ENGINEERING TEST REPORT

Insulation Piercing Connector
(IPC)
KZEP 4/0
P/N 1-0708052-1

502-47418 (I)
REV. A

Test Specification: ANSI C119.5-2009
ACT No.: 4030
Date: 14th July, 2014
Classification: II
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Markham Energy/Utility Products
Test Laboratory

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Engineering Test Report
INSULATION PIERCING CONNECTOR (KZEP)

1. Introduction

1.1 Purpose

Testing was performed on the Insulation Piercing Connector (IPC) KZEP 4/0 to determine its conformance to the requirements of ANSI C119.5-2009. Tests performed at the Markham Energy/Utility Products Test Laboratory [MEUPTL], Canada & SIMEL Test Laboratory [STL], France.

1.2 Scope

This report covers the electrical, mechanical and environmental performance of the Insulation Piercing Connector (IPC) manufactured by TE Connectivity SIMEL S.AS. - Energy Division, France.

The testing was performed from the 22nd January to 8th December, 2010.

1.3 Conclusion

The INSULATION PIERCING CONNECTOR (IPC) KZEP 4/0 complies with the electrical, mechanical and environmental performance requirements of ANSI C119.5-2009, Class W Rating.
Group's 1, 2, 6 & 7 – Performed in Markham Test Laboratory;
Group's 3,4,5,8 & 9 – Performed in SIMEL Test Laboratory.

1.4 Product Description

Insulation Piercing Connector (IPC) provides electrical connection for aluminum and copper stranded conductors without stripping and removing insulation from the conductors. During installation the IPC establishes electrical contact, protects, and seals the contact interface, and electrically insulates the connection, eliminating the need for weather-proofing and re-insulating. It has a torque control nut for precise pressure on conductor and insulation. It has an expanded wire range (#14 AWG to #10 AWG Tap side & #6 AWG to 4/0 AWG Run side Al or Cu) for bare and insulated conductors.

1.5 Test Specimens

The test specimens were randomly selected by SIMEL, Energy Division, TE Connectivity, France and the following part number and quantities were used:

Test Group	Quantity	Conductor combination (all sizes are standard AWG)	Specimen Number	Testing Laboratory
1	4	#6 AAC - #10 Cu	50, 51, 52, 53	MEUPTL
	4	4/0 Cu - #14 Cu	54, 55, 56, 57	
2	3	4/0 AAC - #10 Cu	40, 41, 42	
	3	#6 AAC – #10 Cu	37, 38, 39	
3	2	4/0 AAC - #10Cu	1, 2	STL
	2	#6 AAC - #14 Cu	3, 4	
	2	#6 AAC - #10 Cu	5, 6	
4	6	4/0 AAC – #10 Cu	1, 2, 3, 13, 14, 15	
	6	#6 AAC - #14 Cu	4, 5, 6, 16, 17, 18	
	6	4/0 Cu – #10 Cu	7, 8, 9, 19, 20, 21	
	6	#6 Cu - #14 Cu	10, 11, 12, 22, 23, 24	

1.5 Test Specimens cont'd

Test Group	Quantity	Conductor combination (all sizes are standard AWG)	Specimen Number	Testing Laboratory
5	3	4/0 AAC - #10 Cu	1, 2, 3	STL
	3	#6 AAC – #10 Cu	4, 5, 6	
6	(i) 12 (Test A & B)*	#6 AAC - #14 Cu & #4AAC - #10Cu	4, 6, 10, 14, 30, 31 & 7, 15, 16, 17, 33, 36	MEUPTL
	(ii) 12 of each (Test A)	4/0 AAC – #10 Cu & #6 AAC - #14 Cu	9, 19, 21, 24, 26, 34; 2, 5, 18, 20, 22, 27 & 1, 8, 11, 13, 29, 32; 3, 5, 23, 25, 28, 35	
7	4	#10 Cu – #6 AAC	C5,C6, C7, C8	
	4	#10 Cu – #6 Cu	C1, C2, C3, C4	
8	2	4/0 AAC - #14 Cu	1, 2	STL
	2	#6 AAC - #14 Cu	3, 4	
	2	4/0 Cu - #14 Cu	5, 6	
	2	#6 Cu - #14 Cu	7, 8	
9	2	‡4/0 AAC - #14 Cu	1, 2	
	2	‡#6 AAC - #14 Cu	3, 4	
	2	‡4/0 Cu - #14 Cu	5, 6	
	2	‡#6 Cu - #14 Cu	7, 8	

*: Test A, Insulation Puncture. Test B, Flashover
‡: All conductors are insulated except those marked (‡). Bare conductors are standard stranded cable.

1.5 Test Specimens…..cont'd

Test Conductor specification:

Size	#14 Cu	#10 Cu	4/0 AAC	4/0 Cu
Material	Copper	Copper	Aluminum	Copper
Type	Stranded	Stranded	Stranded	Stranded
Shape	Circular	Circular	Circular	Circular
Type of Stranded conductor	Rigid	Rigid	Rigid	Rigid
Diameter of bare conductor	0.070"	0.115"	0.478"	0.500"
Number of strands	7	7	19	19
Overall Diameter with insulation	0.134"	0.178"	0.598"	0.620"
Material of insulation	XLPE	XLPE	XLPE	XLPE
Thickness of insulation	0.035"	0.037"	0.047"	0.055"
Rated Conductor Tensile Strength [lbs]	124**	293**	2626*	6149**
Marking and lettering on sheath	PIRELLI – G 14 AWG TW75 600V ft1 CSA	ALCAN B 10 AWG COPPER TW 75 600V ft1 CSA	X voltalene RW 90 XLPE 4/0 AWG AL ACM 600 Volts (-40C) SR CSA 2009 008321	GENERAL CABLE – BICC 5R° BRAND SQ (2009) 1C #4/0 AWG CU XLPE RW 90 CSA 600V (-40C) SR
Manufacturer	Pirelli	Alcan	Prysmian	General Cable BICC

Size	#6 AAC	#6 Cu
Material	Aluminum	Copper
Type	Stranded	Stranded
Shape	Circular	Circular
Type of Stranded conductor	Rigid	Rigid
Diameter of bare conductor	0.177"	0.171"
Number of strands	7	7
Overall Diameter with insulation	0.355"	0.272"
Material of insulation	XLPE	XLPE
Thickness of insulation	0.092"	0.047"
Rated Conductor (Tensile) Strength [lbs]	336*	794**
Marking and lettering on sheath	ALCATEL F EXELENE 6AWG ALUM ACM RW90 XLPE (-40°C) 1000V OUTDOOR	ALCATEL F EXELENE #6 AWG
Manufacturer	Alcatel	Alcatel

*: See calculation on page 5.
**: Standard copper RTS values used, as listed in Southwire Power Cable Manual.

1.5 Test Specimens…..cont'd

*: Method for calculating Rated Tensile Strength of Aluminium conductor (see below)

Individually pull all strands of aluminum conductor only (4/0AAC and #6AAC) using Instron tensile machine and fixture, as per ASTM B557/B557M.

Average tensile stress value (at fracture) for all strands (by calculation) was 22ksi.

Determine temper according to ASTM B609 Table 3 Tensile Property Limits.

EXAMPLE:

Using calculation method in ASTM B231;
i) Maximum RTS rating for conductor is (22ksi x Area in^2)
ii) Minimum RTS rating for this conductor is (17ksi x Area in^2 x rating factor) [Rating Factor is 0.96 for 7 strand & 0.93 for 19 strand]. This was the value used for testing purposes.

Hence this calculated value(s) was used to perform % RTS calculations.

