

4' x 5', 5 Para-aramid layers, Dark Blue, 25 kA
Arc Protective Blanket Model: FP407

**TEST PROCEDURE FOR DETERMINING THE PROTECTIVE
PERFORMANCE OF AN ARC PROTECTIVE BLANKET FOR
ELECTRIC ARC HAZARDS
ASTM F2676-2019
K-352196-01- R00**

Prepared for

Fortress Pacific Corporation

Purchase Order # Q418-1920-AH-R00

Issue Date

November 8, 2019

Prepared by: _____ Yosbani Guerra Technologist Transmission & Distribution Technologies	Approved by: _____ Andrew Haines Supervising Technologist Transmission & Distribution Technologies
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Revision History

Rev 00	Description: Initial Issue		
	Issue Date: November 8, 2019	Prepared by: Yosbani Guerra	Approved by: Andrew Haines

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1 Test Objective

This procedure defines the requirements for the testing of Fortress Pacific's arc protective blankets and determination of the blanket's performance regarding its ability to withstand the effects of arc flash and arc blast when hung or anchored near energized equipment. Specifically, the blanket's resistance to breakopen, mechanical strength and ability to self-extinguish flames in response to a controlled maximum arc exposure will be determined. This test will simulate a condition in a vault or substation where the protective blanket may be attached to provide protection from the thermal effects and pressure wave experienced during an electrical fault. Observations and measurements will be recorded for the purposes of evaluation and any other tests required will be performed by the Fortress Pacific Corporation.

The blankets will be tested in accordance with test method ASTM F2676-2019. Test method ASTM F2676-2019 does not evaluate the blankets or assembly under actual fire conditions or any other conditions related to the use of the blanket. The blankets were received for testing at Kinectrics on October 15, 2019 in new condition. The test was performed by Kinectrics Inc. personnel at 800 Kipling Avenue, Toronto, Ontario, Canada, M8Z 5G5 on October 7, 2019 under Fortress Pacific's purchase order # Q418-1920-AH-R00 dated October 10, 2019 and Kinectrics' ISO 9001 quality management program.

Table 1-1 contains specifications of an arc protective blanket and Figure 1.1 & 1.2 show photos of the test specimen.

Table 1-1 Test specimen description

Manufacturer	Fortress Pacific Corporation
Model	FP407
Colour	Dark Blue
Rated Arc Current	25 kA
Blanket construction	5 Layers of Para-aramid (Kevlar, each layer/weight: 200 g/m ²)
Number of attachment points	14 attachment loops
Strap System	14x Para-aramid and carbon fiber adjustable suspension straps
Blanket dimensions	4' x 5'



Figure 1.1 Non-arc test side view



Figure 1.2 Arc test side view – 14 strap system

2 Test Requirements

The two ratings that will be taken into consideration include maximum arc current (kA) and Breakopen Threshold Performance (BTP) expressed as kA*Cycles. The protective blanket will be intentionally forced to breakopen. Cycles are based on 60 Hz. Only those test conditions that are encountered in the Kinectrics' High Current Laboratory are mentioned in this document.

The test standard requires that test specimens are exposed to three arc current levels to determine the test specimen's performance. A table summarizing arc current rating, test arc current levels and number of samples required is provided below:

Table 2-1 Arc Rating Required Samples

Rated Arc Current I_{max} , kA	Test Arc Current Values, kA and No. of Samples		
25	25 (3)	15 (2)	5 (2)

According to Table 2-1, at least three specimens will be exposed to the blankets rating of 25 kA, at least two specimens exposed to 15 kA and at least two specimens exposed to 5 kA.

The arc protective blanket is considered arc rated if all seven test specimens withstand 10 cycles without breakopen at three different arc current levels. The attachment points shall hold the blanket specimen in place for duration of the arc. The attachment devices must remain functional and melting or dripping of the attachments is considered a failure. The average of the tested specimens including attachments cannot have an afterflame of longer than 30 seconds and any single specimen and attachment is to have no more than 60 seconds of afterflame to meet the test requirements.

3 Test Setup and Procedure

The test was conducted in a concrete vault (Figure 3.1) with the blanket suspended on a metal frame (Figure 3.2). The arc test side of the blanket was approximately six inches away from the electrodes and the arc gap was set to be approximately four inches (Figure 3.3). The figures below show the setup of the test as well as the suspension of the protective blanket.

