Test Report for

Suape Textil S/A

Rodovia PE-60, km 7,5
Distrito Industrial Portuario de Suape
Cabo de Santo Agostinho – PE
CEP 54500-000
Brazil

Single layer
Nomex® Comfort, 93% meta-aramid, 5% para-aramid, 2% anti-static
Sample colours 9660 / 9570 / 7480
Nominal weight 4.5 oz/yd²

ARC RATING by ASTM F1959-05

Standard Test Method for Determining Arc Thermal Performance of Textile Materials for Clothing by Electric Arc Exposure Method

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Kinectrics Inc. Report No.: K-418108-002-R00
April 28, 2008

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Note about this report

- The test performed does not apply to electrical contact or electrical shock hazard
- The test result is applicable only to the Test Item, other material or color may have different protection level
- The findings of this report are based on the current test method as described in the Reference Standard
- It is assumed that the information supplied by the client was valid and complete

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TEST REPORT

Test item: Single layer
Nomex® Comfort, 93% meta-aramid, 5% para-aramid, 2% anti-static
Three different colours provided in test lot.
Nominal weight 4.5 oz/yd²
Measured weight before test:
Colour 9660, weight 4.8 oz/yd²
Colour 9570, weight 5.0 oz/yd²
Colour 7480, weight 5.0 oz/yd²

Laundering: Samples tested as received.
Laundering and preparation done by Suape Textil S/A

Test Performed: Determination of the arc thermal performance value of material for use as flame resistant clothing for workers exposed to electric arcs.

Reference Standard: ASTM F1959-05, *Standard Test Method for Determining Arc Thermal Performance of Textile Materials for Clothing by Electric Arc Exposure Method*

RESULTS

Flat Panel Samples:

- **Arc Rating, ATPV:** **6.0 cal/cm²**
- **Heat Attenuation Factor, HAF:** **61.7 %**
- **After flame:** **0 sec**
- **Break-open:** **no samples having break-open**

Notes and Observations:

- Test Parameters: Arc Gap= 30 cm, distance to the arc = 30 cm
- Arc current = 8 kA rms, duration of the arc was varied as indicated in Table 1
- At ATPV level
  - Surface is discoloured and charred.
  - Back has discolouration and some charring.
  - Fabric has no melting or dripping

Garment Samples: No garments evaluated.

Description of Test Method

The Arc Rating is determined by the arc test method defined in the Reference Standard using material in the form of flat specimens. This test method determines the heat transport response through a fabric or fabric system when exposed to the heat energy from an electric arc. The heat transport response is assessed versus the Stoll curve, an approximate human tissue tolerance predictive model that projects the onset of a second-degree burn injury.

Once the burns are recorded, the determination of the ATPV is done by logistic regression. The logistic regression is an S-shaped distribution function as shown in Figure 1. The Arc Rating

ATPV determined by this test method is the amount of energy that predicts a 50% probability of a second degree burn. When break-open of the last FR layer is observed, the analysis of the break-open threshold is performed to determine if this may occur first. The Arc Rating of the fabric is which ever occurs first, this is the lower value of the two.

Because of the variability of the arc exposure, different heat transmission values may be observed at individual panel sensors or incident energy monitors. The evaluation of each sensor is done in accordance with the procedure specified in the Reference Standard.

To allow the fabric to normalize to the environment, the fabric is kept in air-conditioned laboratory conditions for a minimum of 24 hrs before the test. The weight (density) of the fabric is one of the major factors affecting its thermal performance. For this reason, the density of the fabric is measured before the testing. This is an accurate process using die cut samples and a precision scale. The design density of the fabric reported by the manufacturer may be different from the density indicated in the Kinectrics test report for various reasons. The reported value is the density of the material at the time of the test. Factors including but not limited to the manufacturing process and shrinkage during laundering will affect the density of the material.

Individual test sheets, graphs, photographs of the samples and video of every test are provided in digital format to the Client for review.

