

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)**

The European Standard EN 61482-1-2:2007 has the status of a
British Standard

ICS 13.220.40

National foreword

This British Standard is the UK implementation of EN 61482-1-2:2007. It is identical to IEC 61482-1-2:2007. It supersedes DD ENV 50354:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/78, Tools for live working.

A list of organizations represented on this committee can be obtained on request to its secretary.

UK technical committee PEL/78 has consistently opposed the need for this document in view of the existence of the primary document IEC 61482-1 (implemented in the UK as DD CLC/TS 61482-1:2003). However, under CENELEC rules, the UK is obliged to publish it at a national level.

The “box test” referred to in IEC 61482-1-2 (implemented here as BS EN 61482-1-2:2007) evaluates flame-retardant material at two levels of current, 4 kA and 7 kA. In contrast, IEC 61482-1, soon to be revised and published as IEC 61482-1-1, provides a method for determining the Arc Thermal Performance Value (ATPV) of the material.

It is the opinion of UK technical committee PEL/78 that the “box test” does not provide the user with a realistic and reliable test. A premise of this test is that the fault currents will not exceed 4000 A or 7000 A and the worker will not be closer than the specified distance from the arc (in reality this cannot be guaranteed). The energy on the worker’s body is directly proportional to the length of the arc, the current and the duration of the arc. For example, if a worker is positioned at 60 cm from the arc and is exposed to 4 cal/cm², at 30 cm from the arc the energy will be approximately 16 cal/cm². Experience in the field has shown that hazards can range in strength starting from 3 or 4 cal/cm² to levels higher than 40 cal/cm².

UK technical committee PEL/78 believes that IEC 61482-1-1 will provide the best way to determine whether a particular material will provide the best protection for the worker for any given job.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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**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)
(IEC 61482-1-2:2007)**

Travaux sous tension -
Vêtements de protection contre les
dangers thermiques d'un arc électrique -
Partie 1-2: Méthodes d'essai -
Méthode 2: Détermination de la classe
de protection contre l'arc de matériaux et
de vêtements au moyen d'un arc dirigé et
contraint (enceinte d'essai)
(CEI 61482-1-2:2007)

Arbeiten unter Spannung -
Schutzbekleidung gegen die thermischen
Gefahren eines elektrischen Lichtbogens -
Teil 1-2: Prüfverfahren -
Verfahren 2: Bestimmung der
Lichtbogen-Schutzklasse des Materials
und der Kleidung unter Verwendung eines
gerichteten Prüflichtbogens (Box-Test)
(IEC 61482-1-2:2007)

This European Standard was approved by CENELEC on 2007-03-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 78/657/CDV, future edition 1 of IEC 61482-1-2, prepared by IEC TC 78, Live working, was submitted to the IEC-CENELEC parallel Unique Acceptance Procedure and was approved by CENELEC as EN 61482-1-2 on 2007-03-01.

This European Standard supersedes CLC/TS 50354:2003.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2007-12-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2010-03-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61482-1-2:2007 was approved by CENELEC as a European Standard without any modification.

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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)

1 Scope

This part of IEC 61482 specifies methods to test material and garments intended for use in heat- and flame-resistant clothing for workers exposed to electric arcs. In contrast to the test methods in IEC 61482-1-1¹⁾ a directed and constrained electric arc in a low voltage circuit is used to classify material and clothing in defined arc protection classes.

The test methods specified in this document are aimed at rendering a decision whether arc thermal protection is met under defined conditions. Two protection classes are tested. Protection class 1 and protection class 2 are safety requirements covering actual risk potentials due to electric fault arcs.

NOTE 1 In practice there can be higher risks. A risk analysis should clarify the actual risk.

The test methods are not directed toward measuring the arc thermal performance value (ATPV). Methods determining the ATPV are prescribed in IEC 61482-1-1.

