Hugh Hoagland Consulting, Inc.

ArcWear.com

Electric Arc Exposure Tests

Material System

Layer 1
8.0 oz/yd² 271 g/m² 2x1 LH Twill, 65% Modacrylic 35% N317
Style: 85917 - Protera 180
Color: Navy–10057Q
Actual Areal Density (AAD): 8.0 oz/yd² 271 g/m²

Layer 2
14 oz/yd² 474 g/m² Denim, 100% Cotton
Style: S308 Indura
Color: Blue
Actual Areal Density (AAD): 13.7 oz/yd² 464 g/m²

Report Number: 1102P88, Revision: 00

April, 2011

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

Electric Arc Exposure Report

ASTM F 1959/F 1959M-06 a$^{\varepsilon 1}$ Standard Test Method for Determining the Arc Rating of Materials for Clothing

General

At the request of a safety director electric arc exposure tests were conducted on textile systems for a public utility. The safety director arranged with ArcWear.com to facilitate testing by the High Current Laboratory of Kinectrics in Toronto and to review test data.

The tests documented in this report were conducted in accordance with ASTM International Standard F 1959/F 1959M-06 a$^{\varepsilon 1}$ Standard Test Method for Determining the Arc Rating of Materials for Clothing.

Test samples

The test material was received in February, 2011. The test material was washed 3 times and dried by ArcWear.com in accordance with requirements of the above standard. This is specified in the standard to allow for minimal shrinkage while removing contaminants from the material manufacturing process. Following the washing procedure, material was cut into panel test specimens.

Test results

The test program includes minimum of twenty individual panel arc trials. The following test data was recorded for each trial:

- arc exposure electrical conditions: arc trial number, RMS arc current, peak arc current, arc voltage, arc duration, energy dissipated in arc, plots of arc current and arc voltage
- temperature rise response from two monitor and two panel sensors for each panel in each trial, plot of average responses from two panel and two monitor sensors, plot of Incident energy distribution *Ei* from bare shot analysis
- photographs of exposed material panels
- video

Above mentioned test data is part of report and is available for download from ArcWearOnline.com arc testing website. Test data is accessible to the public at no cost.

Essential test data and test results are presented in the table below and on the attached data pages as follows:

- arc rating ATPV or EBT or both and plots of the burn injury probability (ATPV) or breakopen probability (EBT) or both versus *Ei*
- test specimen description and order of layer
- distance from an arc center line to the panel surface
- subjective evaluation
- heat attenuation factor (HAF) and plot of HAF on *Ei*
- ignition probability value (if determined during testing)

Rating

Material system specified in the table below received arc rating as

(ATPV) = 43.5 cal/cm²

Customer	
Layer 1	
Material design	8.0 oz/yd² 271 g/m² 2x1 LH Twill, 65% Modacrylic 35% N317
Style	85917 - Protera 180
Color	Navy–10057Q
Actual Areal Density (AAD) as tested	8.0 oz/yd² 271 g/m²
Layer 2	
Material design	14 oz/yd² 474 g/m² Denim, 100% Cotton
Style	S308 Indura
Color	Blue
Actual Areal Density (AAD) as tested	13.7 oz/yd² 464 g/m²

The order of layering is numbered starting from the outer layer listed first.

Requested by: The Safety Director

Hugh Hoagland

Approved by Hugh Hoagland
Arcwear.com

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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

Date:	FR Fabric Arc Test Summary	KINECTRICS ISO 9001-2008
Wed, Apr 20, 2011		
Ref # K-418310		

Client Information

X
X
(X)
X

Fabric description

Seattle City Light, Two Layers, Style 85917 - Protera 180 8.0 oz/yd² 271 g/m² 2x1 LH Twill, 65% Modacrylic 35% N317, Navy 10057Q, AAD 8.0 oz/yd² 271 g/m² over Style S308 Indura 14 oz/yd² 474 g/m² Denim, 100% Cotton, Blue, AAD 13.7 oz/yd² 464 g/m², ArcWear# 1102P88

Reference Standard

ASTM F1959/F1959M-06a Standard Test Method for Determining the Arc Rating of Materials for Clothing
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Test Parameters: Test current: 8 kA

Distance to Fabric: 12 inches

Arc Gap: 12 inches

Number of samples analysed: 21

Incident Energy Range: 32 to 65 cal/cm²

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 = 43.5 Cal/cm²
Heat Attenuation Factor, HAF = 93.4%

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.