Reported by:

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Terminology

Arc Rating, *n*—value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in cal/cm^2 and is derived from the determined value of ATPV or E_{BT50} (should a material system exhibit a breakopen response below the ATPV value)

Arc Thermal Performance Value (ATPV), the incident energy on a fabric or material that results in a 50 % probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll[1] curve.

Breakopen threshold energy (E_{BT50}), *n*—the incident energy on a fabric or material that results in a 50 % probability that sufficient heat transfer through the tested specimen is predicted to cause the tested specimen to break open. The specimen is considered to exhibit breakopen when any hole is at least 1.6 cm^2 [0.5 in.^{2}] in area or at least 2.5 cm [1.0 in.] in any dimension. In multiple layer specimens of flame resistant material, all the layers must breakopen to meet the definition. In multiple layer specimens, if some of the layers are ignitable, breakopen occurs when these layers are exposed.

Heat Attenuation Factor, HAF, *n— in arc testing*, the percent of the incident energy that is blocked by a material.

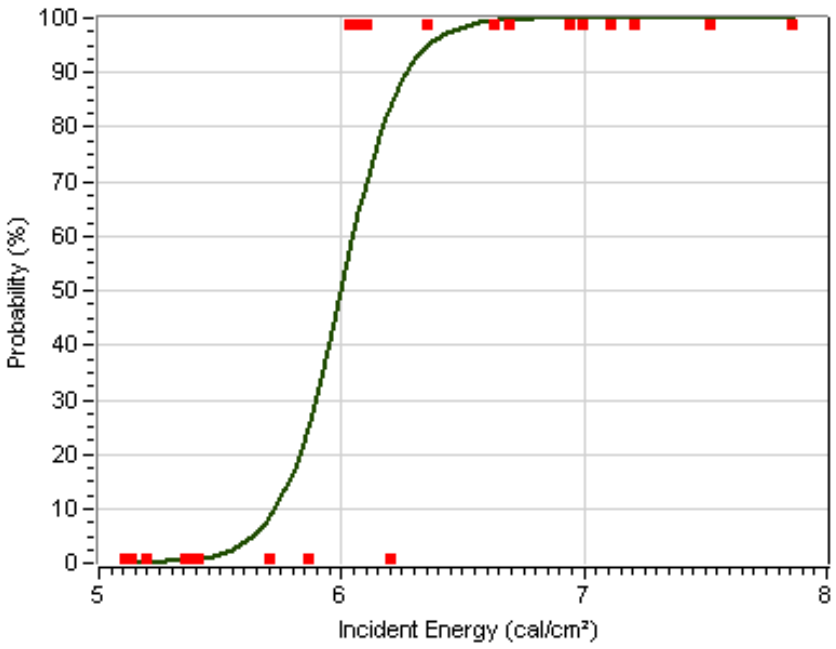
Stoll curve[1], *n*— an empirical predicted second-degree skin burn injury model, also commonly referred to as the *Stoll Response*.

SCD (Stoll Curve Difference)—The time dependent averaged heat energy response for each panel is compared to the Stoll Curve. A second-degree skin burn injury is predicted if the panel sensor heat energy response exceeds the Stoll Response value at any time (positive SCD). If the sensor response is below the Stoll Curve, no burn injury is predicted and a negative SCD is recorded.

[1]Derived from: Stoll, A. M. and Chianta, M. A., "Method and Rating System for Evaluations of Thermal Protection," *Aerospace Medicine* , Vol 40, 1969, pp. 1232-1238 and Stoll, A. M. and Chianta, M. A., "Heat Transfer through Fabrics as Related to Thermal Injury," *Transactions—New York Academy of Sciences*, Vol 33 (7), Nov. 1971, pp. 649-670.

