25kV 200A Deadbreak Elbow Connector Design Test Report

Report Number:	Test Start Date:	Test Complete Date:
RN-R7607	2014 / 10 / 09	2015 / 10 / 15

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1. Partial Discharge - Deadbreak Elbow

Object

To verify the connectors that the parts meet ANSI/IEEE Standard 386-2006 25kV partial discharge requirement of 19kV/3pC.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	10 PCS

Mating Parts

Deadbreak Bushing	25kV 200A
Elbow Test Rod	25kV#C Testing Rod Φ22.30mm

Procedure and Testing Spec

The test voltage shall be raised to 20% above the corona voltage level of 19kV. If corona exceeds 3pC, the test voltage shall be lowered the corona voltage level of 19kV and maintained at this level for at least 3 seconds but not more than 60 seconds. Corona readings taken during this period shall not exceed 3 pC.

Results

Sample number	Corona voltage level
A1	23 kV / 0.5 pC
A2	23 kV / 0.5 pC
A3	23 kV / 0.5 pC
A4	23 kV / 0.5 pC
A5	23 kV / 0.6 pC
A6	23 kV / 0.6 pC
A7	23 kV / 0.6 pC
A8	23 kV / 0.6 pC
A9	23 kV / 0.8 pC
A10	23 kV / 0.8 pC

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2. AC Withstand Voltage Test - Deadbreak Elbow

Object

To verify the connectors that the parts meet ANSI/IEEE standard 386-2006 25kV AC withstand requirement of 40kV/ 1 min.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	10 PCS

Mating Parts

Deadbreak Bushing	25kV 200A
Elbow Test Rod	25kV#C Testing Rod Φ22.30mm

Procedure and Testing Spec

The test voltage shall be raised to the value of 40kV in 30 seconds. The test sample shall withstand the specified test voltage for 1 minute without flashover or puncture.

Results

Sample number	40kV/1min AC withstand voltage
A1	PASS
A2	PASS
A3	PASS
A4	PASS
A5	PASS
A6	PASS
A7	PASS
A8	PASS
A9	PASS
A10	PASS

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3. DC Withstand Voltage Test – Deadbreak Elbow

Object

To verify the connectors that the parts meet the ANSI/IEEE Standard 386-2006 25kV DC withstand voltage testing spec of 78kV/15 min.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	10 PCS

Mating Parts

Deadbreak Bushing	25kV 200A
Elbow Test Rod	25kV#C Testing Rod Φ22.30mm

Procedure and Testing Spec

The test voltage shall have a negative polarity and shall be raised to the value of 78kV. The connector shall withstand the specified test voltage for 15 minutes without flashover or puncture.

Results

Sample number	-78kV/15min DC withstand voltage
A1	PASS
A2	PASS
A3	PASS
A4	PASS
A5	PASS
A6	PASS
A7	PASS
A8	PASS
A9	PASS
A10	PASS

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Fig 3-1 DC Withstand Voltage Test Setup

Fig 3-2 DC Withstand Voltage Test in Progress

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4. Impulse Withstand Testing – Deadbreak Elbow

Object

To verify the connectors that the parts meet ANSI/IEEE Standard 386-2006 25kV impulse withstand testing requirements of 1.2×50μs ±125kV wave., 3 positive and 3 negative full-wave impulses.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	10 PCS

Mating Parts

Deadbreak Bushing	25kV 200A
Elbow Test Rod	25kV#C Testing Rod Φ22.30mm

Procedure and Testing Spec

The test voltage shall be 1.2/50μs wave having the crest value (BIL) of 125kV. The connector shall withstand 3 positive and 3 negative full-wave impulses without flashover or puncture.

Results

Sample number	1.2×50μs±125kV Impulse withstand voltage
A1	PASS
A2	PASS
A3	PASS
A4	PASS
A5	PASS
A6	PASS
A7	PASS
A8	PASS
A9	PASS
A10	PASS

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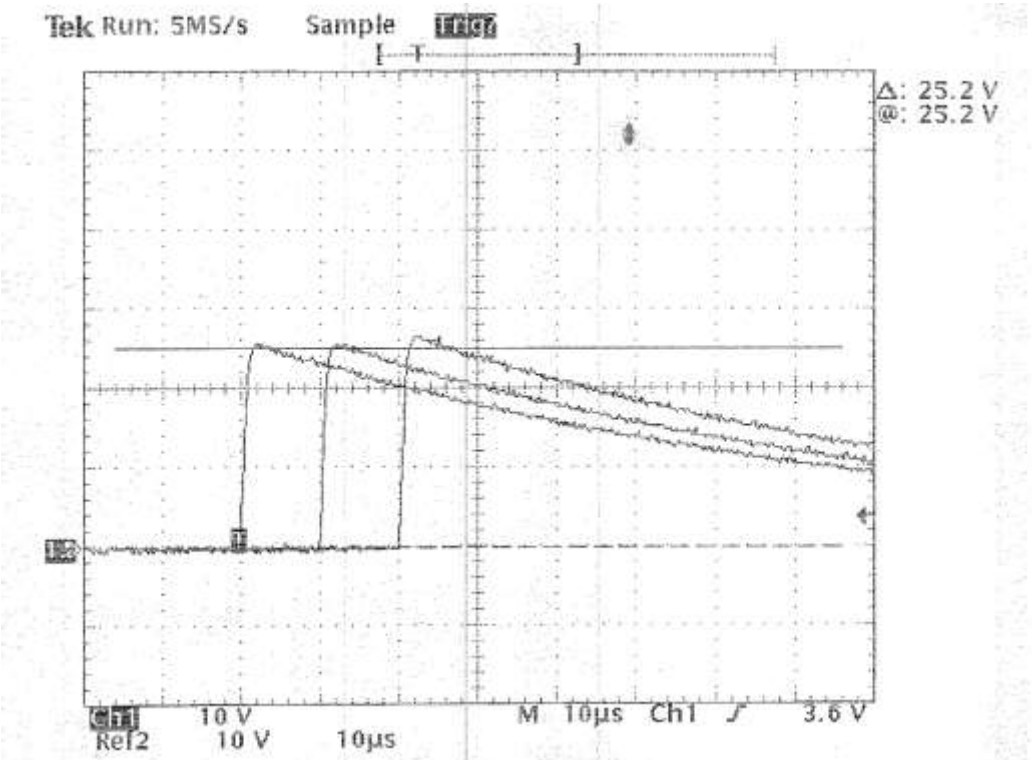
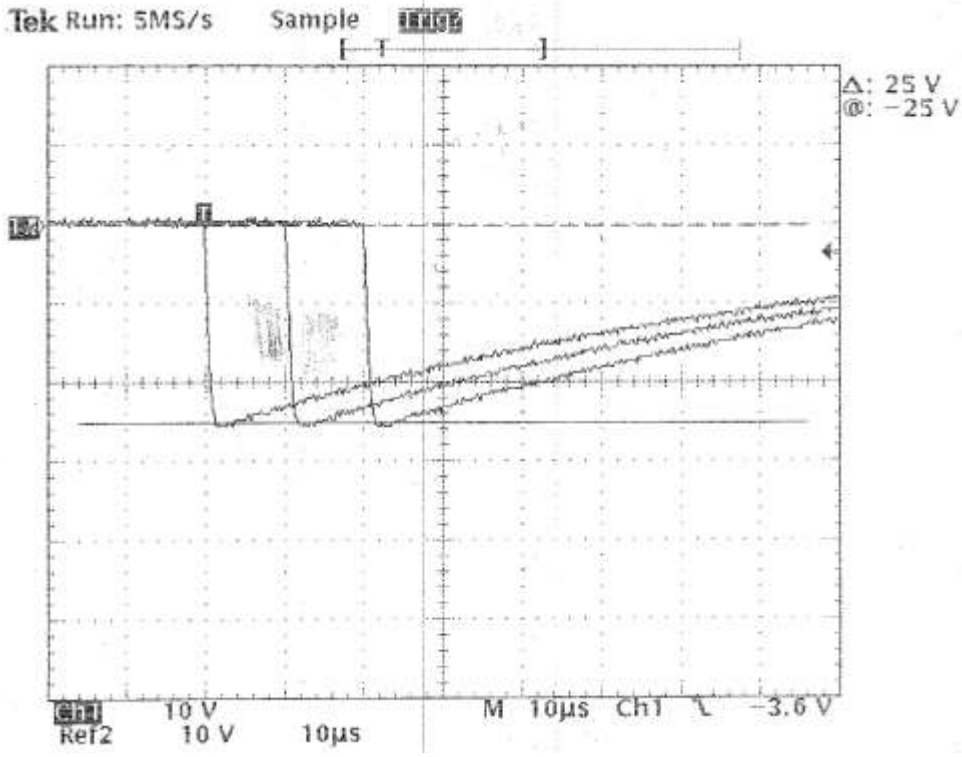


Impulse Withstand – Positive Wave



Impulse Withstand Testing – Negative Wave

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5. Short-time Current Testing – Deadbreak Elbow

Object

To verify the connectors that the parts meet ANSI/IEEE Standard 386-2006 200A short-time current test requirements.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	4 PCS

Mating Parts

Deadbreak Bushing	25kV 200A
Cable Conductor Type	1/0 AWG(Aluminum)

Procedure and Testing Spec

The rms value of the first major loop of a current wave shall be not less than the value specified in Table 2 multiplied by 1.3 (X/R=6) for 200 A connectors The magnitude shall be measured in accordance with ANSI/IEEE C37.09.
Connectors shall withstand the current without separation of interfaces or impairing the ability to meet the other requirements of the standard.

