

Hugh Hoagland Consulting, Inc.

ArcWear.com

Electric Arc Exposure Tests

For NSA

Fabric System

Outer Layer

**9.0 oz/yd² 305 g/m² Woven, 88% Cotton 12% Nylon
Style IC UQ60 (XCYE)
Navy**

Laundered weight (LW) 10.1 oz/yd², 342 g/m²

Inner Layer

**9.0 oz/yd² 305 g/m² Woven, 88% Cotton 12% Nylon
Style IC UQ60 (XCYE)
Navy**

Laundered weight (LW) 10.1 oz/yd², 342 g/m²

January 2011

Tests Conducted at Kinectrics High Current Laboratory
Toronto, Ontario, Canada

Electric Arc Exposure Tests

Materials for use in Electric Arc

NSA

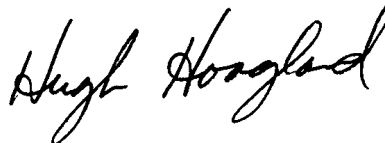
Certificate of Performance

This is to certify that the tests documented in this report were conducted at Kinectrics High Current Laboratory in accordance with ASTM International Standard Test Method F 1959/F 1959M-06ae1. The test samples were washed and dried by NSA in accordance with the above standard.

Fabric system specified in the table below received arc rating as
ATPV = 40.2 cal/cm²

Customer	NSA
Outer Layer	
Fabric design	9.0 oz/yd ² 305 g/m ² Woven, 88% Cotton 12% Nylon
Style	IC UQ60 (XCYE)
Color	Navy
Laundered weight (LW)	10.1 oz/yd ² , 342 g/m ²
Inner Layer	
Fabric design	9.0 oz/yd ² 305 g/m ² Woven, 88% Cotton 12% Nylon
Style	IC UQ60 (XCYE)
Color	Navy
Laundered weight (LW)	10.1 oz/yd ² , 342 g/m ²

Requested by: Mr. Jeff Martin



Approved by Hugh Hoagland
Hugh Hoagland Consulting, Inc.

This report was prepared by Hugh Hoagland Consulting, Inc. as an account of work performed for NSA.

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NSA

Evaluation of Textile Materials

ASTM F 1959/F 1959M-06ae1

Full Scale Arc Tests at Kinectrics High Current Laboratory

At the request of Mr. Jeff Martin, electric arc exposure tests were conducted on textile systems for NSA. Mr. Jeff Martin arranged with Hugh Hoagland Consulting, Inc. to conduct tests at the High Current Laboratory of Kinectrics in Toronto and review test data.

The textiles were tested according to the ASTM F 1959/F 1959M-06ae1 Standard Test Method for Determining the Arc Rating of Materials for Clothing

Introduction

The electrical industry has experienced severe injuries to workers when they have inadvertently been exposed to the energies of the electric arc. Burns resulting in death or requiring lengthy rehabilitation have occurred when workers have been exposed to the thermal effects of an electric arc.

Many of these burns have been further complicated by ignition, melting and continued burning of non-flame resistant materials or non-arc resistant materials.

The materials evaluated by NSA are designed to be resistant to flame and are to be rated for electric arc exposure.

Test Samples

Sample preparation was completed in accordance with ASTM F 1959/F 1959M-06ae1. An adequate amount of material was washed three times and dried. Following the washing procedure, material was cut into panel test samples.

Sample preparation was completed by NSA.

The samples as tested are described in the Table below:

Customer	NSA
Outer Layer	
Fabric design	9.0 oz/yd ² 305 g/m ² Woven, 88% Cotton 12% Nylon
Style	IC UQ60 (XCYE)
Color	Navy
Laundered weight (LW)	10.1 oz/yd ² , 342 g/m ²
Inner Layer	
Fabric design	9.0 oz/yd ² 305 g/m ² Woven, 88% Cotton 12% Nylon
Style	IC UQ60 (XCYE)
Color	Navy
Laundered weight (LW)	10.1 oz/yd ² , 342 g/m ²

Test Method

Test apparatus

The ASTM F 1959/F 1959M-06ae1 Standard Test Method for Determining the Arc Rating of Materials for Clothing requires testing conducted in a high current laboratory with a controlled arc source. Test apparatus is required to be equipped with instrumented sensor panels and instrumented monitor sensors as shown on Figure 1.

The Kinectrics High Current Laboratory uses a 100 MVA supply (100 million volt-amperes). This supply feeds the arc current to the arc electrodes through co-axial circuit.