Figure 1: Determination of arc rating

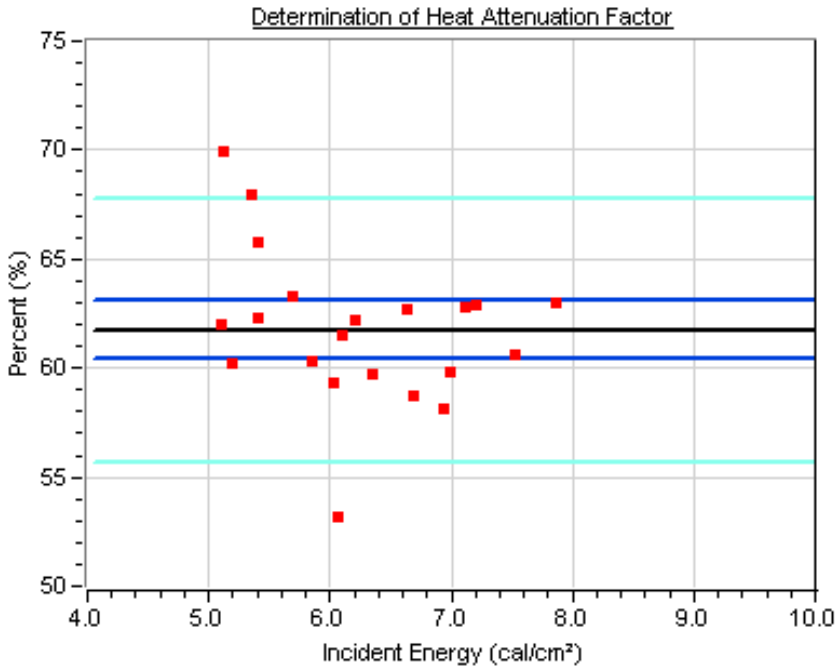
Fabric Description: Nomex® Comfort 4.5 oz/y². Blend: 93% meta-aramid/ 5% para-aramid/ 2% anti-static. In 3 colours: dark green-9660 weight 4.8 oz/y², blue-9570 weight 5.0 oz/y², red-7480 weight 5.0 oz/y²



ATPV = 6.0 cal/cm²

Probability of Burn	Ei
5%	5.6
10%	5.7
20%	5.8
30%	5.9
40%	5.9
50%	6.0
60%	6.0
70%	6.1
80%	6.2
90%	6.3

Pts = 21
Pts above Stoll = 12
Pts Break-Open = 0
Pts always >STOLL = 9
Pts always <STOLL = 8
Pts within 20% = 18
Pts in mix zone = 4



