

Live working — Conductive clothing for use at nominal voltage up to 800 kV a.c. and ± 600 kV d.c.

The European Standard EN 60895:2003 has the status of a
British Standard

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National foreword

This British Standard is the official English language version of EN 60895:2003. It is identical with IEC 60895:2002 and its Corrigendum Februray 2003 . It supersedes BS EN 60895:1997 which is withdrawn.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by tags. [C] <C>

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English version

**Live working –
Conductive clothing for use at nominal voltage
up to 800 kV a.c. and ± 600 kV d.c.
(IEC 60895:2002 + corrigendum 2003, modified)**

Travaux sous tension –
Vêtements conducteurs pour usage
jusqu'à 800 kV de tension nominale
en courant alternatif et ± 600 kV
en courant continu
(CEI 60895:2002 + corrigendum 2003,
modifiée)

Arbeiten unter Spannung –
Leitfähige Kleidung für die Verwendung
bei Nenn-Wechselspannungen bis 800 kV
und Gleichspannungen bis 600 kV
(IEC 60895:2002 + Corrigendum 2003,
modifiziert)

This European Standard was approved by CENELEC on 2003-07-01. 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.

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CENELEC

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Foreword

The text of document 78/469/FDIS, future edition 2 of IEC 60895, prepared by IEC TC 78, Live working, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60895 on 2003-07-01.

A draft amendment, prepared by the Technical Committee CENELEC TC 78, Equipment and tools for live working, was submitted to the formal vote and was approved by CENELEC for inclusion into EN 60895 on 2003-07-01.

This European Standard supersedes EN 60895:1996 and constitutes a technical revision of several sections:

- the scope has been extended to cover the use of conductive clothing to ± 600 kV d.c.;
- revision of the electrical resistance requirements of the fabrics used in conductive clothing;
- revision of the testing procedures for complete clothing.

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) 2004-07-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2006-07-01

This European Standard was prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and supports the essential requirements of Directive 89/686/EEC.

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A, B, C and ZA are normative and annexes D and E are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60895:2002 and its corrigendum February 2003 was approved by CENELEC as a European Standard with agreed common modifications.

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INTRODUCTION

This International Standard provides specifications for protective conductive clothing currently being used without incident in live work by qualified electrical workers throughout the world. The adequacy of this clothing is established by its screening efficiency and the electrical resistance of material and component parts of the conductive clothing. Based on resistance measurements carried out by manufacturers and utilities of used clothing being successfully worn in the field, differences of up to 1 000 fold have been reported.

Verification tests have shown that the clothing is equally effective against the electric field existing in the vicinity of installations up to 800 kV a.c. and ± 600 kV d.c.

This standard has been prepared according to the requirements of IEC 61477, where applicable.

LIVE WORKING – CONDUCTIVE CLOTHING FOR USE AT NOMINAL VOLTAGE UP TO 800 kV AC AND ± 600 kV DC

1 Scope

This International Standard is applicable to conductive clothing, either assembled from component parts or forming a single complete clothing, worn by (electrically) skilled persons during live working (especially bare-hand working) at a nominal power system voltage up to 800 kV a.c. and ± 600 kV d.c.

It is applicable to conductive jackets, trousers, coveralls (one-piece clothing), gloves or mitts, hoods, shoes, overshoe socks and socks.

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 60050-151:2001, *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices*

IEC 60050-651:1999, *International Electrotechnical Vocabulary (IEV) – Part 651: Live working*

IEC 60050-826:1982, *International Electrotechnical Vocabulary (IEV) – Chapter 826: Electrical installations of buildings*

IEC 60212:1971, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60417 (all parts), *Graphical symbols for use on equipment*

IEC 60456:1998, *Clothes washing machines for household use – Methods for measuring the performance*

IEC 60743:2001, *Live working – Terminology for tools, equipment and devices*

IEC 61318/TR2:1994, *Live working – Guidelines for quality assurance plans*

IEC 61477:2001, *Live working – Minimum requirements for the utilization of tools, devices and equipment*

ISO 2859-1:1999, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3175:(all parts), *Textiles – Professional textile cleaning and finishing*

ISO 3290:2001, *Rolling bearings – Balls – Dimensions and tolerances*

ISO 6330:2000, *Textiles – Domestic washing and drying procedures for textile testing*

ISO 9000:2000, *Quality management systems – Fundamentals and vocabulary*

ISO 9001:2000, *Quality management systems – Requirements*

ISO 9004:2000, *Quality management systems – Guidelines for performance improvements*

3 Terms and definitions

For the purposes of this International Standard, the following definitions apply.