Arc electrodes are enclosed within a modified Faraday “cage” to minimize the effects of magnetic fields on the directionality of the arc. The test apparatus is placed in a test cell to minimize or eliminate the effect of rain, wind and ambient temperature.

A series of trials completes one test. Each trial results in three data point.

Following parameters are set, checked and recorded for each trial:

- arc current
- arc duration

- arc electrodes spacing
- distance between test specimen(s) and arc electrode

The peak current is controlled by closing phase angle of the 60 Hz supply source with accuracy of 0.01 cycles.

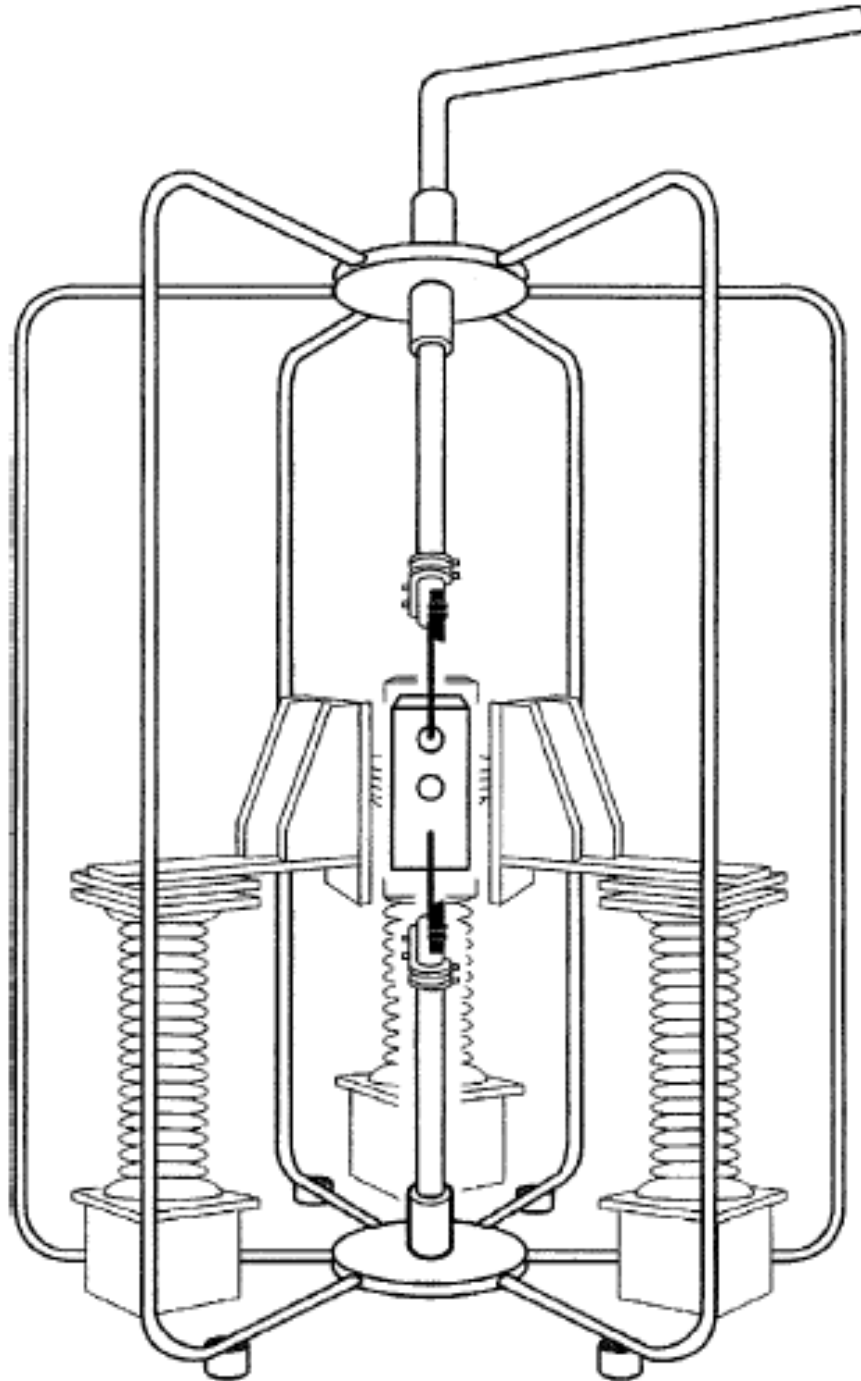


Figure 1. Test Set Up With Cage

Instrumented Panel and Monitor Sensors

Each panel equipped with two copper calorimeters mounted as shown in Figure 2. Two monitor sensors attached with mounting hardware on both sides of each panel. Each monitor sensor is equipped with one copper calorimeter.