HAF = 61.7 %

Confidence Intervals
95% CI = 60.4 , 63.0

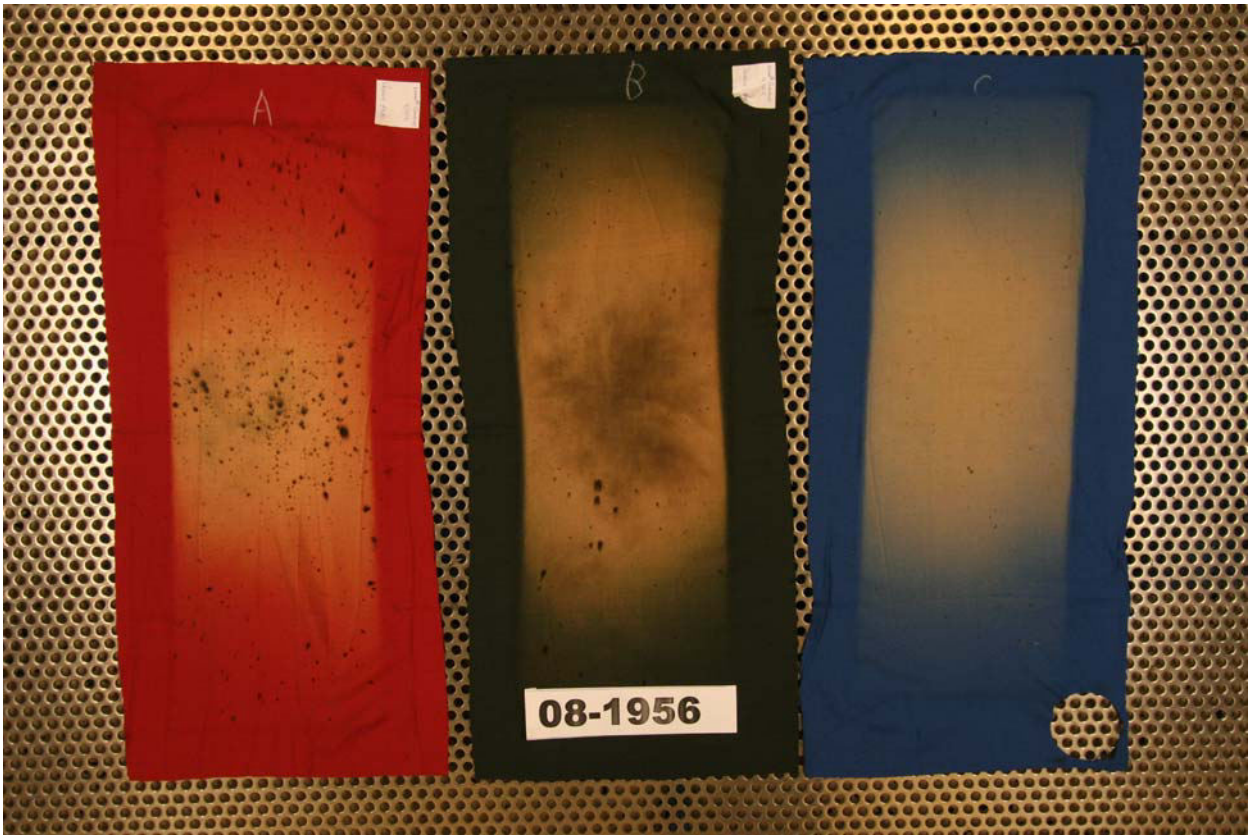
Data pts
Best Fit
95% CI
95% CI pts

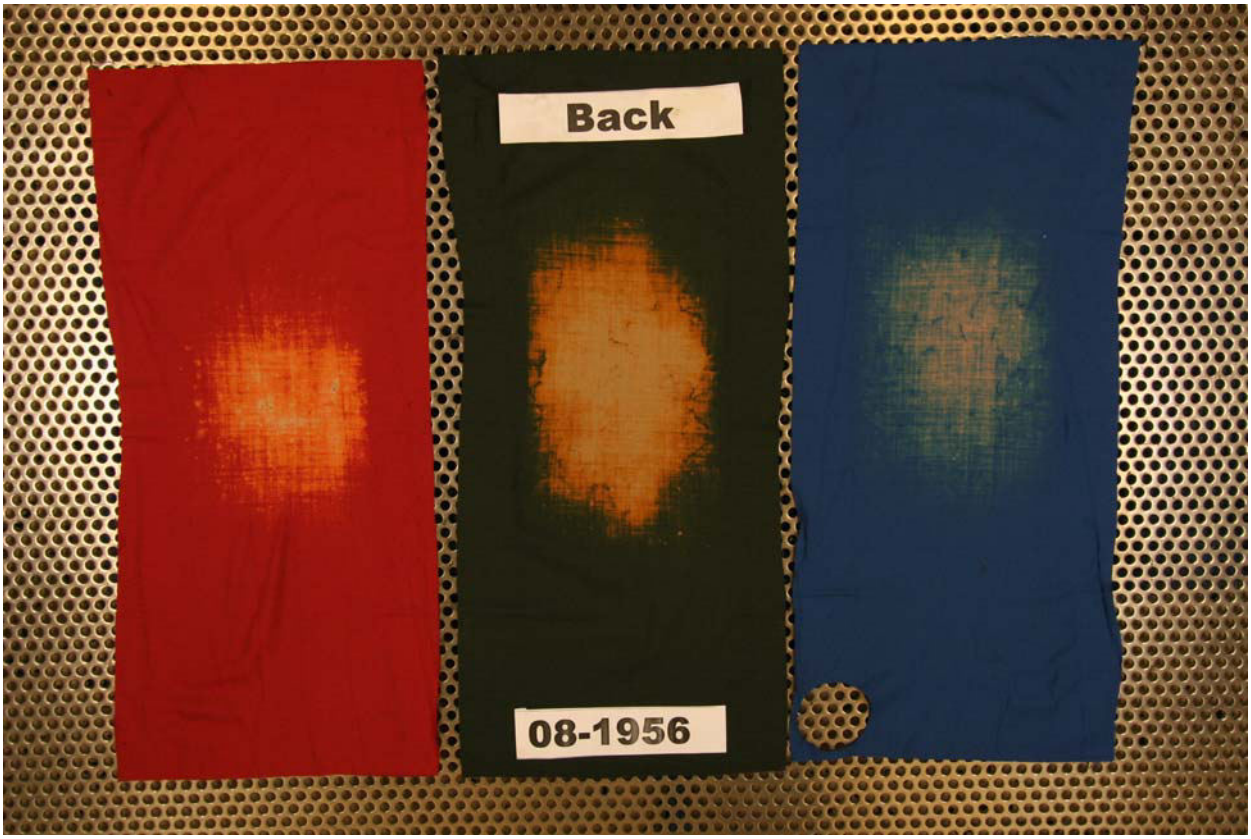
Table 1: Summary of test shots with energy and observations