1.6 Test Sequence

TEST or EXAMINATION (test clauses as per ANSI C119.5-2009)	TEST GROUPS									
	1	2	3	4	5	6 (i)	6 (ii) & (iii)	7	8	9
Examination of Product	1, 4	1,3	1,3	1,3	1,3	1,4	1,3	1,3	1,4	1,3
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Note: Number indicates sequence in which tests were performed.

2. Summary of Testing

2.1 Examination of Product

All specimens submitted for testing were production parts inspected and accepted by the Product Development Engineering Department at Tyco Electronics Canada ULC.

2.2 One Minute Load test (Group 1)

Complied with the requirements for the One minute Load test exceeding the minimum requirement, see below, and applied for 1 minute.

S/N	Shear Torque (Nm)	#6 AAC – #10 Cu	#14 Cu – 4/0 Cu
50	6.93	Pass	-
51	6.99	Pass	-
52	6.88	Pass	-
53	6.87	Pass	-
54	6.92	-	Pass
55	6.70	-	Pass
56	6.96	-	Pass
57	6.83	-	Pass
Requirement	**6.6-8.0Nm**	**50 lbs-force for 1 minute**	**50 lbs-force for 1 minute**

2.3 Tensile Strength [class 3] (Group 1)

The specimens selected for Tensile Strength test complied with the requirements' of the test specification by exceeding the minimum requirement given.

S/N	Shear Torque (Nm)	#6 AAC – #10 Cu	#14 Cu – 4/0 Cu	Failure Mode
50	6.93	>125.6	-	Test Stopped
51	6.99	>125.6	-	Test Stopped
52	6.88	>125.6	-	Test Stopped
53	6.87	>125.6	-	Test Stopped
54	6.92	-	>55	Test Stopped
55	6.70	-	>55	Test Stopped
56	6.96	-	>55	Test Stopped
57	6.83	-	>55	Test Stopped
Requirement	**6.6-8.0Nm**	**>50 lbs-force**	**>50 lbs-force**	-

2.4 Conductor Damage (Group 2)

All samples submitted satisfied the requirements of a run conductor normally used as a non-tensioned supporting member in service loaded to 80% of its rated strength. Load maintained for 1 minute. This was achieved on all specimens assembled with 4/0 AWG AAC run to #10 AWG Cu tap & #6 AWG AAC run to #10 AWG Cu tap.

		Load at Failure (lbs-force)			
S/N	**Shear Torque (Nm)**	**4/0 AAC – #10 Cu**		**#6 AAC – #10 Cu**	
37	6.80	>2700		-	
38	6.69	>2700		-	
39	6.97	>2700		-	
40	6.70	-		>316	
41	6.92	-		>316	
42	6.88	-		>316	
Requirement (lbs-force)	**6.6-8.0Nm**	**2101 (80%)**	**Pass**	**269 (80%)**	**Pass**

2.5 Bolt Tightening (Group 3)

Each specimen submitted for test withstood 120% (7Nm) of the manufacturer's recommended torque without cracking, rupture, or permanent distortion of any connector component that impairs its proper functioning.
Re: APPENDIX A - SIMEL Laboratory Test Report D10008R dated 19/03/2010.

2.6 Shear Head Function (Group 4)

The torque control nut sheared satisfactorily on all specimens within the manufactures shear torque range of 6.6Nm to 8.0Nm, after being conditioned at the low and high temperature specified in the standard.
Re: APPENDIX B - SIMEL Laboratory Test Report D10004R dated 17/03/2010.

2.7 Connector Mounting Test at Low Temperature (Group 5)

Each specimen, in turn, exhibited electrical continuity when subjected to the Low Temperature Connector Mounting Test.
Re: APPENDIX C - SIMEL Laboratory Test Report D10006R dated 18/03/2010.

2.8 Test A, insulation puncture (Group 6 (i), (ii) and (iii))

All three sets of specimens: (i) assembled in the as-received condition, (ii) assembled to a conductor before oven conditioning and (iii) assembled to a conductor after oven conditioning complied with the test requirements.

(i) Assembled in the as-received condition;

S/N	Shear Torque value (Nm)	Conductor type and size	Breakdown (Yes/No)
4	6.85	#6 AAC - #14 Cu	No
6	6.99	#6 AAC - #14 Cu	No
7	6.63	#4 AAC - #10 Cu	No
10	6.88	#6 AAC - #14 Cu	No
14	6.61	#6 AAC - #14 Cu	No
15	6.85	#4 AAC - #10 Cu	No
16	6.98	#4 AAC - #10 Cu	No
17	6.63	#4 AAC - #10 Cu	No
30	6.93	#6 AAC - #14 Cu	No
31	6.96	#6 AAC - #14 Cu	No
33	6.70	#4 AAC - #10 Cu	No
36	6.66	#4 AAC - #10 Cu	No
Requirement	**6.6 – 8.0Nm**	-	**No Breakdown**

2.8 Test A, insulation puncture (Group 6 (i), (ii) and (iii)).....cont'd

(ii) Assembled to a conductor before oven conditioning [168 hours at 121°C];

S/N	Shear Torque value (Nm)	Conductor type and size	Breakdown (Yes/No)
1	7.02	#6 AAC - #14 Cu	No
8	6.65	#6 AAC - #14 Cu	No
9	6.90	4/0 AAC - #10 Cu	No
11	6.88	#6 AAC - #14 Cu	No
13	6.87	#6 AAC - #14 Cu	No
19	6.65	4/0 AAC - #10 Cu	No
21	6.70	4/0 AAC - #10 Cu	No
24	6.93	4/0 AAC - #10 Cu	No
26	6.88	4/0 AAC - #10 Cu	No
29	6.88	#6 AAC - #14 Cu	No
32	6.65	#6 AAC - #14 Cu	No
34	7.40	4/0 AAC - #10 Cu	No
Requirement	6.6 – 8.0Nm	-	No Breakdown

(iii) Assembled to a conductor after oven conditioning [168 hours at 100°C];

S/N	Shear Torque value (Nm)	Conductor type and size	Breakdown (Yes/No)
2	6.65	4/0 AAC - #10 Cu	No
3	7.08	#6 AAC - #14 Cu	No
5	6.72	4/0 AAC - #10 Cu	No
12	6.65	#6 AAC - #14 Cu	No
18	6.99	4/0 AAC - #10 Cu	No
20	6.90	4/0 AAC - #10 Cu	No
22	6.78	4/0 AAC - #10 Cu	No
23	6.90	#6 AAC - #14 Cu	No
25	6.88	#6 AAC - #14 Cu	No
27	6.76	4/0 AAC - #10 Cu	No
28	6.92	#6 AAC - #14 Cu	No
35	6.90	#6 AAC - #14 Cu	No
Requirement	6.6 – 8.0Nm	-	No Breakdown

Additional Information: Approx. length of 8 inches of submerged cable.

2.9 Test B, flashover (Group 6 (i))

All un-conditioned as-received samples used for Test A, insulation puncture (in 2.8) complied with the requirements for this test.

Assembled in the as-received condition (tested immediately after Test A, Insulation Puncture);

S/N	Shear Torque value (Nm)	Conductor type and size	Flashover/Breakdown (Yes/No)
4	6.85	#6 AAC - #14 Cu	No
6	6.99	#6 AAC - #14 Cu	No
7	6.63	#4 AAC - #10 Cu	No
10	6.88	#6 AAC - #14 Cu	No
14	6.61	#6 AAC - #14 Cu	No
15	6.85	#4 AAC - #10 Cu	No
16	6.98	#4 AAC - #10 Cu	No
17	6.63	#4 AAC - #10 Cu	No
30	6.93	#6 AAC - #14 Cu	No
31	6.96	#6 AAC - #14 Cu	No
33	6.70	#4 AAC - #10 Cu	No
36	6.66	#4 AAC - #10 Cu	No
Requirement	**6.6 – 8.0Nm**	-	**No Breakdown**

Note: A 5mA trip sensitivity set-point was used during this test.