Test arranged by

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Test performed at

Kinectrics Inc
Toronto, Ont
Canada
416.207.6305, hcl@kinectrics.com

ASTM F1959/F1959M-06a

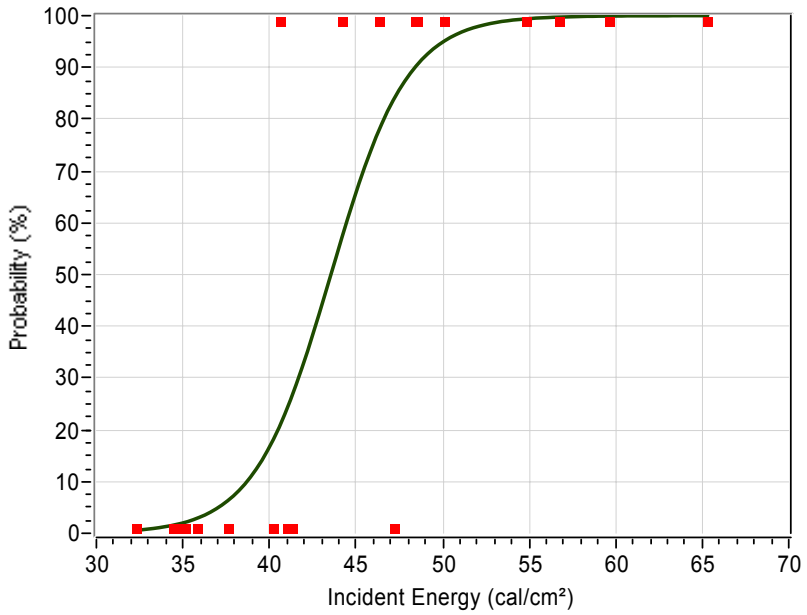
Standard Test Method for Determining the Arc Rating of Materials for Clothing

KINECTRICS
ISO 9001-2008

Client: X
X
(X)
X

Fabric Description: Two Layers, Style 85917 - Protera 180 8.0 oz/yd² 271 g/m² 2x1 LH Twill, 65% Modacrylic 35% N317, Navy 10057Q, AAD 8.0 oz/yd² 271 g/m² over Style S308 Indura 14 oz/yd² 474 g/m² Denim, 100% Cotton, Blue, AAD 13.7 oz/yd² 464 g/m², ArcWear# 1102P88

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

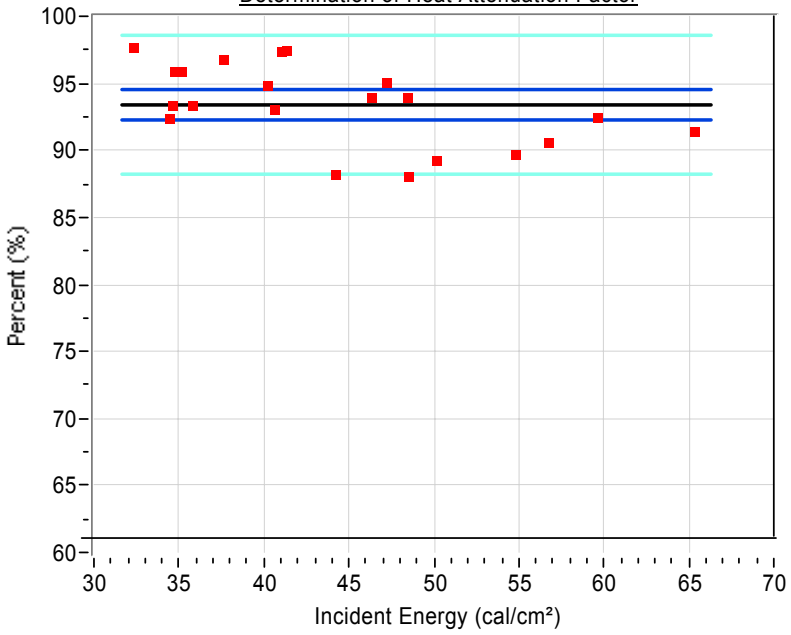


ATPV = 43.5 cal/cm²

Probability of Burn	Ei
5%	37.0
10%	38.7
20%	40.5
30%	41.7
40%	42.7
50%	**43.5**
60%	44.4
70%	45.4
80%	46.6
90%	48.4

