DOCUMENT NO.: KP1/6C/4/1/TSP/01/028

Kenya Power

CONDUCTIVE CLOTHING FOR LIVE WORKING - SPECIFICATION

A Document of the Kenya Power & Lighting Co. Ltd
February 2017

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0.1 CIRCULATION LIST

COPY NO.	COPY HOLDER
1	Manager, Standards
2	Electronic copy (pdf) on Kenya Power server (http://172.16.1.40/dms/browse.php?fFolderId=23)

REVISION OF KPLC STANDARDS

In order to keep abreast of progress in the industry, KPLC standards shall be regularly reviewed. Suggestions for improvements to approved standards, addressed to the Manager, Standards department, are welcome.

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0.2 AMENDMENT RECORD

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
0	2017-02-03	New Issue	Nancy Wairimu	Dr. Eng. Peter Kimemia

FOREWORD

This specification has been prepared by the Standards Department in collaboration with Network Management Division both of The Kenya Power and Lighting Company Limited (KPLC) and it lays down requirements for conductive clothing for live line working.

In preparation of this specification, reference was made to the following document:

IEC 60895: Live working –Conductive clothing for upto 245kV a.c. and ±500 kV D.C.

Acknowledgement is hereby made for assistance derived from this source. A new format of writing the specification as guided by KEBS has also been adopted.

This category of goods has previously been purchased together with live line tools as a package or using direct procurement. This specification is therefore an attempt to promote standardization. There is no other specification in this series.

This specification stipulates the minimum requirements for conductive clothing for live line working acceptable for use in the company and it shall be the responsibility of the suppliers and manufacturers to ensure that the offered design is of the highest quality and guarantees excellent service to KPLC, good workmanship and good engineering practice in the manufacture of conductive clothing for live line working for KPLC.

Users of Kenya Power specifications are responsible for their correct interpretation and application.

The following are members of the team that developed this specification:

Name	Division
Stanley Ngetich	Network Management
Jared Biwott	Network Management
Nancy Wairimu	Infrastructure Development

1. SCOPE

1.1. This specification is for conductive clothing for live line working, 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 245 kV a.c.

1.2. This specification is applicable to conductive jackets, trousers, coveralls, gloves or mitts, hoods, face screen, shoes, overshoe and socks.

1.3. The specification covers requirements of materials, components, design, inspection and tests and schedule of Guaranteed Technical Particulars of conductive clothing.

2. NORMATIVE REFERENCES

The following standards contain provision which through reference in this text constitute provisions of this specification. For dated editions the cited edition will apply; for undated editions the latest edition of the referenced document shall apply.

IEC 60895: Live working –Conductive clothing for upto 800kV a.c. and ±600 kV D.C.

IEC 60815: Selection and dimensioning of high voltage insulators intended for use in polluted conditions –Part 1: Definitions, information and general principles

IEC 60417: Graphical symbols for use on equipment

ISO 3175: Textiles -- Professional care, dry cleaning and wet cleaning of fabrics and garments -- Part 1: Assessment of performance after cleaning and finishing

ISO 6330: Textiles -- Domestic washing and drying procedures for textile testing.

ISO 9001:2008, 2015: Quality Management System –Requirements.

3. DEFINITIONS AND ABBREVIATIONS

For the purpose of this specification the definitions and abbreviations given in the reference standards shall apply together with the following definitions and abbreviations:

3.1. DEFINITIONS

Live Line worker- An electrically skilled person who undertakes task of installation and maintenance of electrical equipment while the equipment is energised.

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

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. 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.

Coverall – One-piece main body of the clothing.

Head Cover (Hood) - Part of the clothing covering the head.

Face Screen - Part of the clothing covering the worker's face. It can be made of conductive, solid, or meshed material having good optical and anti UV qualities.

Overshoe - Sock made of conductive material and worn over shoe/boot.

Screening efficiency - Per cent ratio of the total current injected into the conductive clothing to the current flowing in the body

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.

3.2. ABBREVIATIONS

KPLC- Kenya Power and Lighting Company Limited

IEC – International Electrotechnical Commission.

ISO – International Organization for Standardization.

a.c. - Alternating Current

D.C. - Direct Current

4. REQUIREMENTS

4.1. SERVICE CONDITIONS

4.1.1 The conductive clothing shall be suitable for use outdoors in tropical areas and harsh climatic conditions including areas exposed to:

a) Altitudes of up to 2200m above sea level;

b) Humidity of up to 95%;

c) Average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C

d) Pollution: Design pollution level to be taken as "Heavy" (Pollution level III) for inland and "Very Heavy" (Pollution level IV) for coastal applications in accordance with IEC 60815.