2.10 Current Cycling (Group 7)

There was no evidence of physical damage to the test specimens after 580 cycles of current cycling. The temperatures of the connectors did not exceed the temperature of the control conductor and the temperature difference between the control conductor and the connector was stable between the 100th cycle and the 580th cycle. Stability factor, Si, was achieved when the temperature difference between the control conductor and the connector, including allowance for measurement error, is not more than ±10 for each of the specified temperature measurements recorded. Resistance on each connector was stable by not varying more than ±5% from the average of all the measurement at specified intervals between 100-580 cycles.
Refer to Charts 1 – 8 for full temperature & resistance graphs, pages 23 – 30.

NOTE: S/N C1-C4 used conductor type #6 Cu - #10 Cu;

TABLE 1

Cycle Number	Ambient (°C)	Control (°C)	Connector Temp (°C)				Temperature Difference (°C)				Stability Factor (Si)			
			C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4
100	22.87	121.2	47.2	49.2	47.4	48.2	74.0	72.0	73.8	73.0	2.6	1.8	1.9	1.6
125	22.93	116.4	47.6	48.5	47.2	47.9	68.8	67.9	69.2	68.5	2.5	2.3	2.7	2.8
150	22.98	112.0	48.7	50.5	48.6	47.5	63.3	61.6	63.5	64.6	8.0	8.7	8.4	6.8
175	22.74	116.4	47.3	48.6	46.2	47.5	69.1	67.7	70.2	68.9	2.3	2.5	1.7	2.5
200	22.69	117.3	47.1	48.5	47.0	46.9	70.3	68.8	70.3	70.4	1.1	1.4	1.6	1.0
239	22.66	120.7	46.5	47.4	46.1	47.1	74.2	73.3	74.6	73.6	2.8	3.1	2.8	2.2
280	22.86	120.1	47.5	48.5	47.0	47.5	72.6	71.6	73.1	72.6	1.3	1.4	1.2	1.2
325	22.79	114.4	47.1	48.7	46.6	47.1	67.3	65.7	67.9	67.3	4.0	4.5	4.0	4.1
403	23.04	125.7	48.9	49.5	47.7	48.3	76.7	76.2	78.0	77.4	5.4	6.0	6.1	6.0
480	22.72	117.7	46.9	48.0	46.5	47.1	70.8	69.8	71.2	70.6	0.5	0.4	0.6	0.8
580	23.03	126.5	48.8	48.8	47.5	48.1	77.7	77.6	79.0	78.4	6.3	7.4	7.1	7.0
							71.3	70.2	71.9	71.4	8.0	8.7	8.4	7.0
		1. The connector temperature cannot exceed the control conductor temperature					Average Temperature Difference				Maximum Stability Factor			
											2. The stability factor "Si" shall not exceed 10 for each of the connector temperature measurements recorded at the specified intervals			

2.10 Current Cycling (Group) cont'd

TABLE 2

Cycle Number	Connector Resistance (Corrected to 20C)			
	C1	C2	C3	C4
100	1735.0	1675.2	1726.5	1495.7
125	1726.5	1675.2	1735.0	1495.7
150	1741.4	1689.7	1741.4	1508.6
175	1732.8	1681.0	1732.8	1508.6
200	1732.8	1681.0	1732.8	1500.0
239	1732.8	1681.0	1732.8	1500.0
280	1741.4	1689.7	1741.4	1508.6
325	1726.5	1675.2	1726.5	1495.7
403	1726.5	1675.2	1735.0	1495.7
480	1726.5	1675.2	1726.5	1495.7
580	1726.5	1675.2	1726.5	1495.7
Average Resistance	1731.7	1679.4	1732.5	1500.0
Min Acceptable Resistance (-5%)	1645.1	1595.5	1645.8	1425.0
Max Allowable Resistance (+5%)	1818.3	1763.4	1819.1	1575.0
3. The resistance of the connectors tested shall not vary by more than ±5% from the average of the measured values.				

2.10 Current Cycling (Group 7) cont'd

NOTE: S/N C5-C8 used conductor type #6 AAC – #10 Cu.

TABLE 3

Cycle Number	Ambient (°C)	Control (°C)	Connector Temp (°C)				Temperature Difference (°C)				Stability Factor (Si)			
			C5	C6	C7	C8	C5	C6	C7	C8	C5	C6	C7	C8
100	22.87	121.17	53.03	54.7	53.49	53.14	68.14	66.47	67.68	68.03	1.9	2.1	2.0	2.6
125	22.93	116.4	52.67	54.82	53.49	53.62	63.73	61.58	62.91	62.78	2.5	2.7	2.7	2.7
150	22.98	112.03	53.09	56.99	54.49	54.17	58.94	55.04	57.54	57.86	7.3	9.3	8.1	7.6
175	22.74	116.37	52.42	54.07	53.21	53.14	63.95	62.3	63.16	63.23	2.3	2.0	2.5	2.2
200	22.69	117.3	52.7	54.64	53.34	53.08	64.6	62.66	63.96	64.22	1.7	1.7	1.7	1.3
239	22.66	120.7	51.81	53.41	52.63	52.92	68.89	67.29	68.07	67.78	2.6	3.0	2.4	2.3
280	22.86	120.1	52.46	54.67	53.4	53.7	67.64	65.43	66.7	66.4	1.4	1.1	1.1	0.9
325	22.79	114.41	52.35	54.6	53.28	53.68	62.06	59.81	61.13	60.73	4.2	4.5	4.5	4.7
403	23.04	125.65	52.7	54.84	53.38	53.84	72.95	70.81	72.27	71.81	6.7	6.5	6.6	6.3
480	22.72	117.72	51.86	53.52	52.46	52.89	65.86	64.2	65.26	64.83	0.4	0.1	0.4	0.6
580	23.03	126.47	54.48	54.5	53.12	53.92	71.99	71.97	73.35	72.55	5.7	7.6	7.7	7.1
							66.3	64.3	65.6	65.5	7.3	9.3	8.1	7.6
		1. The connector temperature cannot exceed the control conductor temperature					Average Temperature Difference				Maximum Stability Factor			
											2. The stability factor "Si" shall not exceed 10 for each of the connector temperature measurements recorded at the specified intervals			

2.10 Current Cycling (Group 7) cont'd

TABLE 4

Cycle Number	Connector Resistance (Corrected to 20C)			
	C5	C6	C7	C8
100	1888.9	2170.9	2119.7	2145.3
125	1897.4	2179.5	2119.7	2145.3
150	1913.8	2189.7	2137.9	2163.8
175	1922.4	2189.7	2129.3	2155.2
200	1922.4	2181.0	2129.3	2155.2
239	1931.0	2189.7	2137.9	2163.8
280	1939.7	2198.3	2137.9	2172.4
325	1931.6	2179.5	2119.7	2153.8
403	1914.5	2179.5	2128.2	2170.9
480	1923.1	2179.5	2119.7	2170.9
580	2008.5	2188.0	2119.7	2170.9
Average Resistance	1926.7	2184.1	2127.2	2160.7
Min Acceptable Resistance (-5%)	1830.3	2074.9	2020.8	2052.7
Max Allowable Resistance (+5%)	2023.0	2293.3	2233.5	2268.7
3. The resistance of the connectors tested shall not vary by more than ±5% from the average of the measured values.				

2.11 Dielectric Withstand & Leakage Current Test (Class W) (Group 8)*

After immersion for 24 hours in a tank containing tap water at 25 ±5°C at a depth of at least 12 inches, there was no evidence of breakdown or flashover of the specimens when subjected to the Dielectric Withstand Test. The Leakage Current for all specimens was less than 1mA.

