 4	17,228 4
282	0,083 5	0,287 7	3,411 9
283	0,092 2	0,271 1	3,590 8
284	0,092 6	0,192 7	5,530 0
285	0,137 6	0,216 3	13,944 2
286	0,116 0	0,167 2	10,418 3
287	0,081 4	0,185 2	2,839 1
288	0,094 4	0,341 1	2,763 3
289	0,100 9	0,265 3	2,168 4
290	0,096 0	0,157 2	1,474 5
291	0,089 6	0,209 5	1,376 7
292	0,087 5	0,287 8	2,201 9
293	0,133 6	0,361 7	8,300 1
294	0,189 4	0,407 4	8,048 2
295	0,161 2	0,359 5	1,805 6
296	0,102 8	0,325 7	0,968 8
297	0,091 1	0,300 1	0,755 2
298	0,093 6	0,269 3	0,764 7
299	0,091 0	0,271 1	0,855 0
300	0,091 0	0,288 2	1,019 5
301	0,092 5	0,324 6	1,119 7
302	0,096 9	0,388 7	1,151 0
303	0,099 4	0,290 4	1,327 9
304	0,101 6	0,361 9	1,741 4
305	0,101 6	0,453 0	2,608 7
306	0,096 9	0,384 9	3,086 2
307	0,094 5	0,449 7	3,280 1
308	0,093 6	0,450 2	8,704 7
309	0,100 4	0,347 6	16,463 1
310	0,098 9	0,296 3	13,036 7
311	0,092 4	0,232 1	4,400 2
312	0,091 7	0,267 2	2,389 6

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Table E.1 (continued)

	Emitted total irradiance E_e [W/(m ² nm)] of the selected representative welding processes		
Wavelength	Group A	Group B	Group C
lambda	TIG DC S235 E_e (260 A)	MMA S235 E_e (220 A)	MIG pulse Al E_e (250 A)
313	0,094 6	0,224 2	1,617 9
314	0,098 8	0,207 2	1,070 8
315	0,095 1	0,233 0	0,766 7
316	0,097 3	0,266 7	0,640 0
317	0,099 9	0,223 0	0,575 5
318	0,098 4	0,317 4	0,521 9
319	0,094 8	0,463 6	0,474 2
320	0,094 2	0,460 5	0,439 6
321	0,093 8	0,457 3	0,424 1
322	0,098 5	0,467 2	0,467 2
323	0,105 3	0,461 8	0,583 5
324	0,107 5	0,462 8	0,566 5
325	0,107 7	0,448 2	0,526 6
326	0,099 3	0,320 6	0,463 9
327	0,095 7	0,233 1	0,376 9
328	0,095 7	0,225 2	0,363 1
329	0,095 9	0,222 1	0,350 7
330	0,098 1	0,329 6	0,377 5
331	0,099 7	0,471 9	0,422 1
332	0,095 9	0,334 7	0,259 6
333	0,094 6	0,232 1	2,495 6
334	0,095 2	0,257 7	2,933 3
335	0,097 0	0,338 7	0,557 8
336	0,095 9	0,301 3	0,423 4
337	0,098 2	0,379 3	0,364 0
338	0,097 3	0,471 9	0,327 9
339	0,099 4	0,323 6	0,321 0
340	0,096 1	0,215 7	0,304 9
341	0,093 9	0,209 0	0,293 3
342	0,095 1	0,224 3	0,310 7
343	0,095 9	0,214 9	0,302 2
344	0,107 8	0,336 3	0,429 2
345	0,104 2	0,294 9	0,399 0
346	0,104 6	0,196 7	0,371 5
347	0,113 8	0,250 3	0,384 8
348	0,118 5	0,259 1	0,415 7
349	0,146 1	0,234 8	0,377 3
350	0,121 3	0,223 6	0,332 8
351	0,111 2	0,193 5	0,313 2
352	0,115 5	0,285 6	0,304 6
353	0,107 5	0,523 5	0,485 2

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Table E.1 (continued)

