

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Live working – Protective clothing against the thermal hazards of an electric arc –
Part 2: Requirements**

**Travaux sous tension – Vêtements de protection contre les dangers thermiques
d'un arc électrique –
Partie 2: Exigences**



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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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LIVE WORKING – PROTECTIVE CLOTHING AGAINST THE THERMAL HAZARDS OF AN ELECTRIC ARC –

Part 2: Requirements

FOREWORD

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International Standard IEC 61482-2 has been prepared by IEC technical committee 78: Live Working.

The text of this standard is based on the following documents:

FDIS	Report on voting
78/783/FDIS	78/797/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61482 series, published under the general title *Live working – Protective clothing against the thermal hazards of an electric arc*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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INTRODUCTION

This International Standard has been prepared in accordance with the requirements of IEC 61477.

The products designed and manufactured according to this standard contribute to the safety of the users, provided they are used by skilled persons, in accordance with safe methods of work and the instructions for use.

The product covered by this standard may have an impact on the environment during some or all stages of its life cycle. These impacts can range from slight to significant, be of short-term or long-term, and occur at the global, regional or local level.

This standard does not include requirements and test provisions for the manufacturers of the product, or recommendations to the users of the product for environmental improvement. However, all parties intervening in its design, manufacture, packaging, distribution, use, maintenance, repair, reuse, recovery and disposal are invited to take account of environmental considerations.

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LIVE WORKING – PROTECTIVE CLOTHING AGAINST THE THERMAL HAZARDS OF AN ELECTRIC ARC –

Part 2: Requirements

1 Scope

This part of IEC 61482 is applicable to protective clothing used in work if there is an electric arc hazard.

This standard specifies requirements and test methods applicable to materials and garments for protective clothing for electrical workers against the thermal hazards of an electric arc based on

- relevant general properties of the textiles, tested with selected textile test methods, and
- arc thermal resistance properties, such as
 - the arc rating of materials (ATPV or E_{BT50}), when tested with an open electric arc under defined laboratory conditions according to IEC 61482-1-1, or
 - the arc protection class of materials and garments (Class 1 or Class 2), when tested with a directed and constrained electric arc under defined laboratory conditions according to IEC 61482-1-2.

Requirements of this standard do not address electric shock hazards. The present standard is applicable in combination with standards covering such hazards.

NOTE 1 If conductive fibres are used in the construction of the garments the risk for electric shock hazard should be considered.

This standard does not contain requirements for the protection of head, hands and feet.

NOTE 2 Requirements and tests to cover these hazards are under development.

Requirements of this standard do not cover the electric arc hazards of electric shock, noise, UV emissions, pressure shrapnel, hot oil, the consequences of physical and mental shock and the toxic influences.

NOTE 3 The standard is applicable in combination with standards covering such hazards.

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.

IEC 61318:2007, *Live working – Conformity assessment applicable to tools, devices and equipment*

IEC 61477, *Live working – Minimum requirements for the utilization of tools, devices and equipment*

IEC 61482-1-1, *Live working – Protective clothing against the thermal hazards of an electric arc – Part 1-1: Test methods – Method 1 – Determination of the arc rating (ATPV or E_{BT50}) of flame resistant materials for clothing* ¹⁾

IEC 61482-1-2:2007, *Live working – Protective clothing against the thermal hazards of an electric arc – Part 1-2: Test methods – Method 2 – Determination of arc protection class of material and clothing by using a constrained and directed arc (box test)*

ISO 3175-2, *Textiles – Professional care, drycleaning and wetcleaning of fabrics and garments – Part 2: Procedure for testing performance when cleaning and finishing using tetrachloroethene*

ISO 3758, *Textiles – Care labelling code using symbols*

ISO 5077, *Textiles – Determination of dimensional change in washing and drying*

ISO 6330, *Textiles – Domestic washing and drying procedures for textile testing*

ISO 13688:1998, *Protective clothing – General requirements*

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

ISO 13937-2, *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 14116:2008, *Protective clothing – Protection against heat and flame – Limited flame spread materials, material assemblies and clothing*

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

ISO 17493, *Clothing and equipment for protection against heat – Test method for convective heat resistance using a hot air circulating oven*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61318 and the following apply.

3.1 arc thermal performance value ATPV

in arc testing, the incident energy on a material or a multilayer system of materials that results in a 50 % probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree skin burn injury based on the Stoll curve, without breakopen

NOTE ATPV is expressed in kJ/m^2 or $\text{kW}\cdot\text{s/m}^2$ (cal/cm^2).²⁾

[Definition 3.1.4 of IEC 61482-1-1]

1) To be published.

2) Correlation $1 \text{ cal/cm}^2 = 41,868 \text{ kJ/m}^2$; $1 \text{ kJ/m}^2 = 0,023885 \text{ cal/cm}^2$.

3.2

arc thermal protection

degree of thermal protection offered against electric arc under specific arc testing conditions

NOTE 1 For materials, the arc thermal performance is obtained from the measurement of the transmitted energy and by evaluation of other thermal parameters (burning time, hole formation, melting).

NOTE 2 For garments, the arc thermal performance is obtained by evaluation of thermal parameters (burning time, hole formation, melting) and of the functioning of fasteners and accessories.

