

Conductive clothing for live working at a nominal voltage up to 800 kV a.c.

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- Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
- BECCAMA (BEAMA Electrical Cable Connector and Accessories Manufacturers' Association)
- British Railways Board
- Department of Trade and Industry
- Department of Trade and Industry (Consumer Safety Unit, CA Division)
- Electricity Association
- Federation of British Hand Tool Manufacturers
- GAMBICA (BEAMA Ltd.)
- Industrial Safety (Protective Equipment) Manufacturers' Association
- International Powered Access Federation
- National Association of Glove Manufacturers

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National foreword

This British Standard has been prepared by Technical Committee PEL/78 (formerly PEL/88). It is the English language version of EN 60895:1996 *Conductive clothing for live working at a nominal voltage up to 800 kV a.c.*, published by the European Committee for Electrotechnical Standardization (CENELEC). It was derived from IEC 895:1987, published by the International Electrotechnical Commission (IEC).

The graphics signs, symbols and letters used may be found in the following documents.

BS 3939, *Graphical symbols for electrical power, telecommunications and electronics diagrams — Part 1:1986 General information, general index — Part 2:1985 Symbol elements, qualifying symbols and other symbols having general application — Part 3:1985 Conductors and connecting devices.*

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 36, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Descriptors: Live working, electrical equipment, conductive clothing, characteristic, test

English version

Conductive clothing for live working at a nominal voltage up to 800 kV a.c.

(IEC 895:1987, modified)

Vêtements conducteurs pour travaux sous tension jusqu' à 800 kV de tension nominale en courant alternatif
(CEI 895:1987, modifiée)

Schirmende Schutzbekleidung zum Arbeiten an unter Spannung stehenden Teilen für eine Nennspannung bis a.c. 800 kV
(IEC 895:1987, modifiziert)

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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 of amendment A1

The text of the International Standard IEC 895:1987, prepared by IEC TC 78, Tools for live working, was approved by CENELEC as HD 547 S1 on 1989-12-05.

This Harmonization Document, together with common modifications prepared by the Technical Committee CENELEC TC 78, was submitted to the formal vote and was approved by CENELEC as EN 60895 on 1996-03-05.

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) 1997-03-01
- latest date by which national standards conflicting with the EN have to be withdrawn (dow) 1997-03-01

For products which have complied with HD 547 S1:1990 before 1997-03-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 2002-03-01.

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given only for information.

In this standard, Annex A to Appendix E and Annex ZA are normative.

Annex ZA has been added by CENELEC.

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Introduction

The conductive clothing by the assembly of its different components should constitute an electrically continuous coverall, surrounding the worker with the possible exception of his face. However the worker can be protected by a face shield electrically connected to the suit itself.

If press studs, zip fasteners, hooks and eyes or any other method of fastening are used in the assembly of the complete suit, care should be taken to ensure that the electrical conductivity of the suit is not impaired.

The conductive clothing (complete assembly) should be electrically connected to the conductor or the conductive part on which the live working has to be carried out. This connection shall be made by a conductive braid fixed at one of its extremities to the conductive suit and at the other by a special clamp.

Section 1. General

1 Scope

This standard is applicable to conductive clothing worn by electrical workers during live working (especially bare-hand working) at a nominal voltage level up to 800 kV a.c.

It is applicable to suit, gloves or mitts, hoods, shoes and socks.

The corresponding d.c. values are under consideration.

2 Terminology (see Annex B)

Conductive material

Material composed of metallic threads or non-metallic conductive substances and natural or synthetic threads closely woven or knitted.

Connecting braid

Special conductive braid to connect the conductive suit to the live metal working point.

The connecting braid is equipped at one of its extremities with a connection system to the suit; the other extremity of the braid is equipped with a special clamp.

Hood

Part of the clothing covering the head.

Face shield

Part covering the worker's face. It can be a synthetic and metallized shield having good optical and anti-U.V. qualities, or consisting of a conductive net.

Section 2. Technical requirements

3 Technical requirements on components

The material used shall have the following properties:

3.1 Flame retardancy

Placed in contact with a flame or a fire (e.g. an electric arc), the material shall be constituted to prevent the fire from spreading. This quality shall be checked as indicated in Sub-clause 4.1.

3.2 Wear resistance

The conductive clothing shall be resistant to abrasion and to tearing.

As special tests to check these qualities are difficult to set up and to perform, the satisfaction of the wearer and the life duration of the cloth will be the only elements to consider.

3.3 Electrical resistance

This quality can be considered as a basic element which determines the current carrying capability and the spark discharge properties.

The only direct consequence for a worker of the correct value of electrical resistance, is the low potential difference between two points of the cloth in contact with the skin and is consequently an element of comfort.

3.4 Current-carrying capability

During the worker's travel to his working position (from the metallic structure of the tower or from the ground in an aerial device) and at the moment of his connection to the live conductor, capacitive currents flow through his clothing. These can be significant and it is necessary for the suit to be able to conduct them without damage (heating, smoke . . .).

This capability will be checked as indicated in Sub-clause 4.3.

3.5 Screening efficiency

Material must have a screening efficiency better than 40 dB.

