HUBBELL® POWER SYSTEMS, INC.

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Cable Accessories Test Report Bulletin EU1548-00
25 kV Class 200 Amp
Loadbreak Separable Connector System

CERTIFICATION
The Hubbell Power Systems three phase rated, 25 kV Class, 200 Amp, Loadbreak System is designed to meet or exceed the requirements of the IEEE Standard 386-2006, "Separable Insulated Connector Systems for Power Distribution Systems above 600 Volts". This product complies with the interface dimensions in Figures 7 and 15 of this standard.

This report certifies that the tests shown in the following table have been successfully performed on Hubbell Power Systems, 25 kV Class 200 Amp Loadbreak Connector System in accordance with IEEE 386-2006 that demonstrates complete interchangeability. Separate reports shown in the table provide details of the tests.

Test	Standard	Section	Report No.	Issue Date
Partial Discharge Test	IEEE 386-2006	7.4	Bulletin EU1548-01	2008-04-17
Dielectric Tests (ac, dc, impulse)	IEEE 386-2006	7.5	Bulletin EU1548-02	2008-04-17
Short-time Current Test	IEEE 386-2006	7.6	Bulletin EU1548-03	2008-04-17
Switching Test	IEEE 386-2006	7.7	Bulletin EU1548-04	2008-04-17
Fault-closure Test	IEEE 386-2006	7.8	Bulletin EU1548-05	2008-04-17
Current-cycling Test	IEEE 386-1985	7.10	Bulletin EU1548-06	2008-04-17
Accelerated Sealing Life Test	IEEE 386-2006	7.12	Bulletin EU1548-07	2008-04-17
Cable Pull-out Test	IEEE 386-2006	7.13	Bulletin EU1548-08	2008-04-17
Operating-force Test	IEEE 386-2006	7.14	Bulletin EU1548-09	2008-04-17
Operating-eye Test	IEEE 386-2006	7.15	Bulletin EU1548-10	2008-04-17
Test-point Cap Test	IEEE 386-2006	7.16	Bulletin EU1548-11	2008-04-17
Test-point Test	IEEE 386-2006	7.17	Bulletin EU1548-12	2008-04-17
Shielding Test	IEEE 386-2006	7.18	Bulletin EU1548-13	2008-04-17
Interchangeability	IEEE 386-2006	7.7 & 7.8	Bulletin EU1548-14	2009-07-27
Operating interface AC withstand (Partial Vacuum test)	IEEE 386-2006	Annex B	Bulletin EU1548-15	2008-04-17

S. A. Senthil Kumar

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Product Design Engineer
Date: 7/27/2009

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The Hubbell Power Systems three-phase rated, 25 kV Class, 200 Amp, Loadbreak System consists of the following products:

Loadbreak Elbow Connector 9U01BAD, 9U01BBD
Insulated Cap 9U01BEW
Loadbreak Bushing Insert 225BI
Bimetal Compression Lug 200LUGB

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TEST REPORT BULLETIN EU1548-01

Partial Discharge Test

TEST PROCEDURE:
Each test sample consisted of one cable ready 25 kV 200 Amp elbow, one 25 kV 200 Amp bushing insert and one bushing well. The test voltage was raised to 20% above the partial discharge minimum extinction voltage of 19 kV. If the partial discharge peak value exceeded 3 pC, the test voltage was lowered to 19 kV and was maintained at this level for at least 3 seconds but not more than 60 seconds. Partial discharge readings taken during this interval did not exceed 3 pC peak.

TEST RESULTS:
All ten samples tested met the requirements of Section 7.4 of IEEE Standard 386 - 2006. Table 1 shows a summary of the Partial Discharge Test results.

Table 1: Summary of Partial Discharge Tests

Sample number	Result (Pass / Fail)
1	Pass
2	Pass
3	Pass
4	Pass
5	Pass
6	Pass
7	Pass
8	Pass
9	Pass
10	Pass

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TEST REPORT BULLETIN EU1548-02

Dielectric Tests
(AC, DC, and Impulse Withstand Tests)

TEST PROCEDURE:
Each test sample consisted of one cable ready 25 kV 200 Amp elbow, one 25 kV 200 Amp bushing insert, and one bushing well. For ac withstand tests, the test voltage was raised to 40 kV rms in not more than 30 seconds. The connector withstood the specified test voltage for one minute without flashover or puncture.

