

**Hugh Hoagland Consulting, Inc.**

**ArcWear.com**

**Electric Arc Exposure Tests**

**For Riverside Manufacturing Company**

**Fabric system**

**Outer Layer:**

**7.0 oz/yd<sup>2</sup> Indura Ultrasoft, 88% Cotton 12% Nylon, PFR769,  
SilGray  
Laundered wt. 7.6 oz/yd<sup>2</sup>**

**Inner Layer:**

**6.0 oz/yd<sup>2</sup> MVM XMOH Mohawk Twill, 88% Cotton 12% Nylon, Lot  
17836, Khaki  
Laundered wt. 6.6 oz/yd<sup>2</sup>**

November 2008

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

# Electric Arc Exposure Tests

Materials for use in Electric Arc

## Riverside Manufacturing Company

### 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 the Hugh Hoagland Consulting, Inc. in accordance with the above standard.

Fabric system specified in the table below received arc rating as  
**ATPV= 26.9 cal/cm<sup>2</sup>**

Customer	Riverside Manufacturing Company
Layer 1	
Fabric design	7.0 oz/yd <sup>2</sup> Indura Ultrasoft, 88% Cotton 12% Nylon
Style	PFR769
Color	SilGray
Nominal/Laundered wt	7.6 oz/yd <sup>2</sup>
Layer 2	
Fabric design	6.0 oz/yd <sup>2</sup> MVM XMOH Mohawk Twill, 88% Cotton 12% Nylon
Style	Lot 17836
Color	Khaki
Nominal/Laundered wt	6.6 oz/yd <sup>2</sup>

Requested by: Mr. Will Vereen

Approved by Hugh Hoagland  
Hugh Hoagland Consulting, Inc.

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

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- b) assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

# **Riverside Manufacturing Company**

## **Evaluation of Textile Materials**

### **ASTM F 1959/F 1959M-06ae1**

#### **Full Scale Arc Tests at Kinectrics High Current Laboratory**

At the request of Mr. Will Vereen, electric arc exposure tests were conducted on textile systems for Riverside Manufacturing Company. Mr. Will Vereen 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 used by Riverside Manufacturing Company 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 of each layer was washed three times and dried. Following the washing procedure, material was cut into panels and assembled into two-layered test samples.

Sample preparation was completed by Hugh Hoagland Consulting, Inc..

The samples as tested are described in the Table below:

Customer	Riverside Manufacturing Company
Layer 1	
Fabric design	7.0 oz/yd <sup>2</sup> Indura Ultrasoft, 88% Cotton 12% Nylon
Style	PFR769
Color	SilGray
Nominal/Laundered wt	7.6 oz/yd <sup>2</sup>
Layer 2	
Fabric design	6.0 oz/yd <sup>2</sup> MVM XMOH Mohawk Twill, 88% Cotton 12% Nylon
Style	Lot 17836
Color	Khaki
Nominal/Laundered wt	6.6 oz/yd <sup>2</sup>

