Hugh Hoagland Consulting, Inc.

ArcWear.com

Electric Arc Exposure Tests

For Elvex Corporation

Faceshield

Lens

Elvex Lens, Visor Bracket VB-10
Model FS-18ACR10
Color Light Green
Thickness 1.9 mm 0.075 inch
Hard Hat

Elvex SC-30 Hard Hat with SA-30

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September 2010

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

Electric Arc Exposure Tests

Face shields, Spectacles for use in Electric Arc

Elvex Corporation

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 for Determining The Arc Rating Of Face Protective Products F2178-06.

Faceshield specified in the table below received arc rating as
ATPV = 13.0 cal/cm²

Customer	Elvex Corporation
Faceshield system	
Lens design	Elvex Lens, Visor Bracket VB-10
Style	Model FS-18ACR10
Color	Light Green
Thickness	1.9 mm 0.075 inch
Hard Hat	
Manufacture, Model, Style	Elvex SC-30 Hard Hat with SA-30

Requested by: Mr. Ronald Westerdal

Hugh Hoagland

Approved by Hugh Hoagland
Hugh Hoagland Consulting, Inc.

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

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Elvex Corporation

Evaluation of Faceshield

Standard Test Method for Determining The Arc Rating Of Face Protective Products, ASTM F2178-06

Full Scale Arc Tests at Kinectrics High Current Laboratory

At the request of Mr. Ronald Westerdal, electric arc exposure tests were conducted on several samples of the arc resistant faceshields for Elvex Corporation. Mr. Ronald Westerdal arranged with Hugh Hoagland Consulting, Inc. to conduct tests at the High Current Laboratory of Kinectrics in Toronto and review test data.

The samples of the arc resistant faceshield were tested according to the ASTM F2178-06 Standard Test Method for Determining The Arc Rating Of Face Protective Products. This method evaluates face protective products for ignition, melting and skin burn prediction.

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 faceshields developed by Elvex Corporation are designed to be resistant to flame and are to be rated for electric arc exposure.

Test Samples

The samples as tested are described in the Table below:

Customer	Elvex Corporation
Faceshield system	
Lens design	Elvex Lens, Visor Bracket VB-10
Style	Model FS-18ACR10
Color	Light Green
Thickness	1.9 mm 0.075 inch mm
Hard Hat	
Manufacture, Model, Style	Elvex SC-30 Hard Hat with SA-30

Test Method

Test apparatus

ASTM F2178-06 uses a high current laboratory, a controlled arc source, and instrumented monitor sensors The F2178-06 Standard Test Method for Determining The Arc Rating Of Face Protective Products requires testing conducted in a high current laboratory with a controlled arc source. Test apparatus is required to be equipped with instrumented flame resistant mannequins 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.

Two monitor sensors attached with mounting hardware on both sides of each mannequin.

A series of trials completes one test. Each trial results in two or three data point depending on number of mannequin used. Normally two mannequins are used for better viewing angle of video recording camera.

