

**Hugh Hoagland Consulting, Inc.**

**ArcWear.com**

**Electric Arc Exposure Tests**

**Material System**

**Layer 1**

**8.0 oz/yd<sup>2</sup> 271 g/m<sup>2</sup> 2x1 LH Twill, 65% Modacrylic 35% N317**

**Style: 85917 - Protera 180**

**Color: Navy-10057Q**

**Actual Areal Density (AAD): 8.0 oz/yd<sup>2</sup> 271 g/m<sup>2</sup>**

**Layer 2**

**7 oz/yd<sup>2</sup> 237 g/m<sup>2</sup> Twill, 88% Cotton 12% Nylon**

**Style: S301 Indura Ultra Soft**

**Color: Blue**

**Actual Areal Density (AAD): 8.4 oz/yd<sup>2</sup> 285 g/m<sup>2</sup>**

**Report Number: 1102P85, 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<sup>81</sup> 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<sup>81</sup> 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  $E_i$  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](http://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  $E_i$
- 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  $E_i$
- ignition probability value (if determined during testing)

### Rating

Material system specified in the table below received arc rating as

**(ATPV) = 36.7 cal/cm<sup>2</sup>**

|                                      |   |
|--------------------------------------|---|
| Customer                             | A Public Utility  |
| Layer 1                              |   |
| Material design                      | 8.0 oz/yd <sup>2</sup> 271 g/m <sup>2</sup> 2x1 LH Twill, 65% Modacrylic 35% N317 |
| Style                                | 85917 - Protera 180   |
| Color                                | Navy-10057Q   |
| Actual Areal Density (AAD) as tested | 8.0 oz/yd <sup>2</sup> 271 g/m <sup>2</sup>                                       |
| Layer 2                              |   |
| Material design                      | 7 oz/yd <sup>2</sup> 237 g/m <sup>2</sup> Twill, 88% Cotton 12% Nylon             |
| Style                                | S301 Indura Ultra Soft  |
| Color                                | Blue  |
| Actual Areal Density (AAD) as tested | 8.4 oz/yd <sup>2</sup> 285 g/m <sup>2</sup>                                       |

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

Requested by: The Safety Director



Approved by Hugh Hoagland  
Arcwear.com

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ASTM F1959/F1959M-06ae1

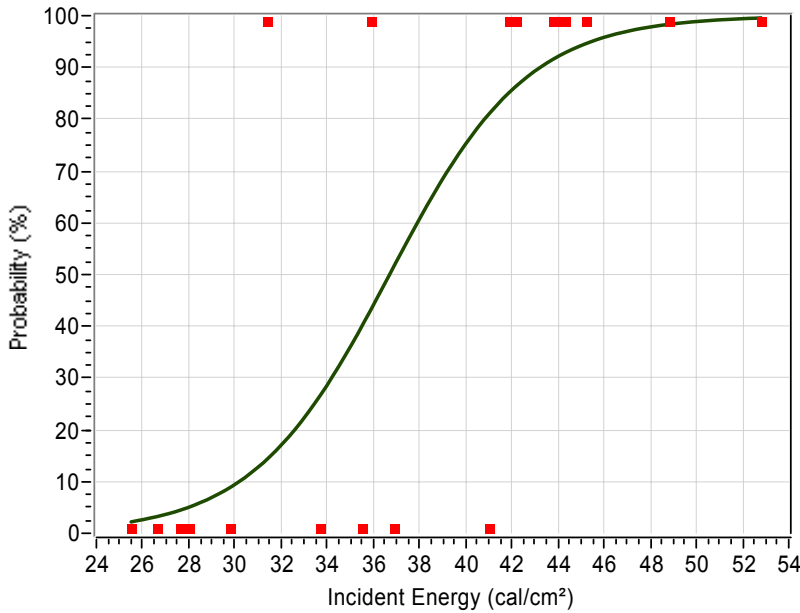
Standard Test Method for Determining the Arc Rating of Materials for Clothing