Re: APPENDIX D - SIMEL Laboratory Test Report I10006A dated 19/02/2010.

2.12 Water Penetration Test (Class W) (Group 9)*

During the immersion of each sample, for a period of 24 hours no specimens showed any evidence or indication of water penetration at the extremity of the insulated tap cable.

Re: APPENDIX E - SIMEL Laboratory Test Report I10003A dated 23/03/2010.

*: To achieve a Class W rating product under test must comply with both requirements of 2.11 and 2.12.

3. Test Methods

3.1 Examination of Product

TE Connectivity SIMEL S.AS. - Energy Division, France and New Product Development Engineering Department at Tyco Electronics Canada ULC., examined specimens visually and functionally.
Test specimen quantity and wire combinations for each test are stated in section 1.5, pages 2 & 3.

3.2 One Minute Load test (Group 1)

The specified load, 80 lbs force [356N] & 50 lbs force [222N], (Table 3 ANSI C119.5-2009), but in this case was held for at least one minute.
After this the machine was returned to zero, the specimen was inspected visually for any slippage.
This process was applied on all specimens in turn.

Representative photographs see Fig. 1 & 2

3.3 Tensile Strength [class 3] (Group 1)

The same initial test method and set of specimens were used for this test as per 3.2, above.

Once assembled, as per manufacturer instructions (PN 1727087-1, code 659422, indice A, EQ00-0366-03, 27/11/03), the specimen was then installed between the upper and lower jaws of the Instron Tensile machine (model 4206-006). The machine was calibrated and an axial load was applied to the test specimens at a rate of 0.5 inch per minute until the minimum load specified in ANSI C119.5-2009, Table 1 (80 lbs force [356N] & 50 lbs force [222N]) was achieved and held for several seconds and returned to zero.
The value for the machine speed was based on a cross-head speed of 0.25"/minute/foot of the total length of the assembly between the jaws of the tensile machine. Length of conductor used was 2-2.5ft each.
This process was applied on all specimens in turn.

Representative photographs see Fig. 1 & 2

3.4 Conductor Damage (Group 2)

Rated Tensile Strength (RTS) was determined by physical test, measurement and calculation based on the standard methods used in ASTM B 231 & B609 Table 3. Therefore the RTS of #10 AWG AAC, #6 AAC and 4/0 AWG AAC used in these tests were found to be 314 lbs, 336 lbs and 2626 lbs respectively.
The run conductor was installed between the upper and lower jaws of the Instron Tensile Machine. After pre-tensioning this conductor to 12% of its rated strength the connector was installed onto the run conductor, with a 12" length of tap conductor, tightened to a maximum torque of 8Nm, as per manufacturer instructions (P/N 1727087-1, code 659422, indice A, EQ00-0366-03, 27/11/03).
The run conductor, on each specimen, was tensioned to 80% of its RTS and held for 1 minute. If no failure was observed, the load was then returned to zero.

The value for the machine speed was based on a cross-head speed of 0.25"/minute/foot of the total length of the assembly between the jaws of the tensile machine. Length of conductor used was 2-2.5ft each.
This process was applied on all specimens in turn.

Representative photographs see Fig. 3 & 4

3.5 Bolt Tightening (Group 3)

Each connector was assembled with a minimum of 2 inches protruding from each end of the connector body.
Each connector, in turn, was tightened up to 8.4 Nm (120% of nominal torque value). The tightening was carried out approximately one quarter turn during 1-3 seconds, with approximately 2 seconds in between tightening operations.

Re: APPENDIX A - SIMEL Laboratory Test Report D10008R dated 19/03/2010.

3.6 Shear Head Function (Group 4)

Prior to the actual shear head test one-half of the samples were subjected to a conditioning temperature for 1 hour at temperature of -10° ± 3°C, and the other half were subjected to a conditioning temperature for 1 hour at temperature of +50° ± 3°C.
After conditioning each connector was assembled onto the conductor within 2 minutes of removal from the conditioning chamber, with a minimum of 2 inches of conductor protruding from each end of the connector body. Each connector, in turn, was tightened until the nut sheared and the shear torque noted. The tightening was carried out approximately one quarter turn during 1-3 seconds, with approximately 2 seconds in between tightening operations.
Re: APPENDIX B - SIMEL Laboratory Test Report D10004R dated 17/03/2010.

3.7 Connector Mounting Test at Low Temperature (Group 5)

The specimens were conditioned in a chamber at -10° ± 2°C for 1 hour. Each connector was installed onto the conductor within 2 minutes of removal from the conditioning chamber, with a minimum of 2 inches of conductor protruding from each end of the connector body.
The nut on the connector was tightened to 70% of the minimum shear torque (4.62Nm), during this assembly procedure.
Re: APPENDIX C - SIMEL Laboratory Test Report D10006R dated 18/03/2010.

3.8 Test A, Insulation Puncture (Group 6 (i), (ii) & (iii))

Three sets of specimens were subjected to this test, assembled as follows:

(i) Assembled to a conductor, no oven conditioning then tested (as-received).

(ii) Assembled to a conductor, oven conditioned then tested.
Specimens assembled to conductors were conditioned in an air-circulating oven at an elevated temperature corresponding to the insulation temperature rating; in this case for a 90°C rating, conditioning temperature was 121°C for 168 hours.

(iii) Individual (un-assembled) specimens were conditioned for 168 h in an air-circulating oven at 100°C. The specimens were then allowed to cool to room temperature. Following the oven conditioning they were again conditioned for 24 hours at a relative humidity of 85 ± 5 percent at 30 ± 2°C. The specimens were then assembled to conductors.

Each specimen, in turn, was embedded in No. 7½ conductive shot that served as the outer electrode. A test voltage of 3400V a.c. was applied between the conductors and the outer electrode for a period of 1 minute.

Representative photographs see Fig. 5 & 6

3.9 Test B, Flashover (Group 6 (i) only)

Only group 6 (i) specimens previously subjected to Test A Insulation Puncture, were then subjected to Test B, Flashover:

After Test A, voltage was then returned to zero. Specimen was covered in AMP Sealing and Dielectric Compound (cat. #275447-1), to prevent insulation puncture the outer surface of the connector insulation, covered in such a manner that it did not interfere with the position of the outer electrode immediately adjacent to the points of conductor entry into the connector.
It was then embedded in No. 7½ conductive shot and the surface of the conductor immediately adjacent to the connector opening was covered with conductive metal foil to serve as the outer electrode. Then the test voltage was rapidly and steadily increased to the maximum Test B voltage of 8000V a.c.
Representative photographs see Fig. 7.

3.10 Current Cycling (Group 7)

A total of eight P/N 1-0708052-1 KZEP 4/0 connectors, were installed in a series circuit using approximately 12" lengths of mostly stripped bare #6 Cu, #6 AAC and #10 Cu insulated conductors, as required between any equalization point and connector, (refer fig. 8 & 9).
Each test loop, see below, were constructed and set-up as per ANSI C119.5-2009, Annex C (Tap configuration).

A total of eight connectors, four with a #6 Cu to #10 Cu configuration and another four with a #6 AAC to #10 Cu configurations. The control conductor, #10 Cu, was 24" in length. AMPACT Terminal Lugs were used to connect the conductor to the power supply, with a minimum of 24" between an equalization point and the power supply.
Once the conductors were inserted into the connector, the bolts were tightened until the bolt sheared off. To measure temperature, two thermocouples were applied to each connector with small holes drilled into the IPC and thermocouples secured by two-part epoxy resin mixed with zinc oxide heat sink compound (refer fig. 10). Another thermocouple was located in the middle of the control conductor.
In order to determine the resistances, Volt-drop measurements were taken on either side of each connector, (refer fig. 9), at the end of every 'CURRENT OFF' cycle. A dc current of 11.9 A was used.
The connectors were energized with a current of approximately; 65 amps , which raised the temperature of the control conductor to 100°C above the ambient temperature.
The cycle time throughout the test was 1 hour 'CURRENT ON' and 1 hour 'CURRENT OFF'. The connectors were subjected to a total of 580 cycles. The temperature of the control conductor and the connectors were taken during the cycles preceding the termination resistance measurements.