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
- temperature rise
- video

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

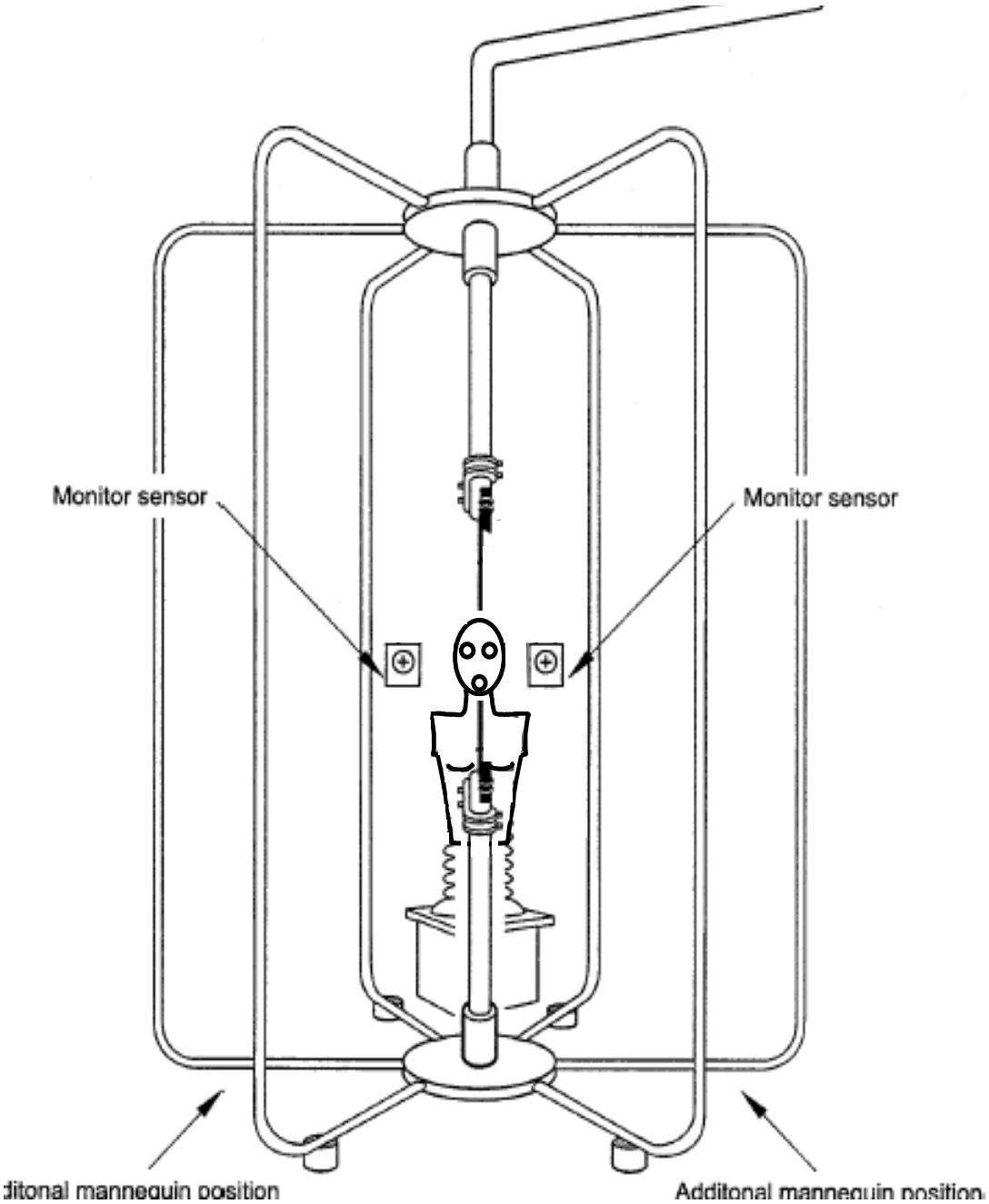


Figure 1. Test Set Up With Cage

Instrumented Mannequin Head

Each mannequin head is equipped with four copper calorimeters mounted in the chin, eyes and mouth. Position of calorimeters and setup detentions are shown on Figure 2.