For dc withstand tests, the test voltage had a negative polarity and was raised to 78 kV. The connector withstood the specified test voltage for 15 minutes without flashover or puncture. For impulse withstand tests, the test voltage had a 1.2/50 microsecond wave shape with a crest value (BIL) of 125kV. All connectors were subjected to three positive and three negative full-wave impulses.

TEST RESULTS:
All ten samples tested met the requirements of Section 7.5 of IEEE Standard 386 - 2006. Table 1 shows the summary of the dielectric test results.

Table 1: Summary of Dielectric Tests

Sample	AC – 40kV rms (1 minute)	DC – 78kV rms (15 minutes)	Impulse – 125kV crest (3 Pos. 3 Neg.)
1	Pass	Pass	Pass
2	Pass	Pass	Pass
3	Pass	Pass	Pass
4	Pass	Pass	Pass
5	Pass	Pass	Pass
6	Pass	Pass	Pass
7	Pass	Pass	Pass
8	Pass	Pass	Pass
9	Pass	Pass	Pass
10	Pass	Pass	Pass

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TEST REPORT BULLETIN EU1548-03
Short-time Current Test

TEST PROCEDURE:
Test samples were mounted in a manner approximating service conditions and the test voltage was below the rated voltage of the test samples. Current magnitudes were measured in accordance with IEEE C37-09 - "IEEE Standard Test Procedure for ac High-voltage Circuit Breakers rated on a Symmetrical Current Basis".

Each test sample consisted of:
25 kV 200A elbow
25 kV 200A bushing insert
25 kV bushing well
Compression connector: bi-metal
Cable conductor type: aluminum
Cable conductor size: 1/0 AWG.

TEST RESULTS:
The test samples withstood the current without separation of interfaces or impairing the ability to meet the requirements of partial discharge, ac and impulse voltage withstand tests. All samples tested met the requirements of Section 7.6 of IEEE Standard 386 - 2006. Table 1 shows a summary of the Short-time Current Test results.

Table 1: Summary of Short-time Current Test

Sample number	Current (kA)	Duration (s)	Result
1	3.5	3.22	Pass
	10	0.18	Pass
2	3.5	3.20	Pass
	10	0.18	Pass
3	3.5	3.20	Pass
	10	0.17	Pass
4	3.5	3.20	Pass
	10	0.18	Pass

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TEST REPORT BULLETIN EU1548-04

Switching Test

TEST PROCEDURE:

Each test sample, consisting of a 25 kV 200A elbow and a bushing insert was subjected to 10 complete switching operations under the conditions listed in Figure 19 and Table 7 of IEEE Standard 386 - 2006. The test circuit complies with Figure 19 (b) of the Standard. Switching was performed manually. The test samples were operated using the parallel method of switching. Each switching operation was recorded by an oscillogram.

TEST RESULTS:

Thirty samples of Hubbell bushing insert and Hubbell elbow were tested. At least 10 consecutive successful tests were recorded, as indicated in Table 1 thus meeting the requirements of Section 7.7 of IEEE Standard 386 – 2006.

Table 1: Summary of Switching Tests

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	P (1)	16	P (16)
2	P (2)	17	P (17)
3	P (3)	18	P (18)
4	P (4)	19	P (19)
5	P (5)	20	P (20)
6	P (6)	21	F
7	P (7)	22	P
8	P (8)	23	P
9	P (9)	24	P
10	P (10)	25	P
11	P (11)	26	P
12	P (12)	27	P
13	P (13)	28	P
14	P (14)	29	P
15	P (15)	30	P

Note: ( ) – Consecutive successful test.

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TEST REPORT BULLETIN EU1548-05
Fault-closure Test

TEST PROCEDURE:
25 kV 200A Hubbell elbow and Hubbell bushing insert connectors that were subjected to the switching test (Bulletin EU1548-04) were then subjected to the fault-closure test with the fault current given in Table 2 and under the conditions listed in Figure 20 and Table 9 of IEEE Standard 386 - 2006. The test was conducted on the samples in the same sequence used for the switching test. The test circuit complies with Figure 20 (b) of the Standard. The closing operation was performed manually and each operation was recorded by an oscillogram.

