CAN/ULC-61482-2:2022

LIVE WORKING – PROTECTIVE CLOTHING AGAINST THE THERMAL HAZARDS OF AN ELECTRIC ARC – PART 2: REQUIREMENTS

International Electrotechnical Commission

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Standard for Live Working – Protective Clothing Against the Thermal Hazards of an Electric Arc – Part 2: Requirements, CAN/ULC-61482-2

Second Edition, Dated August 26, 2021

Summary of Topics

This revision of CAN/ULC-61482-2 dated January 6, 2022 contains an editorial correction to include the degree of correspondence between this National Standard of Canada and the IEC standard.

CAN/ULC-61482-2 is an adoption of IEC 61482-2 second edition, issued 2018. The second edition also reflects the latest SCC approval date from the proposal dated December 8, 2020.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

PLEASE NOTE THAT CERTAIN CODES MAY REFER TO A SUPERSEDED VERSION OF THIS STANDARD. IN THOSE INSTANCES, THE RELEVANT VERSIONS ARE AVAILABLE FOR PURCHASE.

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(IEC 61482-2:2018, IDT)

LIVE WORKING – PROTECTIVE CLOTHING AGAINST THE THERMAL HAZARDS OF AN ELECTRIC ARC – PART 2: REQUIREMENTS

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ULC STANDARDS COMMITTEE ON LIVE WORKING

NAME	AFFILIATION	REGION	CATEGORY
Troy Corbett	Linestar Utility Supply Inc.	Canada	Supply Chain
Jeff Harris	Hycotec Inc	Canada	Supply Chain
Chris Jeans	Consultant	Canada	General Interest
Jeff Laninga	Manitoba Hydro	Manitoba	Commercial / Industrial User
Claude Maurice	Kinectrics	Canada	Testing & Stds Org
Jim McDonald	Powerline Training Consultants	Canada	Commercial / Industrial User
Donald McLachlan	Consultant	Canada	General Interest
Tim Olson (Chair)	TKO Consulting	Canada	General Interest
Jim Pollard	Unlimited PPE	Canada	Producer
Yannick Schlicht	NDE Lab Inc	Canada	Testing & Stds Org
Bernhard Spalteholz	BC Hydro	British Columbia	Commercial / Industrial User
Howard Werden	HSW Utility Solutions Inc.	Canada	General Interest
Laura Werner	ULC Standards	Canada	Project Manager
Gillian Wintonic	ULC Standards	Canada	Project Manager

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Preface

PROTECTIVE CLOTHING AGAINST THE THERMAL HAZARDS OF AN ELECTRIC ARC – Part 2: Requirements

This is the Second Edition of CAN/ULC 61482-2, Live Working – Protective Clothing Against the Thermal Hazards of an Electric Arc – Part 2: Requirements, IEC 61482-2 (Second Edition 2018).

This Edition of the Standard has been formally approved by the ULC Standards Committee on Live Working.

This Standard has been developed in compliance with the requirements of Standards Council of Canada (SCC) for accreditation of a Standards Development Organization.

Only metric SI units of measurement are used in this Standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

This Second Edition National Standard of Canada is based on, and now supersedes, the First Edition of CAN/ULC-61482-2.

Attention is drawn to the possibility that some of the elements of this Canadian standard may be the subject of patent rights. ULC Standards shall not be held responsible for identifying any or all such patent rights.

Requests for interpretation of this Standard should be sent to ULC Standards. The requests should be worded in such a manner as to permit a “yes” or “no” answer based on the literal text of the requirement concerned.

This CAN/ULC-61482-2 Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

Comments or proposals for revisions on any part of the Standard may be submitted at any time. Proposals should be submitted via a Proposal Request in the On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com/canada.

This Standard is intended to be used for conformity assessment.

January 2022

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FOREWORD

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

This second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) new definition for *ELIM*, *ATPV* and *EBT* as used in accordance with IEC 61482-1-1:–;

b) new requirements for the thermal stability of the intermediate layers;

c) additional material requirement for volume resistance;

d) new test procedure for the thermal resistance of sewing threads;

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e) new symbol for marking.

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

FDIS	Report on voting
78/1205/FDIS	78/1228/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 document has been drafted in accordance with the ISO/IEC Directives, Part 2.

Terms defined in Clause 3 are given in *italic* print throughout this standard.

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 stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

• reconfirmed,

• withdrawn,

• replaced by a revised edition, or

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INTRODUCTION

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

The products designed and manufactured according to this document 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 document 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 duration, and occur at the global, regional or local level.

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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 where there is the risk of exposure to an *electric arc hazard*.

