

	<b>Specification</b>	<b>Technology</b>
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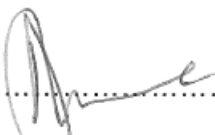

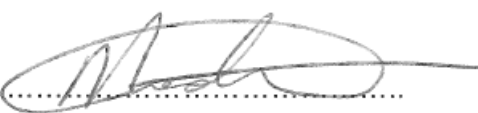

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### **CONTROLLED DISCLOSURE**

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## **1. INTRODUCTION**

This specification satisfies the need for the standardisation of the requirements for Arc Flash Protective Clothing and Personal Protective Equipment (PPE) and to comply with PPE and related legal and Eskom requirements. In a case where a particular PPE requirement is not covered in this specification, the onus is on the Division and/or BU to ensure compliance with all safety requirements in accordance with the relevant standards, regulations or codes of practice for that specific PPE equipment.

This specification does not address electrical shock, arc blast (projectiles, shock waves and hot oil release), the consequences of physical and mental shock and the toxic influences of an electric arc.

The requirements of this specification are in accordance with SANS 724 standard.

## **2. SUPPORTING CLAUSES**

### **2.1 SCOPE**

This document covers the requirements for the fabric and garment in manufacturing, testing and selection for Arc Flash Personal Protective Equipment against the thermal hazards of an electric arc.

#### **2.1.1 Purpose**

The purpose of this specification is to provide minimum requirements to be adhered to by Eskom (user) and the supplier during the manufacturing, testing and selection of personal protective equipment and protective clothing against the thermal hazards of an electrical arc. This specification covers the design, selection and performance requirements of electric arc resistant clothing and equipment for the protection of persons against the thermal hazards of an electric arc, which could occur during operating or working on or near electrical equipment in the workplace.

#### **2.1.2 Applicability**

This document shall apply throughout Eskom Holdings Limited Divisions.

### **2.2 NORMATIVE/INFORMATIVE REFERENCES**

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

#### **2.2.1 Normative**

- |     |                      |   |
|-----|----------------------|---|
| [1] | ISO 9001             | Quality Management Systems.   |
| [2] | SANS 724             | Personal protective equipment and protective clothing against the thermal hazard of an electrical arc.  |
| [3] | 240-44175132         | Eskom Personal Protective Equipment Specification.  |
| [4] | NFPA 70E             | Standard for electrical safety in the workplace.  |
| [5] | SANS 984             | IEEE guide for performing arc-flash hazard calculations.  |
| [6] | ANSI Z 87.1          | Practice for occupational and educational eye and face protection.  |
| [7] | ASTM F1506           | Standard performance specification for flame resistant textile materials for wearing apparel for use by electrical workers exposed to momentary electric arc and related thermal hazards. |
| [8] | ASTM D6413           | Standard Test Method for Flame Resistance of Textiles (Vertical Test).  |
| [9] | ASTM F2675/F2675M-13 | Standard Test Method for Determining Arc Ratings of Hand Protective Products Developed and Used for Electrical Arc Flash Protection.  |

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- [10] ASTM F1891 Standard specification for arc and flame resistant rainwear.
- [11] ASTM F1959 Standard test method for determining the arc rating of materials for clothing.
- [12] ASTM F2178 Standard test method for determining the arc rating and standard specification for face protective products.
- [13] ASTM F2621 Standard practice for determining response characteristics and design integrity of arc-rated finished products in an electric arc exposure.
- [14] AATCC Standard test method 135 for dimensional changes in automatic home laundering of woven and knitted fabrics.
- [15] 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).
- [16] IEC 61482-2 Live working – Protective clothing against the thermal hazards of an electric arc – Part 2: Requirements.
- [17] ISO 17493 Clothing and equipment for protection against heat. Test method for convective heat resistance using a hot air circulating oven.
- [18] SANS 434 Boiler suits and work wear suits (for purpose of sizing).
- [19] SANS 10011 Care-labelling of textile piece-goods, textile articles and clothing.
- [20] SANS 10235 Fibre-content labelling of textiles and textile products.
- [21] SANS 20345 Personal protective equipment – Safety footwear.
- [22] SANS 50352-1 Hearing protectors – Safety requirements and testing – Part 1: Ear-muffs.
- [23] SANS 50352-2 Hearing protectors – Safety requirements and testing – Part 2: Ear-plugs.
- [24] SANS 61482-1-1 Live working – Protective clothing against the thermal hazards of an electric arc – Part 1-1: Test methods – Method 1: Determination of the arc rating (ATPV or EBT50) of flame resistant materials for clothing.