Monitor sensors measure the incident energy (E_i) for the panel. Panel sensors measure the pass through energy that is compared with to the Stoll second-degree burn criteria.

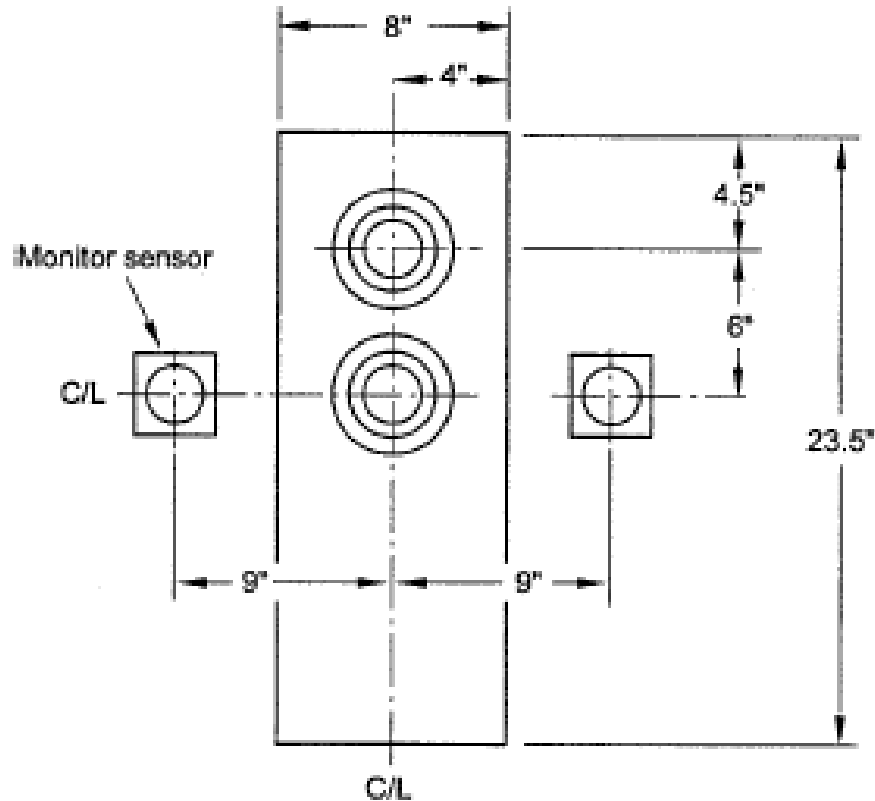


Figure 2. Instrumented Panel and Monitor Sensors

Arc Thermal Energy Measurement

The arc is not a straight vertical column. It may move horizontally or vertically or both. The co-axial supply and the arc “cage” (Fig. 1) reduce this arc movement caused by the magnetic field by the high currents in the test circuit.

The monitor sensors on each side of the panels measure the heat across materials. The temperature rises of the sensors are evaluated to determine the results of each test.

However, in addition to recorded data each trial must be evaluated using visual observations.

Test Results

The test program includes minimum of seven three panel arc trials.