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Figure 3.1. Concrete vault with frame and electrodes

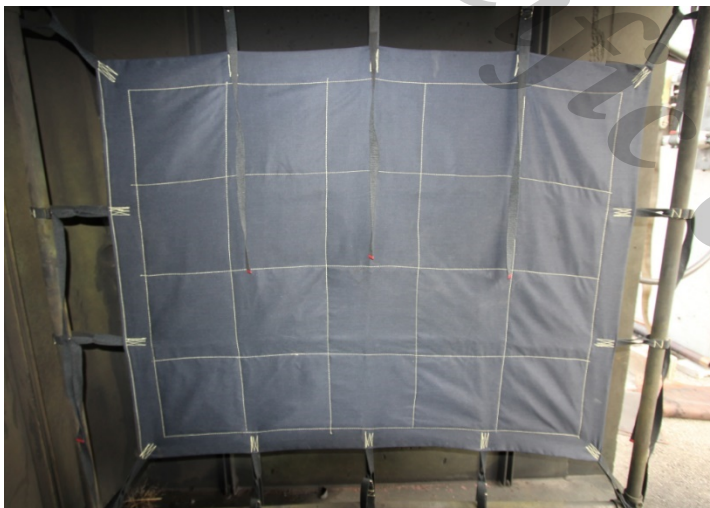


Figure 3.3. Blanket suspension - Non-arc test side view



Figure 3.2. Blanket suspension - side view

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4 Results and Observations

The following table shows the recorded test data for each trial having the blanket tested on the arc test side:

Table 4-1 Test Results

Trial Number	19-7079	19-7080	19-7085	19-7081	19-7082	19-7083	19-7084
Rated Arc Current, I _{max} (kA)	25.0	25.0	25.0	15.0	15.0	5.0	5.0
Specimen Identification [SN]	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Arc Current [Total RMS, kA]	25.4	25.2	25.5	15.4	15.4	5.2	5.2
Duration of Test [cycles]	25.2	30.0	30.0	45.2	45.2	140.0	100.0
Duration to Break-open [ms/cycles]	N/A*	430.0 / 25.8	437.0 / 26.2	750.0 / 45.2	N/A*	1401.0 / 84.1	1447.0 / 86.9
Breakopen Threshold, BTP [kA*cycles]	639.5**	651.3	668.9	697.2	697.3**	440.3	455.3
Number of Failed Attachment Points	0	0	0	0	0	0	0
After-flame [s]	8.0	30.0	23.0	13.0	8.0	26.0	27.0
Melting and Dripping [Yes/No]	No	No	No	No	No	No	No
Average BTP [kA*cycles]	653.2			697.3		447.8	
Average After-flame [s]	20.3			10.5		26.5	

*No break-open

**Based on the full length of the test even though no break-open occurred.

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Figure 4.1 below are the results after three specimens were exposed to the blankets rating of 25 kA. The outcome from tests 19-7079, -7080 and -7085 show the blanket remaining suspended with no mechanical failure or melting or dripping of the attachments. All three specimens were able to withstand at least 10 cycles at the rated arc current and the length of afterflame was less than 60 seconds for each specimen. The specimen from test 19-7079 experienced no break-open and therefore, the break-open threshold value was determined using the entire length of the test.



Figure 4.1. Suspended blanket after test 19-7079 (Top Left), 19-7080 (Top Right) & 19-7085 (Bottom).

Figure 4.2 below are the results after two specimens were exposed to the 15 kA. The outcome from tests 19-7081, and -7082 show the blanket remaining suspended with no mechanical failure or melting or dripping of the attachments. Both specimens were able to withstand at least 10 cycles at the rated arc current and the length of afterflame was less than 60 seconds for each specimen. The specimen from test 19-7082 experienced no break-open and therefore, the break-open threshold value was determined using the entire length of the test.



Figure 4.2. Suspended blanket after test 19-7081 (Left) and 19-7082 (Right)

Figure 4.3 below are the results after two specimens were exposed to the 5 kA. The outcome from tests 19-7083, and -7084 show the blanket remaining suspended with no mechanical failure or melting or dripping of the attachments. Both specimens were able to withstand at least 10 cycles at the rated arc current and the length of afterflame was less than 60 seconds for each specimen.



Figure 4.3. Suspended blanket after test 19-7083 (Left) and 19-7084 (Right)

5 Conclusions

The five-layer Fortress Pacific arc protective blanket, model FP407, successfully met the criteria of ASTM F2676-19. Three test specimens were exposed to a 25 kA current level, two specimens to a 15 kA level and two more specimens to a 5 kA rated arc current. All seven specimens withstood at least 10 cycles without break open. The lowest of the three average BTP values at each current level from Table 4-1 provide the blanket with a 447.8 kA*cycle BTP rating. The average afterflame for all the tests were below 30 seconds and the afterflame for each individual blanket was under 60 seconds. There was no melting or dripping of the attachments and each specimen stayed suspended throughout the duration of their tests.