## 2.2.2 Informative

- [25] N/A

## 2.3 DEFINITIONS

Definition	Description
Acceptable	Means acceptable to the authority administering this specification, or to the parties concluding the purchase contract, as the case may be.
Arc Rating	The value attributed to materials that describe their performance to exposure to an electrical arc discharge. The arc rating is expressed in cal/cm <sup>2</sup> and is derived from the determined value of the arc thermal performance value (ATPV) or energy of break open threshold.
Arc Thermal Performance Value	In arc testing, this means the incident energy on a material or multilayer system of materials that results in a 50% probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll curve, without breaking open.  NOTE: ATPV is expressed in kJ/m <sup>2</sup> or kWxs/m <sup>2</sup> (cal/cm <sup>2</sup> ).

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Definition	Description
Breakopen	In electrical arc testing, this means the material response evidenced by the formation of one or more openings in the material which may allow flame to pass through the material.  NOTE 1: the specimen is considered to exhibit break open when any opening is at least 300 mm <sup>2</sup> in area or at least 25 mm in any dimension. A single thread across the opening does not reduce the size of the hole for the purpose of SANS 61482-1-1 or ASTM F1959.  NOTE 2: a multilayer specimen is considered to exhibit break open when all layers show the formation of one or more openings.
Garment	A single item of clothing (e.g. shirt, trouser, jacket) which may consist of a single layer or multiple layers.
Material	Fabric or other substance from which the garment is made; this may consist of a single or multiple layers
Personal Protective Equipment	All items, including head, face, neck and chin protection, eye protection, hearing protection, body protection, hand and arm protection, foot and leg protection, that is intended to protect a person against the thermal hazards of an electric arc
Protective clothing	An assembly of garments which covers or replaces personal clothing, and which is designed to provide protection against one or more hazards.

### 2.3.1 Disclosure Classification

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

### 2.4 ABBREVIATIONS

Abbreviation	Description
ATPV	Arc thermal performance value
EBT50	Break-open threshold energy
FR	Flame resistant
HRC	Hazard risk category
PPE	Personal protective equipment
GMR	General Machinery Regulations

### 2.5 ROLES AND RESPONSIBILITIES

Sustainability department shall ensure correct Arc Flash PPE is available and complies with this specification.

Commercial department shall ensure that correct Arc Flash PPE that complies with this specification is procured.

GMR2.1 appointees, throughout Eskom Holdings shall ensure safety of personnel by ensuring that Arc Flash PPE complying with this specification is used.

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## **2.6 PROCESS FOR MONITORING**

Not Applicable.

## **2.7 RELATED/SUPPORTING DOCUMENTS**

Not applicable.

## **3. REQUIREMENTS**

### **3.1 GENERAL**

- a) Thermal Arc Protective Equipment and clothing shall be worn by employees who are at risk of being exposed to the thermal hazard of electrical arc.
- b) PPE must be the last means of protection against hazards.
- c) PPE must be kept in a good condition and in working order.
- d) The user must ensure that PPE is cleaned, stored, maintained and used according to the manufacturer's specifications.
- e) The employer shall ensure that the user is trained in the use and limitations of the PPE supplied.
- f) The employer may not allow an employee to work unless an employee is issued with PPE specific to the hazard to which the employee will be exposed.
- g) All PPE shall comply with SANS 724.