Results

10kA/0.17sec

Sample number	1st Cycle Current (peak)	1st Cycle Current (rms)	Current (rms)	Time	Verification	Result
A11&A12	31.1kA	21.9kA	15.0kA	0.17 sec	Normal	PASS
A13&A14	30.1kA	21.3kA	15.0kA	0.18 sec	Normal	PASS

3.5kA/3sec

Sample number	1st Cycle Current (peak)	1st Cycle Current (rms)	Current (rms)	Time	Verification	Result
A11&A12	7.79kA	5.5kA	4.27kA	3.04 sec	Normal	PASS
A13&A14	8.71kA	6.15kA	4.3kA	3.02 sec	Normal	PASS

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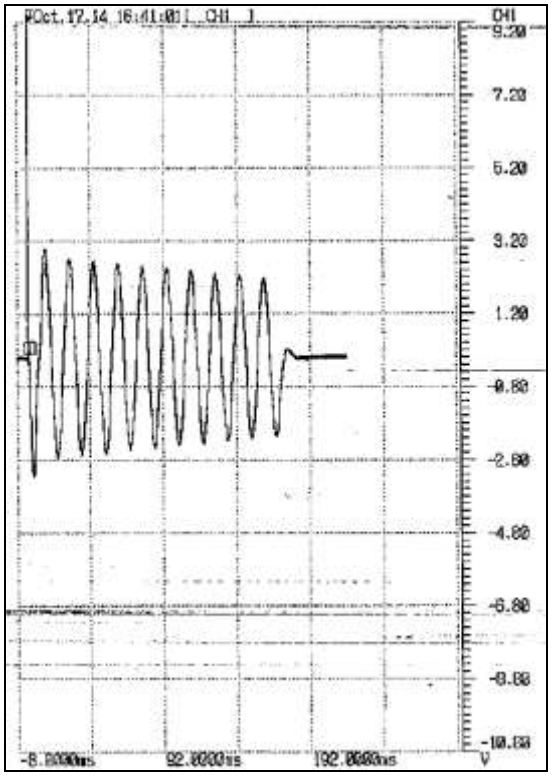
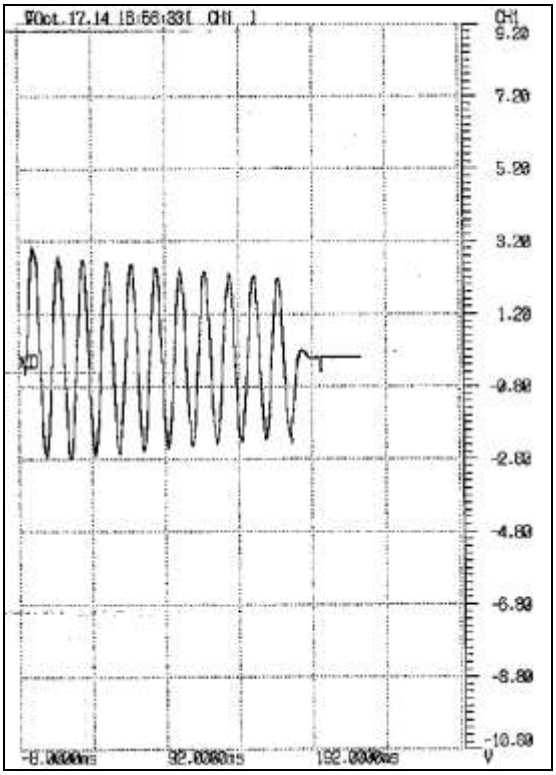


A11&A12 10kA/0.17sec



A13&A14 10kA/0.18sec

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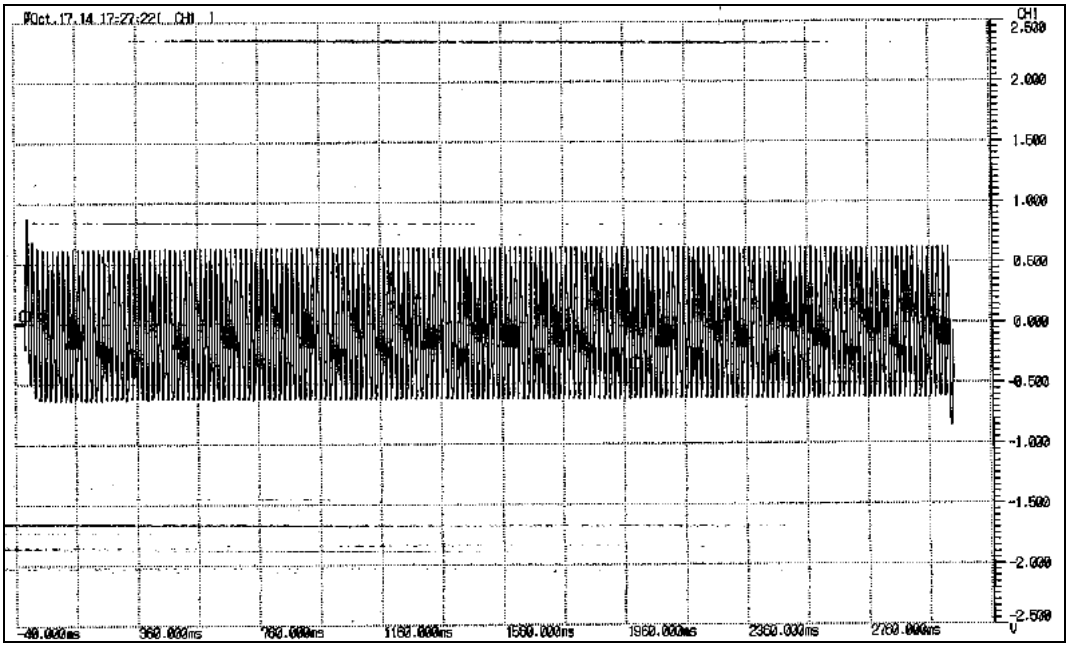
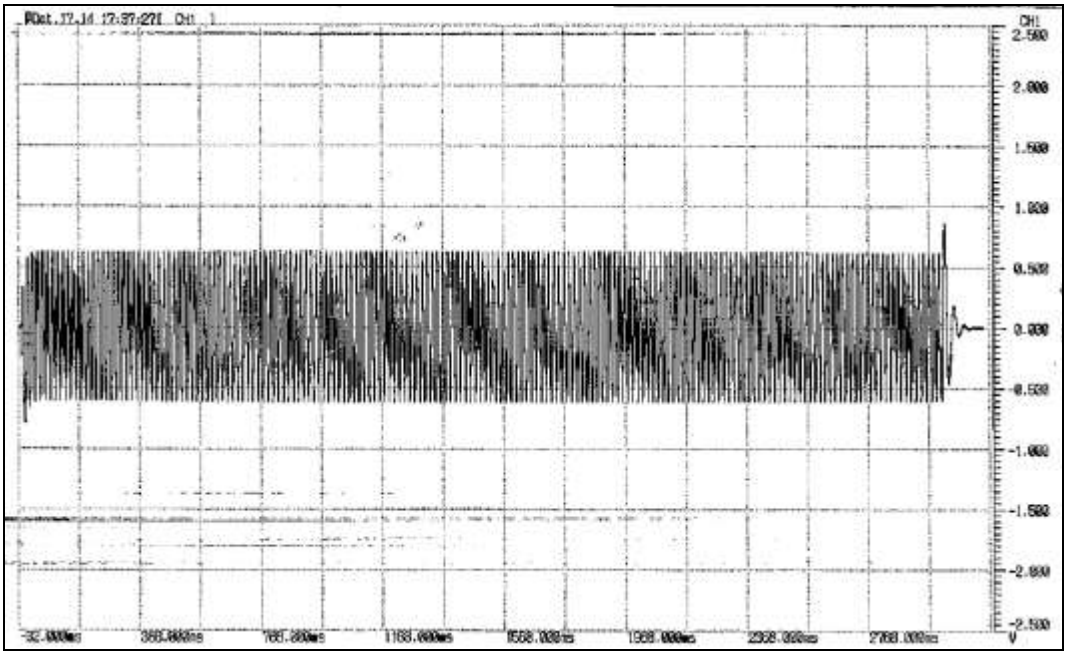


A1&A2 3.5kA/3.04sec



B1&B2 3.5kA/3.02sec

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6. Cable Pull-Out Test Deadbreak Elbow

Object

To verify the compression lug and cable assembly that the parts can meet ANSI/IEEE Standard 386-2006 Cable Pull-Out Test requirements.

Testing Samples

Elbow Compression Lug	200A Bi-Metal Lug	4 PCS

Mating Parts

Cable	1/0 AWG(Aluminum)

Procedure and Testing Spec

The purpose of this test is to determine if the connection between the cable conductor and compression lug of the connector is capable of withstanding a tensile force of 890 N (200 lbf).

The compression lug shall be held in a manner that will not affect the strength of the connection. The tensile force shall be applied to the cable conductor.

The connection shall withstand the applied force for 1 minute without impairing the connector's ability to meet the other requirements of this standard.

Results

Sample number	Measurement	Result
A1	214.28 lbf	PASS
A2	214.28 lbf	PASS
A3	213.4 lbf	PASS
A4	213.4 lbf	PASS

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Fig 6-1 Test in Progress

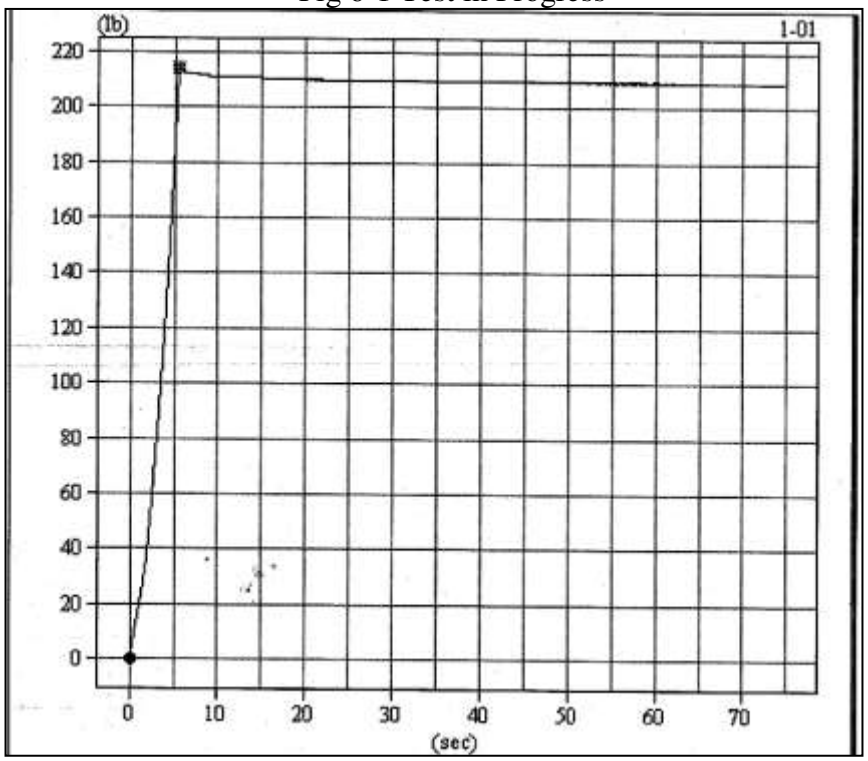

Fig 6-2 Pull Force Diagram

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7. Operating Force Test Deadbreak Elbow

Object

To verify the force of the elbow connector operating force when mating with bushing that the force meets NSI/IEEE Standard 386-2006 operating force requirement.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	4 PCS

Mating Parts

Deadbreak Bushing	25kV 200A
Elbow Test Rod	25kV#C Testing Rod Φ22.30mm

Procedure

The purpose of this test is to demonstrate that the force necessary to operate a connector meets the requirements of 6.2.(44 N - 890 N (10 lbf - 200 lbf) for connectors with hold-down bails)
The elbow shall be assembled with a probe and compression lug and the connector system shall be lubricated in accordance with the manufacturer's instructions.