3.11 Dielectric Withstand & Leakage Current Test (Class W) (Group 8)*

Each test specimen was immersed for 24 hours in a tank containing tap water at room temperature of 25°C ± 5°C. All parts of the connector assembly, except the leads, were submerged to a depth below the surface of at least 12 inches. Whilst being submerged each assembly was subjected to a voltage of 2.2kV, 60Hz applied between the water and the conductor for 1 minute.
Following the Dielectric Withstand test, and still immersed in water, each assembly was subjected to a 600V, 60 Hz potential between water and conductor, and the leakage current measured, as shown in fig. 4 of ANSI C119.5-2009.

Re: APPENDIX D - SIMEL Laboratory Test Report I10006A dated 19/02/2010.

3.12 Water Penetration Test (Class W) (Group 9)*

Each test specimen was immersed for 24 hours in a tank containing tap water at room temperature of 25°C ± 5°C. All parts of the connector assembly, were submerged to a depth below the surface of at least 12 inches, shown in fig. 5 of ANSI C119.5-2009.

Re: APPENDIX E - SIMEL Laboratory Test Report I10003A dated 23/03/2010.

*: To achieve a Class W rating, specimens under test performed in 3.11 and 3.12 must both comply.

4. Validation

Prepared by:

15/7/2014

McGuinne Ryan
Engineering Laboratory Technician
Energy Division
Tyco Electronics Canada ULC.

Reviewed by:

15/7/2014

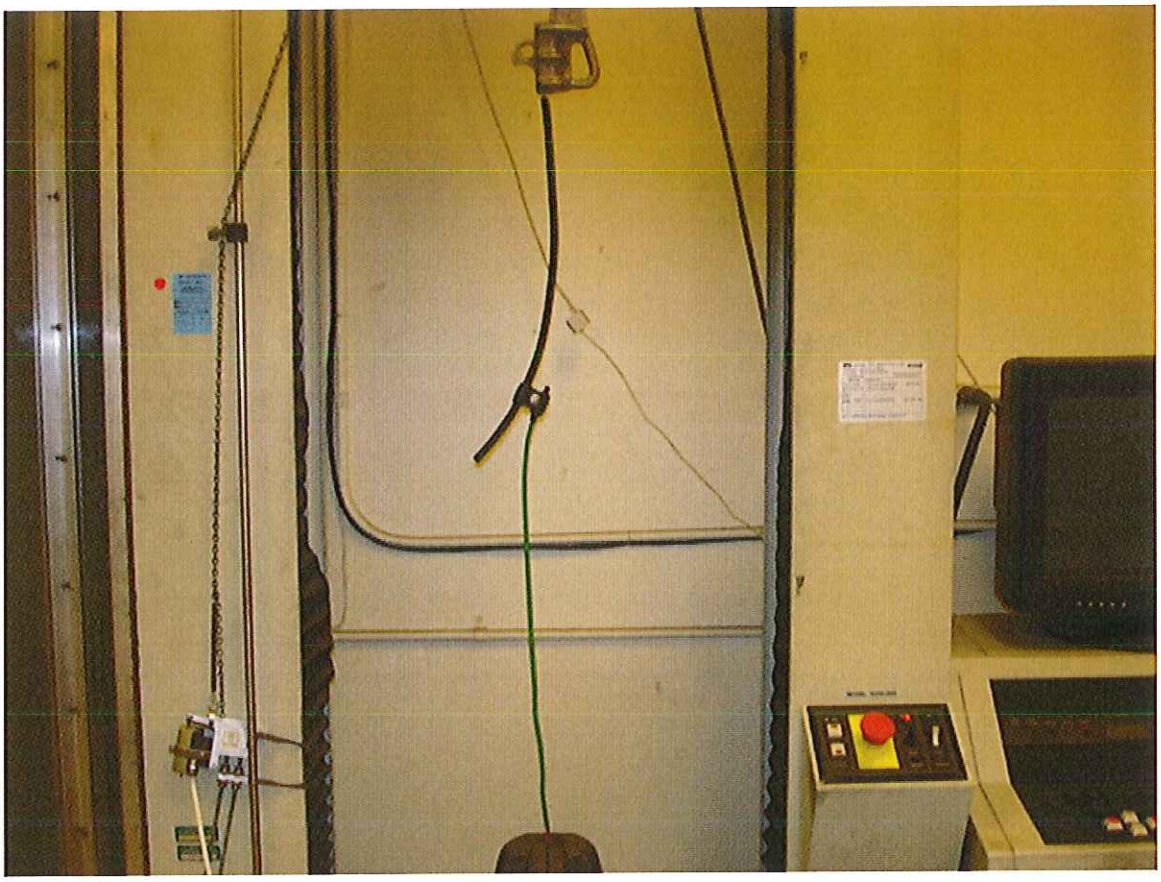
Wayne Holness
Group Leader - Test Laboratory
Energy Division
Tyco Electronics Canada ULC.

Approved by:

07/15/14

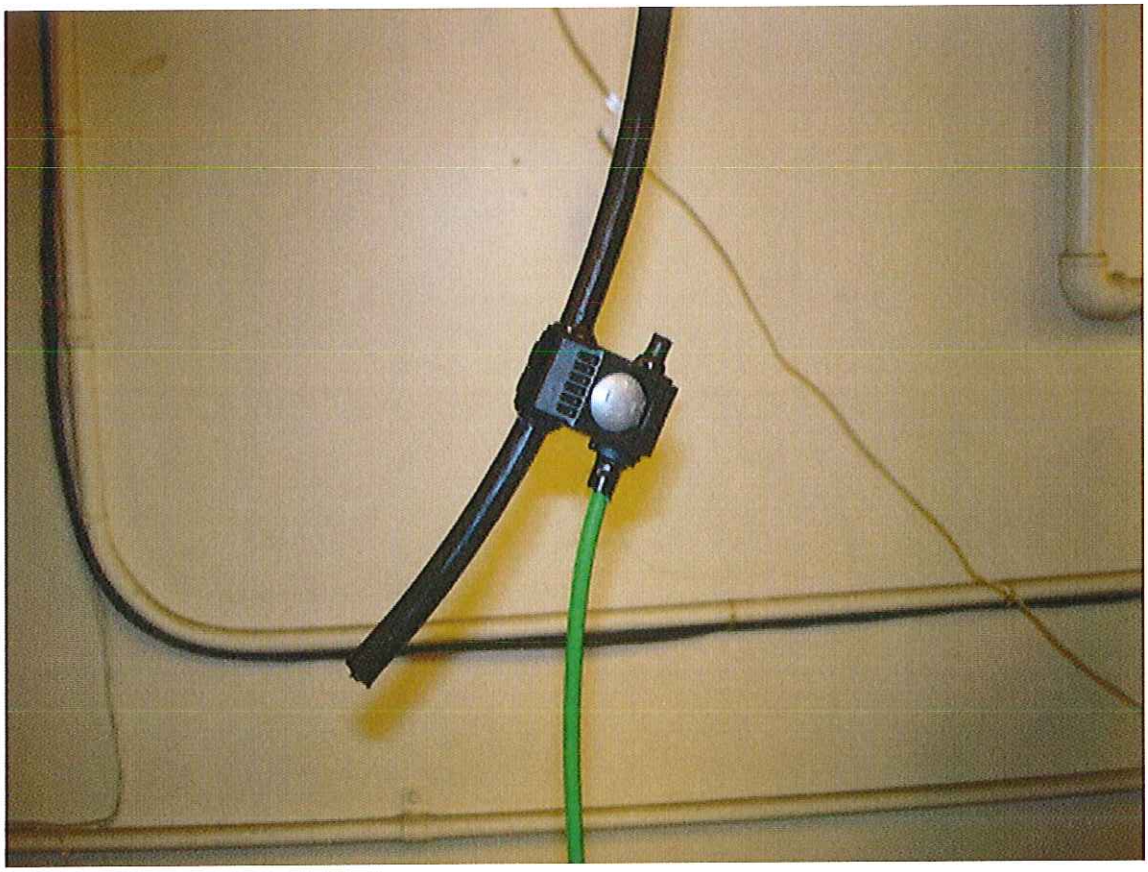
Barry Johnson
Manager, Product Development
Product Development Engineering
Energy Division
Tyco Electronics Canada ULC.