TEST RESULTS:
As shown in Table 1, ten consecutive tests were recorded meeting the criteria that their oscillograms showed no external ground current and that all parts remained within the closed connector assembly. At least one connector in each combination was closed at an instant when the voltage is 80% or more of its peak value. The Hubbell Insert and Hubbell elbow met the requirements of Section 7.8 of IEEE Standard 386 - 2006.

Table 1: Summary of Fault-closure Tests

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	P (1)	16	**
2	P (2)	17	**
3	P (3)	18	**
4	P (4)	19	**
5	P (5)	20	**
6	P (6)	21	***
7	P (7)	22	**
8	P (8)	23	**
9	P (9)	24	**
10	P (10)	25	**
11	**	26	**
12	**	27	**
13	**	28	**
14	**	29	**
15	**	30	**

Note:
( ) - Consecutive successful test.
** - Sample not tested since fault-closure test requirements have been met.
*** - Sample failed in switching test.

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TEST REPORT Bulletin EU1548-06

Current-Cycling Test for 200 Amp Insulated Connectors

1. Accelerated Thermal Test

TEST PROCEDURE:
Four test samples were assembled in series on 1/0 AWG insulated aluminum conductors having a length of 36 in. A control cable was installed in the current-cycling loop between two equalizers. The length of the control cable is 72 inches. 25 kV rated cables with insulation thickness of 260 mils were used for these tests.

Each test sample consisted of:
1) 25 kV, 200A elbow
2) 25 kV, 200A bushing insert
3) 200A Bimetal Compression lug.
4) 25kV, 200A bushing well.

The tests were conducted at an ambient temperature of 20°C in a space free of drafts. The current-cycle amperes were adjusted during the current-on period of the first five cycles to result in a steady-state temperature of 85°C to 95°C on the surface of the conductor in the control cable. The temperature was measured at the approximate center of the control cable. The test consisted of 50 current cycles, with current-on for 3 hours and current-off for 3 hours for each cycle. The temperature of the hottest spot of the connector was measured every 10 cycles and id did not exceed the temperature of the control cable.

The temperature of the following current transfer points was measured. Typical results are shown in Table 1.

a) Probe to compression lug
b) Probe to female contact
c) Piston to copper container

TEST RESULTS:
The temperature measured at the current transfer points of each sample did not exceed the temperature of the control conductor. All samples tested met the requirements of Section 7.10 Option A, of IEEE Standard 386 - 1985.

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Table 1: Summary of Current-Cycling Test for 200 Amp Insulated Connectors
(Temperature measurements)

Sample	Current transfer point	Cycle 10	Cycle 20	Cycle 30	Cycle 40	Cycle 50
1	a	60.6	61.5	67.1	63.1	59.3
	b	57.2	57.6	61.9	59.8	55.8
	c	54.9	55.2	59.5	57.7	53.6
2	a	76.0	79.6	86.1	67.1	63.7
	b	61.6	63.7	68.5	59.0	55.4
	c	58.6	60.3	64.9	57.0	53.5
3	a	65.0	67.0	69.8	66.9	63.0
	b	57.4	58.6	61.4	59.4	55.7
	c	55.0	56.0	58.8	57.0	50.8
4	a	67.6	69.2	72.4	69.5	65.8
	b	58.3	59.2	62.8	60.8	57.0
	c	55.7	56.5	60.1	58.2	51.7
Ambient	-	23.0	21.7	25.7	26.8	22.6
Control conductor	-	92.7	93.6	98.8	93.4	89.6

2. Thermal Test with Off-axis Operation

TEST PROCEDURE:
Four connectors were assembled and tested as described in Option A with the exception that after each 8 current cycles, a mechanical operation was performed on each test sample. The mechanical operation consisted of rotating the elbow 10° in both clockwise and counter clockwise directions by means of a suitable live line tool. The tool was aligned approximately parallel with the axis of the probe.