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5. 測試報告結果判定(Conclusions)

Fortress Pacific所生產型號FP407的五層電弧防護毯成功滿足ASTM F2676-19的標準。在25 kA的電流下，測試了3個測試樣品；在15 kA的水平下，測試了2個測試樣品；在5 kA的額定電弧電流下，亦測試了2個測試樣品。所有七個測試樣品經受了至少10個循環而沒有斷裂。

從表4-1的測試結果中顯示：25kA、15kA及5kA中，即使取其中平均BTP值(kA *週期)中的最低值，仍有447.8。所有測試的平均餘燃均在30秒以下，每條毯子的餘燃均在60秒以下。全部沒有熔滴，每個樣品在整個測試過程中都無脫落。



Appendix A Instrumentation Sheet



INSTRUMENTATION SHEET Kinectrics Testing Laboratories

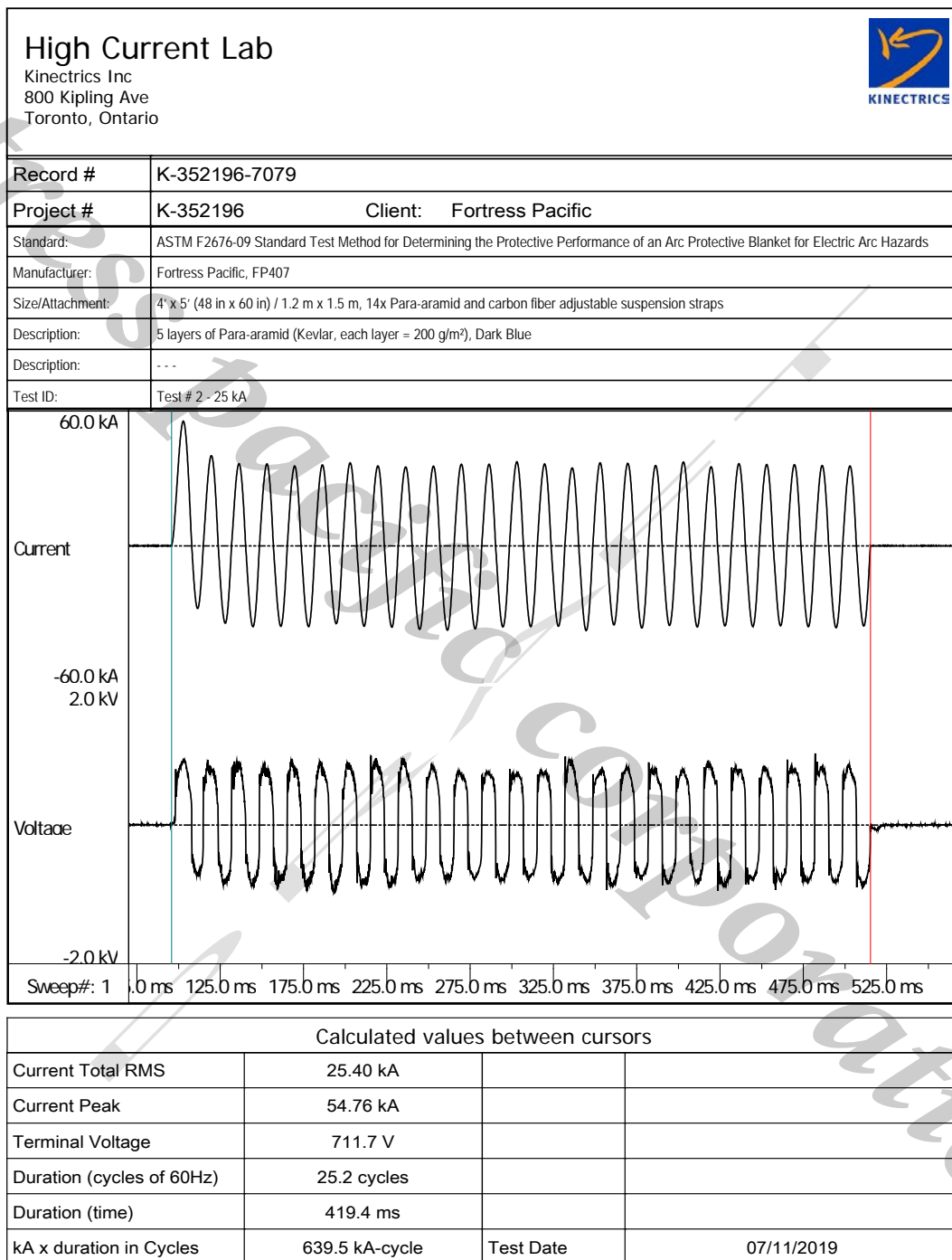
Test Description: ASTM F2676-19 Blast Blanket Testing