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Results

	Sample number	Open	Close	Result
Room Temperature 27℃	A11	16 lbf	116 lbf	PASS
	A12	17 lbf	120 lbf	PASS
	A13	17 lbf	133 lbf	PASS
	A14	18 lbf	128 lbf	PASS
-20 ℃	A11	17 lbf	120 lbf	PASS
	A12	17 lbf	129 lbf	PASS
	A13	18 lbf	132 lbf	PASS
	A14	19 lbf	131 lbf	PASS
65 ℃	A11	16 lbf	114 lbf	PASS
	A12	16 lbf	117 lbf	PASS
	A13	17 lbf	128 lbf	PASS
	A14	17 lbf	125 lbf	PASS

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Fig 7-1 Test Seup

Fig 7-2 Testing in Progress

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8. Operating Eye Test - Deadbreak Elbow

Object

To verify the elbow operating eye that the part meet ANSI/IEEE Standard 386-2006 requirements.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	4 PCS

Mating Parts

Testing Fixture

Procedure and Testing Spec

The purpose of this test is to demonstrate that the operating eye meets the requirements of 6.2 at 25°C ±5°C.
A tensile force shall be gradually applied to the operating eye in the direction of normal operation. The operating eye shall withstand the force for 1 minute.
A rotational force shall be applied with a suitable live-line tool to the operating eye in a clockwise direction and in a counter-clockwise direction.
Some distortion of the operating eye is acceptable provided the connector is serviceable after the test and meets the corona voltage-level requirement specified in Table 1 of IEEE standard 386-2006.

Results

Sample number	500 lbf /min	120 lbf-in rotational force	PD Test
A11	PASS	PASS	23 kV / 1.9 pC
A12	PASS	PASS	23 kV / 0.9 pC
A13	PASS	PASS	23 kV / 1.6 pC
A14	PASS	PASS	23 kV / 0.8 pC

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9. Test Point Cap Test - Deadbreak Elbow

Object

To verify the test point cap of the elbow that the part meets ANSI/IEEE Standard 386-2006 requirement.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	4 PCS
Test Point Cap		4 PCS
Testing Fixture		

Procedure and Testing Spec

The purpose of this test is to demonstrate that the removal force of the test point cap meets the requirements of 6.5.2 and the cap operating eye is capable of withstanding the maximum operating force

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Results

	Sample number	Pull Force (8 lbf – 49 lbf)	100 lbf Pulling	Result
Room Temperature 27℃	A11	19.80 lbf	PASS	PASS
	A12	24.64 lbf	PASS	PASS
	A13	20.68 lbf	PASS	PASS
	A14	25.08 lbf	PASS	PASS
-20 ℃	A11	22.43 lbf	PASS	PASS
	A12	25.33 lbf	PASS	PASS
	A13	23.47 lbf	PASS	PASS
	A14	27.56 lbf	PASS	PASS
65 ℃	A11	19.65 lbf	PASS	PASS
	A12	22.38 lbf	PASS	PASS
	A13	20.22 lbf	PASS	PASS
	A14	24.71 lbf	PASS	PASS

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10. Test Point Test - Deadbreak Elbow

Object

To verify the elbow test point meeting the ANSI/IEEE Standard 386-2006 testing requirement.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	10 PCS

Mating Parts

LCR Meter	Delta united instrument DU-6021
Testing Fixture	

Procedure and Testing Spec

The purpose of this test is to verify that the capacitance values of the test point meet the requirements of 6.5.1. of IEEE 386.
The connector shall be installed on a cable of the type for which it is designed to operate, and the shielding shall be grounded in the normal manner. The capacitances from test point to cable and test point to ground shall be measured with suitable instruments and proper shielding techniques. The measured values shall be within the tolerances specified in 6.5.1. of IEEE 386.

Results

Sample number	Test point and the conductor shall be at least 1.0 pF.	Test point and shield to the capacitance between test point and conductor shall not exceed 12.0	Result
A1	7.48 pF	1.29	PASS
A2	7.60 pF	1.34	PASS
A3	7.72 pF	1.25	PASS
A4	7.51 pF	1.24	PASS
A5	7.86 pF	1.27	PASS
A6	7.64 pF	1.28	PASS
A7	7.75 pF	1.31	PASS
A8	7.92 pF	1.24	PASS
A9	7.69 pF	1.29	PASS
A10	7.71 pF	1.35	PASS

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11. Test Point Voltage Test - Deadbreak Elbow

Object

To verify the elbow test point Voltage meeting the ANSI/IEEE Standard 386-2006 testing requirement.

Testing Samples

Deadbreak Elbow	25-DE200TC06B	10 PCS

Mating Parts

Deadbreak Bushing	25kV 200A
Elbow Test Rod	25kV#C Testing Rod Φ22.30mm
Hi-ZTM Portable HV AC Voltmeter	

Procedure and Testing Spec

A test voltage shall be applied to the conductor system of the connector. The response of a suitable sensing device on the test point shall indicate an energized condition.

Results

Sample number	Test Point Voltage Testing is applied with 15.0kV	Result
A1	12 kV	PASS
A2	12 kV	PASS
A3	12 kV	PASS
A4	12 kV	PASS
A5	12 kV	PASS
A6	11.5 kV	PASS
A7	12 kV	PASS
A8	12 kV	PASS
A9	11.5 kV	PASS
A10	12 kV	PASS

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12. Shielding Test - Deadbreak Elbow

Object

To verify the outer conductive layer of the connector that the material meet ANSI/IEEE Standard 386-2006 requirement of shielding test

Testing Samples

Elbow	25-DE200TC06B	4 PCS

Mating Parts

LCR Meter	Delta united instrument DU-6021

Procedure

1. *Shield Resistance*. The shield resistance measured between the cable entrance and the farthest extremity of the shield from the cable entrance shall be 5000Ω or less.
2. *Fault-Current Initiation.* The semi-conducting shield shall be capable of initiating two consecutive fault-current arcs to ground specified in 4.3, IEEE 592.

Results

1. Shield Resistance

Temperature	Sample number	5000Ω max	Result
27 ℃	A11	1000Ω	PASS
	A12	1101Ω	PASS
	A13	1142Ω	PASS
	A14	1053Ω	PASS

Temperature	Sample number	5000Ω max	Result
90 ℃	A11	1145Ω	PASS
	A12	1326Ω	PASS
	A13	1467Ω	PASS
	A14	1259Ω	PASS

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Temperature	Sample number	5000Ω max	Result
27 ℃ (Air oven aged for 504 h at 121 ℃)	A11	1144Ω	PASS
	A12	1208Ω	PASS
	A13	1232Ω	PASS
	A14	1159Ω	PASS

Temperature	Sample number	5000Ω max	Result
28 ℃ (Air oven aged for 504 h at 121 ℃)	A11	1215Ω	PASS
	A12	1371Ω	PASS
	A13	1582Ω	PASS
	A14	1296Ω	PASS

2. *Fault-Current Initiation:* The outer conductive layers of deadbreak elbow are using the same material with Chardon 25kV Loadbreak Elbow. 2 Chardon Loadbreak Elbows samples successfully initiate two consecutive fault-current arcs to ground in the test performed in Powertech Labs, Surrey, B.C., Canada. All 2 samples passed. Powertech Test Report № PL-26015B. See APPENDIX.

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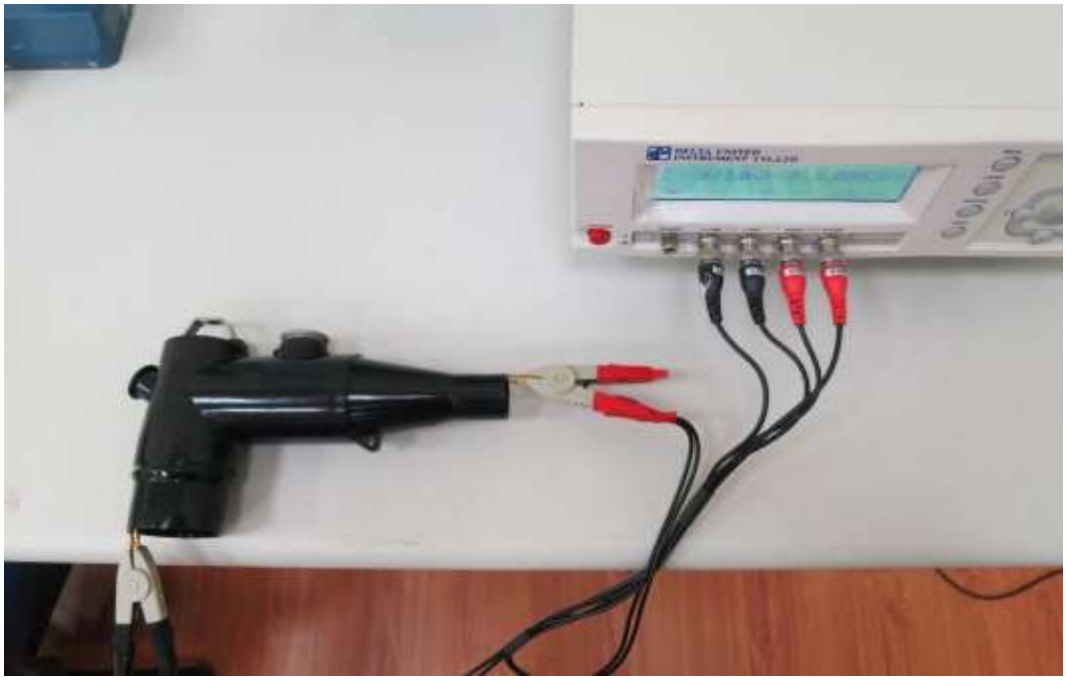

Fig 12-1 Testing in Progress

Fig 12-2 Test Readings

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13. Current Cycling – Accelerated Thermal Test

Object

The purpose of this accelerated test is to demonstrate that 200 A insulated connectors can carry rated current under usual service conditions. Successful completion of the test shall be considered as evidence that the connector meets its rating.

Testing Samples and Mating Parts

Elbow	CHARDON 25-DE200T	4 PCS
Bushing	CHARDON 24-DIB250	4 PCS

Mating Parts

Cable Conductor Type	1/0 AWG(Aluminum)
Cable Insulation Thickness	220 mil
Conductor	200A Bi-Metal Lug
Equalizers	Aluminum Equalizers Size： 106mm(L)20mm(OD)10.1mm(ID)
Bushing Bus	356mm(L), 102mm(W),10mm(T)

Testing Spec

A control cable, used for the purpose of obtaining conductor temperature, shall be installed in the heat cycle loop between two equalizers. Its length shall be 183 cm (72 in). The control cable shall be the same type and size as the cable used to join the connectors under test.

Four connectors shall be assembled in series on AWG No 1/0 insulated aluminum conductors having a length of 91 cm (36 in). The cable insulation thickness shall be selected according to its voltage class (see Table 10 of IEEE 386).Equalizers used shall be in accordance with ANSI C119.4.The bushing bus shall be a flat, rectangular, bus bar 356 mm (14 in) long, 102 mm (4 in) wide, and 10 mm (3/8 in) thick. The bushing wells shall be mounted 31 cm (12 in) apart centered along the midline of the bus bar. The bushing well studs shall be tightened to the bus bar using an installation torque of 9 N·m ± 1 N·m (80 lbf·in ± 10 lbf·in).

