

Test Report



KINECTRICS

Theodolf Fritsche GmbH & Co
Ottengrüner Strasse 86
D-96233 Helmbrechts
Germany

Article No. Fritsche: 44114197 DPF Performance®,
Nomex® Comfort woven, 195 g/m²

ARC RATING by IEC 61482-1-1:2009, Flat Panel Test

Kinectrics Inc. Report No.: K-418223-001-R00

Tested November 10, 2009

Claude Maurice
Project Leader

claudio.maurice@kinectrics.com

PRIVATE INFORMATION

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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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Kinectrics Inc., 800 Kipling Avenue, Toronto, Ontario M8Z 6C4
Tel: 416-207-6305, FAX: 416-207-5717
www.kinectrics.com

Report # K-418223-001-R00

TEST REPORT

Test item: Article No. Fritsche: 44114197 DPF Perf
Nomex® Comfort woven, 195 g/m²

Weight as tested: Measured 210 g/m²

Laundering: Tested as received. Five wash/dry cycles per
(EN ISO 6330:2001 Method 2A (60°C) + Norm)

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: IEC 61482-1-1:2009, *Live working - Protective clothing against the thermal hazards of an electric arc - Part 1-1: Test methods - Method 1 - Determination of the arc rating (ATPV or EBT) of flame resistant materials for clothing*

RESULTS

Flat Panel Samples:

- Arc Rating ATPV = 9.0 cal/cm²
- Heat Attenuation Factor, HAF = 71.7 %
- After flame (Avg of 5 highest): 0 sec
- Break-open: None

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 charred
 - Discolouration on the back
 - Fabric is less flexible (stiff) but not brittle.

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 and break-open observations are recorded, the determination of the Arc Rating is done by logistic regression. The logistic regression is an S-shaped distribution function as shown in Figure 1. The Arc Rating determined by this test method is the amount of energy that predicts a 50% probability of a second degree burn or break-open. When break-open of the fabric (or last

Report # K-418223-001-R00

3 of 7

FR layer) is observed with a mix of burn responses, both values are determined. 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.

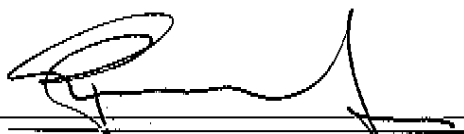
Individual test sheets, graphs, photographs of the samples and video of every test are provided in digital format to the Client for review.

Performed by:

Reviewed by:



Claude Maurice
Project Leader
High Current Laboratory



Emanuel Petrache (Dr)
Principal Engineer
Distribution and Asset Management

Report # K-418223-001-R00

4 of 7

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/cm² 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 Stoll¹ 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 cm² [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.

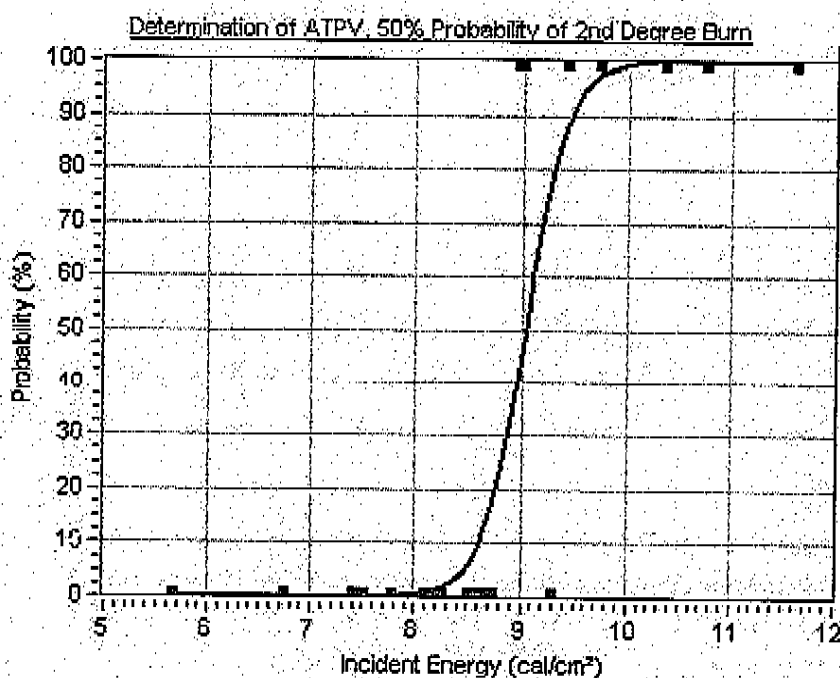
*Stoll curve*¹, *n*— an empirical predicted second-degree skin burn injury model, also commonly referred to as the *Stoll Response*.