Each monitor sensor is equipped with one copper calorimeter

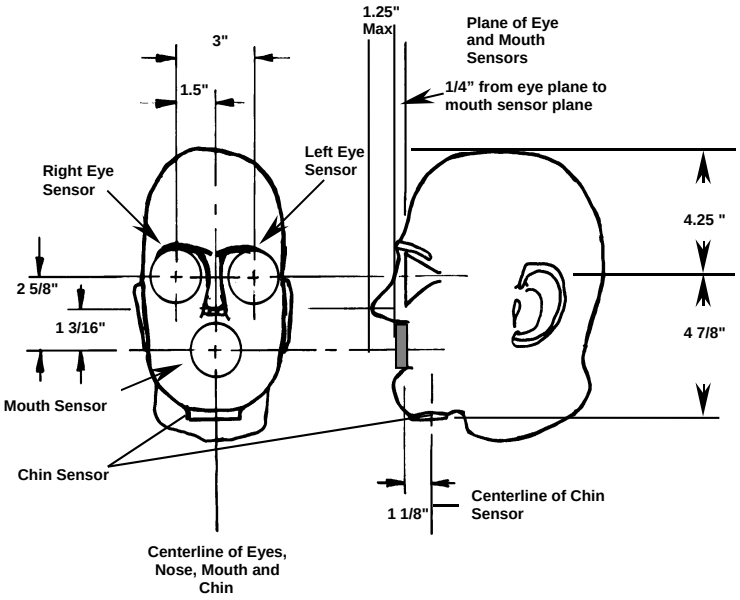


Figure 2. Mannequin head.

The center of the arc (mid point of a gap between the electrodes) is adjusted horizontally with the center of the nose.

Monitor sensors measure the incident energy (E_i) for the mannequin head. Mannequin sensors measure the pass through energy that is compared with the Stoll second-degree burn criteria.

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 mannequin head measure the heat across hoods. The temperature rises of the sensors are evaluated to determine the results of each trial.

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

The standard requires a logistical regression of the point at which the Stoll burn criteria predicts a 50% probability of the onset of second degree burn

Test Results

The test program includes minimum of ten two-mannequin 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.

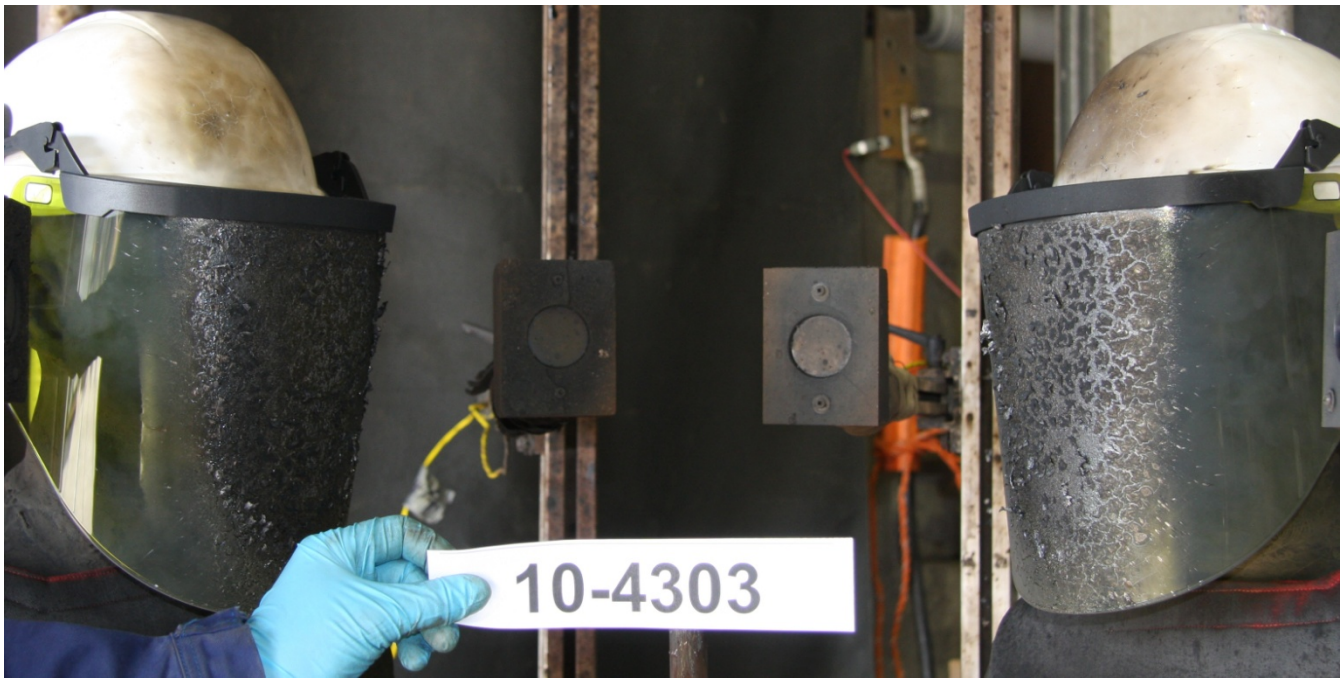
Following test data was recorded for each trial:

- 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 Elvex Corporation and protected with Elvex Corporation 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 faceshield assembly described in the following table received the arc rating below:

Customer	Elvex Corporation
Faceshield system	
Lens design	Elvex Lens, Visor Bracket VB-10
Style	Model FS-18ACR10
Color	Light Green
Thickness	1.9 mm 0.075 inch mm
Hard Hat	
Manufacture, Model, Style	Elvex SC-30 Hard Hat with SA-30

Arc Rating: ATPV = 13.0 cal/cm²

Date:
September 23, 2010

Report #
K-418292

High Current Test Laboratory
Kinectrics Inc., Canada
Test Summary

Client

Elvex

Fabric description

Elvex, Model FS-18ACR10, Thickness 1.9 mm 0.075 inch, Visor Bracket VB-10 tested with Elvex SC-50 Hard Hat equipped with Slot Adapter SA-30, Visor position is all way out

Reference Standard

ASTM F2178-02Standard Test Method for Determining The Arc Rating Of Face Protective Products

Test Parameters: Test current: 12
Distance to Fabric: 12
Arc Gap: 12

Number of samples analysed: 20
Incident Energy Range: 8 to 19 cal/cm²

Summary

The Test Method F2178 is used to to measue the arc rating of products intended for use as face protection for workers exposed ot electric arcs.

Based on the 20 test points 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 = 13.0 Cal/cm²
Heat Attenuation Factor, HAF = 90.7%

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:

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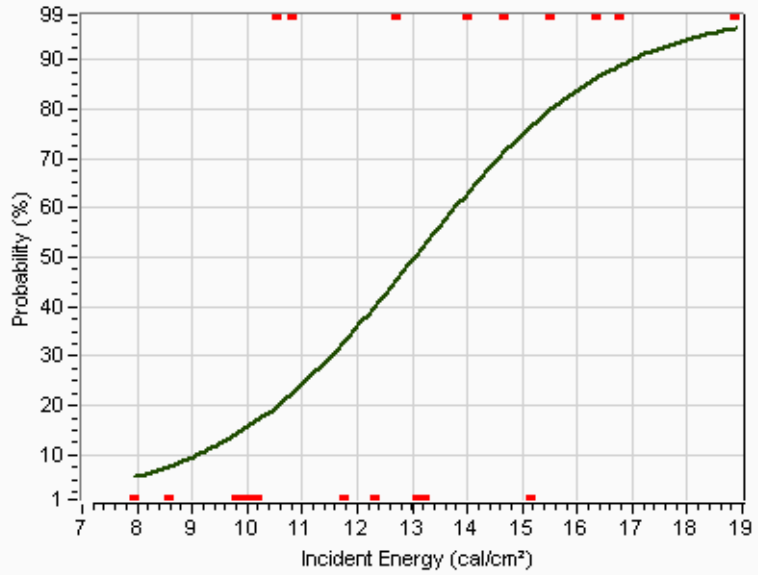
ASTM F2178-02

Standard Test Method for Determining The Arc Rating Of Face Protective Products

Client: Elvex

Fabric Description: Elvex, Model FS-18ACR10, Thickness 1.9 mm 0.075 inch, Visor Bracket VB-10 tested with Elvex SC-50 Hard Hat equipped with Slot Adapter SA-30, Visor position is all way out