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Unless otherwise specified by the manufacturers, the elbow male contact probe shall be threaded into the elbow compression lug using an installation torque of 9 N·m ± 1 N·m (80 lbf·in ± 10 lbf·in).

Current-cycling tests shall be conducted at an ambient temperature of 15 °C to 35 °C in a space free of drafts.

The current-cycle amperes shall be adjusted during the current-on period of the first five cycles to result in a steady-state temperature rise of 100 °C to 105 °C on the control conductor. This current shall then be used during the remainder of the test current-on periods, regardless of the temperature of the control conductor.

The test shall consist of 50 current cycles, with the current on 4 h and off 2 h for each cycle. At the end of each current-on cycle, the assembly shall be de-energized and within 3 min be submerged in water at 5 °C ± 5 °C for the remainder of the current-off cycle. At the end of the 10th, 25th and 40th cycles (± 2 cycles), after the samples have returned to room temperature, a short time ac current of 3500 A ± 300 A rms shall be applied to each sample for a minimum of 3 s.

The temperature of at least the following current transfer points shall be measured at the end of each cycle with the current on:

a) Probe to compression lug
b) Probe to female contact
c) Female contact structure to metallic housing (piston contact)
d) Between bushing insert and bushing well.

These temperatures shall not exceed the temperature of the control conductor.

The temperature differences between the control conductor and the connector shall show a condition of stability from the fifth cycle to the end of the test. Stability is indicated when the change in the individual differences is not more than 10 °C from the average of the measured differences in this interval for this connector.

The dc resistance of the connector system shall be measured at the end of cycles 10, 20, 30, 40, and 50 (± 2 cycles). The dc resistance measurements shall be made between the elbow cable equalizer and the bushing stud after the connector system has stabilized at ambient temperature. Ambient temperature shall be measured by devices located within 61 cm (2 ft.) of the test loop but in a location that minimizes the effect of thermal convection. The ambient temperature shall be recorded at the same time as each set of resistance measurements, and the resistance shall be corrected to 20 °C. The dc resistance shall be stable over the period of measurement. Stability is achieved when any resistance measurement, including allowance for instrument accuracy, does not vary more than ± 5% from the average of all the measurements in this interval.

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Results

Temperature Sensor Area ：a-compression lug/ probe b-probe/louver contact

Unit ℃

Cycle#	A15		A16		A17		A18		cable	Room Temp	Water Temp
	a.	b.	a.	b.	a.	b.	a.	b.			
6	59.2	48.5	58.9	49.1	58.4	49.3	53.1	48.9	101.2	25.1	7.0
7	57.3	46.3	56.1	47.2	58.7	49.2	52.3	47.9	101.5	23.9	7.3
8	58.2	46.8	57.2	46.9	59.5	48.7	54.6	48.7	101.1	22.1	7.9
9	58.6	47.2	57.5	47.1	59.9	47.6	53.2	48.1	100.7	27.3	8.2
10	57.9	46.2	56.4	46.7	59.3	47.9	53.2	47.6	101.3	25.9	7.8
11	59.1	48.1	58.3	47.1	59.1	47.1	52.9	47.8	101.0	23.5	7.3
12	58.8	47.8	57.4	45.8	58.3	47.2	54.6	47.7	100.8	24.8	7.5
13	57.4	46.1	56.1	49.9	58.5	46.9	53.6	48.5	101.9	27.3	7.9
14	57.7	46.5	56.3	47.4	57.4	46.6	53.9	47.3	101.4	23.1	8.0
15	58.6	47.7	57.2	48.1	59.3	46.9	54.4	47.9	102.1	21.9	7.7
16	57.3	46.4	55.9	45.8	57.1	45.8	52.5	48.3	101.6	25.1	7.4
17	59.4	49.0	57.8	47.6	59.2	47.2	54.3	48.1	101.2	29.4	7.1
18	60.1	49.2	57.2	46.9	58.9	46.1	55.9	47.7	100.9	26.9	7.3
19	58.5	48.5	58.1	46.5	58.5	46.8	56.2	47.5	101.1	24.1	7.5
20	58.1	48.6	59.0	49.1	58.7	48.7	57.8	49.7	100.7	32.2	7.6
21	58.9	49.1	57.5	45.1	57.5	48.5	54.6	48.6	102.5	28.5	7.8
22	59.3	48.8	57.9	44.7	57.3	48.8	53.3	47.3	101.7	25.3	8.2
23	57.5	47.2	56.2	43.9	58.6	49.1	54.5	47.6	102.2	24.4	7.9
24	60.2	50.2	58.1	45.9	59.4	49.7	54.2	48.2	101.8	29.4	7.6
25	61.5	51.1	56.9	44.7	58.8	48.9	52.8	47.2	101.6	27.2	7.2
26	60.7	49.8	57.0	45.3	59.8	47.7	51.2	47.4	102.3	24.5	7.4
27	59.2	49.4	58.3	46.6	58.3	48.1	53.8	46.9	102.0	27.5	7.8
28	58.6	48.7	57.6	46.2	59.6	49.2	54.8	47.7	101.9	30.3	8.1
29	58.2	48.5	59.2	46.9	57.5	48.2	54.7	47.4	102.1	26.5	7.6
30	57.9	48.1	56.4	46.3	57.8	49.4	53.4	47.3	102.2	23.4	7.9
31	58.4	48.6	58.1	47.2	58.1	49.2	54.9	46.9	101.8	24.1	7.5
32	59.3	49.0	58.4	47.3	59.2	49.9	53.5	46.4	102.1	29.7	7.3
33	58.1	48.6	57.9	46.8	57.9	48.5	52.4	44.9	102.3	27.1	7.7
34	54.3	44.4	58.3	47.0	57.1	44.2	49.3	43.4	101.3	23.1	7.8
35	59.2	46.8	58.2	47.6	57.8	46.5	49.2	44.6	101.8	24.3	8.1
36	57.6	44.6	57.6	46.1	57.9	43.6	48.7	41.7	100.2	27.2	7.8

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37	58.3	44.8	57.4	45.9	59.2	44.6	48.2	41.4	101.1	28.0	7.4
38	58.4	45.5	58.2	46.0	59.9	44.8	48.9	42.1	101.0	29.5	7.2
39	58.6	46.7	58.5	48.4	59.6	45.2	48.1	45.1	101.9	27.0	7.5
40	58.2	45.0	56.4	45.0	58.5	44.1	48.5	43.0	101.7	29.0	8.2
41	55.0	43.8	52.9	42.7	58.5	43.2	46.9	45.5	101.9	29.1	7.7
42	56.9	44.9	54.7	44.6	58.3	44.9	47.4	44.4	101.5	30.1	7.4
43	54.6	43.0	51.7	42.1	57.8	43.9	46.1	43.8	101.6	31.2	7.9
44	64.4	49.3	57.2	47.4	58.5	51.4	52.5	48.6	100.1	27.7	8.1
45	63.9	51.9	59.3	49.1	60.4	48.2	53.6	46.4	101.2	26.9	7.7
46	62.5	50.6	58.1	49.6	61.6	47.3	53.1	46.2	102.0	26.5	7.5
47	64.1	52.2	58.7	50.1	59.7	50.4	52.2	46.7	100.5	27.5	7.2
48	61.5	51.8	59.5	49.9	58.8	50.1	54.6	47.6	101.9	27.1	7.6
49	62.4	50.5	58.3	50.8	57.5	50.9	53.2	46.9	102.5	26.9	8.0
50	63.8	52.4	58.1	50.6	56.9	51.8	52.8	48.5	101.3	26.4	7.9
平均	59.1	47.9	57.3	46.9	58.7	47.6	52.5	46.7	101.6	26.6	7.5
Max Temp Delta (Cycle	5.3 (44)	4.9 (43)	5.6 (43)	4.8 (43)	3.0 (46)	4.4 (41)	6.4 (43)	5.3 (37)	100.1 ~ 102.5	21.9 ~ 32.2	7.0 ~ 8.2
Remark	Temp difference does not vary more than 10 ℃, meets the requirement of the standard.										

Resistance Measurement Unit：mΩ

Date	Week #	Room Temp	Equalizers-I1 / Bushing Well-I1		Equalizers-I2 / Bushing Well-I2		Equalizers-I3 / Bushing Well-I3		Equalizers-I4 / Bushing Well-I4	
10/17	9	27.3	0.69	0.98%	0.70	1.00%	0.69	0.99%	0.69	0.98%
10/20	20	32.2	0.70	1.00%	0.71	1.01%	0.69	0.99%	0.70	0.99%
10/23	32	29.7	0.70	1.00%	0.70	1.00%	0.71	1.02%	0.71	1.01%
10/25	40	29.0	0.71	1.01%	0.70	1.00%	0.70	1.00%	0.70	0.99%
10/28	50	26.4	0.70	1.00%	0.69	0.98%	0.69	0.99%	0.71	1.01%
Average			0.70		0.70		0.696		0.702	

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Short-time Current 3500A/3 sec

25kV200A Elbow 2014-Oct-17 9th Cycle
3.5kA/3sec X/R 6

Sample Number	1st Cycle Current (peak)	1st Cycle Current (rms)	Current (rms)	Time	Verification	Result
A15&A16	7.61kA	5.38kA	4.47kA	3.05 sec	Normal	PASS
A17&A18	8.2kA	5.8kA	4.17kA	3.05 sec	Normal	PASS

25kV200A Elbow 2014-Oct-21 23rd Cycle
3.5kA/3sec X/R 6

Sample Number	1st Cycle Current (peak)	1st Cycle Current (rms)	Current (rms)	Time	Verification	Result
A15&A16	6.86kA	4.85kA	4.21kA	3.09 sec	Normal	PASS
A17&A18	8.43kA	5.96kA	4.23kA	3.07 sec	Normal	PASS

25kV200A Elbow 2014-Oct-25 40th Cycle
3.5kA/3sec X/R 6

Sample Number	1st Cycle Current (peak)	1st Cycle Current (rms)	Current (rms)	Time	Verification	Result
A15&A16	7.32kA	5.17kA	4.1kA	3.07 sec	Normal	PASS
A17&A18	7.61kA	5.38kA	4.15kA	3.08 sec	Normal	PASS