4.2. GENERAL REQUIREMENTS

4.2.1 The conductive clothing shall be manufactured in accordance with IEC 60895.

4.2.2 The general arrangement shall be as shown in figure 1.

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

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

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

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

4.2.7 All component parts of the conductive clothing intended for use together shall be assembled according to the manufacturer's instructions. The bonding resistance between the garment and any component parts shall not exceed 100 Ω.

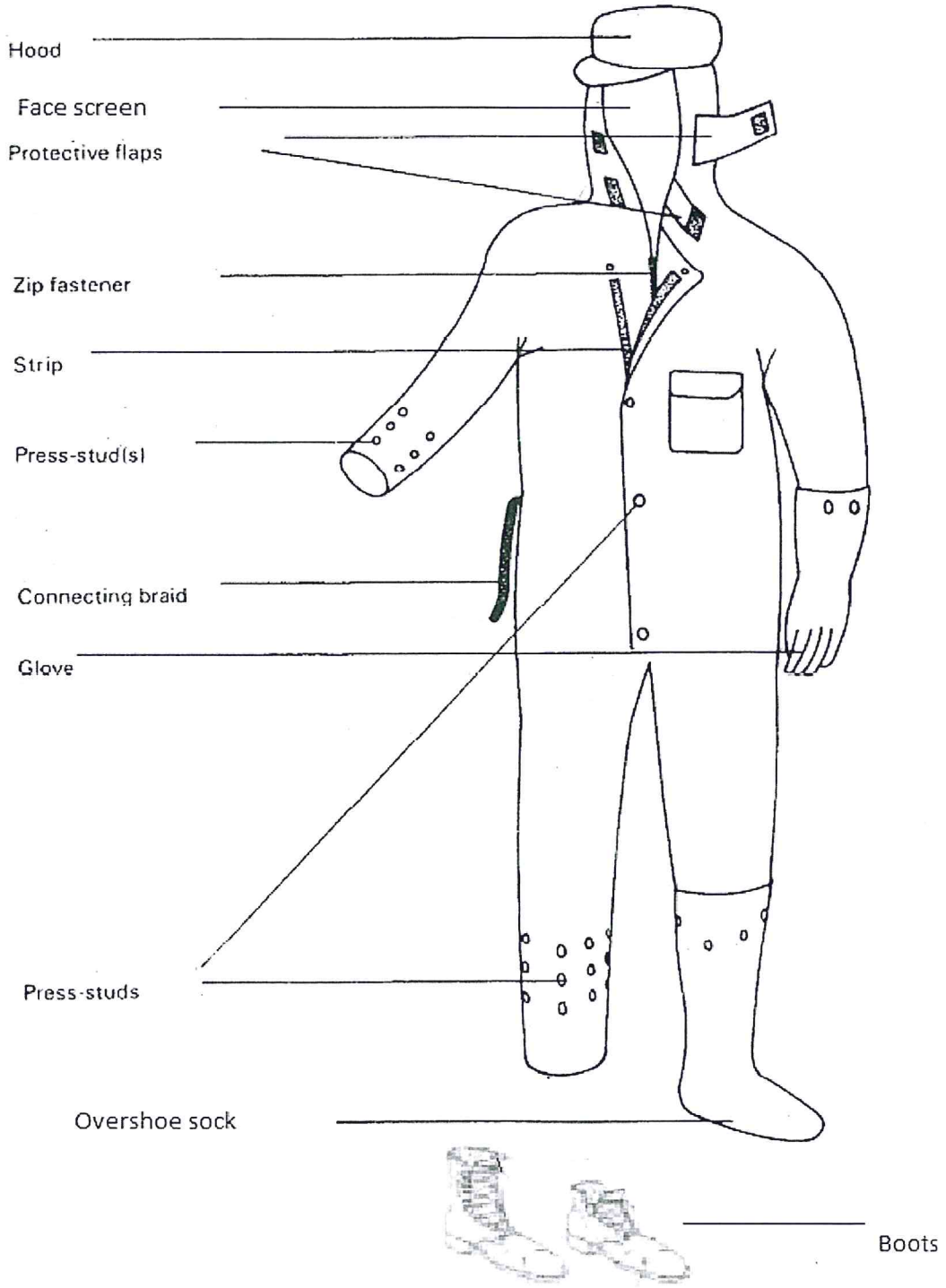


Figure 1: General arrangement of a complete conductive suit

4.3. TECHNICAL REQUIREMENTS OF CONDUCTIVE MATERIAL

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

4.3.1 Flame Retardancy

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

4.3.2 Electrical Resistance

The electrical resistance of a unit R_S shall be given by the formula:

$$R_S = R_{measured} \times \frac{WIDTH}{LENGTH} = \frac{U}{I} \times \frac{W}{L}$$

Where;

U is the measured voltage in V

I is the test current in A

W is the width of test specimen in mm

L is the length of the specimen in mm.