Test Date: November 7, 2019

Item No.	Description	Asset #/ sn	Stated Accuracy	Calibration date	Calibration due date	Test parameter
1	Nicolet Waveform Analyzer BE256	KIN-04738	±0.5%	Mar 14, 2019	Mar 14, 2020	Waveform Recorder: Voltage & Current
2	Current transformer (CT2)	KIN-04506	±0.5%	Dec 1, 2017	Dec 1, 2020	Current transformer to measure current across test item
3	Resistive instrumentation shunt panel	KIN-03460	±0.5%	June 18, 2019	June 18, 2021	Non inductive shunt, 0.5 ohms (with line item 2)
4	Potential Transformer, PT#1	KIN-01193	±0.5%	April 18, 2018	April 18, 2021	2400V/120V Potential Transformer to measure voltage across test item
5	Isolation Amplifier BE560, CH1	KIN-1708	±0.5%	April 18, 2019	April 18, 2020	Used with line item 4 to measure voltage

Test performed by: High Current Lab Team
Project Number: K-352196 Fortress Pacific

Appendix B Test Waveforms

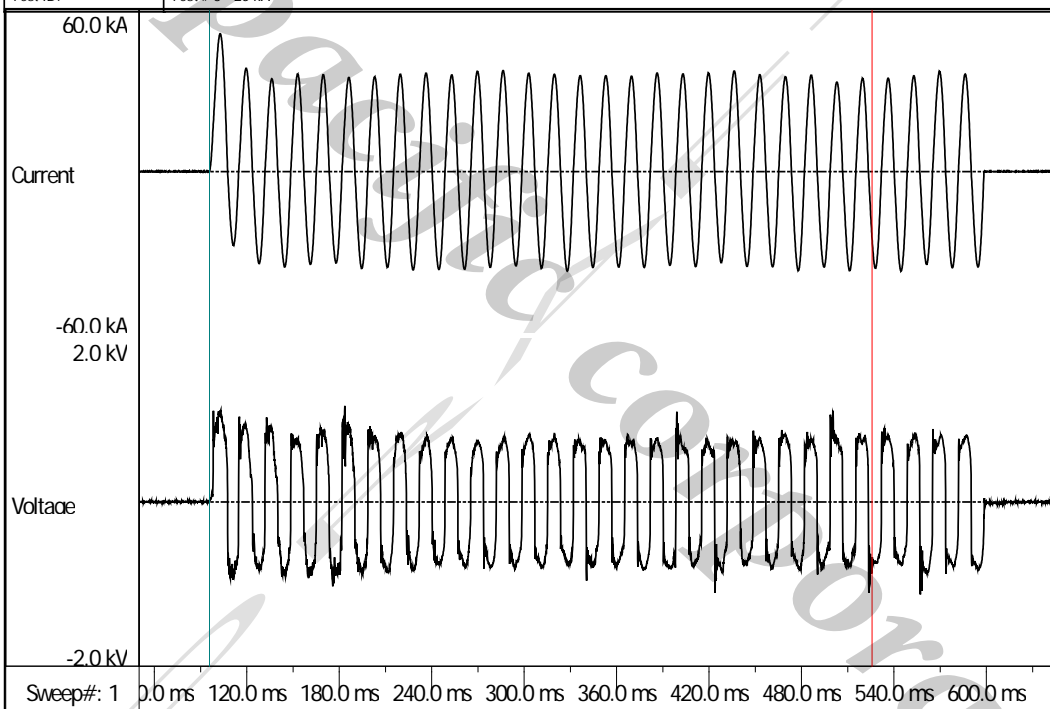


High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario



Record #	K-352196-7080		
Project #	K-352196	Client:	Fortress Pacific
Standard:	ASTM F2676-09 Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards		
Manufacturer:	Fortress Pacific, FP407		
Size/Attachment:	4' x 5' (48 in x 60 in) / 1.2 m x 1.5 m, 14x Para-aramid and carbon fiber adjustable suspension straps		
Description:	5 layers of Para-aramid (Kevlar, each layer = 200 g/m²), Dark Blue		
Description:	- - -		
Test ID:	Test # 3 - 25 kA		