### **3.2 MINIMUM REQUIREMENTS FOR PERSONAL PROTECTIVE EQUIPMENT**

#### **3.2.1 Face protective equipment**

##### **3.2.1.1 Eye protection (goggles and visors)**

- a) Eye protective equipment shall comply with the requirements of EN 166 and ASTM F2178.1 or ANSI Z 87.1 and ASTM F2178.1. Face protective equipment, which may incorporate eye protection, shall comply with the requirements of ANSI Z 87.1 and ASTM F2178. This include the requirements for infrared protection (the wearer's vision shall not be obstructed).
- b) The arc rating of the visor shall be equal to or higher than the value assigned to the hood.
- c) The visor and the face shield must be anti-scratch and anti-fog.
- d) Eye protection shall be marked and care-labelled in accordance with EN 166 or ANSI Z.

##### **3.2.1.2 Balaclava**

- a) Arc-rated material must be used for a balaclava, arc rated, consistent with the construction, design and protection of the garments.
- b) The test report on the thermal performance of the balaclava is required.

##### **3.2.1.3 Hood**

- a) Fabric used for hoods shall be of the same, or higher, arc rating as that for protective clothing and shall fully cover the chest, neck and head of the user.

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- b) Fabric used for hoods shall be arc rated material that is permanently flame resistant so that the flame-resistant quality of the material (i.e. the material does not continue to burn after exposure to and removal of a source of ignition) cannot be removed due to usage and/or laundering.
- c) The arc rating shall be indelibly marked on the fabric of the hood.
- d) The manufacturer of the material shall prove that he/she has followed the same documented manufacturing process as for the type-tested material.
- e) When hoods are tested in accordance with ASTM F2178, they shall comply with the requirements of ASTM F1506 or IEC 61482-2.
- f) When exterior air is supplied into the hood, the air hoses and pump housing shall be either covered by arc rated or constructed of non-melting and non-flammable materials.
- g) The colour of the hood should preferably be Navy blue, Pantone 19\_3920.
- h) The hood shall be marked and care-labelled in accordance with EN 166 or ANSI Z.

### **3.2.2 Minimum requirements for gloves**

- a) Hand protection shall be of arc rated material and tested in accordance with ASTM F2675/F2675M-13.
- b) The test report on the thermal performance of the gloves is required.

### **3.2.3 Minimum requirements for rainwear**

- a) Rainwear shall comply with the requirements of ASTM F1891.
- b) The rainwear shall be Navy blue in colour.
- c) The rain suits shall be fitted with arc rated reflective strips on the circumference of both sleeves on the inner upper arm of the jacket, and with reflective strips on both legs above the knees. The reflective strips shall be visible in the day and at night.
- d) The Zero Harm identification shall appear on the right side of the sleeve and shall be in accordance with Eskom's Corporate Identity.
- e) The Eskom logo shall be silk-screened in accordance with Eskom's Corporate Identity, on the front and back.
- f) The size of the Eskom logo on the front shall be 65 mm high and 150 mm high on the back.
- g) The jacket shall have a nylon zip and a closed fly front secured by non-conductive press-studs.

NOTE 1: some rainwear will not be constructed of fabric (see the definition of "material"). For this reason, and for the purposes of this standard, rainwear shall comply with the requirements of ASTM F1891.

NOTE 2: size designations are included in ASTM F1891.

### **3.2.4 Minimum requirements for safety shoes**

- a) The shoes shall be non-metallic and have a carbon fibre toe-cap; tread surface type sole shall be rubber; and be oil, petrol and slip resistant and have a penetration-resistant insert.
- b) The shoes must be full grain leather on the upper part.
- c) Shoes shall comply with Safety Shoes Electrical Testing Specification 34-232.
- d) The colour of the shoes shall be dark brown. Where it is not possible to obtain brown, then black will be the only alternative and the laces shall match the relevant boot colour.

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- e) The shoes shall comply with the requirements of SANS 20345 and be marked with the SABS SANS 20345:2008 mark of approval.