This standard specifies tests with which it is possible to evaluate materials and protective clothing based on the use of a directed and constrained electric arc under defined laboratory conditions (box-test). A practical scenario concerning test set-up and test conditions, electrical and constructional parameters is selected.

For the tests a low voltage procedure is used. The tests can optionally be carried out in two fixed test classes, selected by the amount of prospective short circuit current:

Class 1	4 kA;
Class 2	7 kA.

The defined duration of the electric arc is 500 ms in both test classes.

NOTE 2 These conditions represent e.g. low voltage environmental conditions during an electric fault.

Materials and clothing will be tested with two methods: the material box test method and the garment box test method.

¹⁾ IEC 61482-1, Ed.1 (2002) is currently under revision. The next edition will be numbered IEC 61482-1-1.

The material box test method is used to measure and find material response to an arc exposure when tested in a flat configuration. A quantitative measurement of the arc thermal performance is made by means of the energy transmitted through the material.

The garment box test method is used to test the function of the protective clothing after an arc exposure, including all the garment findings, sewing tread, fastenings and other accessories; no heat flux will be measured.

Testing refers to the thermal arc effects; it does not apply to other effects like noise, light emissions, pressure rise, hot oil, electric shock, the consequences of physical and mental shock or toxic influences.

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 60584-1, *Thermocouples – Part 1: Reference tables*

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

ISO 9151, *Protective clothing against heat and flame – Determination of heat transmission on exposure to flame*

3 Terms, definitions and symbols

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

3.1

arc current

I_{arc}

current actually flowing in the electric test circuit during arc duration (through the arc); as r.m.s. value the average during arc duration

NOTE 1 Arc current is expressed in A.

NOTE 2 The arc current flowing during arc duration fluctuates due to the non-linear arc impedance stochastically varying with time.

3.2

arc duration

time duration of the arc

NOTE Arc duration is expressed in s.

3.3

arc energy

W_{arc}

electrical energy supplied to the arc and converted in the arc; sum of the instantaneous arc voltage values multiplied by the instantaneous arc current values multiplied by the incremental time values during the arc duration

NOTE Arc energy is expressed in kJ or kW·s.

3.4

arc gap

distance between the arc electrodes

NOTE Arc gap is expressed in mm.

3.5

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.

3.6

arc voltage

voltage across the arc

NOTE Arc voltage is expressed in V.

3.7

burning time

time for which a flame is visible after arc exposition

NOTE Burning time is expressed in s.

3.8

calorimeter

device for measuring the heat flux and incident energy

3.9

charring

formation of carbonaceous residue as the result of pyrolysis or incomplete combustion

3.10

clothing

assembly of garments worn by workers

3.11

delta peak temperature

ΔT_p

difference between the maximum temperature and the initial temperature of the sensor during the test exposure time

NOTE 1 Delta peak temperature is expressed in °C.

NOTE 2 The symbol ΔT_p is used without index when testing with material; an additional index "0" is used when testing without material for calibration (ΔT_{p0}).

3.12**direct exposure incident energy** E_{i0}

heat energy or incident energy emitted by the electric arc and received at a calorimeter directly exposed to the arc without material influence; used for calibration

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

3.13**dripping**

material response evidenced by flowing of the fibre polymer

3.14**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.

3.15**embrittlement**

formation of a brittle residue as the result of pyrolysis or incomplete combustion

3.16**exposure time**

total test time interval of observation and measurement

NOTE Exposure time is expressed in s.

3.17**garment**

single item of clothing which may consist of single or multiple layers

3.18**heat flux**

thermal intensity of an electrical arc indicated by the amount of energy transmitted per unit area and time

NOTE Heat flux is expressed in kW/m^2 .

3.19**hole formation**

existence of holes in the test specimen material with minimum 5 mm in any direction

3.20**ignition**

initiation of combustion

²⁾ Correlation: $1 \text{ cal/cm}^2 = 41,868 \text{ kJ/m}^2$; $1 \text{ kJ/m}^2 = 0,023 \text{ 885 cal/cm}^2$.