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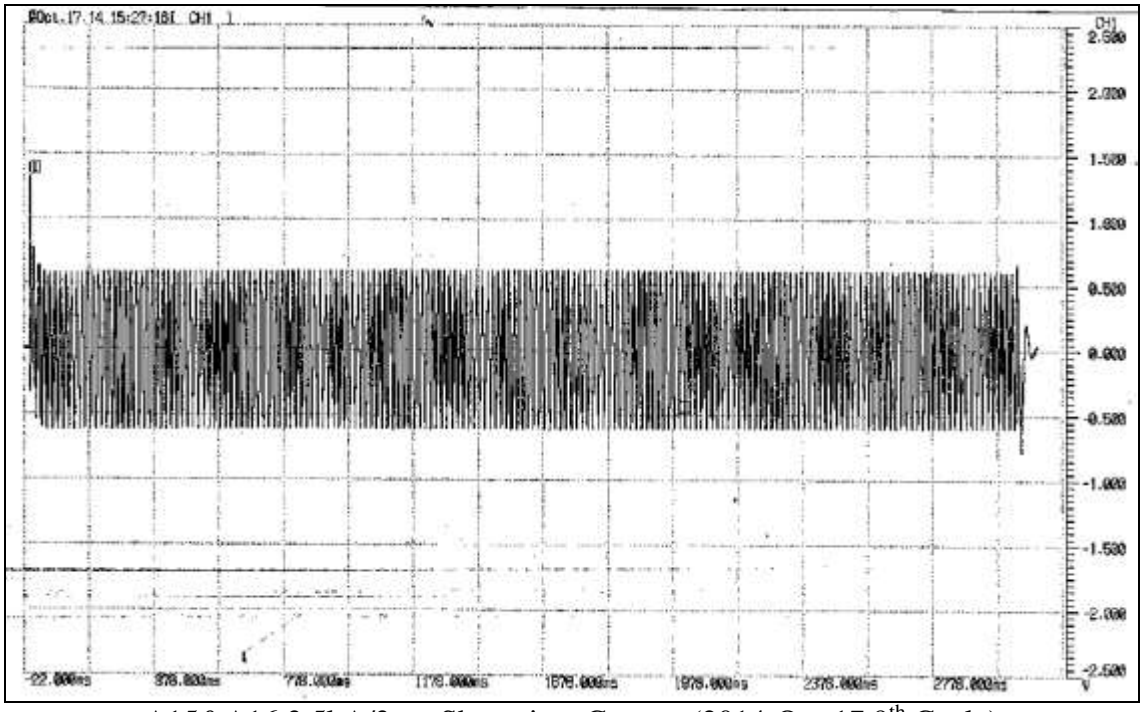
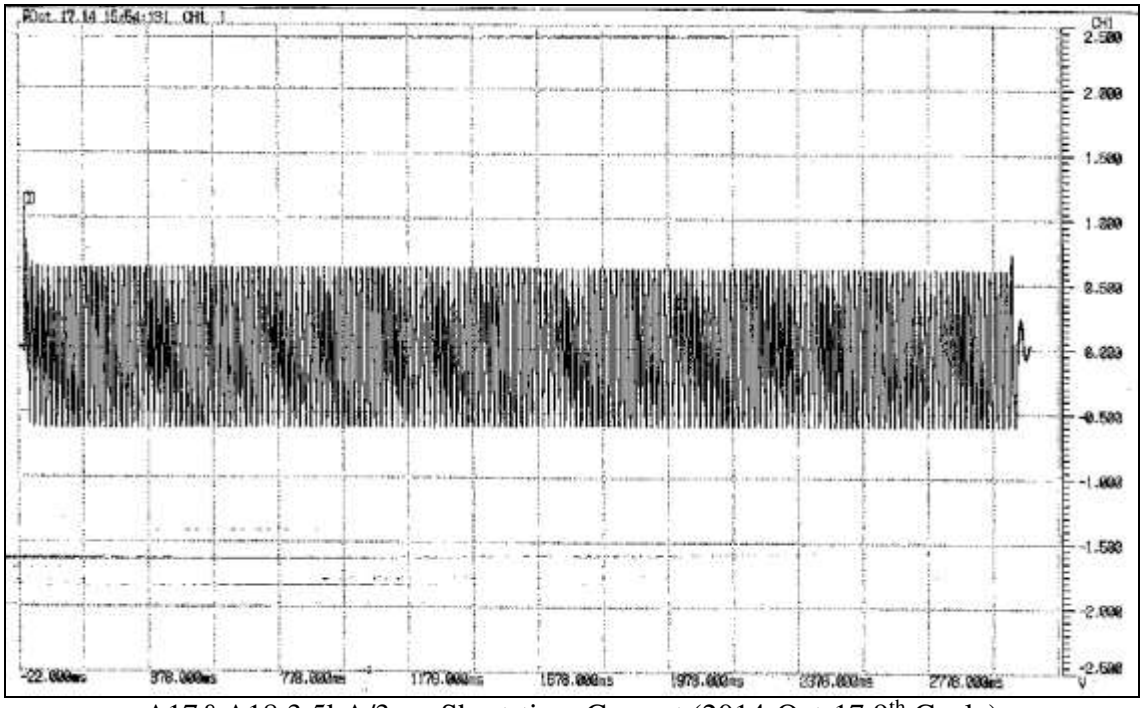


A15&A16 3.5kA/3sec Short-time Current (2014-Oct-17 9th Cycle)



A17&A18 3.5kA/3sec Short-time Current (2014-Oct-17 9th Cycle)

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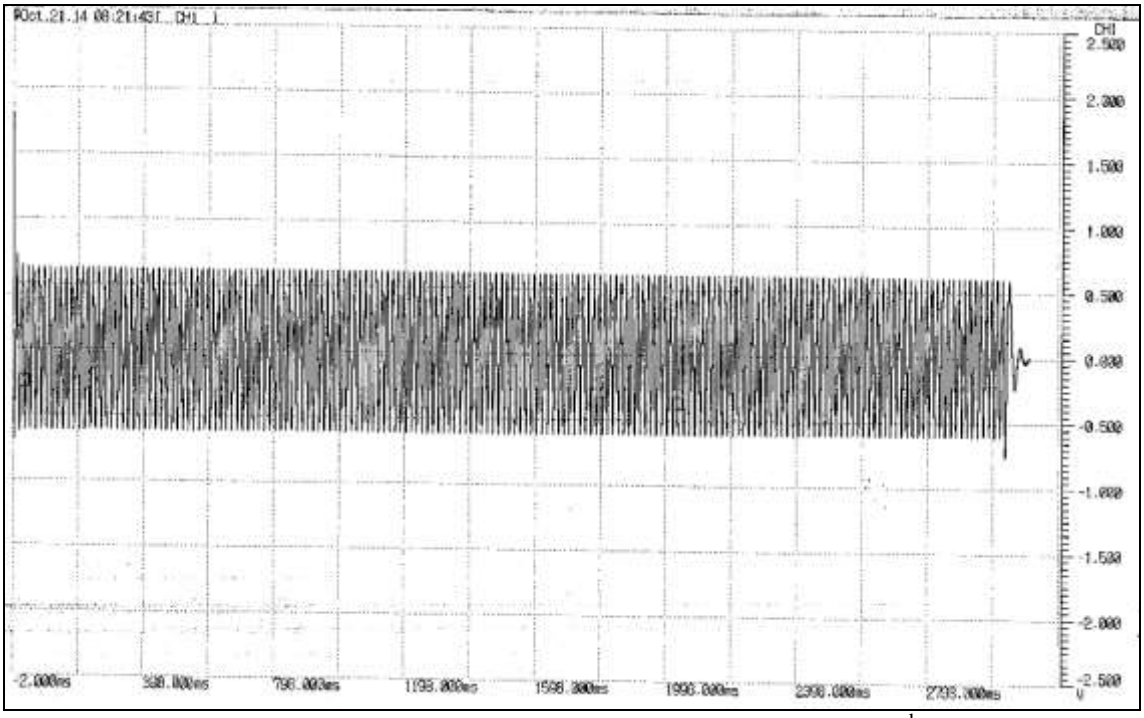
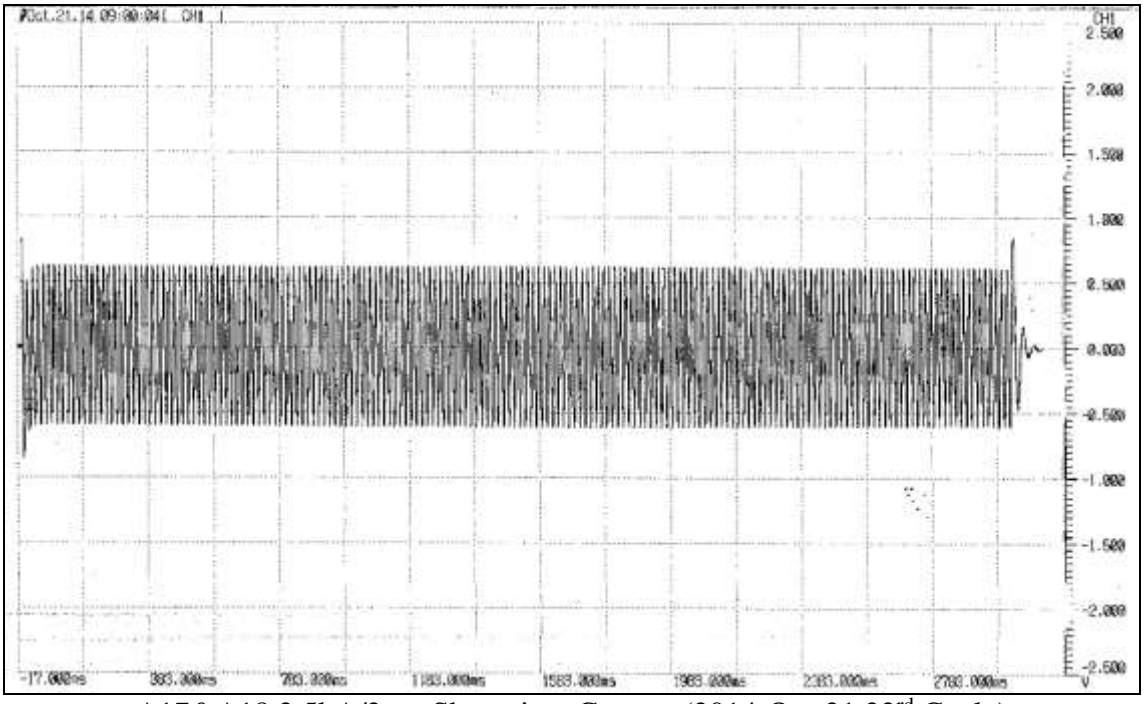


A15&A16 3.5kA/3sec Short-time Current (2014-Oct-21 23rd Cycle)



A17&A18 3.5kA/3sec Short-time Current (2014-Oct-21 23rd Cycle)