Fig. 1



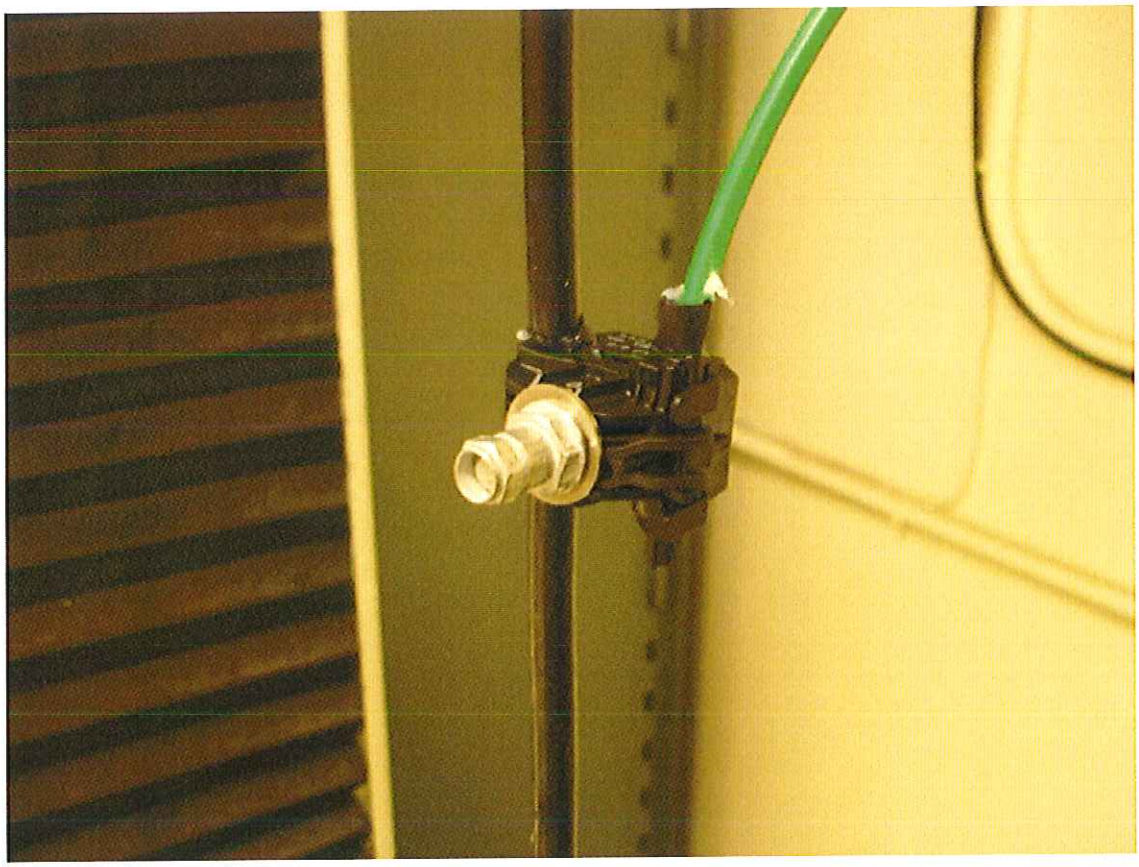
Representative photograph of KZEP 4/0 P/N 1-0708052-1 test set-up for Tensile Strength & One Minute Load tests (Group 1) ANSI C119.5-2009

Fig. 2



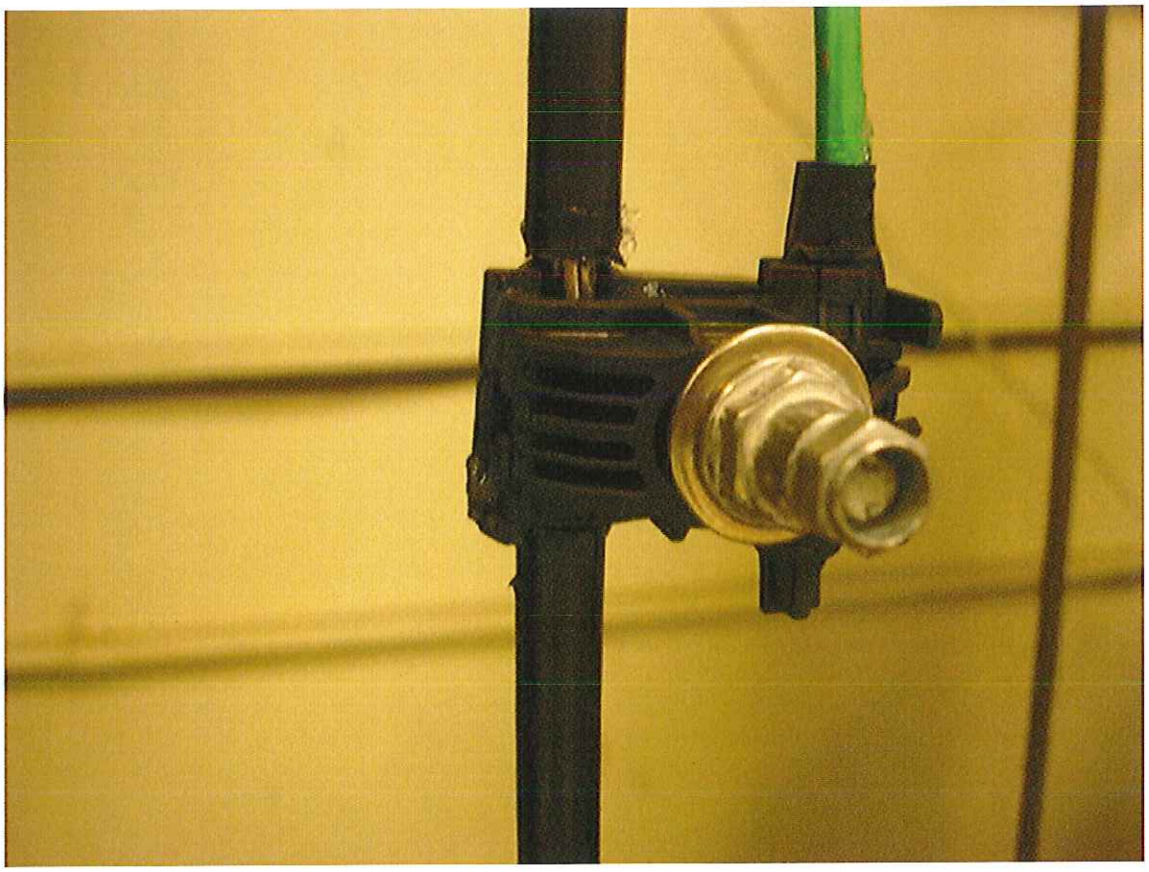
Representative close-up view of KZEP 4/0 P/N 1-0708052-1 during for Tensile Strength & One Minute Load tests (Group 1) ANSI C119.5-2009