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...

¹Derived 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 ATPV using IEC 61482-1-1:2009 Logistic Regression

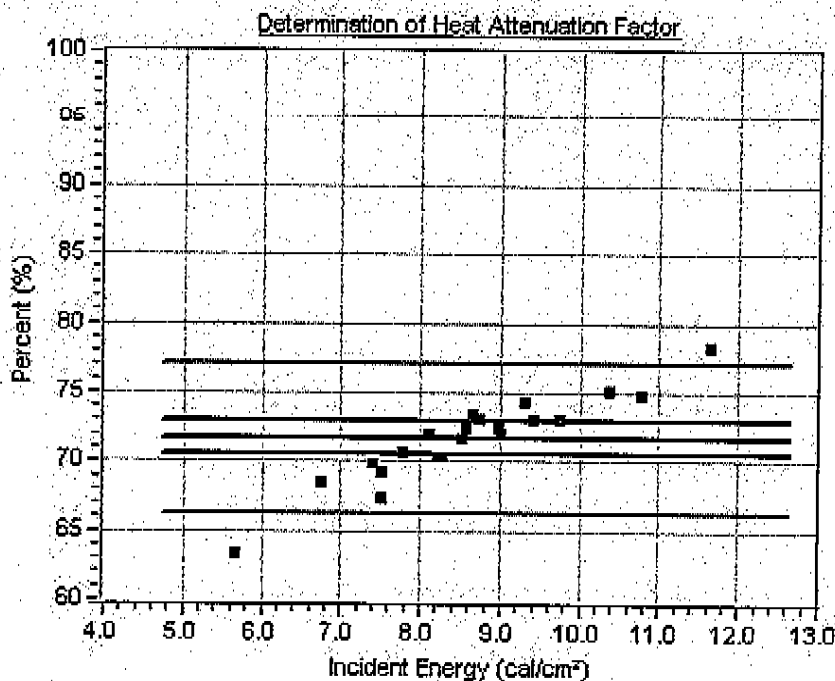
Fabric Article No. Fritsche: 44114197 DPF Performance®
Description: Nomex® Comfort woven, 195 g/m² after 5x wash/dry cycles



ATPV = 9.0 cal/cm²





Probability of Burn	Ei
5%	8.5
10%	8.6
20%	8.8
30%	8.9
40%	9.0
50%	9.0
60%	9.1
70%	9.2
80%	9.3
90%	9.5

Pts = 21
 # Pts above Stoll = 7
 # Pts Break-Open = 0
 # Pts always <STOLL = 5
 # Pts always >STOLL = 13
 # Pts within 20% = 18
 # Pts in mix zone = 3



HAF = 71.7 %

Confidence Intervals
 95% CI = 70.5, 72.9

Data pts 
 Best Fit 
 95% CI 
 95% CI pts 

Report # K-418223-001-R00

7 of 7

Test 09-5238, Panel A: 8.2, Panel B: 9.0, Panel C: 9.3 cal/cm², near the ATPV level
At near ATPV level surface is charred, fabric is stiff but not brittle
Back has some discolouration.