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

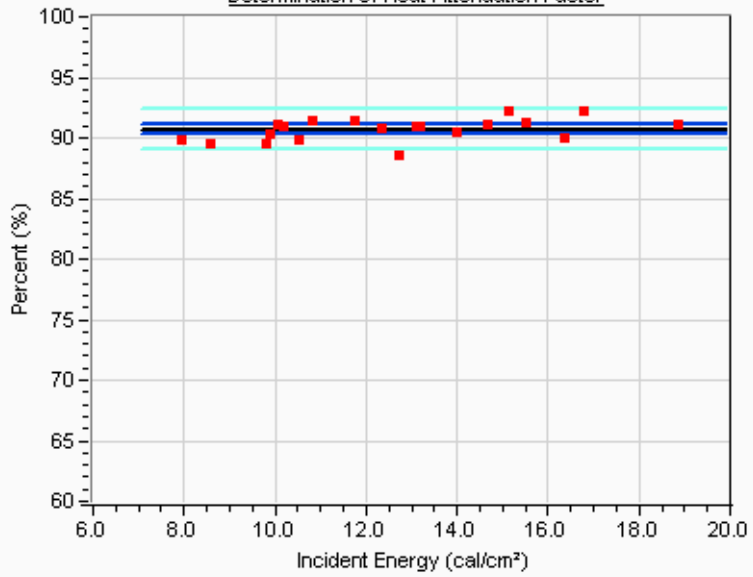


ATPV = 13.0 cal/cm²

Probability of Burn	Ei
5%	7.9
10%	9.1
20%	10.6
30%	11.5
40%	12.3
50%	13.0
60%	13.8
70%	14.6
80%	15.5
90%	17.0

Pts = 20
Pts above Stoll = 9
Pts Break-Open = 0
Pts always >STOLL = 4
Pts always <STOLL = 6
Pts within 20% = 11
Pts in mix zone = 10

Determination of Heat Attenuation Factor



HAF = 90.7 %

Confidence Intervals
95% CI = 90.3 , 91.1

Data pts
Best Fit
95% CI
95% CI pts

Kinectrics WO: K-418292

September 23, 2010

Fabric Description: Elvex, Model FS-18ACR10, Thickness 1.9 mm 0.075 inch, Visor Bracket VB-10 tested with Elvex SC-50 Hard Hat equipped with Slot Adapter SA-30, Visor position is all way out

	Test #	Panel	Cycles # (60Hz)	Ei cal/cm²	SCD cal/cm²	HAF %	Burn yes/no	Break Open Y/N	After Flame sec.	Omit Y/N	Comment
1	10-4300	A	14	10.81	0.20	91.5	Yes	-	-	No	
2	10-4300	B	14	10.98	-0.09	90.2	No	-	-	Yes	Different Visor position
3	10-4301	A	14	10.08	-0.45	91.1	No	-	-	No	
4	10-4301	B	14	9.89	-0.43	89.5	No	-	-	Yes	Different Visor position
5	10-4302	A	16	11.76	-0.18	91.5	No	-	-	No	
6	10-4302	B	16	10.18	-0.61	91.0	No	-	-	No	
7	10-4303	A	18	15.15	-0.26	92.3	No	-	-	No	
8	10-4303	B	18	13.21	-0.37	90.9	No	-	-	No	
9	10-4304	A	20	16.35	1.54	90.0	Yes	-	-	No	
10	10-4304	B	20	14.67	0.61	91.1	Yes	-	-	No	
11	10-4305	A	22	18.87	1.82	91.1	Yes	-	-	No	
12	10-4305	B	22	16.77	1.13	92.3	Yes	-	-	No	
13	10-4306	A	12	8.57	-0.60	89.6	No	-	-	No	
14	10-4306	B	12	7.93	-0.18	89.8	No	-	-	No	
15	10-4307	A	17	12.71	0.06	88.6	Yes	-	-	No	
16	10-4307	B	17	10.54	0.06	89.9	Yes	-	-	No	
17	10-4308	A	15	9.89	-0.21	90.3	No	-	-	No	
18	10-4308	B	15	9.80	-0.20	89.5	No	-	-	No	
19	10-4309	A	19	14.01	0.36	90.5	Yes	-	-	No	
20	10-4309	B	19	15.50	0.47	91.3	Yes	-	-	No	
21	10-4310	A	18	12.33	-0.25	90.8	No	-	-	No	
22	10-4310	B	18	13.10	-0.09	90.9	No	-	-	No	
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