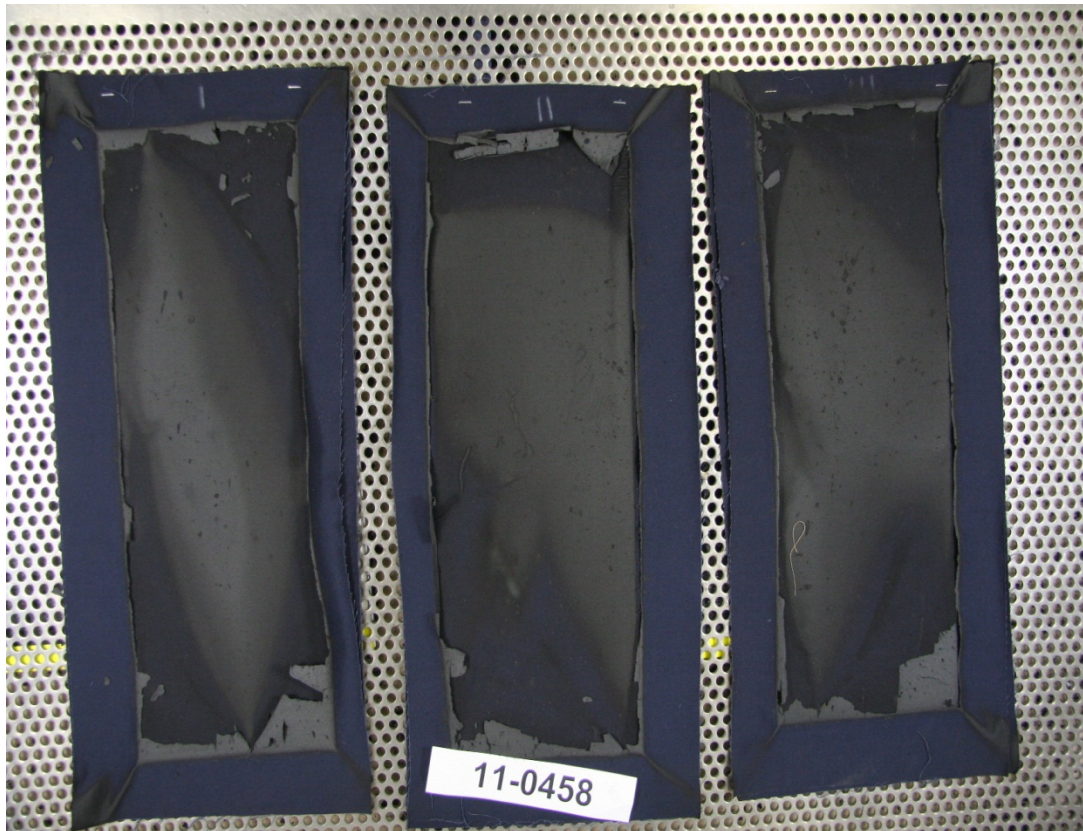
Following test data was recorded for each trial:

- arc exposure electrical conditions (arc test and arc trial numbers, RMS arc current, peak arc current, arc voltage, arc duration, energy dissipated in arc, plots of arc current and arc voltage)
- temperature rise of monitor and panel calorimeters
- photographs of exposed fabric swatches
- video

Above mentioned test data is part of report and is available for download from ArcWearOnline.com arc testing website. Test data is accessible only to NSA and protected with NSA unique password.

Test data CD or DVD is available at additional request.

Test observations, result(s) of statistical analysis, and graphs are shown on attached three pages. Photograph below demonstrates exposed swatches at ATPV/EBT level or close to it.



Conclusions

The material under test received the arc rating below:

Customer	NSA
Outer Layer	
Fabric design	9.0 oz/yd ² 305 g/m ² Woven, 88% Cotton 12% Nylon
Style	IC UQ60 (XCYE)
Color	Navy
Laundered weight (LW)	10.1 oz/yd ² , 342 g/m ²
Inner Layer	
Fabric design	9.0 oz/yd ² 305 g/m ² Woven, 88% Cotton 12% Nylon
Style	IC UQ60 (XCYE)
Color	Navy
Laundered weight (LW)	10.1 oz/yd ² , 342 g/m ²

Arc Rating: ATPV = 40.2 cal/cm²

Date:
Sat, Jan 29, 2011

Report #
K-418310

High Current Test Laboratory
Kinectrics Inc., Canada
Test Summary

Client

National Safety Apparel, Inc.

Fabric description

NSA, Two Layers of Style IC UQ60 (XCYE) 9.0 oz/yd² 305 g/m² Woven, 88% Cotton 12% Nylon, Navy,
LW 10.1 oz/yd² 342 g/m²

Reference Standard

ASTM F1959/F1959M-06ae1 Standard Test Method for Determining the Arc Rating of Materials for Clothing

Test Parameters:

Test current: 8kA

Number of samples analysed: 27

Distance to Fabric: 12

Incident Energy Range: 19 to 45 cal/cm²

Arc Gap: 12

Summary

The arc rating of this material is intended for use as flame resistant clothing for workers exposed to electric arcs. The material used in this test method are in the form of flat specimens, actual performance of the complete garment may vary depending on the final design and assembly of the garment. This test method does not apply to the electrical contact or electrical shock hazard.

Based on the data obtained and analysed in accordance with the latest version of the applicable standards, the following Arc Rating was calculated.

Arc Thermal Performance Value, ATPV = 40.2 Cal/cm²
Heat Attenuation Factor, HAF = 92.1%

Panel data and observations of the fabric samples after the arc exposure were collected and summarized in the attached table. The graphs and statistics on the attached sheets provide more detailed information to better understand the Arc Rating assigned to this material. The client shall review this full report, the video recordings of the arc exposure and the photographs of the samples after the test to determine if the material meets the intended specification.