NOTE Further information on terminology is illustrated in figure 1.

3.1

conductive clothing

clothing made of natural or synthetic material with integral interwoven conductive fibres, or layers, used to provide electrical continuity between all parts of the clothing and a reduction of electric field

[IEC 60743, definition 8.2.7, modified]

3.2

conductive material

material composed of metallic threads or non-metallic conductive substances and natural or synthetic threads closely woven, knitted, or layered

3.3

equipotential bonding lead (bonding lead)

flexible metallic connection used by the worker to connect or disconnect his or her conductive clothing, bucket or screen, to or from another conductive part to create equipotential bonding

NOTE 1 This lead is not an earthing device.

NOTE 2 The means of securing or connecting the lead shall be such that under emergency conditions, for example, a fall, the lead can separate.

[IEV 651-07-07, modified]

3.4

head cover (hood)

part of the clothing, either as a separate item or integrated into a complete garment, that covers the head

3.5

face screen for electrical works

protective device made of conductive, solid, or meshed material

NOTE It provides electrical continuity with the conductive clothing of the worker and a reduction of electric field to the face, or part thereof

[IEC 60743, definition 8.4.3]

3.6

conductive overshoe sock

sock made of conductive material and worn over shoe/boot

3.7

garment

main body of the clothing consisting of jacket and trousers

3.8

component parts

additional elements of the complete clothing such as gloves, socks, head protection, and footwear worn in addition to the main garment and bounded to it

3.9

shielding efficiency

base log 10 of the ratio of a voltage without the conductive clothing to the voltage measured at the spot with conductive clothing

3.10

screening efficiency

per cent ratio of the total current injected into the conductive clothing to the current flowing in the body

3.11

equipotential bonding

electrical connection putting various exposed conductive parts and extraneous conductive parts at a substantially equal potential

[IEV 826-04-09]

4 Technical requirements

4.1 General

The conductive clothing shall constitute an electrically continuous assembly for the worker.

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

Bonding lead shall be capable of withstanding anticipated electrical and mechanical stresses.

4.2 Technical requirements for conductive material

The material used to manufacture the conductive clothing shall have the following properties.

NOTE The material used to manufacture the conductive clothing should be resistant to abrasion and to tearing.

4.2.1 Flame retardancy

The material used in conductive clothing shall not ignite and continue to burn when exposed to an ignition source.

4.2.2 Electrical resistance

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

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, which is thus an element of comfort.

4.2.3 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. It is necessary for the clothing to be able to conduct them. There shall be no damage to the material.

4.2.4 Shielding and screening efficiencies

The material used for the conductive clothing or the component parts shall attenuate the electric field. The attenuation of the material is determined by shielding efficiency, and that of the conductive clothing by screening efficiency. Shielding and screening efficiencies are defined in 3.9 and 3.10.

These efficiencies shall meet the requirements of this standard.

4.2.5 Requirements to withstand cleaning

To ensure that the efficiency and flame-retardant properties of the conductive clothing do not deteriorate excessively after repeated cleaning, the material shall be subjected to 10 wash-dry cycles in accordance with ISO 6330 and/or 10 dry-cleaning cycles in accordance with ISO 3175. After completion of the 10 washing/cleaning cycles, the shielding efficiency and flame-retardant properties of the material shall still meet the specified requirements.

4.2.6 Spark-discharge protection

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

4.3 Specific requirements for component parts

4.3.1 Conductive gloves, overshoe socks and socks

The maximum resistance value of gloves and overshoe socks or socks, when measured using the specified electrodes, is determined by the manufacturer to meet the bonding requirements of 7.1.