## 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.

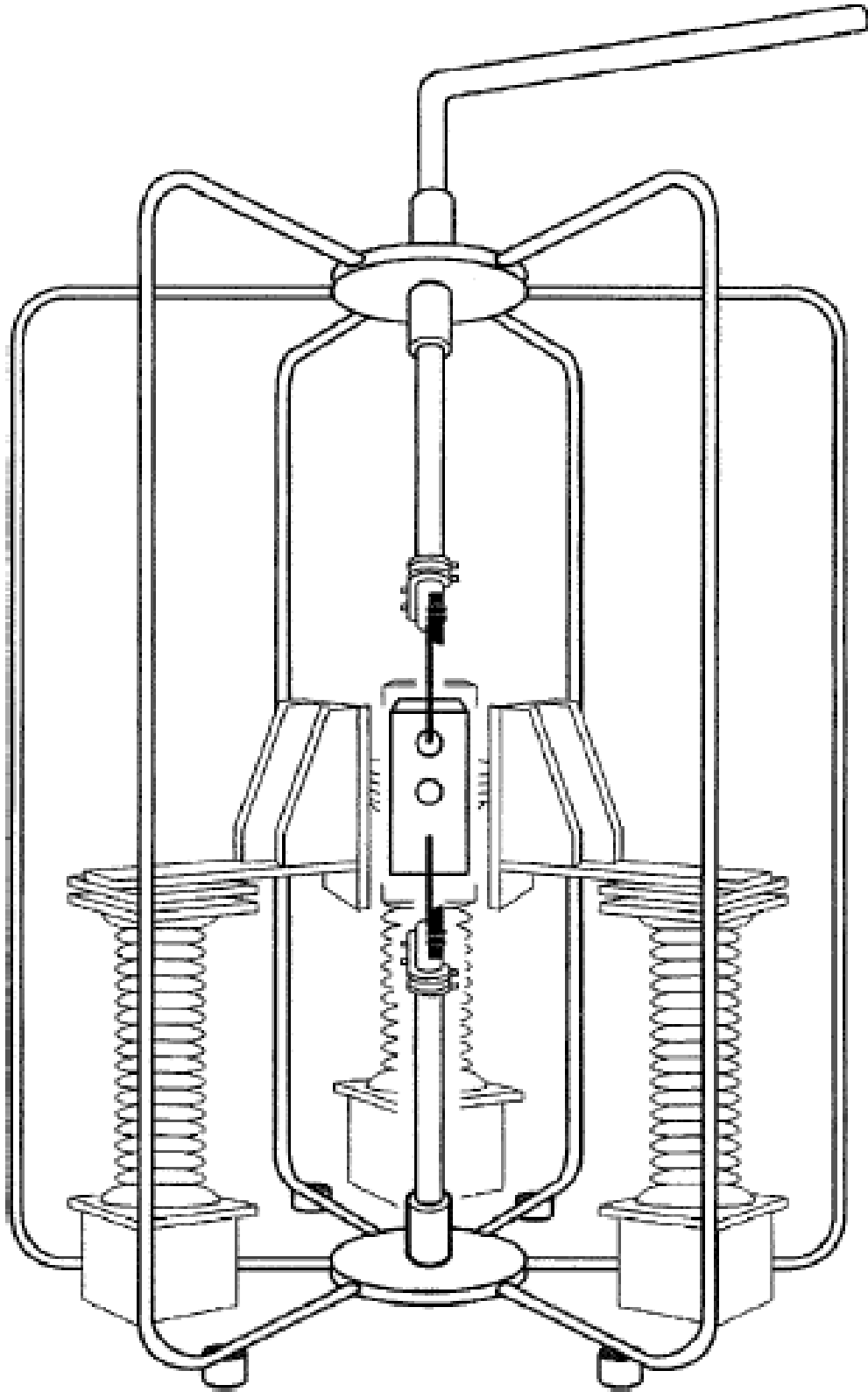
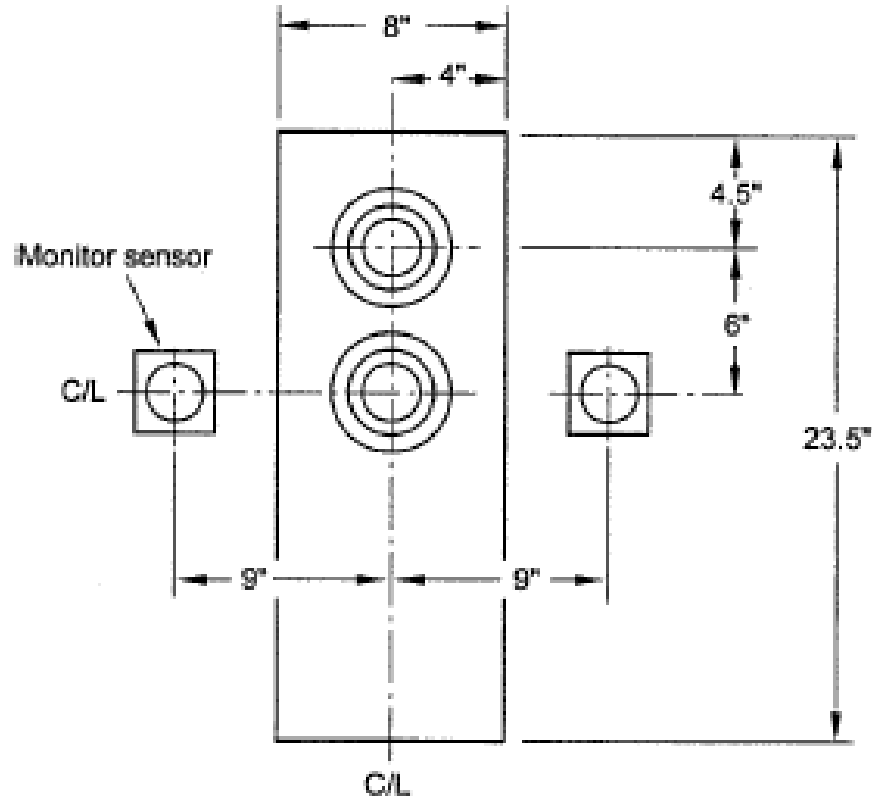


Figure 1. Test Set Up With Cage

## ***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. The test data set is evaluated using logistic regression method. A comparison of logistic regression to linear regression is also available on request.