**Client:** X  
X  
(X)  
X

**Fabric:** Two Layers, Style 85917 - Protera180 8.0 oz/yd<sup>2</sup> 271 g/m<sup>2</sup> 2x1 LH Twill, 65% Modacrylic  
**Description:** 35% N317, Navy 10057Q, AAD 8.0 oz/yd<sup>2</sup> 271 g/m<sup>2</sup> over Style S301 Indura Ultra Soft 7 oz/yd<sup>2</sup> 237 g/m<sup>2</sup> Twill, 88% Cotton 12% Nylon, Blue, AAD 8.4 oz/yd<sup>2</sup> 285 g/m<sup>2</sup>, ArcWear# 1102P85

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

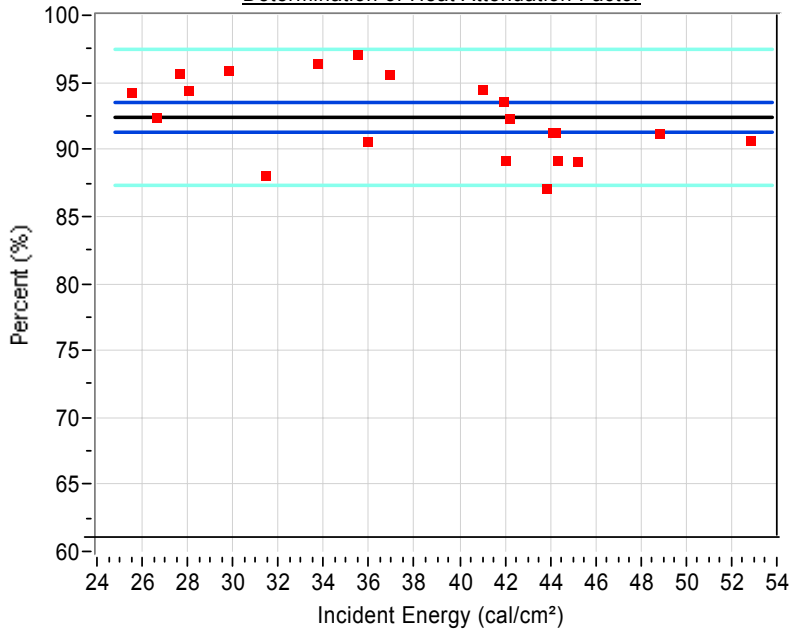


**ATPV = 36.7 cal/cm<sup>2</sup>**

| Probability of Burn | E <sub>i</sub> |
|---------------------|----------------|
| 5%                  | 28.0           |
| 10%                 | 30.2           |
| 20%                 | 32.6           |
| 30%                 | 34.2           |
| 40%                 | 35.5           |
| <b>50%</b>          | <b>36.7</b>    |
| 60%                 | 37.9           |
| 70%                 | 39.2           |
| 80%                 | 40.8           |
| 90%                 | 43.2           |

# Pts = 21  
# Pts above Stoll = 12  
# Pts Break-Open = 4  
# Pts always >STOLL = 10  
# Pts always <STOLL = 5  
# Pts within 20% = 11  
# Pts in mix zone = 6

Determination of Heat Attenuation Factor



**HAF = 92.4 %**

Confidence Intervals  
95% CI = 91.3 , 93.5

Data pts

Best Fit

95% CI

95% CI pts

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

Client: X  
X  
(C)  
X



**Fabric Description:** Two Layers, Style 85917 - Protera180 8.0 oz/yd<sup>2</sup> 271 g/m<sup>2</sup> 2x1 LH Twill, 65% Modacrylic  
35% N317, Navy 10057Q, AAD 8.0 oz/yd<sup>2</sup> 271 g/m<sup>2</sup> over Style S301 Indura Ultra Soft 7 oz/yd<sup>2</sup> 237 g/m<sup>2</sup> Twill,  
88% Cotton 12% Nylon, Blue, AAD 8.4 oz/yd<sup>2</sup> 285 g/m<sup>2</sup>, ArcWear# 1102P85