Each test sample consisted of:
1) 25 kV, 200A elbow
2) 25 kV, 200A bushing insert
3) 200A Bimetal Compression lug.
4) 25kV, 200A bushing well.

Each connector was subjected to 6 complete test cycles, each cycle consisting of the mechanical operations followed by current cycling. The temperature of the following current transfer points was measured:

d) Probe to compression lug
e) Probe to female contact
f) Piston to copper container.

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TEST RESULTS:
The temperature measured at the current transfer points of each sample did not exceed the temperature of the control conductor. All samples tested met the requirements of Section 7.10, Option B of IEEE Standard 386 - 1985. Table 2 shows a summary of the test results.

Table 2: Summary of Current-Cycling Test for 200 Amp Insulated Connectors
(With Off-axis Operation)

Sample	Current transfer point	Cycle 10	Cycle 20	Cycle 30	Cycle 40	Cycle 50
1	a	60.7	57.8	63.9	65.9	64.7
	b	57.4	54.8	59.8	59.2	58.4
	c	55.0	52.4	57.4	56.8	56.0
2	a	66.2	64.1	68.8	68.1	67.3
	b	57.0	55.2	59.5	58.7	58.1
	c	55.2	53.3	57.6	56.6	56.1
3	a	65.3	62.9	67.7	67.5	66.9
	b	57.3	55.1	59.6	59.5	59.1
	c	54.6	52.4	56.8	56.5	56.0
4	a	68.7	66.3	71.6	73.0	72.0
	b	58.8	56.5	61.6	63.3	62.6
	c	56.0	53.9	58.8	59.7	59.0
Ambient	-	23.4	21.5	26.0	24.8	24.0
Control conductor	-	90.4	87.1	92.9	91.5	90.7

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TEST REPORT BULLETIN EU1548-07

Accelerated Sealing Life Test

TEST PROCEDURE:
Four connector assemblies were placed in an oven with 121°C+/- 3°C temperatures and remained there for three weeks. After this time elapsed, the four samples were removed from the oven, each operated once, connected in series, and subjected to 50 cycles of the following sequence of operations.

1. The assemblies were heated in air using sufficient current to raise the temperature of the conductor of the control cable to 90°C+/- 5°C for 1 hour.
2. The assemblies were de-energized and within 3 minutes, submerged in 25°C+/- 10°C conductive water (5000Ω/cm maximum) to a depth of 30 cm for 1 hour.

Each sample assembly consisted of:

1) 25kV, 200A elbow
2) 25kV, 200A bushing insert
3) Bushing well
4) Cable conductor type: aluminum
5) Cable conductor size: 1/0 AWG.

TEST RESULTS:
After the 50th cycle, each connector and cable assembly withstood a design impulse test. The test point was capable of passing the voltage test. All samples tested met the requirements of Section 7.12 of IEEE Standard 386 - 2006. Table 1 shows individual results of the Accelerated Sealing Life Test.

Table 1: Summary of Accelerated Sealing Life Test

Sample number	Impulse withstand (125kV BIL)	Test point indication
1	Pass	Pass
2	Pass	Pass
3	Pass	Pass
4	Pass	Pass

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TEST REPORT BULLETIN EU1548-08

Cable Pull-out Test (Tensile Strength)

TEST PROCEDURE:

Four connector/cable assemblies were tested. The compression lug was held in a manner that did not affect the strength of the connection. A tensile force of 200 lbf was applied to the cable conductor for 1 minute.

Each sample assembly consisted of:
200 A compression lug: bi-metal
Cable insulation thickness: 260 mils
Cable insulation type: TRXLPE
Cable conductor type: aluminum
Cable conductor size: 1/0 AWG conc. stranded
Compression tool: Burndy MD-6
Compression die: Burndy W-243 (4 impressions).

TEST RESULTS:

All samples tested met the requirements of Section 7.13 of IEEE Standard 386 - 2006.