Detailed test data, test observations, statistical analysis, and graphs are shown on attached three pages and photograph.



The arc voltage record, arc current record, arc duration, arc energy and the temperature rise record for each sensor are included on CD. Each test was video taped. Video is included on CD.

CD is a part of this report.


## Conclusions

The material under test received the arc rating below:

Customer	Riverside Manufacturing Company
Layer 1	
Fabric design	7.0 oz/yd <sup>2</sup> Indura Ultrasoft, 88% Cotton 12% Nylon
Style	PFR769
Color	SilGray
Nominal/Laundered wt	7.6 oz/yd <sup>2</sup>
Layer 3	
Fabric design	6.0 oz/yd <sup>2</sup> MVM XMOH Mohawk Twill, 88% Cotton 12% Nylon
Style	Lot 17836
Color	Khaki
Nominal/Laundered wt	6.6 oz/yd <sup>2</sup>

**Arc Rating: ATPV= 26.9 cal/cm<sup>2</sup>**



Date: November 18, 2008	<b>High Current Test Laboratory</b> <b>Kinectrics Inc., Canada</b> <b>Test Summary</b>	
Report # K-418135		
<b><u>Client</u></b> Riverside		
<b><u>Fabric description</u></b> Riverside 7.0 oz/yd <sup>2</sup> UltraSoft, 88/12 Cotton/Nylon, Silgray (PFR769) weight 7.6 oz/yd <sup>2</sup> over MVM XMOH Lot 17836 6.0 oz/yd <sup>2</sup> Mohawk Twill, 88/12 Cotton/Nylon, Khaki, weight 6.6 oz/yd <sup>2</sup>		
<b><u>Reference Standard</u></b> ASTM F1959/F1959M-05 Standard Test Method for Determining the Arc Rating of Materials for Clothing		
<b><u>Test Parameters:</u></b> Test current: 8 kA Distance to Fabric: 12 inches Arc Gap: 12 inches		
Number of samples analysed: 21 Incident Energy Range: 10 to 32 cal/cm <sup>2</sup>		
<b><u>Summary</u></b> 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.  The Arc Rating was calculated in accordance with ASTM F1959-05.		
<b>Arc Thermal Performance Value, ATPV = 26.9 Cal/cm<sup>2</sup></b> <b>Heat Attenuation Factor, HAF = 87.5%</b>		
The measured data and observations of the test 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 item. 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.		
<b><u>Test performed by:</u></b> Hugh Hoagland ArcWear.com 502-314-7158 hugh@arcwear.com		<b><u>Contact information</u></b> Will Vereen Riverside 1-800-841-8677 ext 200 wvereen@riversideuniforms.com

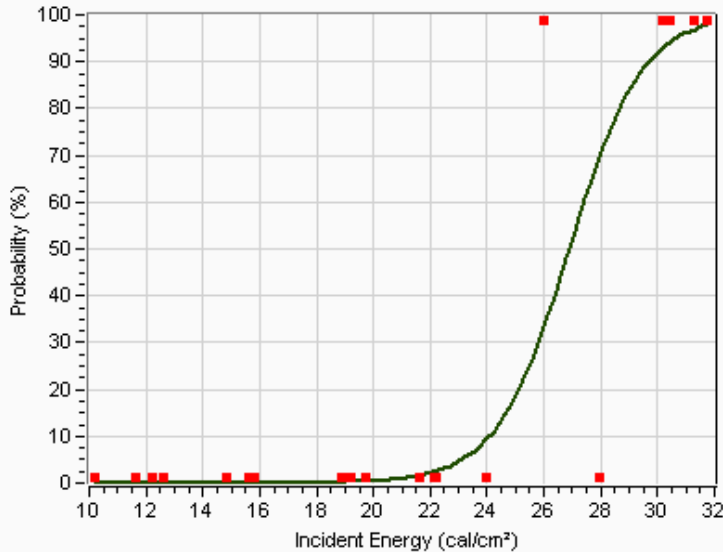
ASTM F1959/F1959M-05  
Standard Test Method for Determining the Arc Rating of Materials for Clothing



**Client:** Riverside

**Fabric Description:** Riverside 7.0 oz/yd<sup>2</sup> UltraSoft, 88/12 Cotton/Nylon, Silgray (PFR769) weight 7.6 oz/yd<sup>2</sup> over MVM XMOH Lot 17836 6.0 oz/yd<sup>2</sup> Mohawk Twill, 88/12 Cotton/Nylon, Khaki, weight 6.6 oz/yd<sup>2</sup>