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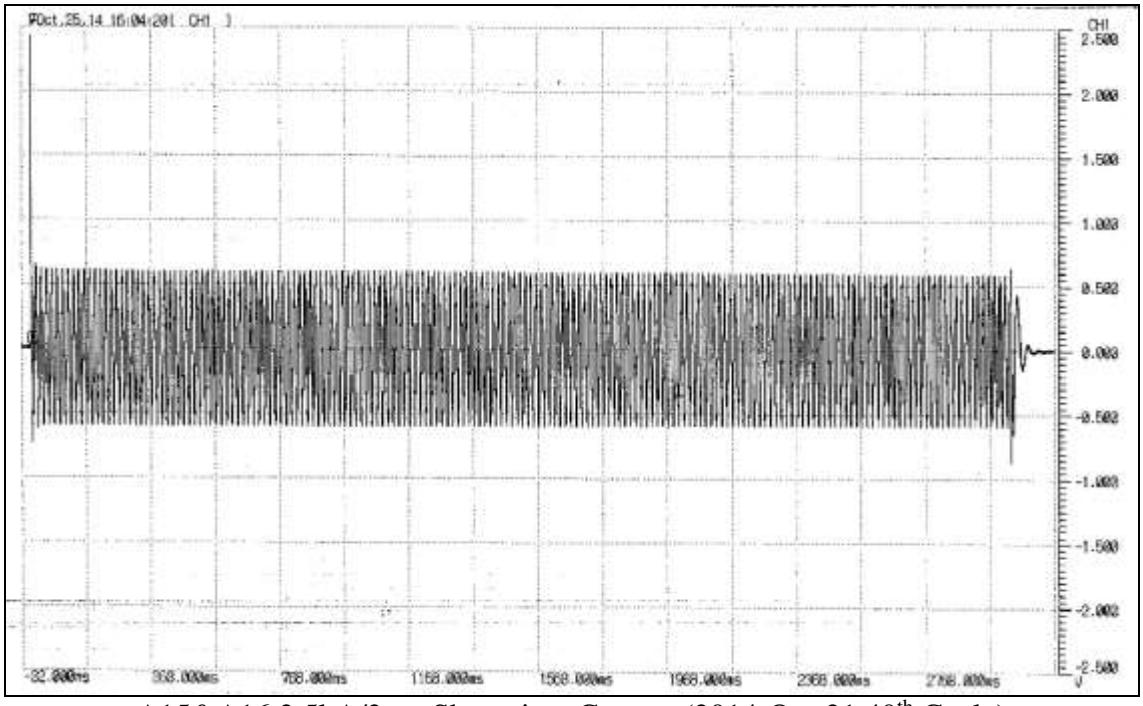
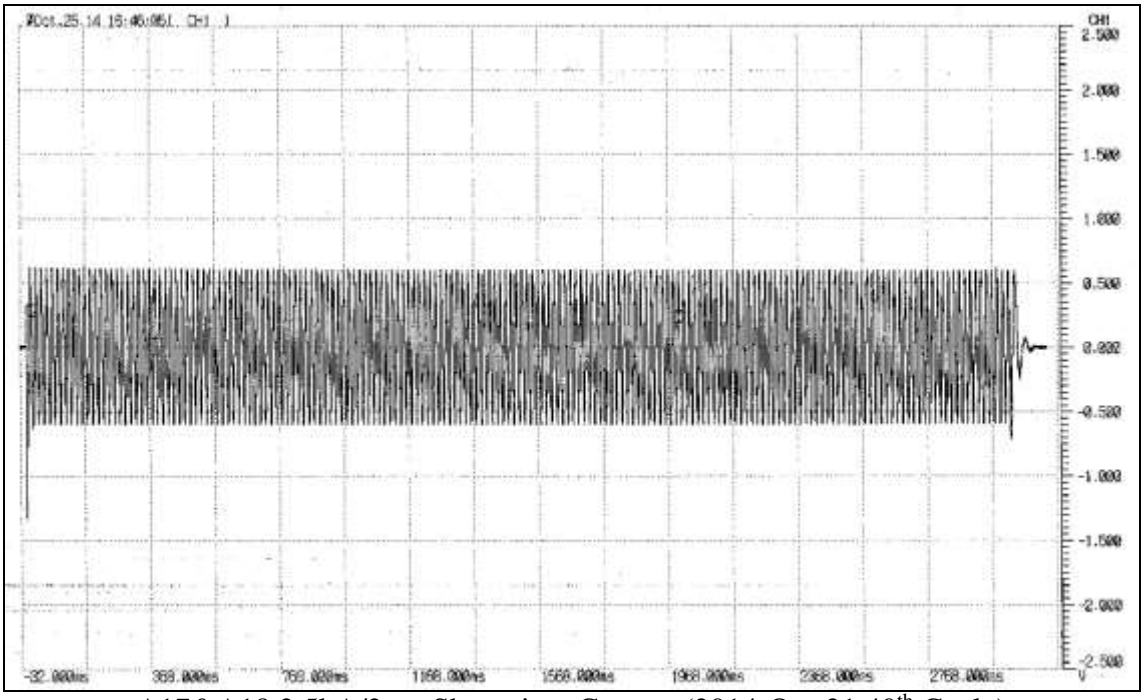


A15&A16 3.5kA/3sec Short-time Current (2014-Oct-21 40th Cycle)



A17&A18 3.5kA/3sec Short-time Current (2014-Oct-21 40th Cycle)

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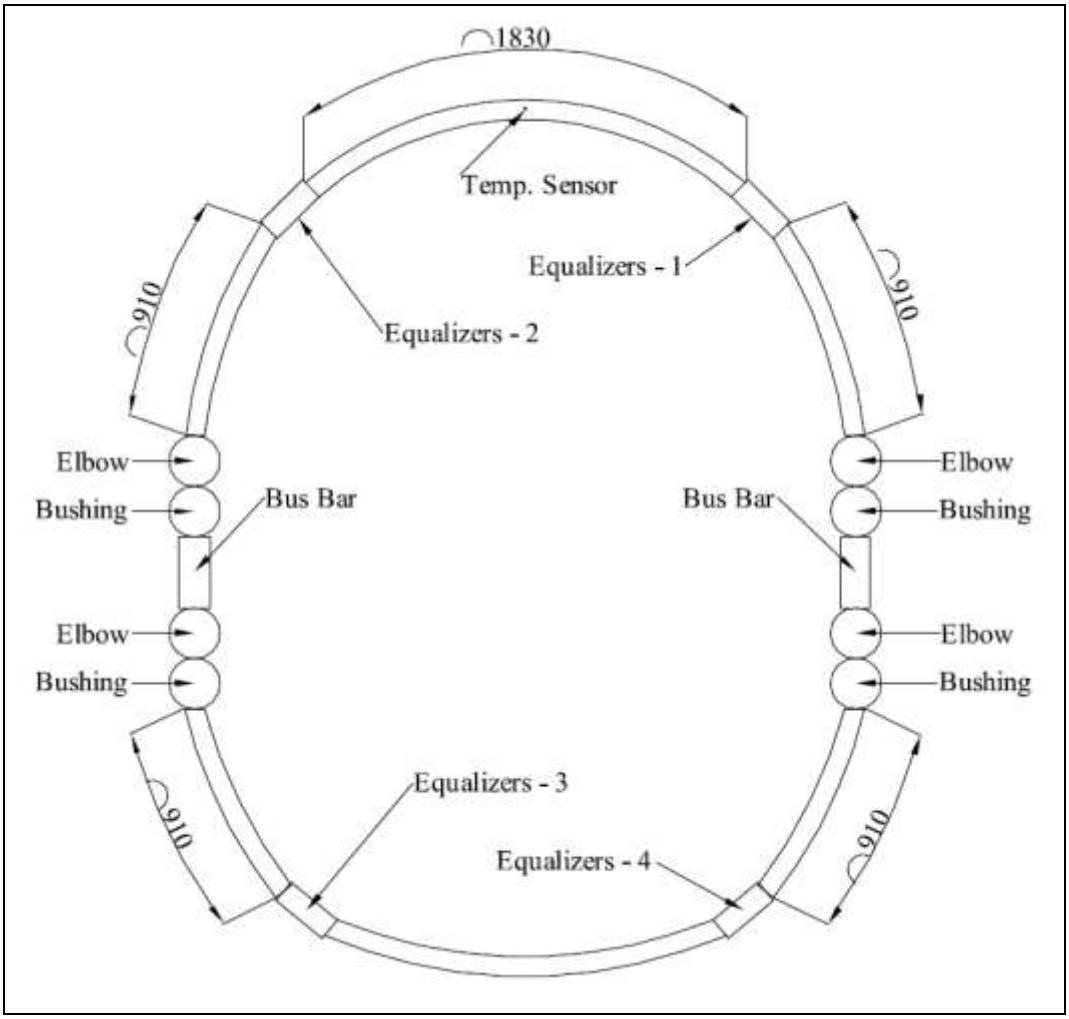

Fig 13-1 Test Setup Diagram

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14. Accelerated Sealing Life Test

Object

To verify the connector can maintain a long-tern seal at all interfaces to prevent the entrance of moisture.

Testing Samples and Mating Parts

Elbow	CHARDON 25-DE200T	4 PCS
Bushing	CHARDON 24-DIB250	4 PCS

Mating Parts

Cable Conductor Type	1/0 AWG(Aluminum)
Cable Insulation Thickness	220 mil
Conductor	200A Bi-Metal Lug
Equalizers	Aluminum Equalizers Size： 106mm(L)20mm(OD)10.1mm(ID)
Bushing Bus	356mm(L), 102mm(W),10mm(T)

Procedure

1. The four connector assemblies shall be placed in an oven having 121 °C temperature and remain there for three weeks.
2. After the time has elapsed, the four samples shall be subjected to 50 cycles of the following sequence of operations: The assemblies shall be heated in air using sufficient current to raise the temperature of the connector of the control cable to 90 °C ± 5 °C for 1 hour.
3. The assemblies shall be de-energized and within 3 min, submerged in 25 °C ± 10 °C conductive water (5000 Ω-cm maximum) to a depth of 30 cm (1 ft) for 1 hour.
4. After 50^{th} cycle, the connector and cable assembly shall withstand a design impulse test of IEEE 7.5.3(1.2*50μS impulse wave of 125kV, 3 positive and 3 negative) and test point voltage test.(During the impulse test, the bushing well and bushing bus were soaked into the silicone oil.)