This document specifies requirements and test methods applicable to *materials* and *garments* for *protective clothing* for electrical workers against the thermal hazards of an *electric arc*.

Electric shock hazard is not covered by this document, which is applicable in combination with standards covering such hazards.

Other effects than the thermal effects of an *electric arc* like noise, light emissions, pressure rise, hot oil, electric shock, the consequences of physical and mental shock or toxic influences are not covered by this document.

Protection of eyes, face, head, hands and feet against *electric arc hazard* is not covered by this document.

NOTE Requirements and tests to cover *electric arc hazards* to these parts of the body are under development.

Protective clothing for work intentionally using an *electric arc*, e.g. arc welding, plasma torch, is not covered by this document.

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.

IEC 60417, *Graphical symbols for use on equipment* (available at: http://www.graphical-symbols.info/equipment)

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

IEC 61340-2-3:2016, *Electrostatics – Part 2-3: Methods of test for determining the resistance and resistivity of solid materials used to avoid electrostatic charge accumulation*

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

IEC 61482-1-1:–[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 (ELIM, ATPV and/or EBT) of clothing materials and of protective clothing using an open arc*

[1] Under preparation. Stage at time of publication: IEC CDV 61482-1-1:2017.

IEC 61482-1-2*, 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)*

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ISO 3146, *Plastics – Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarizing-microscope methods*

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

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

ISO 13688:2013, *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 13938-2, *Textiles – Bursting properties of fabrics – Part 2: Pneumatic method for determination of bursting strength and bursting distension*

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

ISO 17493:2016, *Clothing and equipment for protection against heat – Test method for convective heat resistance using a hot air circulating oven*

ISO 30023, *Textiles – Qualification symbols for labelling workwear to be industrially laundered*

3 Terms, definitions, symbols and units

3.1 Terms and definitions

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

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

• IEC Electropedia: available at http://www.electropedia.org/

• ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
arc protection class
APC
<*electric arc* testing> category of *arc thermal protection* of a *material* and/or product tested in accordance with the box test (APC 1 or APC 2)

Note 1 to entry: The *arc protection class* is characterized by the test energy level of arc exposure (*arc energy* and incident energy).

Note 2 to entry: Tested *material* and/or products show *arc thermal protection* at minimum up to the *class* energy level but, in general, the actual exposure energy limit up to which the *material* and/or product provide protection is higher.

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3.1.2
arc rating
<*electric arc* testing> numerical value attributed to a product, that describes its protective performance when exposed to an electric arc

Note 1 to entry: The *arc rating* can be the arc thermal performance value (*ATPV*), the *breakopen* threshold energy (*EBT*) or the *incident energy limit* (*ELIM*).

Note 2 to entry: The *arc rating* is expressed in kJ/m^2 (cal/cm^2).

3.1.3
arc thermal protection
<*electric arc* testing> degree of thermal protection offered against *electric arc* under specific arc testing conditions indicated by either *arc rating* or *arc protection class*

Note 1 to entry: For *materials*, the *arc thermal protection* is obtained from the measurement of the transmitted energy and by evaluation of other thermal parameters (burning time, hole formation, melting).

Note 2 to entry: For *garments*, the *arc thermal protection* is obtained by evaluation of thermal parameters (burning time, hole formation, melting) of the *material*(s) from which the *garment* is made and of the functioning of the closures and accessories.

3.1.4
arc thermal performance value
ATPV
<*electric arc* testing> numerical value of incident energy attributed to a product that describes its thermal properties of attenuating (reducing) a heat flux generated by an *electric arc*

Note 1 to entry: The *ATPV* of a *material* or material assembly is calculated using logistic regression analysis applied to the data points obtained from testing a set of test specimens. It is the value of incident energy at which the heat transfer through the test specimens is enough to reach the Stoll criteria with 50 % probability.

Note 2 to entry: The *ATPV* attributed to a *garment* or garment assembly is either equal to or lower than the *ATPV* of the *material* or material assembly of which it is made, depending on whether the tested specimen(s) fulfil also additional visual design and performance assessment criteria.

3.1.5
breakopen threshold energy
EBT
<*electric arc* testing> numerical value of incident energy attributed to a product that describes its breakopen properties when exposed to heat flux generated by an *electric arc*

Note 1 to entry: The *EBT* of a *material* or material assembly is calculated using logistic regression analysis applied to the data points obtained from testing a set of test specimens. It is the value of incident energy at which breakopen occurs with 50 % probability.

Note 2 to entry: The *EBT* attributed to a *garment* or garment assembly is either equal to or lower than the *EBT* of the *material* or material assembly of which it is made, depending on whether the tested specimen(s) fulfil also additional visual design and performance assessment criteria.