Fabric Description: Nomex® Comfort 4.5 oz/y². Blend: 93% meta-aramid/ 5% para-aramid/ 2% anti-static.
In 3 colours: dark green-9660 weight 4.8 oz/y², blue-9570 weight 5.0 oz/y², red-7480 weight 5.0 oz/y²

	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	08-1956	A	7.1	5.36	-0.42	68.0	No	-	-	No	Discolored on front and some discolouration on back
2	08-1956	B	7.1	5.11	-0.37	62.0	No	-	-	No	"
3	08-1956	C	7.1	5.40	-0.33	65.8	No	-	-	No	"
4	08-1957	A	9.1	7.11	0.39	62.8	Yes	-	-	No	Charring on front and discoloured on back, weak
5	08-1957	B	9.1	6.10	0.02	61.5	Yes	-	-	No	"
6	08-1957	C	9.1	6.94	0.63	58.1	Yes	-	-	No	"
7	08-1958	A	8.1	5.13	-0.45	69.9	No	-	-	No	Discolored on front and some discolouration on back
8	08-1958	B	8.1	5.20	-0.17	60.2	No	-	-	No	"
9	08-1958	C	8.1	6.69	0.48	58.7	Yes	-	-	No	Charring on front and discoloured on back, weak
10	08-1959	A	8.6	5.41	-0.21	62.3	No	-	-	No	Discolored on front and back
11	08-1959	B	8.6	6.35	0.15	59.7	Yes	-	-	No	Charring on front and discoloured on back
12	08-1959	C	8.6	7.52	0.62	60.6	Yes	-	-	No	Charring on front and discoloured on back, weak
13	08-1960	A	8.1	6.63	0.07	62.7	Yes	-	-	No	Charring on front and discoloured on back
14	08-1960	B	8.1	5.86	-0.02	60.3	No	-	-	No	"
15	08-1960	C	8.1	5.70	-0.11	63.3	No	-	-	No	Discolored on front and some discolouration on back
16	08-1961	A	8.6	7.86	0.46	63.0	Yes	-	-	No	Charring on front and discoloured on back, weaker
17	08-1961	B	8.6	7.21	0.34	62.9	Yes	-	-	No	Charring on front and discoloured on back
18	08-1961	C	8.6	6.20	-0.01	62.2	No	-	-	No	Discolored on front and some discolouration on back
19	08-1962	A	8.6	6.99	0.49	59.8	Yes	-	-	No	Charring on front and discoloured on back, weaker
20	08-1962	B	8.6	6.03	0.06	59.3	Yes	-	-	No	Charring on front and discoloured on back
21	08-1962	C	8.6	6.06	0.52	53.2	Yes	-	-	No	Discolored on front and some discolouration on back
22											
23											
24											
25											
26											
27											
28											
29											
30											