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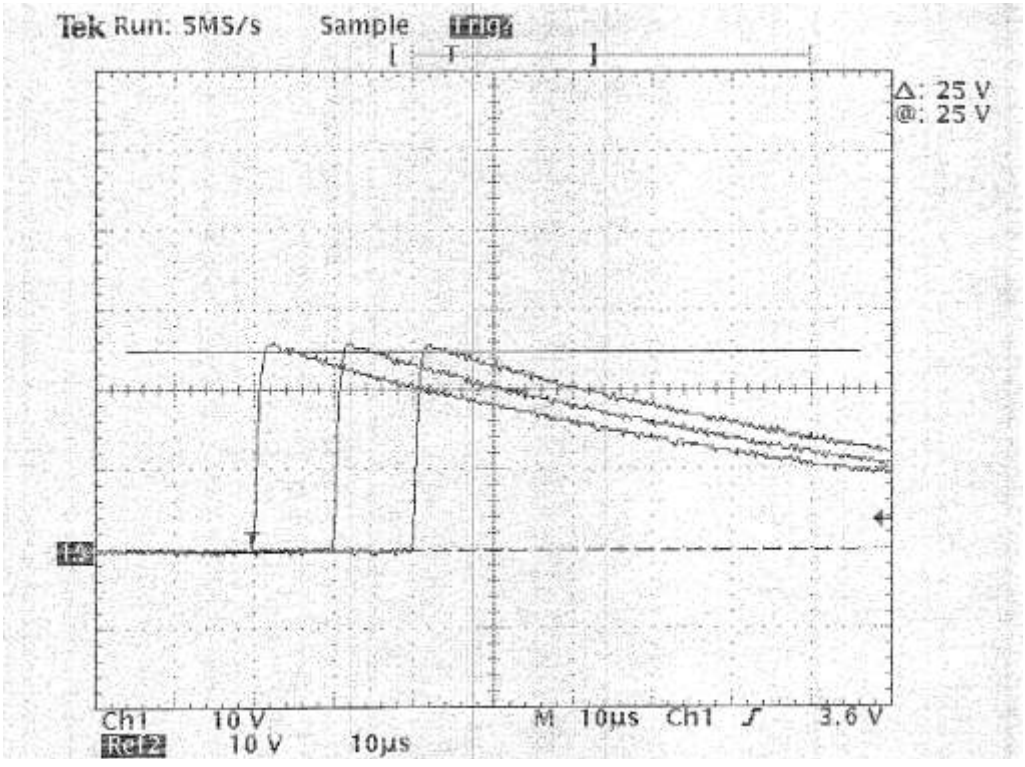
Results

Sample #	PD Testing Before Acc Life Sealing Test	AC Withstand Testing Before Acc Life Sealing Test	Impulse Testing Before Acc Life Sealing Test	PD Testing After Acc Life Sealing Test	Test Point Voltage Testing
B1	23kV0.5pC	40kV/1m Pass	±125kV 3 Shots Each, Pass	±125kV 3 Shots Each, Pass	13.0kV
B2	23kV0.6pC	40kV/1m Pass			13.0kV
B3	23kV0.6pC	40kV/1m Pass			12.5kV
B4	23kV0.8pC	40kV/1m Pass			13.0kV
Remark	● Tested with Bushing Insert and Elbow Assembly ● Cable Temp：89.1~91.3℃ ● Water Temp：29.8~32.9℃ ● Resistance of Water：3461 Ω-cm ● Depth of Water：30 cm ● Test Point Voltage Testing is applied with 15.0kV				



Impulse Testing Waveform before Accelerated Sealing Life Test – Positive Wave

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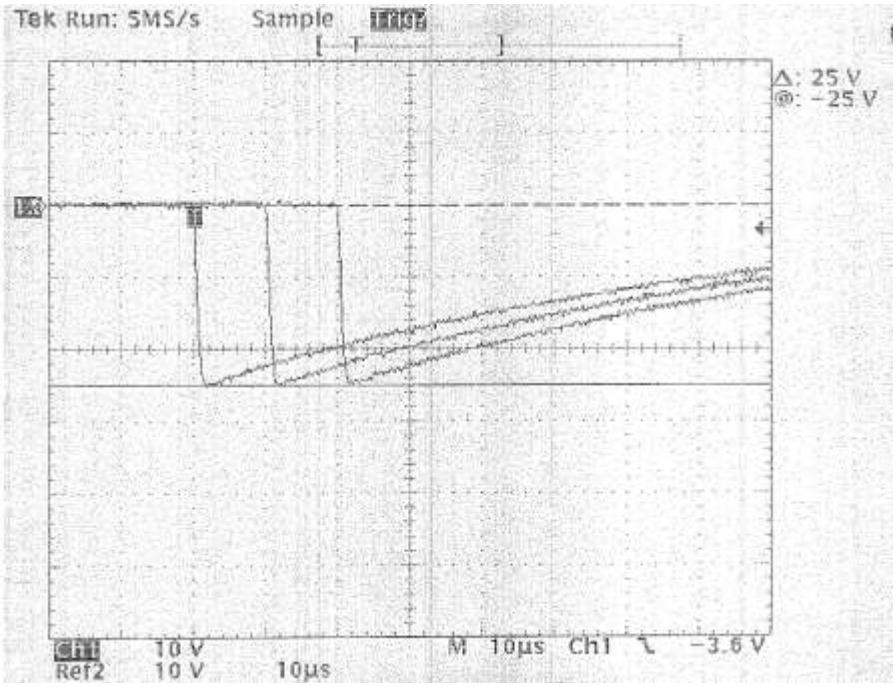
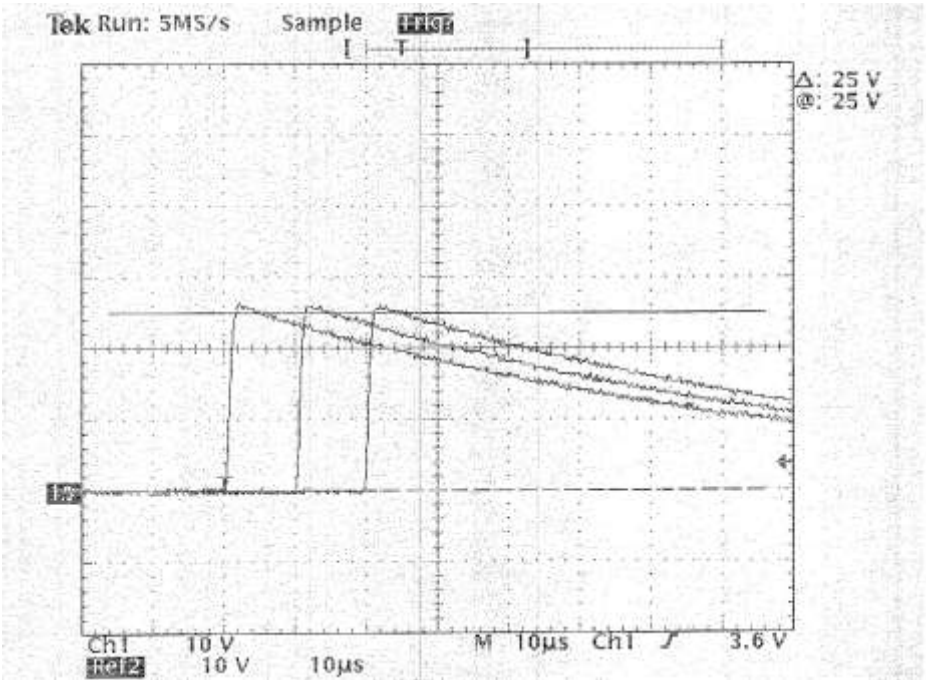


Impulse Testing Waveform before Accelerated Sealing Life Test – Negative Wave



Impulse Testing Waveform after Accelerated Sealing Life Test – Positive Wave

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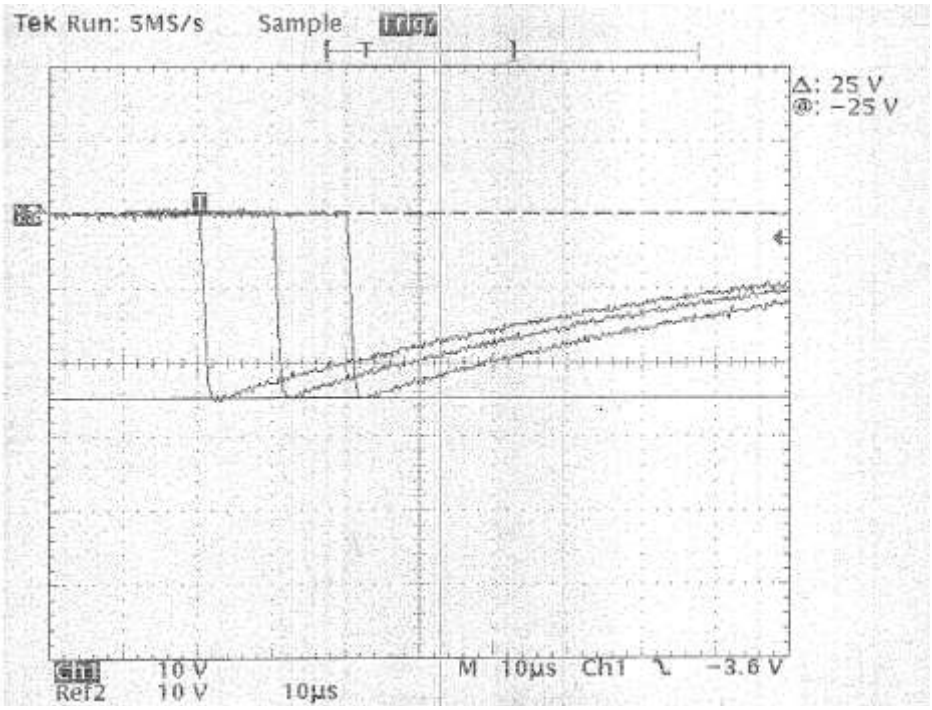

Impulse Testing Waveform after Accelerated Sealing Life Test – Negative Wave

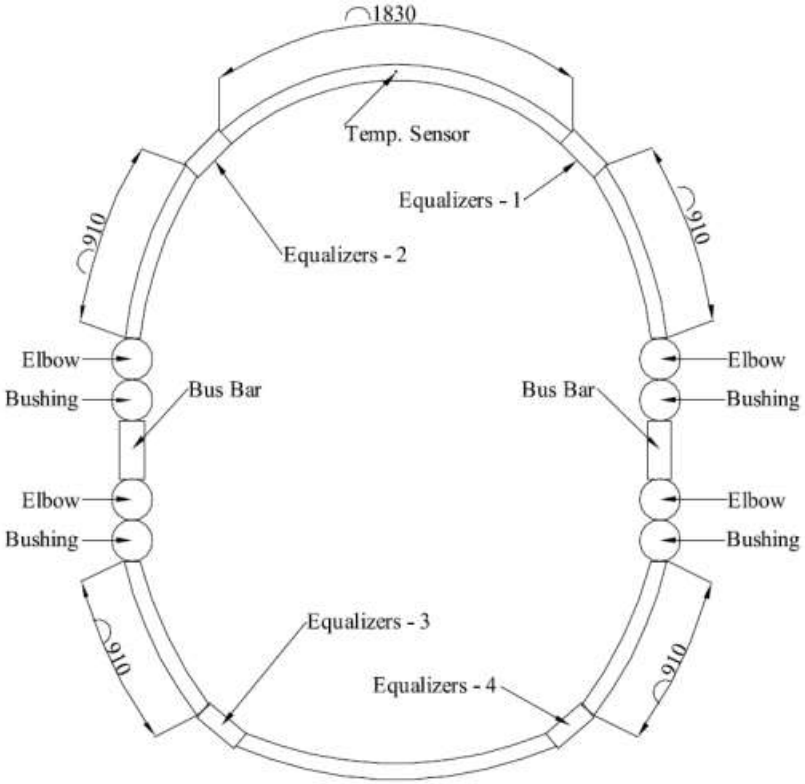

Fig 14-1 Test Setup Diagram

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15. Current-cycling test – Thermal Test with Off-axis Operation

Object

The purpose of this test is to demonstrate that loadbreak and deadbreak 200 A connectors can carry rated load current after being subjected to an off-axis operating force. Successful completion of these tests shall be considered as evidence that the connector meets its rating.