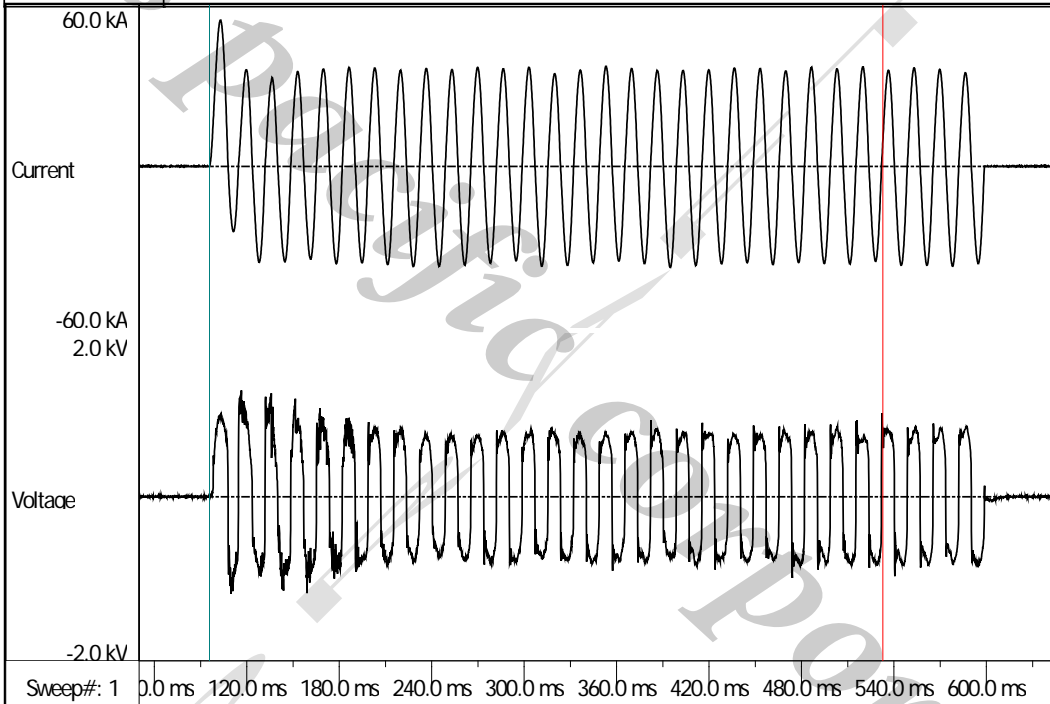
Calculated values between cursors			
Current Total RMS	25.23 kA		
Current Peak	51.11 kA		
Terminal Voltage	701.4 V		
Duration (cycles of 60Hz)	25.8 cycles		
Duration (time)	430.0 ms		
kA x duration in Cycles	651.3 kA-cycle	Test Date	07/11/2019

High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario



Record #	K-352196-7085		
Project #	K-352196	Client:	Fortress Pacific
Standard:	ASTM F2676-09 Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards		
Manufacturer:	Fortress Pacific, FP407		
Size/Attachment:	4' x 5' (48 in x 60 in) / 1.2 m x 1.5 m, 14x Para-aramid and carbon fiber adjustable suspension straps		
Description:	5 layers of Para-aramid (Kevlar, each layer = 200 g/m²), Dark Blue		
Description:			
Test ID:	Test # 8 - 25 kA		



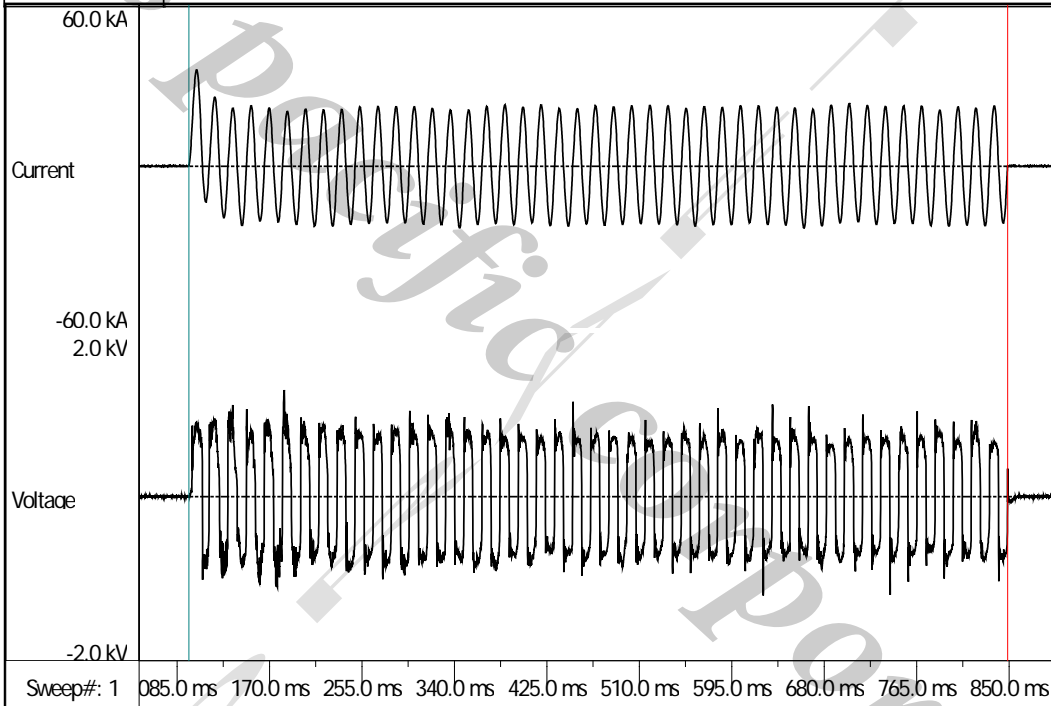
Calculated values between cursors			
Current Total RMS	25.50 kA		
Current Peak	54.23 kA		
Terminal Voltage	712.1 V		
Duration (cycles of 60Hz)	26.2 cycles		
Duration (time)	437.0 ms		
kA x duration in Cycles	668.9 kA-cycle	Test Date	07/11/2019