Test 08-1956, Panel A: 5.4 cal/cm², Panel B: 5.1 cal/cm², Panel C: 5.4 cal/cm², near the ATPV level
Surface is discoloured and charred.
Back has discolouration, not weak





Test 08-1962, Panel A: 7.0 cal/cm², Panel B: 6.0 cal/cm², Panel C: 6.1 cal/cm², near the ATPV level
Surface is discoloured and charred.
Back has discolouration and some charring.

CERTIFICATE OF COMPLIANCE

Certificate Number	MH46575
Report Reference	MH46575-20190810
Issue Date	2022-MAY-18
Issued to:	DUPONT SPECIALTY PRODUCTS USA, LLC 5401 JEFFERSON DAVIS HWY RICHMOND VA 23234
This certificate confirms that representative samples of	COMPONENT – FLAME RESISTANT CLOTHING FOR PROTECTION OF INDUSTRIAL PERSONNEL AGAINST SHORT-DURATION EXPOSURES FROM FIRE See Attached Table
	Have been investigated by UL in accordance with the component requirements in the Standard(s) indicated on this Certificate. UL Recognized components are incomplete in certain constructional features or restricted in performance capabilities and are intended for installation in complete equipment submitted for investigation to UL LLC.
Standard(s) for Safety:	NFPA 2112, Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Short Duration Thermal Exposures from Fire, 2018 Edition
Additional Information:	See the UL Online Certifications Directory at https://iq.ulprospector.com for additional information.

This *Certificate of Compliance* does not provide authorization to apply the UL Recognized Component Mark. Only the UL Follow-Up Services Procedure provides authorization to apply the UL Mark.

Only those products bearing the UL Recognized Component Mark should be considered as being UL Certified and covered under UL's Follow-Up Services.

Look for the UL Recognized Component Mark on the product.

Bruce Mahrenholz, Director North American Certification Program

UL LLC

CERTIFICATE OF COMPLIANCE

Certificate Number MH46575
Report Reference MH46575-20190810
Issue Date 2022-MAY-18

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements.

Style Designation	Weight (oz/yd²)	Material Composition	Weave/ Knit	Finish
Nomex Comfort: NCFAB6xxx0xx45PWZA, NCFABAxxx0xx45PWZA	4.5	98% Nomex® and Kevlar® /2% Anti-Stat	Plain	None
Nomex Comfort: NCFAB6xxxWxx45PWZA OR NCFABAxxxWxx45PWZA	4.5	98% Nomex® and Kevlar® /2% P140 Anti-Stat	Plain	Wicking
NCFABBxxxWxx45PWZA	4.5	98% Nomex® and Kevlar®, 2% Anti-Stat	Plain	Wicking
Nomex Comfort: NCFAB6xxx0xx602TZA, NCFABAxxx0xx602TZA	6.0	98% Nomex® and Kevlar® /2% Anti-Stat	Twill	None
Nomex Comfort: NCFAB6xxxWxx602TZA OR NCFABAxxxWxx602TZA	6.0	98% Nomex® and Kevlar® /2% P140 Anti-Stat	Twill	Wicking
NCFABBxxxWxx602TZA	6.0	98% Nomex® and Kevlar®, 2% Anti-Stat	Twill	Wicking

Bruce Mahrenholz, Director North American Certification Program

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