

Hugh Hoagland Consulting, Inc.



Electric Arc Exposure Tests

For Flamesafe

Fabric

 $\label{eq:continuous} \begin{array}{c} \textbf{6.8} \text{ oz/y} \, \textbf{d}^2, \, 230 \, \text{g/m}^2 \, \text{Interlock Knit, 100\% Cotton ,} \\ \text{Style ILUCO 38160,} \\ \text{Navy} \\ \text{Laundered weight (LW) 8.1 oz/y} \, \textbf{d}^2, \, 274 \, \text{g/m}^2 \end{array}$

October 2010

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



Electric Arc Exposure Tests

Materials for use in Electric Arc

Flamesafe

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

Fabric system specified in the table below received arc rating as ATPV = 13.9 cal/cm²

Customer									
	Flamesafe								
	Layer 1								
Fabric design	6.8 oz/yd², 230 g/m² Interlock Knit, 100%								
_	Cotton								
Style	ILUCO 38160								
Color	Navy								
Laundered weight (LW)	8.1 oz/yd², 274 g/m²								

Requested by: Mr. Peter Bloom

Approved by Hugh Hoagland Hugh Hoagland Consulting, Inc.

Hugh Honglad



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

Flamesafe.

Neither Hugh Hoagland Consulting, Inc., nor its affiliates, nor any person acting on behalf of any of them:

- a) makes any warranty, express or implied, with respect to the use of any information, apparatus, method, or process disclosed in this report or that such use may not infringe privately owned rights; or
- 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.



Flamesafe

Evaluation of Textile Materials

ASTM F 1959/F 1959M-06ae1

Full Scale Arc Tests at Kinectrics High Current Laboratory

At the request of Mr. Peter Bloom, electric arc exposure tests were conducted on textile systems for

Flamesafe. Mr. Peter Bloom 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 developed by

Flamesafe 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 Hugh Hoagland Consulting, Inc..

The samples as tested are described in the Table below:

Customer								
	Flamesafe							
Layer 1								
Fabric design	6.8 oz/yd², 230 g/m² Interlock Knit, 100% Cotto							
Style	ILUCO 38160							
Color	Navy							
Laundered weight (LW)	8.1 oz/yd², 274 g/m²							

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.



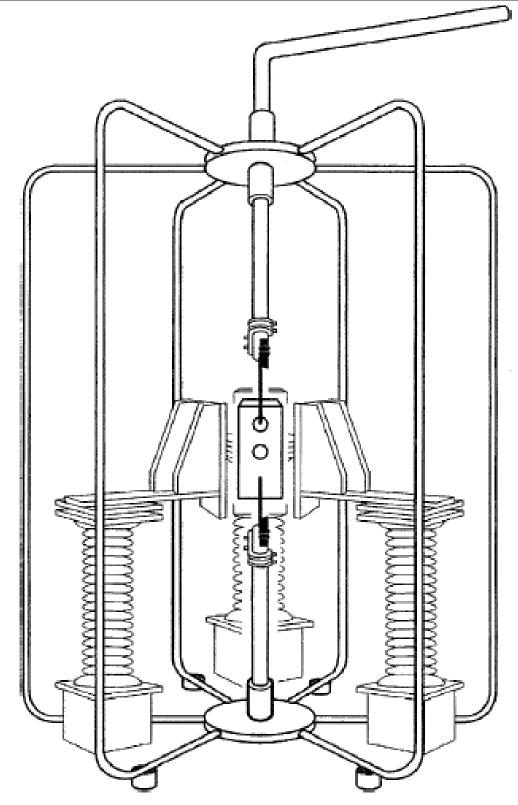


Figure 1. Test Set Up With Cage



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.

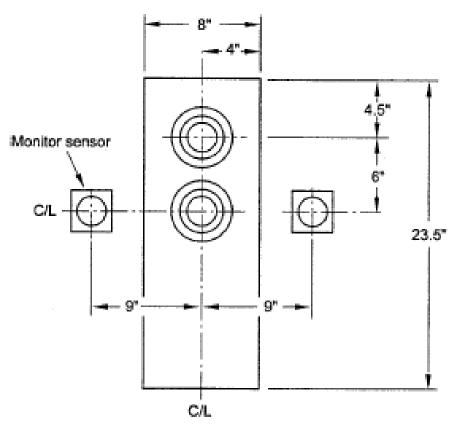


Figure 2. Instrumented Panel and Monitor Sensors

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

Flamesafe and protected with

Flamesafe 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									
	Flamesafe								
Layer 1									
Fabric design	6.8 oz/yd², 230 g/m² Interlock Knit, 100% Cotton								
Style	ILUCO 38160								
Color	Navy								
Laundered weight (LW)	8.1 oz/yd², 274 g/m²								

Arc Rating: ATPV = 13.9 cal/cm²



Date:

Wednesday, October

Report #

K-418292

High Current Test Laboratory Kinectrics Inc., Canada Test Summary

Client

Flamesafe Workwear

Fabric description

FSM, ILUCO 34190 6.8 oz/yd² 230 g/m² Interlock Knit, 100% Cotton, Navy LW 8.1 oz/yd² 274 g/m²

Reference Standard

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

Test Parameters: Test current: 12 Number of samples analysed: 21

Distance to Fabric: 12 Incident Energy Range: 9 to 19 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 = 13.9 Cal/cm² Heat Attenuation Factor, HAF = 86.0%

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 sampless after the test to determine if the material meets the intended specification.