R_S is in Ω per square

The arithmetic mean value shall be lower than 7 Ω per square. No individual value shall be higher than 10 Ω per square. This will ensure the low potential difference between two points of the cloth in contact with the skin and is consequently an element of comfort.

4.3.3 Current Carrying Capacity

The material shall be capable of conducting currents without damage to the material. When a current of 1A is established through the specimen for a duration of 15 minutes, there shall be no flame, incandescent point, smoke or carbonization between contact electrodes.

4.3.4 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. The shielding efficiency shall be greater than 40 dB.

4.3.5 **Cleaning withstand requirements**

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.

4.3.6 **Spark Discharge requirements**

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).

5. TESTS REQUIREMENTS

5.1. The conductive suit shall be tested in accordance to the requirements of IEC 60895, ISO 6330, ISO 3175 and provision of this specification.

5.2. The following tests shall be performed on the specimens of the material used in manufacturing of conductive suit, garment, component parts and the complete clothing:

Table 1: List of tests as per IEC 60895

No.	Item	Test	Type of Test
1	Material used in manufacturing of conductive suit	Flame retardancy test	Type test
		Electrical resistance test	Type test
		Current carrying capability	Type test
		Shielding efficiency	Type test
		Resistance to cleaning	Type test
2	Garment	Electrical resistance	Type test and routine test
3	Gloves and Mitts	Electrical resistance	Type test
		Spark discharge protection	Type test
4	Overshoe socks and sock	Electrical resistance	Type test
5	Footwear	Electrical resistance	Type test
6	Head cover (hood)	Electrical resistance	Type test
7	Complete clothing	Bonding test	Type test and routine test
		Efficiency	Type test

6. MARKING AND PACKING

6.1. MARKING

6.1.1. The type of marking shall be such that it does not compromise the conductivity and other characteristics of the conductive clothing. Each conductive item shall have the following information; marked legibly and indelibly:

a) Name and trademark of manufacturer;
b) Standard of manufacture;
c) Type reference and size;
d) Year of manufacture
e) Symbol IEC-60417-5216 - suitable for live working; double triangle, attached by sewing, adhesion or other suitable means.

6.2. PACKING

6.2.1. 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. 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.

6.2.2. Component parts shall be packed individually.

6.2.3. Each piece of the conductive clothing shall come with the manufacturer's instructions for use and care. These instructions shall include, as a minimum, recommendations for cleaning, storage and periodic testing.

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APPENDICIES

A: TESTS AND INSPECTION (Normative)

A.1 It shall be the responsibility of the supplier to test or to have all the relevant tests performed.

A.2 Copies of previous test certificates and test reports by a third party testing laboratory accredited to ISO/IEC 17025 shall be submitted with the tender for the purpose of technical evaluation. A copy of the accreditation certificate for the testing laboratory shall also be submitted with the tender (all in English Language). Any translations of certificates and test reports into English language shall be signed and stamped by the Testing Authority.

A.3 Every batch of conductive clothing shall be subject to inspection by Kenya Power staff at the place of manufacture and tests/inspection carried out using the sampling plan as per IEC 60895. Test reports shall be completed (by the manufacturer) and made available by the supplier to Kenya Power for approval before delivery of the items.

A.4 On receipt of the conductive clothing, Kenya Power will inspect them and may perform any of the relevant tests in order to verify compliance with the specification. The supplier shall replace without charge to Kenya Power, conductive clothing which upon examination, test or use fail to meet any or all of the requirements in the specification.

B: QUALITY MANAGEMENT SYSTEM (Normative)

B.1 The supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the conductive clothing physical properties, tests and documentation, will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008 or 2015.

B.2 The Manufacturer's Declaration of Conformity to applicable standards and copies of quality management certifications including copy of valid and relevant ISO 9001:2008 or 2015 certificate shall be submitted with the tender for evaluation.