### **3.2.5 Minimum requirements for hearing protection**

- a) Hearing protection shall comply with the requirements of SANS 50352-1 or SANS 50352-2.

## **3.3 MINIMUM REQUIREMENTS FOR PERSONAL PROTECTIVE CLOTHING GARMENTS**

### **3.3.1 General**

- a) Arc rating can be expressed as “Arc-thermal performance value” (ATPV) or “Energy Break-open Threshold (EBT50)” depending on the test method used – IEC 61482-1-1 or ASTM F1959.
- b) In the case of garment certification, both the material and the garment shall comply with the relevant requirements for the item.
- c) The arc rating of the protective clothing is determined by the rating of the garment with the lowest arc rating, for example protective clothing that consists of a 20 cal/cm<sup>2</sup> hood, 40 cal/cm<sup>2</sup> jacket and 25 cal/cm<sup>2</sup> trousers shall have an arc rating of 20 cal/cm<sup>2</sup>.
- d) The arc rating of the garment shall be equal to the arc rating of the material with the lowest arc rating used in the construction of the garment.
- e) The material manufacturer shall prove that he/she has followed the same documented manufacturing process as per the type-tested material.
- f) During its service life, protective clothing shall keep its arc thermal properties when cleaned in accordance with the instructions for use. The manufacturer shall stipulate the service life of a garment in terms of the cleaning cycles or in terms of other means acceptable to both the manufacturer and the user. Such other means shall be explained in writing before procurement.
- g) All garments shall last for a minimum of 100 cleaning cycles.
- h) All garments that have been exposed to an electric arc flash shall be withdrawn from service.
- i) The size ranges of protective clothing shall be in accordance with the requirements of SANS 434.
- j) Dimensional changes shall not exceed 3% on exposure to heat (washing), which shall be calculated in accordance with ASTM F1506 and AATCC 135.
- k) Non-melting underwear (e.g. silk, rayon) shall be worn when the arc rated garment is used.
- l) Where garment pieces of various suppliers are used, it is required that the user ensure the type tested combination of garments are not compromised.

### **3.3.2 Material requirements**

- a) Material used in the construction of garments shall comply with the requirements of IEC 61482-2 or ASTM F1506.
- b) The material manufacturer shall prove that he/she has followed the same documented manufacturing process as per the type-tested material.
- c) The fabric for the electric arc garment shall comply with the requirements of NFPA 70E.

### **3.3.3 Test and specification requirements**

- a) Protective clothing shall comply with the requirements of IEC 61482-2 or ASTM F2621.

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- b) Protective clothing shall be tested and the minimum requirements in 3.3.3(c) and 3.3.3(d) shall be fulfilled.
- c) When protective clothing constructed from single-layer material is tested, no part of the protective clothing shall display an after-flame of longer than 2 seconds, in accordance with test method ASTM D6413. Garments shall not break open and all findings, thread, fasteners, closures and accessories holding the garment together shall perform as expected, and no ignition, melting and dripping or other effects that could reduce the protection of the user shall occur.
- d) When protective clothing constructed from multi-layered fabric is tested, no part of the protective clothing shall display a limited after-flame of more than the greatest after-flame time in the SANS 61482-1-1, IEC 61482-1-2 or ASTM F1959 test reports. Garments shall not break open and all findings, thread, fasteners, closures and accessories holding the garment together should perform as expected, and no ignition, melting and dripping or other effects that could reduce the protection of the user shall occur.
- e) Compliance with the requirements in 3.3.3 (a), 3.3.3(b) and 3.3.3(c) shall be noted in the test report or test certificate.