Testing Samples

Deadbreak Elbow	25-DE200TC	4 PCS

Mating Parts

Bushing Well	Chardon 200A Bushing Well CH200BW	4 PCS
Cable Conductor Type	1/0 AWG Aluminum Cable	
Cable Insulation Thickness	260 mil	
Conductor	Chardon 200A BiMetal Connector 1/0	
Equalizers	Aluminum Equalizers Size：106mm(L), 20mm(OD), 10.1mm(ID)	
Bushing Bus	356mm(L),102mm(W),10mm(T)	

Procedure

The purpose of this test is to demonstrate that loadbreak and deadbreak 200 A connectors can carry rated load current after being subjected toan off-axis operating force. Successful completion of these tests shall be considered as evidence thatthe connector meets its rating.

Each connector shall be subjected to six cycles, each consisting of a mechanical operation as specified in 7.10.2.1 and current cycling as specified in 7.10.2.2. of IEEE 386

The elbow shall be disassembled with a 12.7 mm (0.5 in) wide pulling band, as shown in Figure 21 of IEEE 386 for application of an off-axis force. Grounding tabs or other obstructions may be removed to apply the pulling band. No provision is made for an off-axis closing force since it is not consistently reproducible.

Four connectors shall be assembled in series on AWG No. 1/0 insulated aluminum

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conductors having a length of 91 cm (36 in). The cable insulation thickness shall be selected according to its voltage class (see Table 10 of IEEE 386).

Results

Thermal couple installation areas:

1) At the compression lug
2) At the midpoint of the bushing contact

Unit:℃

Cycle#	A11		A12		A13		A14		Control Cable	Room Temp
	A11-1	A11-2	A12-1	A12-2	A13-1	A13-2	A14-1	A14-2		
1	71.8	60,3	63.2	48.5	68.2	52.3	73.3	61.8	89.1	30.0
2	72.3	60.0	63.4	49.9	67.7	51.9	72.4	57.5	90.4	29.6
3	72.5	60.1	65.5	50.4	66.4	51.7	74.2	57.9	90.6	29.0
4	72.4	60.5	66.4	53.1	68.1	53.2	68,6	57.1	90.5	30.6
5	72.4	61.0	66.3	53.0	66.6	53.9	70.5	57.4	90.5	30.0
6	72.6	61.7	66.5	52.7	68.2	53.7	70.7	57.6	90.8	29.4
7	73.1	62.5	66.1	53.5	67.8	53.2	70.8	57.3	90.9	29.0
8	73.3	62.4	65.4	51.7	68.3	53.6	72.3	58.1	90.9	28.8
9	72.7	60.5	61.0	50.2	66.8	50.6	68.7	54.2	90.8	28.1
10	73.3	61.0	61.2	49.7	66.5	50.8	68.1	54.8	91.0	27.5
11	73.1	62.2	62.4	49.3	66.3	50.9	68.5	54.0	91.0	27.4
12	73.6	63.2	63.0	49.5	67.0	52.3	67.7	53.6	91.2	29.2
13	73.5	63.2	63.3	49.1	67.7	52.0	68.0	53.2	91.3	28.4
14	73.2	63.1	63.6	49.2	66.8	51.5	67.3	53.5	91.2	27.8
15	72.9	63.0	64.2	49.6	67.7	51.7	67.0	53.0	90.8	27.0
16	73.6	63.5	65.0	49.9	68.3	52.3	68.7	53.1	90.9	28.0
17	73.7	63.4	64.8	48.9	67.6	51.7	67.7	52.6	91.1	26.7
18	73.4	63.2	64.5	49.1	67.3	51.1	67.1	52.4	90.8	26.6
19	73.9	63.4	65.2	49.9	67.1	51.0	68,0	52.6	90.6	26.3
20	74.2	62.4	63.4	49.2	72.2	53.8	69.5	55.3	91.4	28.6
21	74.3	61.7	62.9	49.6	72.0	55.4	70.2	57.4	89.8	27.8
22	74.2	62.0	63.3	49.9	72.1	57.1	71.3	57.8	89.3	27.1
23	74.5	63.1	64.5	50.2	71.5	57.1	73.2	58.0	88.9	26.6
24	73.4	63.2	65.0	51.2	72.3	59.2	72.7	59.1	89.1	29.1
25	73.1	62.7	65.1	50.5	74.0	58.4	74.7	60.2	89.1	27.5
26	73.9	62.9	65.2	51.4	74.2	58.2	74.8	60.3	89.1	26,3

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27	73.7	62.5	65.3	51.2	74.6	58.8	75.2	60.5	89.1	26.0
28	73.8	62.3	64.8	49.4	72.2	57.7	76.5	61.3	89.1	28.6
29	72.6	62.1	63.9	50.6	73.1	58.0	76.2	61.0	89.0	28.2
30	73.1	62.7	65.1	51.5	74.1	58.2	76.1	60.7	89.1	27.6
31	73.0	62.4	64.8	52.0	75.2	59.3	75.4	60.2	88.8	26.1
32	73.2	62.5	63.7	51.3	76.3	60.1	75.3	58.6	89.1	29.2
33	74.0	62.8	63.5	51.6	77.7	60.5	76.0	57.3	89.3	28.0
34	73.7	63.2	63.2	51.3	76.8	60.2	75.2	57.8	89.5	26.6
35	73.6	62.8	63.0	51.0	76.3	60.6	76.0	56.2	89.5	26.0
36	73.4	62.8	62.7	50.7	76.0	59.2	76.2	57.4	90.4	29.2
37	73.1	62.2	62.5	50.6	75.7	59.4	76.1	57.2	89.7	27.8
38	73.9	62.4	62.6	50.3	75.3	59.4	75.3	56.7	89.0	26.7
39	73.4	62.0	62.2	50.4	76.2	59.6	75.1	56.2	89.0	26.0
40	72.6	62.8	62.7	51.3	75.7	59.2	74.3	56.0	89.1	29.0
41	72.5	63.0	62.8	51.5	75.1	59.0	74.5	55.6	89.1	28.2
42	73.0	63.6	63.2	51.5	76.1	59.5	74.1	56.7	89.0	28.1
43	73.1	63.9	63.5	51.6	77.1	60.2	75.0	56.6	89.1	26.8
44	72.6	64.0	63.6	52.0	76.6	60.4	74.6	57.3	89.2	26.2
45	73.5	63.8	64.1	52.5	76.2	59.6	75.9	57.9	88.9	29.5
46	74.4	64.0	64.7	52.6	76.0	59.2	75.1	56.8	89.1	28.1
47	74.6	64.2	64.7	52.7	77.1	60.3	75.3	57.7	89.2	28.3
48	75.1	64.8	65.3	53.4	77.3	60.0	75.1	60.3	89.5	30.2
Ave.	73.4	61.3	64.0	50.8	72.0	56.2	69.7	57.0	89.9	27.4
Remark	After six cycles, the average temperatures of each thermal couple are not higher than control cable temperature.									

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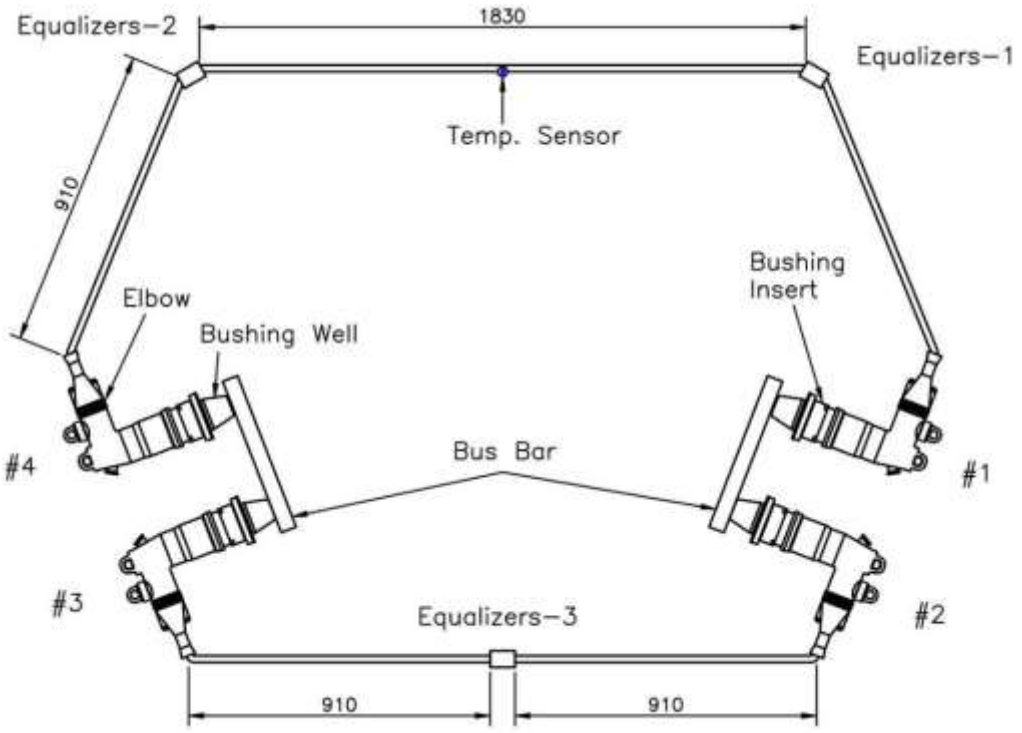

Fig 15-1 Current Cycling Test Setup

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APPENDIX -External Test Report

Powertech Labs Inc. • 12388 - 88th Avenue, Surrey, B.C. Canada • V3W 7R7

Test Report № PL-26015B

The tests were performed in accordance with
IEEE Standard 592-2007, section 4.3

Project №:	PL-26015	**Test Date:**	13 September 2013
Tested equipment:	Two Separable Insulated Connectors manufactured by Chardon Taiwan Corporation, prefaulted in accordance with IEEE Standard 592-2007, Figure 1. The samples were numbered by the client.		
Voltage rating:	15.2 $kV_{phase\text{-}to\text{-}ground}$		
Test voltage:	11.7 $kV_{phase\text{-}to\text{-}ground}$		
Test current:	10 kA_{rms}		
Markings:	Elbow- Chardon, 15.2/26.3 kV, 200A Load Break Cable- TPC. 25 kV 1/C #1AWG CU, XLPE 260 mils		
Tests performed:	Fault-Current Initiation Tests per Section 4.3. Each sample was subjected to two current pulses at 10 kA_{rms}, 10 cycles.		
Test results:	All tested samples passed the tests.		
Remarks:	Identification of the tested Connectors was based on the markings on the samples. The samples were supplied already prefaulted.		

Tested by:

Oct. 21, 2013

K.Tabarraee M.A.SC., EIT
Electrical Engineer, High Power Lab

Reviewed by:

21 October 2013

T. Stefanski M.Sc., P. Eng.
Head of High Power Lab