Test performed at:

Hugh Hoagland ArcWear.com 502-314-7158 ArcWear.com

Contact information

Peter Bloom Flamesafe Workwear +61 400445544 pbloom@flamesafe.biz

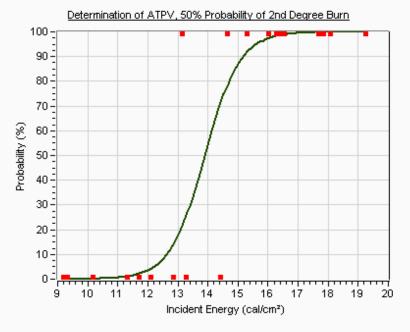


ASTM F1959/F1959M-06ae1 Standard Test Method for Determining the Arc Rating of Materials for Clothing

Client: Flamesafe Workwear

Kinectrics WO: K-418292

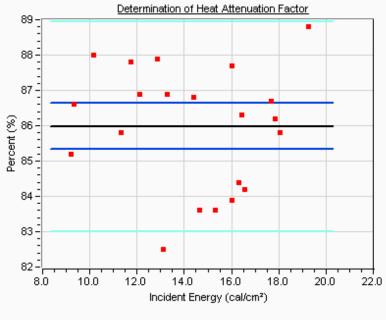
FSM, ILUCO 34190 6.8 oz/yd² 230 g/m² Interlock Knit, 100% Cotton, Navy LW 8.1 Description: oz/yd² 274 g/m²



$ATPV = 13.9 \text{ cal/cm}^2$

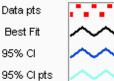
Probability of Burn	Ei
5%	12.2
10%	12.6
20%	13.1
30%	13.4
40%	13.7
50%	13.9
60%	14.1
70%	14.4
80%	14.7
90%	15.2

Pts = 21 # Pts above Stoll = 12 # Pts Break-Open = 1 # Pts always > STOLL = 11 # Pts always < STOLL = 7 # Pts within 20% = 14 # Pts in mix zone = 3



HAF = 86.0 %

Confidence Intervals 95% CI = 85.3 , 86.6



Wednesday, October 27, 2010



FSM, ILUCO 34190 6.8 ozlyd² 230 g/m² Interlock Knit, 100% Cotton, Navy LW 8.1 ozlyd² 274 g/m²	reak After Omit Comment ipen Flame Y/III Sec. Y/III	으 .	· · · · · · · ·	에 .	· - No	· - No	. ol .	. In the second of the second	. Ho	· · · · · · · · · · · · · · · · · · ·	. Ho	91	의	91	160	으 .	· · · · · · · · · · · · · · · · · · ·	. Ho	으로 ·	· · · · · · · · · · · · · · · · · · ·	91	의								
n² Interlock	Break Open V/N						-	-					>			,	-		,											
. 230 g/m	Burn yes/no	2	No	180	He He	No	No	Yes	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes								
3 ozvyď	#AF	9.98	85.2	88.0	87.8	85.8	86.9	83.9	86.8	83.6	86.7	85.8	8.8.8	84.2	84.4	86.3	86.9	87.9	87.7	83.6	82.5	86.2								
190 6.8	SCD cal/cm²	-0.70	-0.62	-0.71	-0.57	-0.51	-0.35	0.63	-0.27	95.0	0.49	99.0	0.31	0.63	65.0	0.37	-0.58	-0.56	0.09	0.39	0.13	0.57								
UCO 34	Ei cal/cm²	9.32	9.20	10.18	11.72	11.32	13.26	16.01	14.41	15.30	17.68	18.07	19.26	16.54	16.29	16.42	12.11	12.86	16.02	14.66	13.13	17.84								
		п	-	-	\vdash		H			.2	.2	23.2	23.2	21.2	21.2	21.2	17.2	17.2	17.2	18.2	18.2	18.2								
FSM, IL	Cycles # (60Hz)	11.1	11.1	11.1	15.2	15.2	15.2	19.2	19.2	19.2	23.2	2	2	~	١.,				l	, ,				ı	- 1					
		A 11.1		C 11.1		B 15.2	C 15.2	A 19.2	B 19.3	C 19	A 23	B 2:	C 2	A 2	8	c	А	В	C	А	В	C								
Fabric FSM, IL Description:	Test # Panel Cycles #				A	В	О	А		C				H				10-4978 B	10-4978 C	10-4979 A	10-4979 B	10-4979 C								