Screening efficiency of a conductive fabric is defined by the ratio of energy that would be received by a body without a screen to energy received by the same body screened by the conductive fabric. A ratio of two voltages measured in these conditions is used to calculate screening efficiency of the conductive fabric.

3.6 Cleaning requirements

To ensure that the screening efficiency and flame retardant properties of the clothing do not deteriorate excessively after repeated cleaning, the clothing shall be subjected to 10 wash-dry cycles and/or 10 dry-cleaning cycles. The screening effect and flame retardant properties shall still meet the specified requirements after the tests.

3.7 Spark discharge protection

To provide protection from spark discharges directly to the worker, the spacing between any individual adjacent conducting components in the fabric (except for face shield) shall not exceed 5 mm under all normal wearing conditions including stretching (such as at the elbows or knees).

3.8 Requirements on:

3.8.1 *Gloves and socks*

The resistance of gloves and socks shall be low enough for the maximum expected current flow through them not to be perceptible to the worker. This resistance shall have a maximum value of 100 Ω for gloves and 10 Ω for socks, when measured using the specified electrodes.

3.8.2 *Footwear*

The footwear resistance shall be low enough so that if the footwear is used alone, without conductive clothing, the voltage drop across the footwear, due to the induced current in a person in the highest expected field strength, will not result in an annoying discharge. The resistance shall have a maximum value of 500 Ω , when measured using the specified electrodes. If conductive socks are used, the shoes may be of a normal type without special conducting properties.

3.8.3 *Hood and face shield*

A conductive hood is necessary to provide screening effect.

It may be completed especially for very high voltages by a facial conductive shield. If no face shield is provided, protective flaps, conductive visor and the shape of the hood, shall ensure face protection. A bond between hood, facial shield and suit shall be provided.

3.8.4 *Clothing (complete assembly)*

Additional tests (Sub-clause 5.6) shall be carried out on the complete assembly to prove the actual values of screening efficiency and resistance in order to detect manufacturing faults.

3.8.5 *Marking*

Each conductive suit shall carry at least the following permanent information:

- name or trade mark of the manufacturer,
- type reference and size (in accordance with ISO standards),
- year of manufacture.

Each conductive item shall carry a blue triangle firmly attached, by sewing, adhesion or other suitable means. This triangle will be:

- dark blue 3 mm border on light blue background,
- side dimension shall be 50 mm or smaller if the conductive item is too small for such a triangle.

3.8.6 Packaging

As the conductive thread of the conductive fabric may become oxidized in the ambient air, the conductive fabric shall be packaged so that such oxidation is retarded during long storage. For example, the conductive suit may be packaged inside a plastic bag with tissue paper protecting the conductive suit from contact with the plastic bag.

Section 3. Type tests

4 Knitted or woven fabric used for the suit, hood, socks and gloves, and basic shielding fabric used for face shield

4.1 Flame retardancy test

4.1.1 Principle of test

Ignition of a rectangular test specimen vertically hung, by a standard ignition specimen, according to prescribed conditions is the principle of the test, and includes the measurement of the burned area and classification of the tested fabric according to results.

4.1.2 Test apparatus

Apparatus shall consist of:

- a test chamber,
- a specimen holder,
- accessories.

4.1.2.1 The test chamber (see Annex C, Figure C.1, Figure C.2, Figure C.3 and Figure C.4, page 24) is made of approximating 1.5 mm thickness steel-plates. The interior walls of the chamber will be painted black.

The chamber is composed of:

- a) a steel box 570 mm wide $\times$ 400 mm deep $\times$ 1 000 mm high, with an air vent in the lower part of the back and of the front. These air vents shall have the following dimensions:
height = 116 mm, length = 440 mm;
- b) a glass door above the front air vent;
- c) a 300 mm $\times$ 300 mm steel deflector plate, above the top of the chamber which is penetrated by a 200 mm diameter hole;
- d) the test chamber shall have a support for the test specimen holder (see Annex C, Figure C.5 and Figure C.6, page 25). The lower part of the test specimen holder shall be placed 110 mm above the base of the chamber.

4.1.2.2 The test specimen holder (see Annex C, Figure C.5, Figure C.6 and Figure C.7, page 26) is composed of:

- a) a support (1) on which two 5 mm thick bars (2), spaced 150 mm apart, are fixed.
- b) two holding bars (3), 5 mm thick held on the two bars (2) with clips.

The support (1) and the bars (2) and (3) shall be of metal.

The size of bars (2) and (3) (see Annex C, Figure C.6) shall be such that the test specimen is well supported.

4.1.2.3 The accessories include:

- a) standard ignition linen specimen: whitened, not dressed, textile 67 % polyester, 33 % cotton — 110 g/m².
- b) clamp;
- c) clips;
- d) scale (0.001 g precision);
- e) pattern for test specimen cutting;
- f) tracing-paper;
- g) a mirror of approximately 250 $\times$ 300 mm, placed in a corner of the chamber, used to observe the burning on the rear of the fabric.

4.2 Test specimens

4.2.1 Shape and dimensions

Rectangular test specimens shall have dimensions of 150 mm × 300 mm after being attached to the specimen holder.