B.3 The bidder shall indicate the delivery time of the items, manufacturer's monthly & annual production capacity and experience in the production of the type and size of items being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers for similar type of the conductive suits sold in the last five years as well as reference letters from at least four of the customers shall be submitted with the tender for evaluation.

C: DOCUMENTATION (Normative)

C.1 The bidder shall submit its tender complete with technical documents for tender evaluation. The technical documents to be submitted (all in English language) for tender evaluation shall include the following:

a) Fully filled clause by clause guaranteed technical particulars (GTP) signed by the manufacturer;
b) Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
c) Sales records for the last five years and at least four customer reference letters;
d) Details of manufacturing capacity and the manufacturer's experience;
e) Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
f) Copy of accreditation certificate to ISO/IEC 17025 for the third party testing laboratory;
g) Manufacturers letter of authorization, ISO 9001certificate and other technical documents required in the tender.

C.2 The successful bidder (supplier) shall submit the following documents/details to The Kenya Power & Lighting Company for approval before manufacture:

a) Fully filled clause by clause guaranteed technical particulars (GTP) stamped and signed by the manufacturer;
b) Design Drawings with details of the conductive clothing to be manufactured for KPLC, stamped and signed.
c) Quality assurance plan (QAP) that will be used to ensure that the design, material; workmanship, tests, service capability, maintenance and documentation will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001.
d) Marking details and method to be used in marking the conductive clothing.
e) Packaging details (including packaging materials).

C.3 Each piece of the conductive clothing shall come with the manufacturer's instructions for use and care. These instructions shall include, as a minimum, recommendations for cleaning, storage and periodic testing.

D: GUARANTEED TECHNICAL PARTICULARS (Normative)

(To be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records for previous five years, four customer reference letters, details of suppliers' capacity and experience; and copies of complete type test certificates and test reports for tender evaluation, all in English Language)

Tender No. .....

Bidder's name and Address.....

Clause number		Bidder's offer
Manufacturer's Name and address		Specify
Country of Manufacture		Specify
1.	Scope	State
2.	Normative References	State
3.	Definitions and Abbreviations	State
4.	Requirements	
4.1	Service Conditions	State
4.2	General Requirements	
4.2.1	Standard of Manufacture	Specify
4.2.2	conductive clothing shall constitute an electrically continuous assembly	Specify
4.2.3	Where fasteners are used, care shall be taken to ensure that the electrical conductivity of the clothing is not impaired.	Specify
4.2.4	Bonding lead shall be capable of withstanding anticipated electrical and mechanical stresses	Specify
4.2.5	Conductive material shall be resistant to abrasion and to tearing	Specify
4.2.6	Bonding resistance of the complete conductive clothing	Specify
4.3	Technical requirements of conductive material	
4.3.1	Flame retardancy	Specify
4.3.2	Electrical resistance	Specify
4.3.3	Current carrying capability	Specify
4.3.4	Shielding and screening resistance	Specify
4.3.5	Cleaning withstand requirements	Specify
4.3.6	Spark discharge requirements	Specify
5	Test Requirements	
5.1	Standards of testing	State
5.2	Tests to be performed on conductive material	Provide test reports
	Tests to be performed on the garment	Provide test reports

Clause number		Bidder's offer
	Tests to be performed on the component parts	Provide test reports
	Tests to be performed on the complete clothing	Provide test reports
6	Marking and Packing	
6.1	Marking	State compliance
6.2	Packing	State compliance
A	Test and inspection	
A.1	Responsibility of carrying out tests	State
A.2	Copies of Type Test Reports submitted with tender	Provide
A.3	FAT by KPLC staff	State compliance
	Test reports to be submitted by supplier to KPLC for approval before delivery.	Provide
A.4	Inspection at the stores and replacement of rejected items	State compliance
B	Quality Management System	
B.1	Quality Assurance Plan	Provide
B.2	Copy of ISO 9001 Certificate	Provide
B.3	Manufacturer's experience	Provide
	Manufacturing Capacity (units per month)	
	List of previous customers	
	Customer reference letters	
C	Documentation	
C.1	Documents submitted with tender	Provide
C.2	Documents to be submitted by supplier to KPLC for approval before manufacture	Provide
C.3	Recommendation for use, cleaning, storage and periodic testing	State compliance
	Statement of compliance to specification (indicate deviations if any & supporting documents)	State compliance

.....

Manufacturer's Name, Signature, Stamp and Date