Test performed at:

Hugh Hoagland
ArcWear.com
502-333-0510
Hugh@ArcWear.com

Contact information

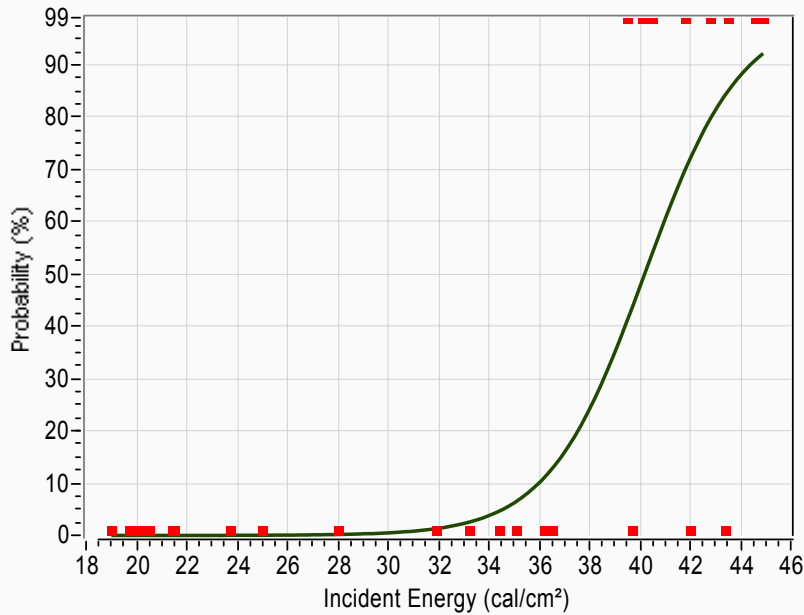
Jeff Martin
National Safety Apparel, Inc.
(216) 941-1111 ext 3171
jmartin@nsamfg.com

ASTM F1959/F1959M-06ae1
Standard Test Method for Determining the Arc Rating of Materials for Clothing

Client: National Safety Apparel, Inc.

Fabric NSA, Two Layers of Style IC UQ60 (XCYE) 9.0 oz/yd² 305 g/m² Woven, 88% Cotton
Description: 12% Nylon, Navy, LW 10.1 oz/yd² 342 g/m²

Determination of ATPV. 50% Probability of 2nd Degree Burn

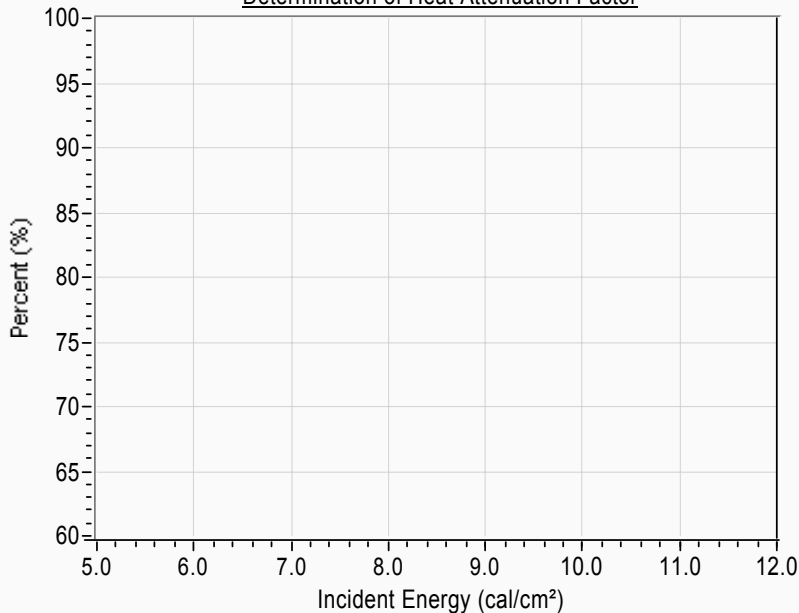


ATPV = 40.2 cal/cm²

Probability of Burn	E _i
5%	34.6
10%	36.0
20%	37.5
30%	38.6
40%	39.4
50%	40.2
60%	41.0
70%	41.8
80%	42.8
90%	44.4




Pts = 27
 # Pts above Stoll = 8
 # Pts Break-Open = 0
 # Pts always >STOLL = 3
 # Pts always <STOLL = 16
 # Pts within 20% = 16
 # Pts in mix zone = 8

Determination of Heat Attenuation Factor



HAF = 92.1 %

Confidence Intervals
 95% CI = 91.4 , 92.8

Data pts 
 Best Fit 
 95% CI 
 95% CI pts 