For knitted fabric (e.g. socks and gloves) the manufacturer shall provide flat test specimens with the above dimensions.

4.2.2 Number

a) Woven fabric

Tests shall be performed on three test specimens which are cut so that their length is parallel with the warp direction and three test specimens having their length parallel to the weft direction.

b) Knitted fabric

Only three test specimens shall be provided for knitted material unless it is not directionally uniform. In this case, six test specimens shall be provided (three for each direction).

4.2.3 Sampling

The outlines of the test specimens are drawn from the model so that their length corresponds to the direction of test.

The test specimens shall be cut so that:

- the middle point is on a 45° oblique line in regard of edges of a roll of fabric;
- the sides are parallel with the exterior edges of a roll of fabric.

A distribution of test specimens shall be taken in places where no defect appears. The outlines of the exterior of the test specimen shall be at least 50 mm from the edges of the roll of fabric.

4.3 Procedure of test

For each test specimen, the procedure of the test shall be as follows:

4.3.1 Preparation of standard ignition specimen (see Annex C, Figure C.8, page 26)

Cut a 25 mm × 80 mm strip of polyester-cotton (see Sub-clause 4.1.2.3) (the length is parallel with the warp direction). This textile strip is folded in the length direction to 25 mm × 20 mm dimensions. The ends of the specimen are put in the interior of the fold (Annex C, Figure C.8).

4.3.2 Clamping standard ignition specimen

The standard ignition specimen shall be clamped in the centre of the lower part of the test specimen. The clamp shall be fixed horizontally, so that:

- the standard ignition specimen has two thicknesses on each side of the test specimen,
- the end of the standard ignition specimen is 10 mm lower than the lower part of the test specimen.

4.4 Test

The test specimen is fixed on the specimen holder, so that the lower part of the test specimen coincides with the lower part of the specimen holder. The standard ignition specimen must be equidistant from the vertical rods.

The specimen holder is hung vertically in the test chamber.

A standard ignition specimen shall burn normally for about 25 s to 30 s.

Apply a flame to the lower part of the standard ignition specimen until it is ignited (about 2 s) and immediately close the door of the test chamber.

Observe the burning test specimen during test and note the following:

- points of residual afterglowing,
- melting,
- distortion of test specimen,
- smoke.

Measurement of burned area:

At the end of the test and after 15 min in the atmospheric conditions according to code 18 °C–28 °C/45 %–75 % of IEC Publication 212, using scissors, remove the completely burned or melted areas,

- lay the test specimen flat on the model so that remaining contours coincide with the model ones,
- measure the burned area of the test specimen by cutting up and scaling tracing-paper planimetry, or measurement of a geometric area.

4.5 Results

The test is considered as successful if the following conditions are met by each of the six specimens:

- the burned area of test specimen is less than or equal to 100 cm²,
- the burned area does not extend to the vertical parts of the specimen holder, nor to the upper edge of the test specimen.

4.6 Electrical resistance

Either method A or method B below shall be used to determine the electrical resistance of the fabric. In case of dispute, method B shall be used.

NOTE Standard procedures to determine electrical resistance of fabric in connection with its antistatic properties are unreliable when the electrical resistance of highly conductive fabric has to be determined. Indeed, these standard procedures do not take into account the interference of the transition resistance from electrode to test specimen which is of primary importance when low resistance test specimens have to be measured.

4.6.1 Method A

4.6.1.1 Apparatus

a) Measuring electrodes

Electrical resistance measurements of textile materials in general require the use of a special electrode system for making electrical contact with the test specimen.

Such a measuring electrode system consists of a cylindrical centre-electrode (1) surrounded by a ring-electrode (2), respectively indicated as (1) and (2) in Figure C.9, page 27.

The material of these electrodes shall be copper. Both electrode parts are mounted together with an insulating plastic disc (3) 10 mm thick. A well chosen number of screws (5) lock the electrodes to the plastic disc.

The height of the system (h of Figure C.9) shall be such that the total weight of the system inclusive of the plastic disc, screws and electrical connecting parts is 20 ± 0.5 N. As a consequence, the contact pressure on the test specimen will correspond to approximately 4 000 Pa. Special care shall be taken with those surface parts which will make contact with the test specimen (surfaces 6 in Figure C.9).

All surfaces 6 shall be:

- in one plane,
- lapped,
- gold plated. The thickness of the coating will be 5 ± 1 µm.

b) Resistance measurement

For the resistance measurement, a low resistance measuring device with a range of 0 to 1 Ω and an accuracy of 1 mΩ shall be used.

4.6.1.2 Preparation of test specimens

a) Number and dimensions of test specimens

Three pieces approximately 120 mm × 120 mm shall be cut from the fabric to be tested.

b) Contact coating on test specimen

In order to decrease the transition resistance between electrode-system and test specimen, the surfaces of the samples in contact with the electrodes (upper surface shown in Figure C.9) shall be coated with a conductive paint having characteristics as described in Annex A.

An oxidation process might deteriorate the conductivity of the paint on the test specimen. As a consequence, the measurements should take place within 24 h after the paint has been applied to the test specimen.