High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario



Record #	K-352196-7081		
Project #	K-352196	Client:	Fortress Pacific
Standard:	ASTM F2676-09 Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards		
Manufacturer:	Fortress Pacific, FP407		
Size/Attachment:	4' x 5' (48 in x 60 in) / 1.2 m x 1.5 m, 14x Para-aramid and carbon fiber adjustable suspension straps		
Description:	5 layers of Para-aramid (Kevlar, each layer = 200 g/m²), Dark Blue		
Description:			
Test ID:	Test # 4 - 15 kA		



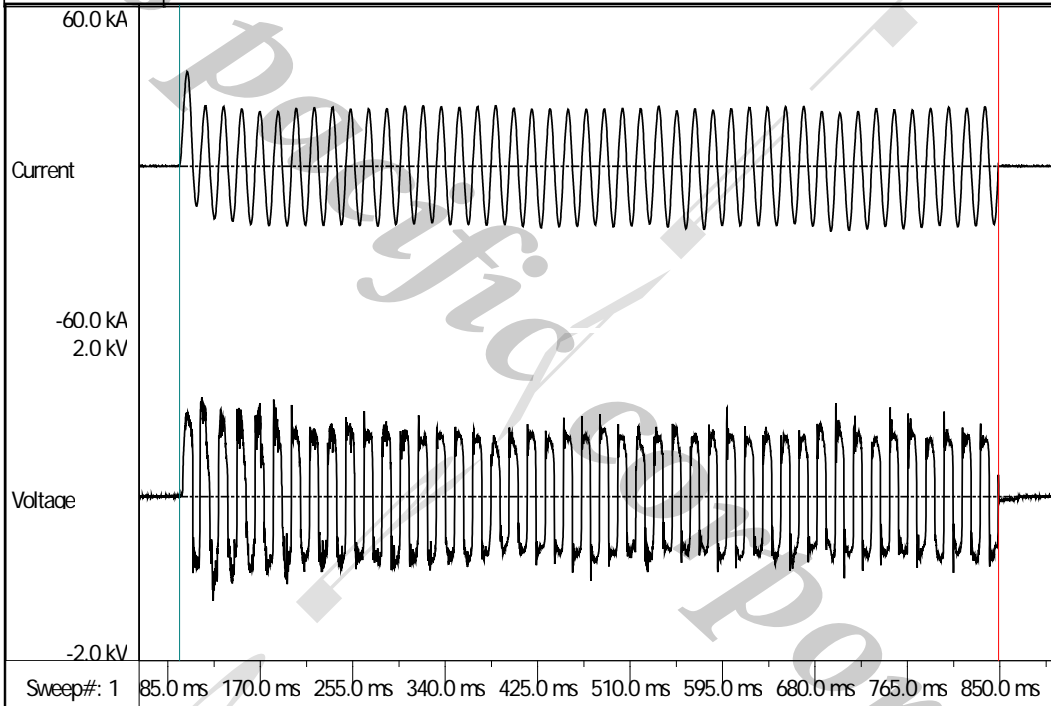
Calculated values between cursors			
Current Total RMS	15.43 kA		
Current Peak	35.74 kA		
Terminal Voltage	687.1 V		
Duration (cycles of 60Hz)	45.2 cycles		
Duration (time)	752.8 ms		
kA x duration in Cycles	697.2 kA-cycle	Test Date	07/11/2019