3.1.6
electric arc
self-maintained gas conduction for which most of the charge carriers are electrons supplied by primary-electron emission

Note 1 to entry: During live working, the *electric arc* is generated by gas ionization 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.

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[SOURCE: IEC 60050-121:1998, 121-13-12, modified – Note 1 to entry has been added to refer specifically to live working and arc testing.]

3.1.7
electric arc hazard
potential harm from an energy release from an *electric arc* usually caused by a short circuit or equipment failure in electrotechnical work

Note 1 to entry: An *electric arc hazard* exists when live electrical conductors or parts are exposed and when they are inside an item of equipment, even when guarded or enclosed, if a worker is interacting with the equipment in a way which could cause an *electric arc*. Under normal operating conditions, enclosed energized equipment that has been properly designed, installed and maintained is not likely to pose an *electric arc hazard*.

Note 2 to entry: Documents such as NFPA 70E, IEEE 1584, ISSA Guide, and DGUV-I 203-77 help to assess hazards from the practical perspective.

Note 3 to entry: The hazards may include thermal effects, noise, pressure wave effects, ejected parts effects, molten metal, optical and other effects. Different PPE (personal protective equipment) may be required to protect from different effects. It is important that the risk assessment consider all the potential effects.

3.1.8
garment
single item of clothing which can consist of single or multiple layers of *material*

3.1.9
garment system
garment assembly for which a specific *arc rating* or *arc protection class* is attributed after having performed an arc test

3.1.10
hardware
non-fabric items forming part of or optional extras in a *garment*

3.1.11
incident energy limit
ELIM
<*electric arc testing*> numerical value of incident energy attributed to a product, below which there is no data point with the amount of heat transmitted through the product reaching the Stoll criteria or with the product exhibiting breakopen

Note 1 to entry: The *ELIM* of a *material* or material assembly is calculated from data points obtained from testing a set of test specimens, which are also used for the determination of the *ATPV* and/or *EBT*.

Note 2 to entry: The *ELIM* attributed to a *garment* or garment assembly is either equal to or lower than the *ELIM* of the *material* or material assembly of which it is made, depending on whether the tested specimen(s) fulfil also additional visual design and performance assessment criteria.

3.1.12
material
substances, excluding *hardware*, of which an item of clothing is made

[SOURCE ISO 11612:2015, 3.13]

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3.1.13
open arc
<*electric arc* testing> *electric arc* between two vertically opposing electrodes intended to provide an equal distribution of emitted energy around the centre line formed by the electrodes and where the emitted energy is not directed by means of any physical constraints (e.g. enclosure, wall)

3.1.14
protective clothing
clothing which covers or replaces personal clothing, and which is designed to provide protection against one or more hazards

[SOURCE: ISO/TR 11610:2004, 3.178]

3.2 Symbols and units

APC	arc protection class	1 or 2
ATPV	arc thermal performance value	kJ/m^2 or cal/cm^2
EBT	breakopen threshold energy	kJ/m^2 or cal/cm^2
ELIM	incident energy limit	kJ/m^2 or cal/cm^2

NOTE $1\ kJ/m^2 = 1\ kW{\cdot}s/m^2 = 0{,}1\ J/cm^2 = 0{,}023\ 885\ cal/cm^2$

$1\ cal/cm^2 = 41{,}840\ kJ/m^2 = 41{,}840\ kW{\cdot}s/m^2$

4 Requirements

4.1 General

General requirements for *protective clothing* against the thermal hazard of an electric arc which are not specifically covered in this document shall be in accordance with ISO 13688.

4.2 Design requirements for protective clothing

Garments protecting the upper part of the body shall have sleeves which extend to provide full coverage to the wrists and shall provide coverage up to the neck. *Garments* protecting the lower part of the body shall provide full coverage from the waist to the ankles.

Closures of the *garment* shall be designed in a way that the opening function is still present after being exposed to an arc when tested according to 5.2.5.

Accessories (e.g. labels, badges, retro-reflective material) and closures used in *garment* construction shall not contribute to the severity of the injuries to the wearer in the event of an *electric arc* and related thermal exposure when the clothing is tested according to the garment test in 5.4. Separation of the closure shall not occur.

Sewing thread utilized in the construction of *garments* shall be made of an inherently flame-resistant fibre and shall not melt when tested according to 5.2.5. Threads in seams that have no influence on protection, e.g. hems, pocket seams, need not be flame resistant.

No uncovered outside metal parts shall be permitted in the clothing. *Hardware* penetrating the outer *material* of the *garment* shall not be exposed to the innermost surface of the *garment*.

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