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TEST REPORT BULLETIN EU1548-09

Operating-force Test

TEST PROCEDURE:
Each test sample, consisting of a 25kV, 200A elbow with its probe and compression lug and a bushing insert, was assembled and lubricated in accordance with the manufacturer's instruction. Each test consisted of closing and then reopening the connector within 10 minutes. The force was gradually applied at a constant rate of 5 inches per minute to the operating-eye parallel to the axis of the probe. The temperature of the connector was -20 °C ± 5 °C, 25 °C ± 5 °C, and 65 °C ± 5 °C, respectively, for the three separate tests.

TEST RESULTS:
All samples tested met the requirements of Section 7.14 of IEEE Standard 386 - 2006. The forces required to open or close the connection were within the range of 50 to 200 lbf. A summary of the test results is shown in Table 1.

Table 1: Summary of Operating-force Test

Sample number	Loadmake (lbf) @ -20°C	Loadbreak (lbf) @ -20°C	Loadmake (lbf) @ -20°C	Loadbreak (lbf) @ -20°C	Loadmake (lbf) @ -20°C	Loadbreak (lbf) @ -20°C
1	Pass	Pass	Pass	Pass	Pass	Pass
2	Pass	Pass	Pass	Pass	Pass	Pass
3	Pass	Pass	Pass	Pass	Pass	Pass
4	Pass	Pass	Pass	Pass	Pass	Pass

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TEST REPORT BULLETIN EU1548-10
Operating-eye Test

TEST PROCEDURE:
A static tensile force of 500 lbf was gradually applied to the operating-eye of each elbow in the direction of normal operation. The force was applied for a minimum of one minute. A rotational force of 120 lbf-in was applied with a suitable live-line tool to the operating-eye in a clockwise direction and in a counter-clockwise direction. After the tensile and rotational forces were applied, each elbow was subjected to the Partial Discharge Test. All tests were performed at ambient temperature of 25 °C ± 5 °C.

TEST RESULTS:
All samples tested met the requirement of Section 7.15 of IEEE Standard 386 – 2006. There was little or no distortion to the operating-eye on all samples tested. A summary of test results is shown in Table 1.

Table 1: Summary of operating-eye test results

Sample number	Static force (500lbf)	Rotational force (120 in-lbs)	Partial discharge test
1	Pass	Pass	Pass
2	Pass	Pass	Pass
3	Pass	Pass	Pass
4	Pass	Pass	Pass

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TEST REPORT BULLETIN EU1548-11
Test-point Cap Test

1. Test-Point Cap Operating Force

TEST PROCEDURE:
A tensile force was gradually applied to the test-point cap in the direction parallel with the probe axis at -20 ºC, 25 ºC, and 65 ºC.

TEST RESULTS:
The force required to remove the test-point cap was within the range of 8 to 49 lbf. All samples tested met the requirements of Section 7.16.1 of IEEE Standard 386 - 2006. Table 1 shows individual results of the Test-point Cap Operating Force Test.

Table 1: Test-point Cap Operating Force Test

Sample number	Operating force (lbf)		
	-20 ºC	25 ºC	65 ºC
1	Pass	Pass	Pass
2	Pass	Pass	Pass
3	Pass	Pass	Pass
4	Pass	Pass	Pass

2. Test-Point Cap Operating Withstand

TEST PROCEDURE:
A tensile force of 100 lbs was applied to the test-point cap operating eye for 1 minute at -20 ºC, 25ºC, and 65 ºC.

TEST RESULTS:
All samples tested met the requirements of Section 7.16.2 of IEEE Standard 386 - 2006.

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TEST REPORT BULLETIN EU1548-12
Test-point Test

1. Test-point Capacitance Test

TEST PROCEDURE:
An elbow was installed on a cable of the type for which it is designed to operate. The shielding of the elbow was grounded in the normal manner. The capacitance from the test-point of the elbow to the cable conductor and the test-point to the shield was measured with suitable instruments and proper shielding techniques.

TEST RESULTS:
The capacitance between the test-point and the cable conductor was at least 1.0 pF. The ratio of the capacitance between the test-point and shield to the capacitance between test-point and cable conductor did not exceed 12. All samples tested met the requirements of Section 7.17.1 of IEEE Standard 386 - 2006. Table 1 shows individual results of the Test-point Capacitance Test.