High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario



Record #	K-352196-7082		
Project #	K-352196	Client:	Fortress Pacific
Standard:	ASTM F2676-09 Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards		
Manufacturer:	Fortress Pacific, FP407		
Size/Attachment:	4' x 5' (48 in x 60 in) / 1.2 m x 1.5 m, 14x Para-aramid and carbon fiber adjustable suspension straps		
Description:	5 layers of Para-aramid (Kevlar, each layer = 200 g/m²), Dark Blue		
Description:			
Test ID:	Test # 5 - 15 kA		



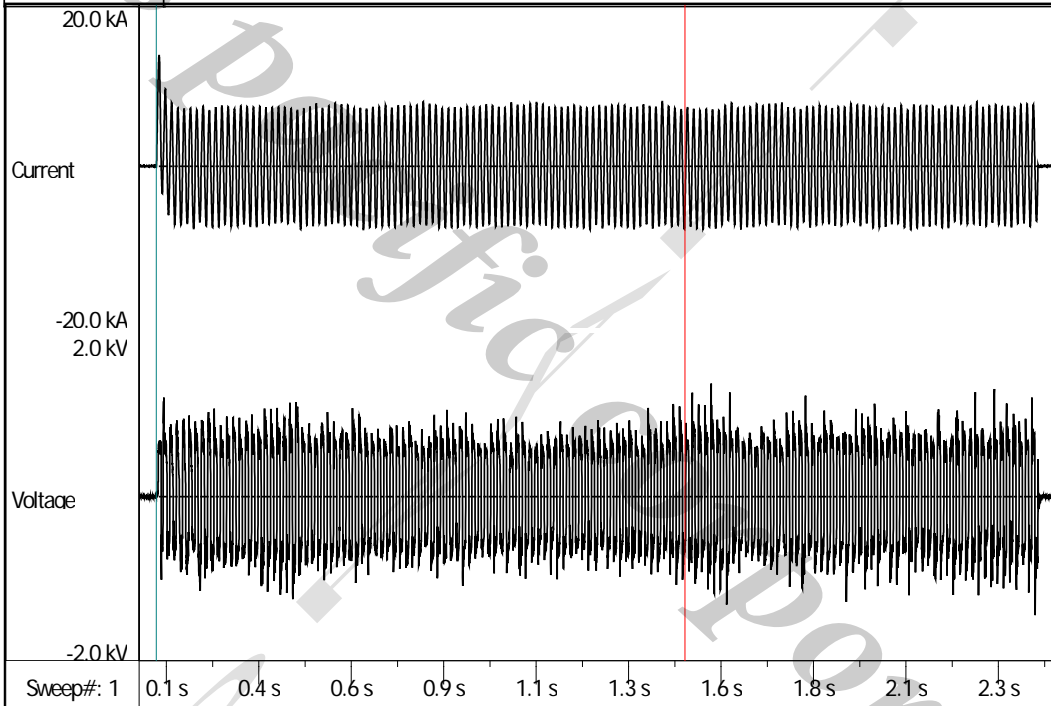
Calculated values between cursors			
Current Total RMS	15.43 kA		
Current Peak	35.05 kA		
Terminal Voltage	686.6 V		
Duration (cycles of 60Hz)	45.2 cycles		
Duration (time)	753.0 ms		
kA x duration in Cycles	697.3 kA-cycle	Test Date	07/11/2019

High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario



Record #	K-352196-7083		
Project #	K-352196	Client:	Fortress Pacific
Standard:	ASTM F2676-09 Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards		
Manufacturer:	Fortress Pacific, FP407		
Size/Attachment:	4' x 5' (48 in x 60 in) / 1.2 m x 1.5 m, 14x Para-aramid and carbon fiber adjustable suspension straps		
Description:	5 layers of Para-aramid (Kevlar, each layer = 200 g/m²), Dark Blue		
Description:			
Test ID:	Test # 6 - 5 kA		