Fig. 3



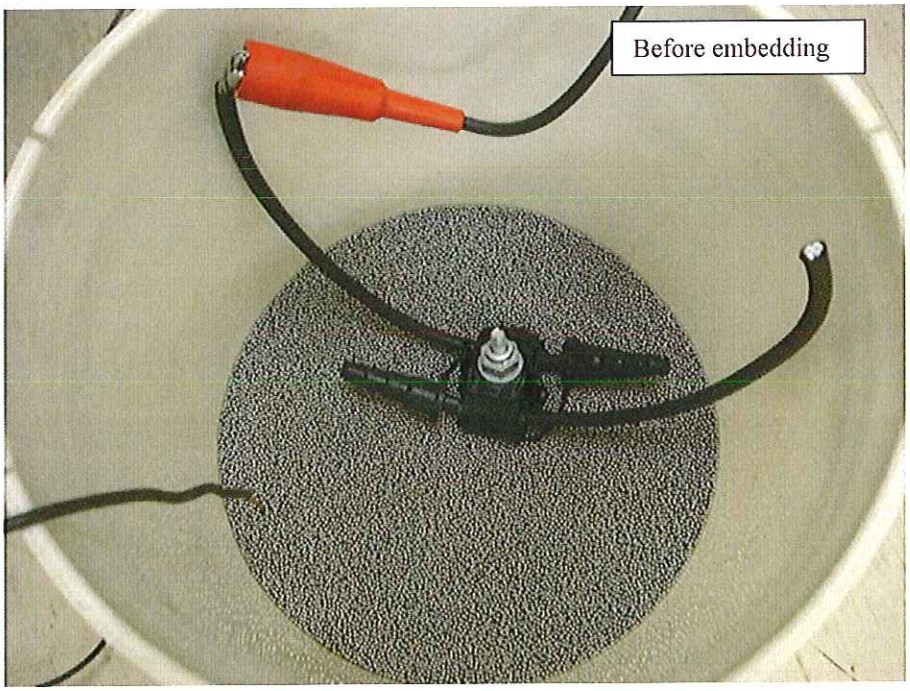
Representative photograph of KZEP 4/0 P/N 1-0708052-1 (#6 AWG AAC to #10 AWG Cu) test set-up for Conductor Damage test (Group 2)
ANSI C119.5-2009

Fig. 4



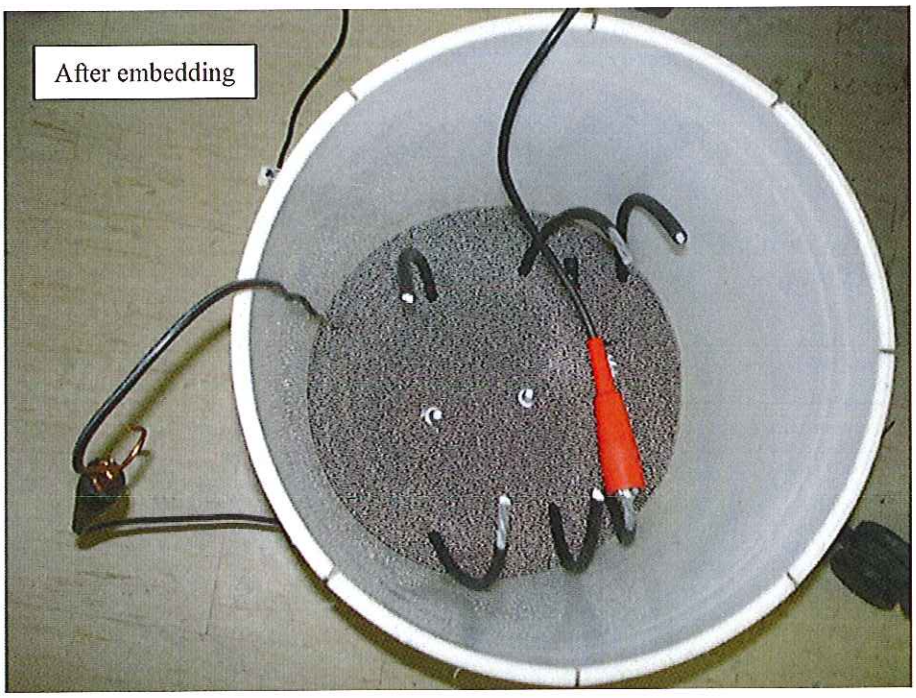
Representative close-up view of KZEP 4/0 P/N 1-0708052-1
(#6 AWG AAC to #10 AWG Cu conductor) after Conductor Damage test
(Group 2) ANSI C119.5-2009

Fig. 5



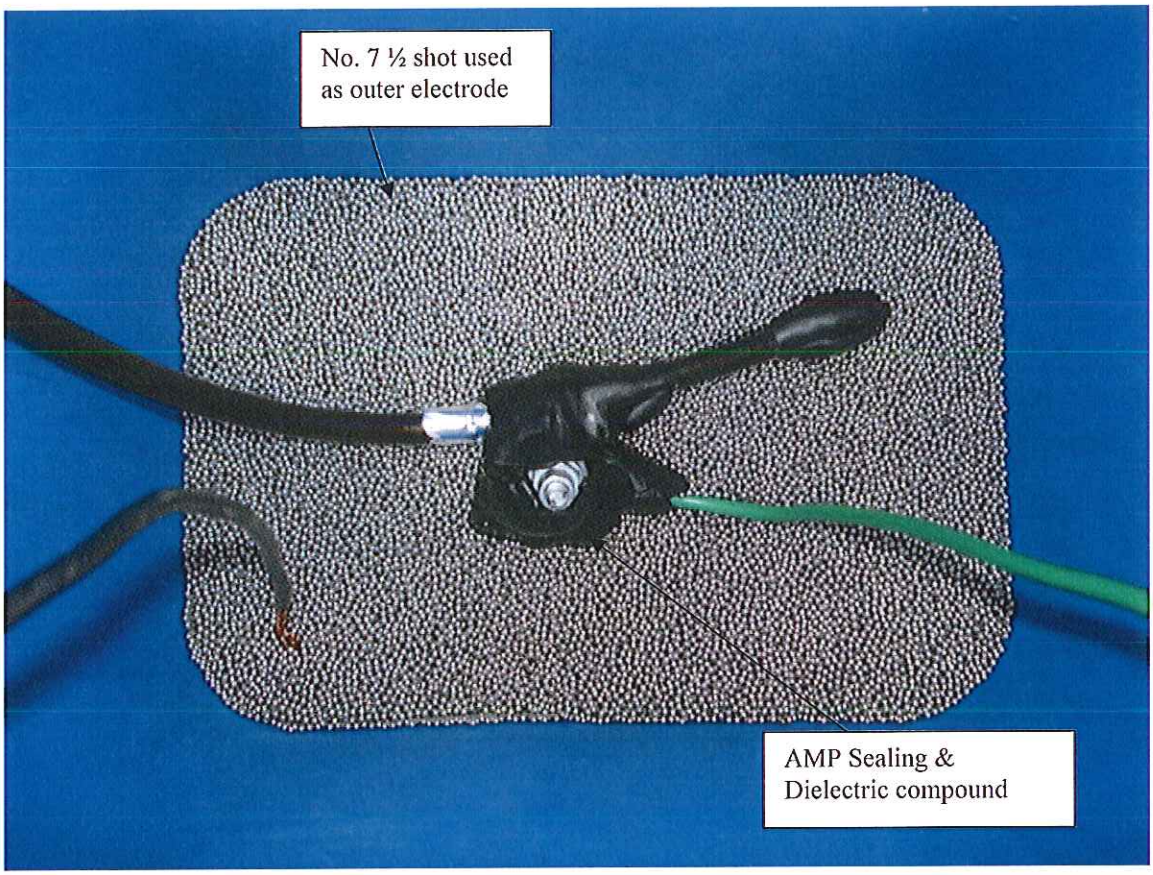
Representative photograph of KZEP 4/0 P/N 1-0708052-1 set-up prior to being embedded in 7 ½ shot during Insulation Puncture test

