Test Report for

QUALYTEXTIL S.A.
Rua do Luxemburgo, 260 - Lote 82/83
41.230130 PIRAJA SALVADOR - BA
BRAZIL

3 layer system
3 layers of: 247 g/m², Tecasafe Plus, laundered 100 times
48% Modacrylic-FR, 37% Celulose Fiber, 15% Para-Aramid, orange
Measured weight: 264 g/m² (each layer)

ARC RATING by ASTM F1959-06

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

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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: 3 layers of:
247 g/m², Tecasafe Plus, laundered 100 times
48% Modacrylic-FR, 37% Celulose Fiber, 15% Para-Aramid, orange
Measured weight before test = 264 g/m² (each layer)

Laundering: Tested as received,

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 F1959-06**, *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:** **43.0 cal/cm²**
- **Heat Attenuation Factor, HAF:** **94.9 %**
- **After flame (average of 5 highest):** **0 sec**
- **Break-open:** **0 sample 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
  - Ablation of 1st layer
  - 2nd layer charred , weak
  - 3rd layer has no charring
  - Light discoloration on back
  - Fabric has no melting or dripping.

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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Reviewed by:

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Distribution and Asset Management

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.

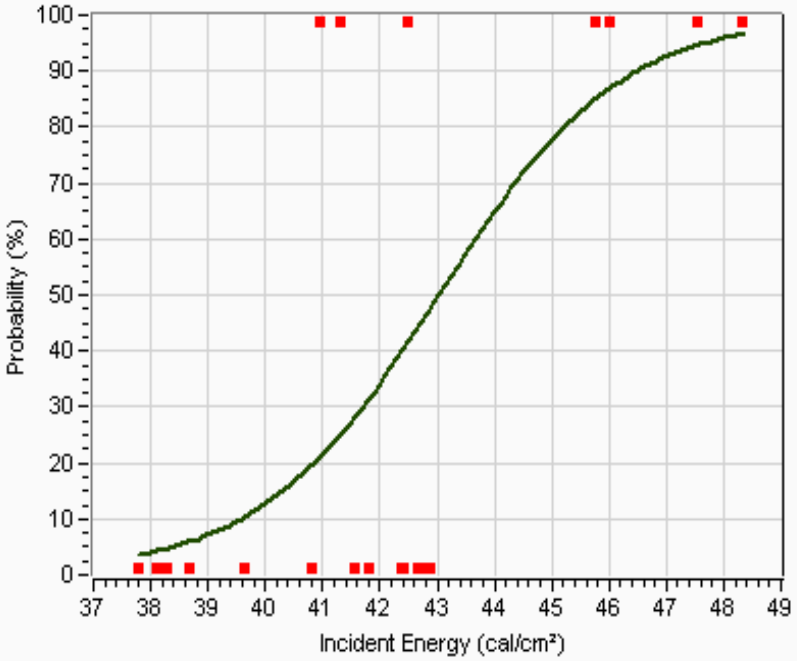
Stoll curve[1], *n*— an empirical predicted second-degree skin burn injury model, also commonly referred to as the *Stoll Response*.

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

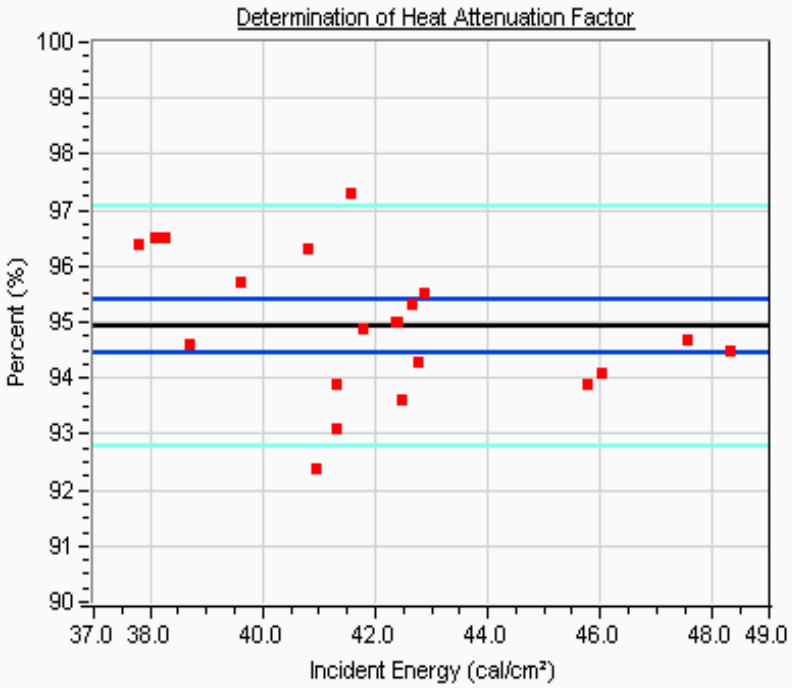
Fabric Description: Tecasafe Plus, 100x laundered, 3 layers, 48% modacrylic-FR, 37% celulose fiber, 15% para-aramid, orange, nominal weight: 247 g/m², measured weight before test 268 g/m² (7.9 oz/yd²) each layer