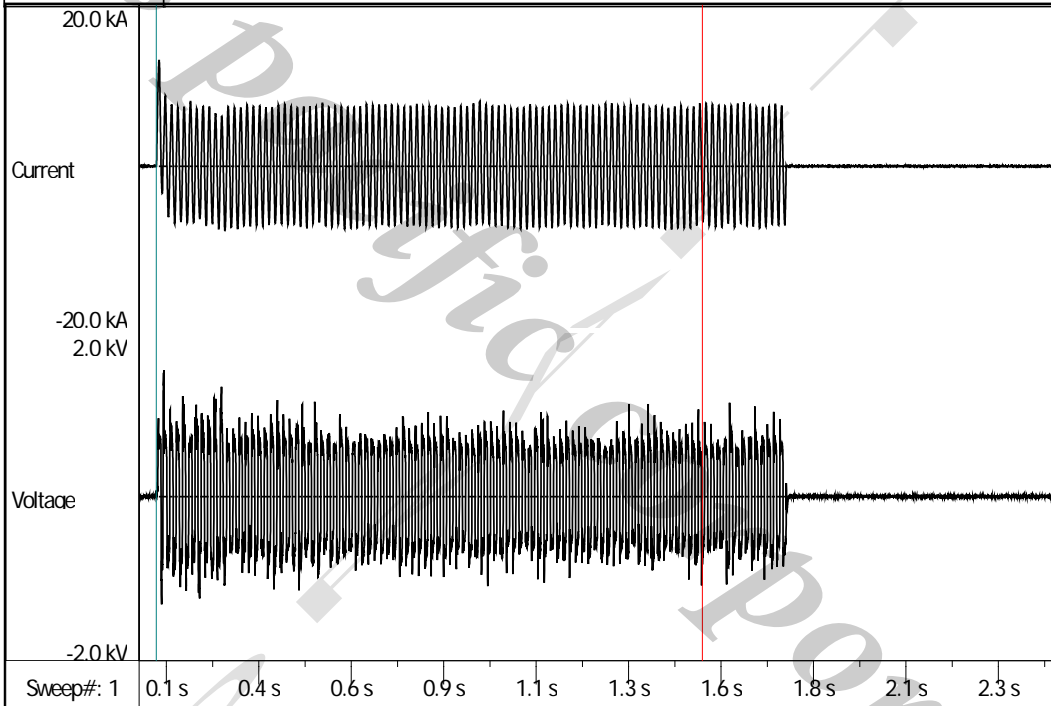
Calculated values between cursors			
Current Total RMS	5.236 kA		
Current Peak	13.67 kA		
Terminal Voltage	638.7 V		
Duration (cycles of 60Hz)	84.1 cycles		
Duration (time)	1.401 s		
kA x duration in Cycles	440.3 kA-cycle	Test Date	07/11/2019

High Current Lab

Kinectrics Inc
800 Kipling Ave
Toronto, Ontario



Record #	K-352196-7084		
Project #	K-352196	Client:	Fortress Pacific
Standard:	ASTM F2676-09 Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards		
Manufacturer:	Fortress Pacific, FP407		
Size/Attachment:	4' x 5' (48 in x 60 in) / 1.2 m x 1.5 m, 14x Para-aramid and carbon fiber adjustable suspension straps		
Description:	5 layers of Para-aramid (Kevlar, each layer = 200 g/m²), Dark Blue		
Description:			
Test ID:	Test # 7 - 5 kA		



Calculated values between cursors			
Current Total RMS	5.242 kA		
Current Peak	13.05 kA		
Terminal Voltage	637.6 V		
Duration (cycles of 60Hz)	86.9 cycles		
Duration (time)	1.447 s		
kA x duration in Cycles	455.3 kA-cycle	Test Date	07/11/2019

Appendix C Kinectrics ISO 9001 Certificate of Registration



CERTIFICATE OF REGISTRATION

This is to certify that
Kinectrics Inc.
Kinectrics North America Inc., Kinectrics International Europe ApS, Kinectrics GmbH or
Kinectrics International Inc.
800 Kipling Avenue Unit 2 Toronto, Ontario M8Z 5G5 Canada

Refer to Attachment to Certificate of Registration dated May 30, 2018 for additional certified sites
operates a
Quality Management System
which complies with the requirements of
ISO 9001:2015
for the following scope of certification

The registration covers the Quality Management System for consulting, scientific, and engineering services within our facilities and at field sites in the civil, chemical, electrical, environmental, mechanical, materials and metallurgical fields, safety and licensing, research, design and development and general project management for clients in the nuclear industry, electric power generation transmission & distribution, and related energy sectors. Within the nuclear industry services, life cycle management, safety assessment and analysis, probabilistic risk assessment regulatory affairs and licensing, fuel and fuel channel assessments, environment, waste management, decommissioning and health physics, and engineering and operations support.

Certificate No.: CERT-0119294	Original Certification Date: July 7, 1998
File No.: 006555	Certification Effective Date: May 24, 2018
Issue Date: May 30, 2018	Certification Expiry Date: May 23, 2021


Nicole Grantham
General Manager SAI Global Certification Services

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