 # Pts = 21
 # Pts above Stoll = 10
 # Pts Break-Open = 3
 # Pts always >STOLL = 7
 # Pts always <STOLL = 8
 # Pts within 20% = 13
 # Pts in mix zone = 6

Determination of Heat Attenuation Factor



HAF = 93.4 %

Confidence Intervals
95% CI = 92.3 , 94.5

Data pts
Best Fit
95% CI
95% CI pts

Ref#: K-418310

Wed, Apr 20, 2011

ASTM F1959/F1959M-06a

Standard Test Method for Determining the Arc Rating of Materials for Clothing

Client: X
X
(X)
X

Fabric Description: Two Layers, Style 85917 - Protera 180 8.0 oz/yd² 271 g/m² 2x1 LH Twill, 65% Modacrylic 35% N317, Navy 10057Q, AAD 8.0 oz/yd² 271 g/m² over Style S308 Indura 14 oz/yd² 474 g/m² Denim, 100% Cotton, Blue, AAD 13.7 oz/yd² 464 g/m², ArcWear# 1102P88

KINECTRICS
ISO 9001-2008

	Test #	Panel	Test Current A	Cycles of 60Hz	Ei Cal/cm²	SCD Cal/cm²	HAF %	Break Open Y/N	Break Open Y/N	Ablation Y/N	After Flame sec.	Omit Y/N	Comment
1	K-418310-2131	A	8059	80.2	59.6	2.17	92.5	Yes	Y	-	1.5	No	
2	K-418310-2131	B	8059	80.2	56.7	3.0	90.6	Yes	-	-	1.5	No	
3	K-418310-2131	C	8059	80.2	65.3	3.6	91.4	Yes	Y	-	-	No	
4	K-418310-2244	A	8119	50.1	35.8	-0.18	93.4	No	-	-	-	No	
5	K-418310-2244	B	8119	50.1	35.1	-0.8	95.9	No	-	-	-	No	
6	K-418310-2244	C	8119	50.1	34.4	-0.1	92.4	No	-	-	-	No	
7	K-418310-2245	A	8128	55.2	40.2	-0.43	94.9	No	-	-	-	No	
8	K-418310-2245	B	8128	55.2	37.6	-1.0	96.8	No	-	-	-	No	
9	K-418310-2245	C	8128	55.2	40.6	0.1	93.1	Yes	-	-	-	No	
10	K-418310-2246	A	8102	60.1	46.3	0.10	94.0	Yes	-	-	-	No	
11	K-418310-2246	B	8102	60.1	41.0	-1.2	97.4	No	-	-	-	No	
12	K-418310-2246	C	8102	60.1	54.8	3.4	89.7	Yes	Y	-	1.5	No	
13	K-418310-2247	A	8112	65.2	44.2	2.96	88.2	Yes	-	-	1	No	
14	K-418310-2247	B	8112	65.2	47.2	-0.5	95.1	No	-	-	-	No	
15	K-418310-2247	C	8112	65.2	48.5	3.5	88.1	Yes	-	-	1	No	
16	K-418310-2249	A	8117	45.2	34.7	-0.82	95.9	No	-	-	-	No	
17	K-418310-2249	B	8117	45.2	32.3	-1.2	97.7	No	-	-	-	No	
18	K-418310-2249	C	8117	45.2	34.6	-0.2	93.4	No	-	-	-	No	
19	K-418310-2250	A	8114	63.2	48.4	0.19	94.0	Yes	-	-	-	No	
20	K-418310-2250	B	8114	63.2	41.3	-1.2	97.5	No	-	-	-	No	
21	K-418310-2250	C	8114	63.2	50.1	3.1	89.3	Yes	-	-	1	No	
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