Table 1: Summary of Test-point Capacitance Test (pF)

Sample number	Test-point to Cable	Test-point to ground	Capacitance ratio
1	1.08	8.70	8.06
2	1.07	8.79	8.21
3	1.13	8.71	7.71
4	1.15	8.62	7.50
5	1.07	8.71	8.14
6	1.13	8.50	7.52
7	1.15	8.68	7.55
8	1.16	8.59	7.41
9	1.13	8.59	7.60
10	1.09	8.55	7.84

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2. Test-point Voltage Test

TEST PROCEDURE:
A test voltage was applied to the conductor system of the connector. The response of a suitable sensing device (Portable HI-Z Voltmeter, Model VM25-A with a VMP5-A probe tip) on the test point indicated an energized condition.

TEST RESULTS:
All samples tested met the requirements of Section 7.17.2 of IEEE Standard 386 - 2006. Table 2 shows individual results of the Test-point Voltage Test.

Table 2: Summary of Test-point Voltage Test

Sample number	Applied voltage (kV)	Test point voltage (kV)
1	15.0	9.5
2	15.0	10.0
3	15.0	10.0
4	15.0	10.0
5	15.0	10.0
6	15.0	10.0
7	15.0	10.0
8	15.0	10.0
9	15.0	10.0
10	15.0	10.0

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TEST REPORT BULLETIN EU1548-13
Shielding Test

1. Shield Resistance Test

TEST PROCEDURE:
The test procedure and requirements were in accordance with IEEE Standard 592-1990, "IEEE Standard for Exposed Semi conducting Shields on Premolded High-Voltage Cable Joints and Separable Insulated Connectors".

The resistance of the semi-conducting shield of 25kV, 200A elbow test samples was measured using the volt-ammeter method. The voltage was measured with the current adjusted to 1.0 mA ± 0.2 mA. The current connections were made on the shield at the farthest shield extremity, using a circumferential connection at both locations to give a uniform current distribution. Resistance measurements were made on unaged test specimens and samples that had been oven aged for 504 hours at 121°C. Resistance measurements were made with the test specimen temperature at 20°C and 90°C.

TEST RESULTS:
All samples tested met the requirements of Section 7.18 of IEEE Standard 386 - 2006. Resistance of all test samples did not exceed 5000 Ω. Table 1 shows individual results of the Shield Resistance Test.

Table 1: Summary of Shield Resistance Test

Sample number	Unaged		Sample number	Aged	
	20°C	90°C		20°C	90°C
1	Pass	Pass	5	Pass	Pass
2	Pass	Pass	6	Pass	Pass
3	Pass	Pass	7	Pass	Pass
4	Pass	Pass	8	Pass	Pass

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2. Fault-current Initiation Test

TEST PROCEDURE:
The test procedure and requirements were in accordance with the Fault-Current Initiation Test in IEEE Standard 592-1990, "IEEE Standard for Exposed Semi conducting Shields on Premolded High-Voltage Cable Joints and Separable Insulated Connectors". The circuit parameters were 6 kV maximum and 11 kA rms symmetrical available short circuit current. The copper-tungsten faulting rod was located between the semi conducting shield and probe at the extremity farthest from the cable entrance. Each test sample was subjected to two tests causing initiation of the fault current arc to ground with each operation having minimum current flow duration of 10 cycles.

TEST RESULTS:
All samples tested met the requirements of Section 7.18 of IEEE Standard 386 - 2006. Table 2 shows individual results of the Fault-current Initiation Test.

Table 2: Summary of Fault-current Initiation Test

Sample number	Test number	Test voltage (kV)	Test current (kA)	Duration (Cycles)
1	1	6.0	11	11.5
1	2	6.0	11	11.0
2	1	6.0	11	11.0
2	2	6.0	11	11.5
3	1	6.0	11	11.5
3	2	6.0	11	11.5
4	1	6.0	11	12.0
4	2	6.0	11	11.0

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CABLE ACCESSORIES TEST REPORT BULLETIN EU1548-14

Switching and Fault-Closure Interchangeability

1. Switching Test

TEST PROCEDURE:
Each test sample, consisting of a 25 kV 200A elbow and a bushing insert was subjected to 10 complete switching operations under the conditions listed in Figure 19 and Table 7 of IEEE Standard 386 - 2006. The test circuit complies with Figure 19 (b) of the Standard. Switching was performed manually. The test samples were operated using the parallel method of switching. Each switching operation was recorded by an oscillogram.