#### **3.3.4 Design requirements**

- a) The garment shall be designed in such a way that it does not influence or hinder the wearer in performing his/her work.
- b) Garments that protect the upper part of the body shall have long sleeves up to the wrists with cuffs.
- c) Garments shall cover potentially exposed areas as completely as possible.
- d) Very tight-fitting garment shall be avoided. Loose-fitting clothing provides additional thermal insulation because of air space.
- e) The fasteners of a garment shall be designed in such a way that the opening function is still present and operational after exposure to an electrical arc.
- f) The thread, fasteners, findings and closures used in the construction of a garment shall not contribute to the severity of injuries to the wearer in the event of an electric arc.
- g) No exposed external metal shall be permitted in the clothing. If internal metal or thermoplastic parts (e.g. fasteners, buttons and accessories) are used, they shall be covered on the inside to prevent skin contact.
- h) The sewing thread utilised in the construction of garments shall not melt when tested at a temperature of 260 °C in accordance with ISO 17493. There are many seams that have no influence on the protection of the wearer (e.g. hems, pocket seams, etc.)
- i) The colour of both the jacket and pants should preferably be Navy blue Pantone 19\_3920.
- j) The arc suits shall be fitted with arc rated reflective strips on the circumference of both sleeves on the inner upper arm of the jacket, and with reflective strips on both legs above the knees. The reflective strips shall be visible in the day and at night.
- k) The Eskom logo shall appear on the left top side of the jacket in white and shall be in accordance with the Eskom Corporate Identity. The thread used for the embroidery shall comply to the requirements stipulated in SANS 724.
- l) The Zero Harm identification shall appear on the right side of the sleeve of the top of the jacket and shall be in accordance with the Eskom Corporate Identity. The thread used for the embroidery shall comply with the requirements stipulated in SANS 724.
- m) The shirts shall be corporate colour (grey), (CKS 129-188c).

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- n) The Eskom logo shall appear on the left top side of the shirt/jacket in white and shall be in accordance with the Eskom Corporate Identity, below it shall be the ATPV value of the garment. The thread used for the embroidery shall comply with the requirements stipulated in SANS 724.
- o) The Zero Harm identification shall appear on the right side of the sleeve of the top of the shirt and shall be in accordance with the Eskom Corporate Identity. The thread used for the embroidery shall comply with the requirements stipulated in SANS 724.
- p) No pockets are allowed on the garment.

### **3.4 MARKING AND LABELLING**

- a) All labels shall be permanently secured so that they, including the marking, will outlast the service life of the garment.
- b) Arc flash protection clothing markings shall comply with SANS 10011 or ASTM F1506.
- c) The following information shall be included as a minimum on the label secured to the garment:
  - The manufacturer's name or trade mark;
  - Year of manufacture or garment serial number for purpose of tracking.
  - The size designation;
  - The arc rating designation ATPV;
  - The composition of the material in accordance with SANS 10235 or ASTM F1506;
  - The care-labelling instructions in accordance with SANS 10011 or ASTM F1506;
  - The service life (in accordance with 3.3.1 (f));
  - The relevant normative marking requirements of referenced standards;
  - The washing control label and;
  - The arc-rating designation applicable to the material shall be clearly shown on the garment. For arc flash protection clothing, the ATPV designation applicable to the material and the Eskom logo shall be clearly visible on all components of the suit. Size of the letters shall be 20 mm in height and 3 mm in width.

**NOTE:** the arc flash protective equipment that was purchased before the approval of these specifications shall continue to be used until it is due for replacement or damaged, then it can be replaced with the PPE in the new specification.

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## 4. AUTHORISATION

This document has been seen and accepted by:

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## 5. REVISIONS

<b>Date</b>	<b>Rev.</b>	<b>Compiler</b>	<b>Remarks</b>
October 2013	1	M. Bizior	First Revision Published after Review Process
September 2016	1.1	D. Monyane	Updated Draft after Comments Review Process
November 2016	2	D. Monyane	Final Rev 2 Document for Authorisation and Publication
March 2017	2.1	D. Monyane	Updated Draft from Study Committee Review Process
April 2017	3	D. Monyane	Final Rev 3 Document for Authorisation and Publication

## 6. DEVELOPMENT TEAM

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