4.3.2 Conductive footwear

The maximum resistance value, when measured using the specified electrodes, is determined by the manufacturer to meet the bonding requirements of 7.1.

4.3.3 Conductive head cover and face screen

A conductive head cover is necessary to provide the worker with a full screening effect.

Further screening protection can be provided by a conductive screen for the face.

If no face screen is provided, protective flaps, conductive visor and the shape of the hood shall ensure face protection. Provision shall be made for an effective and efficient electrical bond between any head cover, screen or face screen and the total garment.

The resistance of the bond shall be checked and meet the requirements of 7.1.

4.4 Marking

Each conductive item shall carry, as a minimum, the following permanent markings:

- name or trade mark of the manufacturer;
- type reference and size (in accordance with ISO standards);
- year of manufacture;
-  serial number or batch number; 
- symbol IEC-60417-5216 – suitable for live working; double triangle (see annex A), attached by sewing, adhesion or other suitable means;
-  number of the relevant European Standard immediately adjacent to the symbol with year of publication (EN 60895:2003). 

Markings shall be clearly visible and legible to a person with normal or corrected vision without additional magnification.

4.5 Packaging

The conductive material may become oxidized when stored in the ambient air conditions. The manufactured clothing shall be packaged for shipment in such a way that oxidation is retarded. If the parts of clothing are to be issued by the user separately, individual packaging of parts should be requested by the user. For example, the conductive clothing may be packaged inside an airtight plastic bag with tissue paper protecting the conductive clothing from contact with the plastic bag.

4.6 Manufacturer's instructions

Each piece of the conductive clothing shall come with the manufacturer's instructions for use and care.  These instructions shall include, as a minimum, the following information:

- the significance of any marking (see 4.4);
- the type of packaging suitable for transport (see 4.5);
- performance as recorded during the technical tests to check the levels of protection (see Clauses 5, 6, 7, and 8);
- the end of life deadline or period to end of life of the product ; alternatively, the conditions of periodic testing ensuring a safe use until the end of life of the product (see E.3);
- storage, use, cleaning, maintenance, servicing and disinfection. Cleaning, maintenance or disinfectant products recommended by the manufacturer and the relevant instructions. 

5 Type tests of conductive material (specimen)

These tests shall apply to specimens of the material used in the manufacturing of conductive clothing.

5.1 Flame-retardancy test

5.1.1 Principle of test

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

5.1.2 Test apparatus

The test equipment shall consist of

5.1.2 Test apparatus

The test equipment shall consist of

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

5.1.2.1 Test chamber

The test chamber (see figure 2) shall be made of steel plate not less than 1,5 mm thick. The interior walls of the chamber shall be painted matt black.

The chamber shall be composed of

- a) a steel box 570 mm wide × 400 mm deep × 1 000 mm high, with one air vent each in the lower back and front. These air vents shall measure 116 mm in height and 440 mm in length;
- b) a glass door above the front air vent;
- c) a 300 mm × 300 mm steel deflector plate above the top of the chamber, which is penetrated by a 200 mm diameter hole;
- d) a support for the test specimen holder (see figure 3a). The lower part of the test specimen holder shall be placed 110 mm above the base of the chamber.

5.1.2.2 Test specimen holder

The test specimen holder (see figures 3a and 3b) shall be composed of

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

The support and all the bars shall be made of metal.

The size of all bars shall be such that the test specimen is well supported.

5.1.2.3 Accessories

Accessories include

- a) a standard ignition linen specimen: whitened, not dressed, composed of 67 % polyester, 33 % cotton – 110 g/m²;
- b) a clamp;
- c) clips;
- d) a weighing scale (0,001 g precision);
- e) a pattern for test specimen cutting;
- f) tracing paper;
- g) a mirror of approximately 250 mm × 300 mm, placed in a corner of the chamber, used to observe the burning on the rear of the test specimen.

5.1.3 Test specimens

5.1.3.1 Shape and dimensions

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

For knitted material (for example, socks and gloves) the manufacturer shall provide flat test specimens with the above dimensions.