	Emitted total irradiance E_e [W/(m ² nm)] of the selected representative welding processes		
Wavelength	Group A	Group B	Group C
lambda	TIG DC S235 E_e (260 A)	MMA S235 E_e (220 A)	MIG pulse Al E_e (250 A)
354	0,130 2	0,556 8	0,523 1
355	0,152 2	0,555 6	0,558 4
356	0,161 4	0,546 5	0,429 2
357	0,161 1	0,572 4	0,653 3
358	0,180 7	0,612 8	0,656 6
359	0,162 4	0,502 1	0,659 6
360	0,105 8	0,414 1	0,379 7
361	0,105 6	0,616 0	0,416 4
362	0,099 4	0,470 8	0,368 3
363	0,098 0	0,464 0	0,332 8
364	0,099 9	0,489 2	0,307 1
365	0,099 8	0,491 8	0,317 9
366	0,100 9	0,359 5	0,324 8
367	0,096 6	0,255 6	0,324 9
368	0,097 2	0,361 2	0,327 8
369	0,095 1	0,430 9	0,330 8
370	0,094 6	0,432 8	0,338 7
371	0,096 3	0,421 7	0,364 4
372	0,105 3	0,464 2	0,398 3
373	0,122 7	0,673 6	0,413 8
374	0,107 4	0,867 0	0,445 7
375	0,098 5	0,742 7	0,486 8
376	0,103 4	0,674 4	0,567 5
377	0,106 9	0,437 7	0,642 0
378	0,105 7	0,240 4	0,772 5
379	0,099 9	0,372 2	1,058 3
380	0,100 5	0,444 6	1,633 3
381	0,106 5	0,475 0	2,837 4
382	0,102 5	0,740 2	5,778 9
383	0,115 4	0,803 0	19,026 8
384	0,115 1	0,754 5	21,202 1
385	0,115 7	0,495 1	9,048 2
386	0,102 0	0,529 6	5,990 4
387	0,106 2	0,477 2	3,409 5
388	0,098 1	0,618 1	1,998 9
389	0,097 1	0,566 7	1,825 2
390	0,096 3	0,549 5	1,668 2
391	0,094 8	0,487 0	0,963 8
392	0,095 1	0,384 6	0,833 9
393	0,125 3	0,579 8	0,569 7
394	0,117 9	0,434 7	4,785 4

Table E.1 (continued)

	Emitted total irradiance E_e [W/(m ² nm)] of the selected representative welding processes		
Wavelength	Group A	Group B	Group C
λ	TIG DC S235 E_e (260 A)	MMA S235 E_e (220 A)	MIG pulse Al E_e (250 A)
395	0,114 7	0,413 1	5,961 0
396	0,101 3	0,528 0	8,301 8
397	0,106 9	0,509 4	6,339 7
398	0,097 9	0,353 0	1,827 6
399	0,095 0	0,378 2	0,950 1
400	0,091 4	0,377 9	0,673 6
E_e	20,337 0	59,251 0	554,325 0

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Annex F
(normative)

Spectral weighing function $S_{\text{eff}}(\lambda)$ for use in [Table D.1](#), column F

Table F.1 — Spectral weighing function $S_{\text{eff}}(\lambda)$ ^[13]

Wavelength λ	Spectral weighing function $S_{\text{eff}}(\lambda)$
200	0,030 0
201	0,033 4
202	0,037 1
203	0,041 2
204	0,045 9
205	0,051 0
206	0,055 1
207	0,059 5
208	0,064 3
209	0,069 4
210	0,075 0
211	0,078 6
212	0,082 4
213	0,086 4
214	0,090 6
215	0,095 0
216	0,099 5
217	0,104 3
218	0,109 3
219	0,114 5
220	0,120 0
221	0,125 7
222	0,131 6
223	0,137 8
224	0,144 4
225	0,150 0
226	0,158 3
227	0,165 8
228	0,173 7
229	0,181 9
230	0,190 0
231	0,199 5
232	0,208 9
233	0,218 8
234	0,229 2
235	0,240 0

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