Complete interchangeability switching test was conducted on the Hubbell bushing insert mated with elbows manufactured by Elastimold (Thomas & Betts), Cooper Power Systems, and the Hubbell elbow mated with bushing inserts manufactured by Elastimold (Thomas & Betts), Cooper Power Systems.

TEST RESULTS:
In each test series, at least 10 consecutive successful tests were recorded as indicated in Tables 1 and 2. In each successful test, the sample withstood 10 complete switching operations without arcing to ground or impairing the ability to meet the other requirements of the standard. The test samples met the requirements of Section 7.7 of IEEE Standard 386 – 2006. The results provide confirmation that the Hubbell switch module met or exceeded the complete switching interchangeability requirements.

Table 1. Summary of Switching Tests
Test Sample: Hubbell Bushing Insert with Elastimold (T&B) Elbow (273LR-H5240)

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	P	16	P (14)
2	F	17	P (15)
3	P (1)	18	P (16)
4	P (2)	19	P (17)
5	P (3)	20	P (18)
6	P (4)	21	F
7	P (5)	22	P
8	P (6)	23	F
9	P (7)	24	P
10	P (8)	25	P
11	P (9)	26	P
12	P (10)	27	P
13	P (11)	28	P
14	P (12)	29	P
15	P (13)	30	P

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Test Sample: Hubbell Elbow with Elastimold (T&B) Bushing Insert (2701A4)

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	P	16	P (6)
2	P	17	P (7)
3	P	18	P (8)
4	F	19	P (9)
5	P	20	P (10)
6	P	21	P (11)
7	P	22	P (12)
8	P	23	P (13)
9	P	24	P (14)
10	F	25	P (15)
11	P (1)	26	P (16)
12	P (2)	27	P (17)
13	P (3)	28	P (18)
14	P (4)	29	P (19)
15	P (5)	30	P (20)

Test Sample: Hubbell Busing Insert with Cooper(CPS) Elbow (LE225M)

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	P	16	F
2	P	17	P
3	P	18	P
4	F	19	F
5	P (1)	20	P
6	P (2)	21	P
7	P (3)	22	P
8	P (4)	23	P
9	P (5)	24	F
10	P (6)	25	P
11	P (7)	26	P
12	P (8)	27	P
13	P (9)	28	F
14	P (10)	29	P
15	P (11)	30	F

Note: ( ) – Consecutive successful test.

Test Sample: Hubbell Elbow with Cooper(CPS) Bushing Insert (LBI225)

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	P (1)	16	P
2	P (2)	17	P
3	P (3)	18	P
4	P (4)	19	P
5	P (5)	20	P
6	P (6)	21	P
7	P (7)	22	P
8	P (8)	23	P
9	P (9)	24	P
10	P (10)	25	P
11	P (11)	26	P
12	P (12)	27	P
13	F	28	F
14	P	29	P
15	P	30	F

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2. Fault-closure Test

TEST PROCEDURE:
25kV 200A elbow and bushing insert connectors that were subjected to the switching test were then subjected to the fault-closure test with the fault current given in Table 2 and under the conditions listed in Figure 20 and Table 9 of IEEE Standard 386 - 2006. The test was conducted on the samples in the same sequence used for the switching test. The test circuit complies with Figure 20 (b) of the Standard. The closing operation was performed manually and each operation was recorded by an oscillogram.

TEST RESULTS:
As shown in Table 1, ten consecutive tests were recorded meeting the criteria that their oscillograms showed no external ground current and that all parts remained within the closed connector assembly. At least one connector in each combination was closed at an instant when the voltage is 80% or more of its peak value. The samples tested met requirements of Section 7.8 of IEEE Standard 386 - 2006. The results provide confirmation that the Hubbell switch module met or exceeded the fault-closure complete interchangeability requirements.