[Definition 3.5 of IEC 61482-1-2:2007]

3.3

breakopen threshold energy

E_{BT50}

incident energy on a fabric or material that results in a 50 % probability that sufficient heat transfer through the tested specimen is predicted to cause the tested specimen to break open

NOTE The breakopen threshold energy is expressed in kJ/m^2 or $\text{kW}\cdot\text{s/m}^2$ (cal/cm^2)³⁾

[Definition 3.1.8 of IEC 61482-1-1, modified]

3.4

clothing

assembly of garments worn by workers

3.5

electric arc

self-maintained gas conduction for which most of the charge carriers are electrons supplied by primary-electron emission

[IEV 121-13-12]

NOTE During live working, the electric arc is generated by gas ionisation arising from an unintentional electrical conducting connection or breakdown between live parts or a live part and the earth path of an electrical installation or an electrical device. During testing, the electric arc is initiated by the blowing of a fuse wire.

3.6

garment

single item of clothing which may consist of single or multiple layer(s)

3.7

material

fabric or other substances of which the garment is made, this may consist of single or multiple layers

3.8

protective clothing

clothing which covers or replaces personal clothing and which is designed to provide protection against one or more hazards

[Definition 3.4 of ISO 13688:1998]

3) Correlation $1 \text{ cal/cm}^2 = 41,868 \text{ kJ/m}^2$; $1 \text{ kJ/m}^2 = 0,023885 \text{ cal/cm}^2$.

3.9

Stoll curve

curve of thermal energy and time produced from data on human tissue tolerance to heat and used to predict the onset of second-degree burn injury

[Definition 3.29 of IEC 61482-1-2:2007]

3.10

test current

I_{arc} class

prospective short-circuit current of the electric test circuit (predicted current), characterising a test class, r.m.s. value (symmetrical AC component)

NOTE Test current is expressed in A.

[Definition 3.30 of IEC 61482-1-2:2007]

4 Requirements

4.1 General

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

4.2 Design requirements for protective clothing

The garment shall be designed in a way, that they do not influence or hinder the wearer performing work.

Garments protecting the upper part of the body shall have long sleeves.

Fasteners of the garment shall be designed in a way that the opening function is still present after being exposed to an accidental arc.

Thread, accessories and closures used in garment construction shall not contribute to the severity of the injuries to the wearer in the event of a momentary electric arc and related thermal exposure.

No exposed external metal shall be permitted in the clothing. If internal metal and/or melting parts (e.g. fasteners, buttons, and accessories) are used they shall be covered to the inside to avoid skin contact.

All parts of a garment shall be made of arc thermal resistant materials. In case different materials are used e.g. for the front and back the exact information shall be given where the weaker area is located (e.g. by means of a drawing of the garment including dimensions and warning indication).

The front side of the garment and the complete sleeves (all around the arms and over the complete length of the arms) of the garment (e.g. jackets) shall fulfil the same arc thermal resistance requirements. If due to comfort requirements the garment is not produced of the same materials in all areas then this shall be clearly stated in the instructions for use.

NOTE 1 These requirements are also valid for garments protecting the lower part of the body (e.g. trousers, chaps, leggings).

Sewing thread utilized in the construction of garments shall be made of an inherently flame-resistant fibre and shall not melt when tested at a temperature of 260 °C in accordance with

ISO 17493. There are many seams in a garment that have no influence on protection, e.g. hems, pocket seams, etc. The sewing thread there need not be flame resistant.

During its service life, protective clothing shall keep its arc thermal properties when cleaned according to the instructions for use.

If a single manufacturer makes claims for a garment system as arc thermal protective clothing, then this garment system shall be tested and shall fulfil the requirements of this standard.

NOTE 2 If the user is wearing a garment system (e.g. jacket + shirt) from different manufacturers as arc thermal protective clothing, then this garment system should be tested to determine how the system fulfils the requirements of this standard.

4.3 General material requirements

4.3.1 Limited flame spread of material

4.3.1.1 Classification of limited flame spread index

All materials claiming compliance with this standard shall achieve a specified limited flame spread index when tested in accordance with ISO 15025 Procedure A (see 5.3.1) and classified according to ISO 14116.

4.3.1.2 Single layer material

If a single-layer material is used in the garment, this material shall fulfil the limited flame spread index 3.

4.3.1.3 Multi-layer material

If a multi-layer material is used in the garment, the following requirements shall be fulfilled:

- all outer layer and innermost layer materials shall fulfil the limited flame spread index 3,
- all middle layers shall fulfil in minimum the flame spread index 1.

4.3.2 Mechanical properties of woven outer material

4.3.2.1 Tear resistance

The woven outer material shall have a tear resistance of at least 15 N (for weight higher than 220 g/m²) or at least 10 N (for weight within 150 g/m² and 220 g/m²) in the machine and the cross directions tested according to ISO 13937-2.

4.3.2.2 Tensile strength

The woven outer material shall have a tensile strength of at least 400 N (for weight higher than 220 g/m²) or at least 250 N (for weight within 150 g/m² and 220 g/m²) in the machine and the cross directions tested according to ISO 13934-1.

4.3.3 Burst strength of knitted outer material

The knitted outer material shall have a burst strength of at least 200 kPa tested according to ISO 13938-1.

4.3.4 Dimensional change due to laundering and/or dry cleaning of outer material

The woven outer material shall have a dimensional change according to ISO 5077 not exceeding ± 3 % in the machine and the cross directions tested according to 5.3.4.