TEST SPECIMEN:

THERMAL DIELECTRIC SAFETY RUBBER BOOTS, MFG. SKELLERUP INDUSTRIES, STYLE #202280/202281

TEST DESCRIPTION:

ELECTRIC ARC EXPOSURE TEST OF RUBBER BOOTS

TEST REPORT: K-352043-1803T01 R00

Client
ArcWear
3018 Eastpoint Parkway
Louisville, KY 40223

Producer
Skellerup Industries Ltd.
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Sample received	Test Date	Report Date
2018-Mar-20	2018-Mar-22	2018-Jun-05

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Revision History

Rev	Description		
00	Initial report creation.		
	Issue Date 2018-Jun-05	Prepared by Andrew Haines	Approved by Kenneth Cheng
Rev	Description		
	Issue Date	Prepared by	Verified by

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- The test performed does not apply to electrical contact or electrical shock hazard
- The test result is applicable only to the Test Specimens delivered to Kinectrics, other material, garment design or color may have a different response.
- It is the clients' responsibility to provide full and accurate information about the items supplied.
- No test is done to validate the fiber content or composition of the test item.
- Photographs of the test specimens and waveforms of the arc current, voltage and calorimeters with the circuit and arc exposure calibration records are available from Kinectrics and provided to the client separately from this report.

1 Test Protocol:

Electrical Arc Exposure Test of Rubber Boots

At the time of this test, there was no directly applicable test standard to cover arc testing of this item as the typical test standard used for the evaluation of garments, ASTM F2621, requires the base fabric or material system to have an established arc rating (AR). It was decided after discussion between Kinectrics and Arcwear to adopt the general set-up and procedure used for evaluation of finished garments in accordance with ASTM 2621-12.

The purpose of this test was to observe the response characteristics of safety boots when exposed to an open-air electric arc. The materials and boots are not arc rated. At the request of the Client, the goal was to evaluate the response of the safety boot to a 40 cal/cm² arc exposure. Following the arc exposure, the boot was examined for evidence of melting, dripping and ignition. Areas of particular interest were seams, materials, linings and shoe laces. The front area was examined for evidence of arc energy that may enter and expose inside of the boot.

1.1 Test Description

In order to complete testing, the test laboratory used the test fixture described in *ASTM F2621-12 Standard Practice for Determining Response Characteristics and Design Integrity of Arc Rated Finished Products in an Electric Arc Exposure.* Although the products being evaluated do not strictly fall within the scope of this standard, the apparatus and procedure was adopted to suit the Client's requirements. The test procedure involved installing the finished product onto a secure platform with instrumented calorimeters on each side in order to evaluate the boots for melting, dripping and ignition response to an arc flash exposure.

Other effects than the thermal effects of an electric arc like noise, light emissions, pressure rise, hot oil, electric shock, the consequences of physical and mental shock or toxic influences are not covered by this evaluation.

1.2 Acceptance criteria for products exposed to electrical arc:

The product is considered as having met minimum requirements and *may* be suitable for complying to ASTM F1506, NFPA 70E and CSA Z462 workplace electrical safety requirements if the acceptance criteria defined in Table 1-1 are met.

Table 1-1: Acceptance Criteria for Tests on Arc Rated Finished Products

Parameter	Criterion
Ignition	No electric arc ignition
After-flame time	Less than 5 seconds
Closure	Any device used to retain closure of a garment shall not fail as to allow the garment to open and it shall remain functional to allow the garment to be easily removed.
Melting	No melting through to the inner side
Melting/Dripping	No melting and dripping of molten materials to the floor.
Break-Open	No hole bigger exceeding 160 mm² in area or 25 mm in any direction in the innermost layer.
Front closure	Closure does not fail to keep garment closed and remains operable.

2 Test Parameters:

The following test circuit parameters and conditions were used.

- Electric arc current: 8 kA rms ± 10%, 60 Hz
- Open circuit voltage: 2500 V rms ± 10%, 60 Hz
- Nominal Heat Flux Density: 2100 kW/m^2 (50 cal/cm²·s).
- Arc duration: Varied to obtain required incident energy
- Electrode gap: 305 mm (12 inches)
- Distance from boot face to electrode: 305 mm (12 inches)

3 Test Specimen:

The following test sample identification was provided or obtained from the identification tag in the boot (when available).

Product Description: Skellerup Industries Ltd., Thermal Dielectric Safety Rubber Boot, Style #202280/202281 - Quatro Dielectric Thermal, ArcWear# 1803T01

Producer: Skellerup Industries Ltd.
Material Arc Rating Test Report: **Arc rating of boot material has not been established.**
Pre-treatment reported by client: None.
Pre-conditioning by Kinectrics: In controlled laboratory conditions for minimum 24 hrs.
Deviations and abnormalities: None.

4 Results and Observations:

The detailed test observations are provided in the following product evaluation form. These were completed at the time of the test. The subjective evaluation of the product involved documenting product design or material response concerns that may lower the protection level of the boot in an arc flash incident. The test observations were performed by a qualified observer that has knowledge of behavior of textiles in an arc exposure and in depth knowledge of arc testing specifications and requirements. A summary of the test results is given in Table 4-1, Photographs of the boot before and after the arc exposure are provided in Figures 6-1-6-4.

Table 4-1: Summary of test Results

General product	**Shot # 18-1434A Side Exposure**	**Shot # 18-1434B Side Exposure**	**Shot # 18-2468A Front and Side Exposure**	**Shot # 18-2468B Front and Side Exposure**
	42.2 cal/cm²	45.2 cal/cm²	37.1 cal/cm²	37.4 cal/cm²
Break-open through the product (Y/N, area & size)	N	N	N	N
Afterflame (seconds and location)	3.5, tread	3.5, tread	2, tread	0
Ignition of any component (Y/N)	N	N	N	N
Melting and dripping (Y/N and area)	N	N	N	N
Shrinkage (none, slight, moderate, major)	None	None	None	None
Closure Failure *(Y/N)*	N/A	N/A	N/A	N/A

4.1 Observations:

There was no evidence of melting, dripping, or ignition of any component of the rubber boots samples tested.

5 Interpretation of Results:

Based on the results and observations of the shoe at the exposed level, the boot exhibited good overall performance and did not exhibit afterflame, melting, dripping or ignition during testing. Indicator clothing placed inside the boot showed no sign of energy transfer inside the boot.

NFPA 70E-2012 Section 130.7 (12) Exception No. 2 requires the employer to address multiple hazards while also addressing the arc flash hazard. These shoes are primarily shock protection, but based on this testing the shoes should not contribute to injury from an arc flash of up to 40 cal/cm^2 due to ignition, melting, dripping or energy transfer through the shoe rubber.

6 Photographs

The following photographs are representative of the observed test results.

Figure 6-1: Boots as tested prior to arc exposure 18-01434

Figure 6-2: Boots as tested following arc exposure 18-01434

Figure 6-3: Boots as tested prior to arc exposure 18-2468

Figure 6-4: Boots as tested following arc exposure 18-2468