Table 1. Summary of Fault-closure Tests

Test sample: Hubbell Bushing Insert with Elastimold (T&B) Elbow (273LR-H5240)

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	P (1)	16	**
2	***	17	**
3	P (2)	18	**
4	P (3)	19	**
5	P (4)	20	**
6	P (5)	21	***
7	P (6)	22	**
8	P (7)	23	***
9	P (8)	24	**
10	P (9)	25	**
11	P (10)	26	**
12	**	27	**
13	**	28	**
14	**	29	**
15	**	30	**

Test sample: Hubbell Elbow with Elastimold (T&B) Bushing Insert (2701A4)

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	P (1)	16	**
2	P (2)	17	**
3	P (3)	18	**
4	***	19	**
5	P (4)	20	**
6	P (5)	21	**
7	P (6)	22	**
8	P (7)	23	**
9	P (8)	24	**
10	P (9)	25	**
11	***	26	**
12	P (10)	27	**
13	**	28	**
14	**	29	**
15	**	30	**

Test Sample: Hubbell Busing Insert with Cooper(CPS) Elbow (LE225M)

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	F	16	***
2	F	17	P(5)
3	P	18	P(6)
4	***	19	***
5	F	20	P(7)
6	P	21	P(8)
7	P	22	P(9)
8	P	23	P(10)
9	P	24	***
10	P	25	**
11	F	26	**
12	P (1)	27	**
13	P (2)	28	**
14	P (3)	29	**
15	P (4)	30	**

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Test Sample: Hubbell Elbow with Cooper(CPS) Bushing Insert (LBI225)

Sample Number	Pass/Fail	Sample Number	Pass/Fail
1	P (1)	16	**
2	P (2)	17	**
3	P (3)	18	**
4	P (4)	19	**
5	P (5)	20	**
6	P (6)	21	**
7	P (7)	22	**
8	P (8)	23	**
9	P (9)	24	**
10	P (10)	25	**
11	**	26	**
12	**	27	**
13	***	28	***
14	**	29	**
15	**	30	***

Note:
( ) - Consecutive successful test.
** - Sample not tested since fault-closure test requirements have been met.
*** - Sample failed in switching test.

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TEST REPORT BULLETIN EU1548-15
Operating Interface AC withstand test – Partial vacuum test

OBJECTIVE
To demonstrate that the Hubbell Power Systems 25kV, 200A loadbreak separable connector system is capable of performing an open operation under high operating force, low temperature, elevated voltage and zero load current conditions without flashover to ground.

TEST PROCEDURE
Each test sample consisted of a Hubbell bushing insert with a vented ring and a mating part such as an Elbow or an Insulating cap. The connectors were cleaned with a laboratory grade isopropyl alcohol and air dried for at least 15 minutes before assembly. The connectors were assembled without grease on the operating interface at an ambient temperature of 25°C ±5 °C. The assembled connectors were then chilled in a cold chamber between -20°C and -25°C for at least 16 hours.

Separation force tests were performed on 4 representative assemblies of Elbows and Caps at -20°C per Annex B requirements of IEEE Standard 386 – 2006. Twelve connector assemblies were individually tested within 10 minutes after removal from the cold chamber. A pneumatic operator with an average operating speed of 35± 5 in/sec during the initial 1.0 inch of travel was used to perform the test.

TEST RESULTS
All connector assemblies were successfully separated without a flashover to ground or impairment of the connector's ability to meet the other requirements of the standard. Table 1 illustrates the combinations tested along with the test conditions. The above results conclude that the Hubbell power systems 25kV loadbreak connectors met the requirements of Annex B of IEEE standard 386 – 2006.

Table 1: Summary of partial vacuum tests

Bushing insert with partial vaccum solution	Mating connector	Number of samples	Minimum test voltage (kV)	Result
Hubbell	Hubbell Elbow	12	26.6	Pass
Hubbell	Hubbell insulating cap	12	26.6	Pass
Hubbell	Elastimold elbow	12	26.6	Pass
Hubbell	Elastimold insulating cap	12	26.6	Pass
Hubbell	Cooper elbow	12	26.6	Pass
Hubbell	Cooper insulating cap	12	26.6	Pass