| Test # | Panel         | Test Current A | Cycles of 60Hz | Ei Cal/cm <sup>2</sup> | SCD Cal/cm <sup>2</sup> | HAF % | Break Open Y/N | Break Open Y/N | Ablation Y/N | After Flame sec. | Omit Y/N | Comment |
|--------|---------------|----------------|----------------|------------------------|-------------------------|-------|----------------|----------------|--------------|------------------|----------|---------|
| 1      | K-418310-2283 | A              | 8132           | 60.2                   | 44.2                    | 1.59  | 91.3           | Yes            | -            | Y                | -        | No      |
| 2      | K-418310-2283 | B              | 8132           | 60.2                   | 44.1                    | 1.5   | 91.3           | Yes            | -            | Y                | -        | No      |
| 3      | K-418310-2283 | C              | 8132           | 60.2                   | 43.8                    | 4.1   | 87.1           | Yes            | Y            | Y                | -        | No      |
| 4      | K-418310-2284 | A              | 8137           | 50.2                   | 42.2                    | 0.92  | 92.3           | Yes            | -            | Y                | -        | No      |
| 5      | K-418310-2284 | B              | 8137           | 50.2                   | 36.9                    | -0.7  | 95.6           | No             | -            | Y                | -        | No      |
| 6      | K-418310-2284 | C              | 8137           | 50.2                   | 35.9                    | 1.1   | 90.6           | Yes            | -            | Y                | -        | No      |
| 7      | K-418310-2285 | A              | 8166           | 40.2                   | 33.7                    | -1.05 | 96.4           | No             | -            | Y                | -        | No      |
| 8      | K-418310-2285 | B              | 8166           | 40.2                   | 28.0                    | -0.9  | 94.4           | No             | -            | Y                | -        | No      |
| 9      | K-418310-2285 | C              | 8166           | 40.2                   | 26.6                    | -0.2  | 92.4           | No             | -            | Y                | -        | No      |
| 10     | K-418310-2286 | A              | 8113           | 45.1                   | 41.0                    | -0.28 | 94.5           | No             | -            | Y                | -        | No      |
| 11     | K-418310-2286 | B              | 8113           | 45.1                   | 35.5                    | -1.1  | 97.1           | No             | -            | Y                | -        | No      |
| 12     | K-418310-2286 | C              | 8113           | 45.1                   | 31.4                    | 1.5   | 88.1           | Yes            | -            | Y                | -        | No      |
| 13     | K-418310-2287 | A              | 8195           | 35.2                   | 29.8                    | -1.01 | 95.9           | No             | -            | Y                | -        | No      |
| 14     | K-418310-2287 | B              | 8195           | 35.2                   | 25.5                    | -1.1  | 94.3           | No             | -            | Y                | -        | No      |
| 15     | K-418310-2287 | C              | 8195           | 35.2                   | 27.6                    | -1.0  | 95.7           | No             | -            | Y                | -        | No      |
| 16     | K-418310-2288 | A              | 8101           | 65.2                   | 52.8                    | 2.86  | 90.7           | Yes            | Y            | Y                | -        | No      |
| 17     | K-418310-2288 | B              | 8101           | 65.2                   | 45.2                    | 2.7   | 89.1           | Yes            | -            | Y                | -        | No      |
| 18     | K-418310-2288 | C              | 8101           | 65.2                   | 48.8                    | 2.4   | 91.2           | Yes            | Y            | Y                | -        | No      |
| 19     | K-418310-2289 | A              | 8095           | 55.2                   | 42.0                    | 2.19  | 89.2           | Yes            | -            | -                | -        | No      |
| 20     | K-418310-2289 | B              | 8095           | 55.2                   | 41.9                    | 0.2   | 93.6           | Yes            | -            | -                | -        | No      |
| 21     | K-418310-2289 | C              | 8095           | 55.2                   | 44.3                    | 2.6   | 89.2           | Yes            | Y            | -                | -        | No      |
| 22     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 23     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 24     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 25     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 26     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 27     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 28     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 29     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 30     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 31     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 32     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 33     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 34     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 35     |               |                |                |                        |                         |       |                |                |              |                  |          |         |
| 36     |               |                |                |                        |                         |       |                |                |              |                  |          |         |

Ref #: K-418310

Thu, Apr 21, 2011