ATPV = 43.0 cal/cm²

Probability of Burn	Ei
5%	38.4
10%	39.6
20%	40.9
30%	41.7
40%	42.4
50%	43.0
60%	43.7
70%	44.4
80%	45.2
90%	46.5

Pts = 21
Pts above Stoll = 8
Pts Break-Open = 0
Pts always >STOLL = 4
Pts always <STOLL = 6
Pts within 20% = 21
Pts in mix zone = 11



HAF = 94.9 %

Confidence Intervals
95% CI = 94.5 , 95.4

Table 1: Summary of test shots with energy and observations

Fabric Description: Tecasafe Plus, 100x laundered, 3 layers, 48% modacrylic-FR, 37% celulose fiber, 15% para-aramid, orange, nominal weight: 247 g/m², measured weight before test 268 g/m² (7.9 oz/yd²) each layer

	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	09-3912	A	50.0	38.09	-0.89	96.5	No	-	-	No	Ablation of first layer, charring of second layer
2	09-3912	B	50.0	38.69	-0.35	94.6	No	-	-	No	Ablation of first layer, second layer charred
3	09-3912	C	50.0	41.32	0.02	93.9	Yes	-	-	No	"
4	09-3913	A	55.0	38.27	-0.95	96.5	No	-	-	No	Ablation of first layer, charring of second layer
5	09-3913	B	55.0	42.38	-0.37	95.0	No	-	-	No	Ablation of first layer, second layer charred
6	09-3913	C	55.0	41.30	0.29	93.1	Yes	-	-	No	Ablation of first layer, second layer charred, weak
7	09-3914	A	60.1	42.65	-0.56	95.3	No	-	-	No	Ablation of first 2 layers
8	09-3914	B	60.1	48.31	0.20	94.5	Yes	-	-	No	Ablation of first layer, second layer charred, weak
9	09-3914	C	60.1	46.02	0.14	94.1	Yes	-	-	No	"
10	09-3915	A	58.1	39.62	-0.74	95.7	No	-	-	No	Ablation of first layer, second layer charred
11	09-3915	B	58.1	45.76	0.14	93.9	Yes	-	-	No	Ablation of first layer, second layer charred, weak
12	09-3915	C	58.1	42.41	-0.15	95.0	No	-	-	No	Ablation of first 2 layers
13	09-3916	A	56.0	41.57	-1.09	97.3	No	-	-	No	Ablation of first layer, second layer charred, weak
14	09-3916	B	56.0	40.96	0.47	92.4	Yes	-	-	No	"
15	09-3916	C	56.0	42.75	-0.07	94.3	No	-	-	No	"
16	09-3917	A	59.1	40.81	-0.89	96.3	No	-	-	No	Ablation of first layer, second layer charred, weak
17	09-3917	B	59.1	47.54	0.01	94.7	Yes	-	-	No	Ablation of first 2 layers
18	09-3917	C	59.1	42.47	0.07	93.6	Yes	-	-	No	Ablation of first layer, second layer charred, weak
19	09-3918	A	55.0	37.80	-1.08	96.4	No	-	-	No	"
20	09-3918	B	55.0	41.80	-0.40	94.9	No	-	-	No	"
21	09-3918	C	55.0	42.88	-0.28	95.5	No	-	-	No	Ablation of first 2 layers
22											
23											
24											

Test 09-3916, Panel I: 41.6 cal/cm², below ATPV level
Panel II: 41 cal/cm², below ATPV level, Panel III: 42.8 cal/cm², near ATPV level
Panels II&III: Ablation of 1st layer, 2nd layer charred and weak, discoloration on back
Panel I: Ablation of 1st layer, light charring of 2nd layer, small spots on back