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

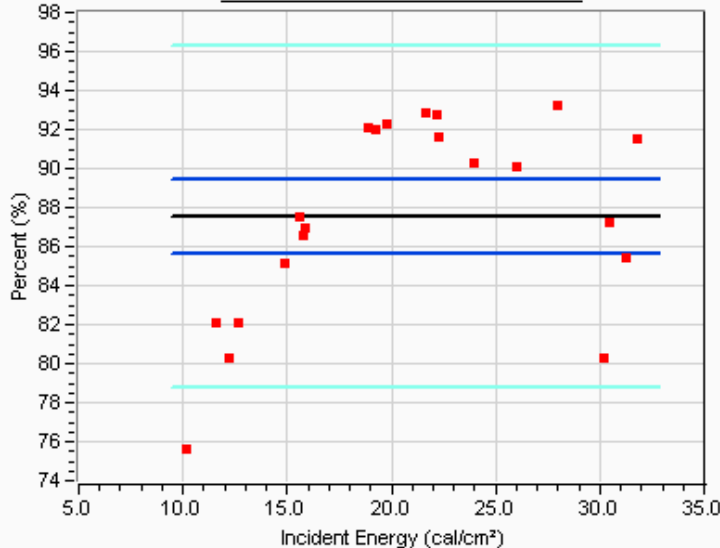


**ATPV = 26.9 cal/cm<sup>2</sup>**

Probability of Burn	Ei
5%	23.1
10%	24.1
20%	25.1
30%	25.8
40%	26.4
50%	26.9
60%	27.4
70%	28.0
80%	28.7
90%	29.7

# Pts = 21  
 # Pts above Stoll = 5  
 # Pts Break-Open = 0  
 # Pts always >STOLL = 4  
 # Pts always <STOLL = 15  
 # Pts within 20% = 10  
 # Pts in mix zone = 2

Determination of Heat Attenuation Factor



**HAF = 87.5 %**

Confidence Intervals  
 95% CI = 85.6 , 89.4

Data pts   
 Best Fit   
 95% CI   
 95% CI pts



ASTM F1959/F1959M-05  
Standard Test Method for Determining the Arc Rating of Materials for

Client: Riverside

Fabric Description: Riverside 7.0 oz/yd<sup>2</sup> UltraSoft, 88/12 Cotton/Nylon, Silgray (PFR769) weight 7.6 oz/yd<sup>2</sup> over MVM XMOH Lot 17836 6.0 oz/yd<sup>2</sup> Mohawk Twill, 88/12 Cotton/Nylon, Khaki, weight 6.6 oz/yd<sup>2</sup>

Test #	Panel	Cycles # (60Hz)	Ei cal/cm <sup>2</sup>	SCD cal/cm <sup>2</sup>	HAF %	Burn yes/no	Break Open Y/II	After Flame sec.	Omit Y/II	Comment	Ignition T-shirt
1	08-4621	A	15.1	10.18	-0.18	75.6	No	-	-	No	
2	08-4621	B	15.1	11.63	-0.32	82.1	No	-	-	No	
3	08-4621	C	15.1	12.20	-0.14	80.3	No	-	-	No	
4	08-4622	A	19.0	12.64	-0.26	82.1	No	-	-	No	
5	08-4622	B	19.0	15.61	-0.39	87.5	No	-	-	No	
6	08-4622	C	19.0	15.82	-0.31	87.0	No	-	-	No	
7	08-4623	A	23.1	14.86	-0.20	85.1	No	-	-	No	
8	08-4623	B	23.1	15.81	-0.28	86.6	No	-	-	No	
9	08-4623	C	23.1	21.63	-0.48	92.9	No	-	-	No	B/O top layer
10	08-4624	A	27.1	18.86	-0.70	92.1	No	-	-	No	B/O top layer
11	08-4624	B	27.1	19.74	-0.58	92.3	No	-	-	No	B/O top layer
12	08-4624	C	27.1	19.23	-0.48	92.0	No	-	-	No	B/O top layer
13	08-4625	A	31.1	23.98	-0.04	90.3	No	-	-	No	B/O top layer
14	08-4625	B	31.1	22.17	-0.46	92.8	No	-	-	No	B/O top layer
15	08-4625	C	31.1	22.24	-0.30	91.6	No	-	-	No	B/O top layer
16	08-4626	A	37.1	25.97	0.10	90.1	Yes	-	-	No	B/O top layer
17	08-4626	B	37.1	27.93	-0.30	93.2	No	-	-	No	B/O top layer
18	08-4626	C	37.1	30.43	1.50	87.2	Yes	-	-	No	B/O top layer
19	08-4627	A	41.1	31.28	2.20	85.4	Yes	-	-	No	B/O top layer
20	08-4627	B	41.1	31.77	0.27	91.5	Yes	-	-	No	B/O top layer
21	08-4627	C	41.1	30.16	3.84	80.3	Yes	-	-	No	B/O top layer
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