Fig. 6



Representative photograph of two KZEP 4/0 P/N 1-0708052-1 set-up (embedded in 7 ½ shot) during Insulation Puncture test
(Group 6) ANSI C119.5-2009

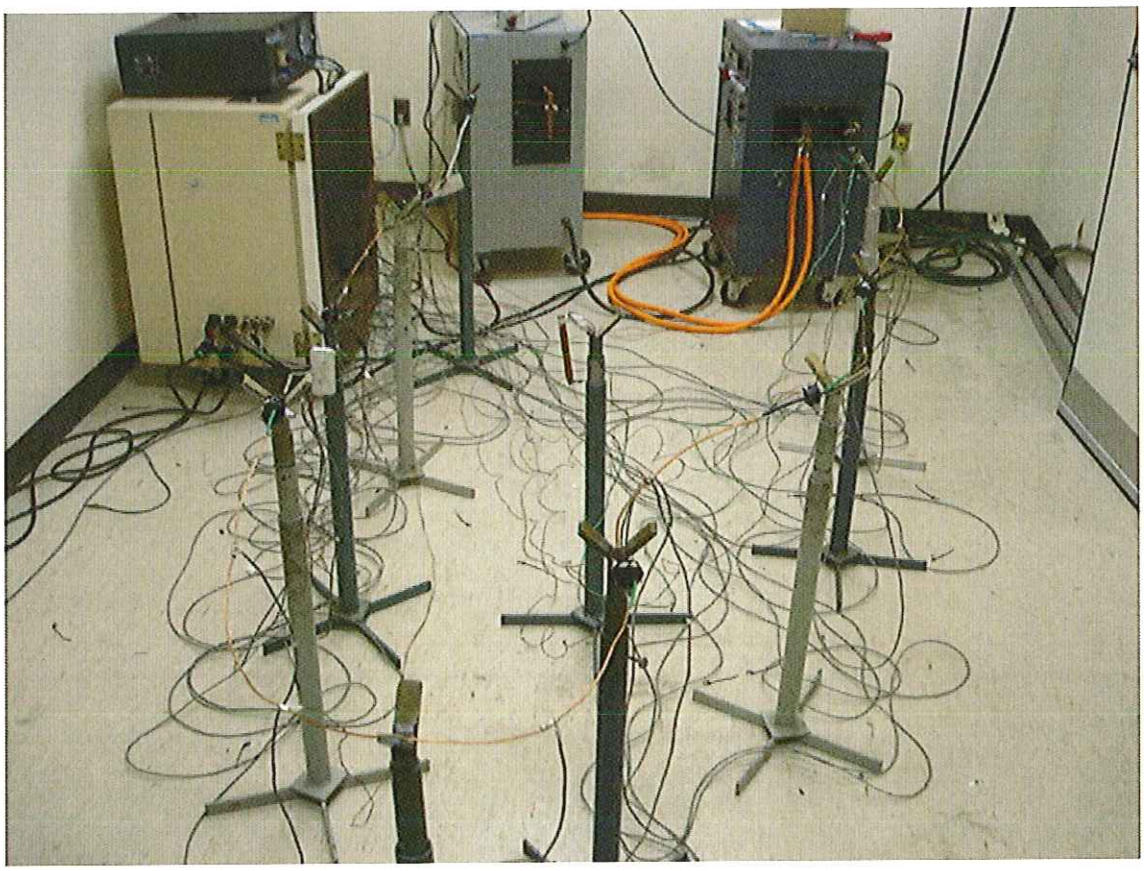
Fig. 7



Representative close-up view of KZEP 4/0 P/N 1-0708052-1 set-up, sealed and prior to being embedded in 7 ½ shot during Flashover test

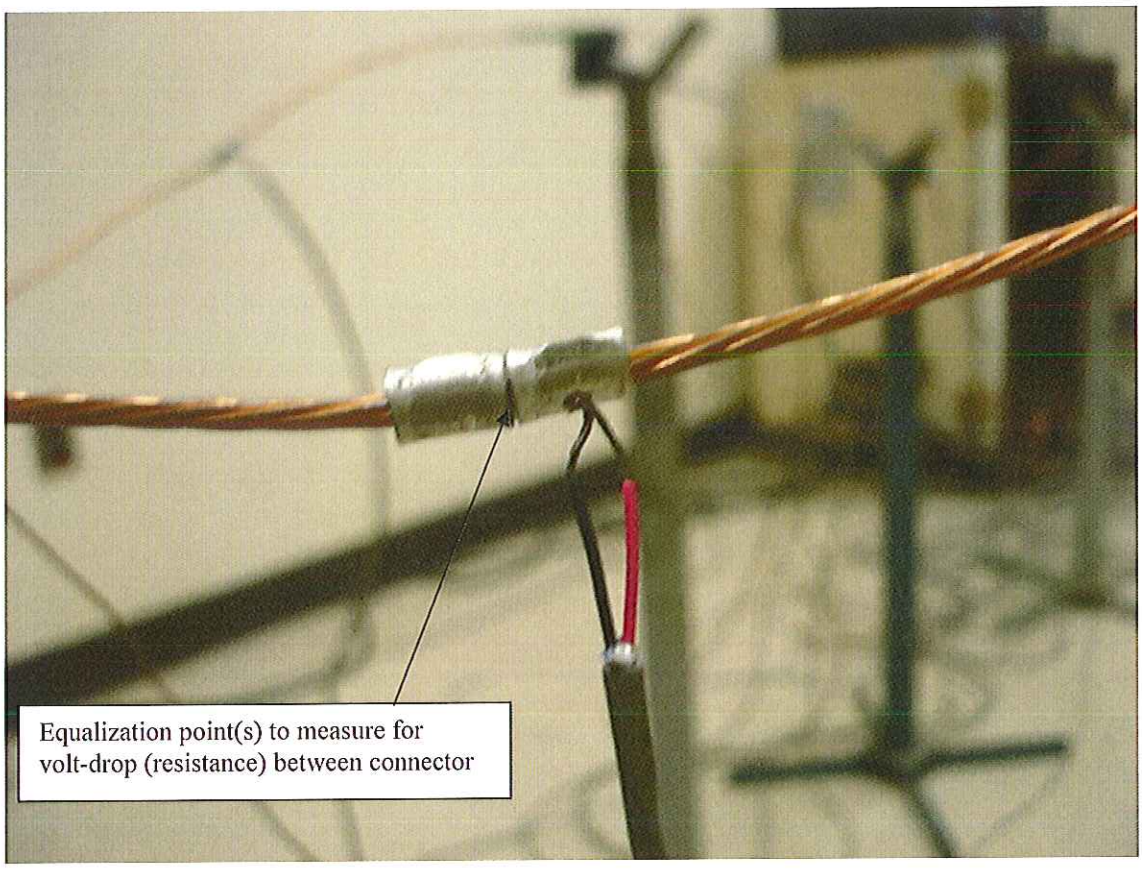
(Group 6(i)) ANSI C119.5-2009

Fig. 8



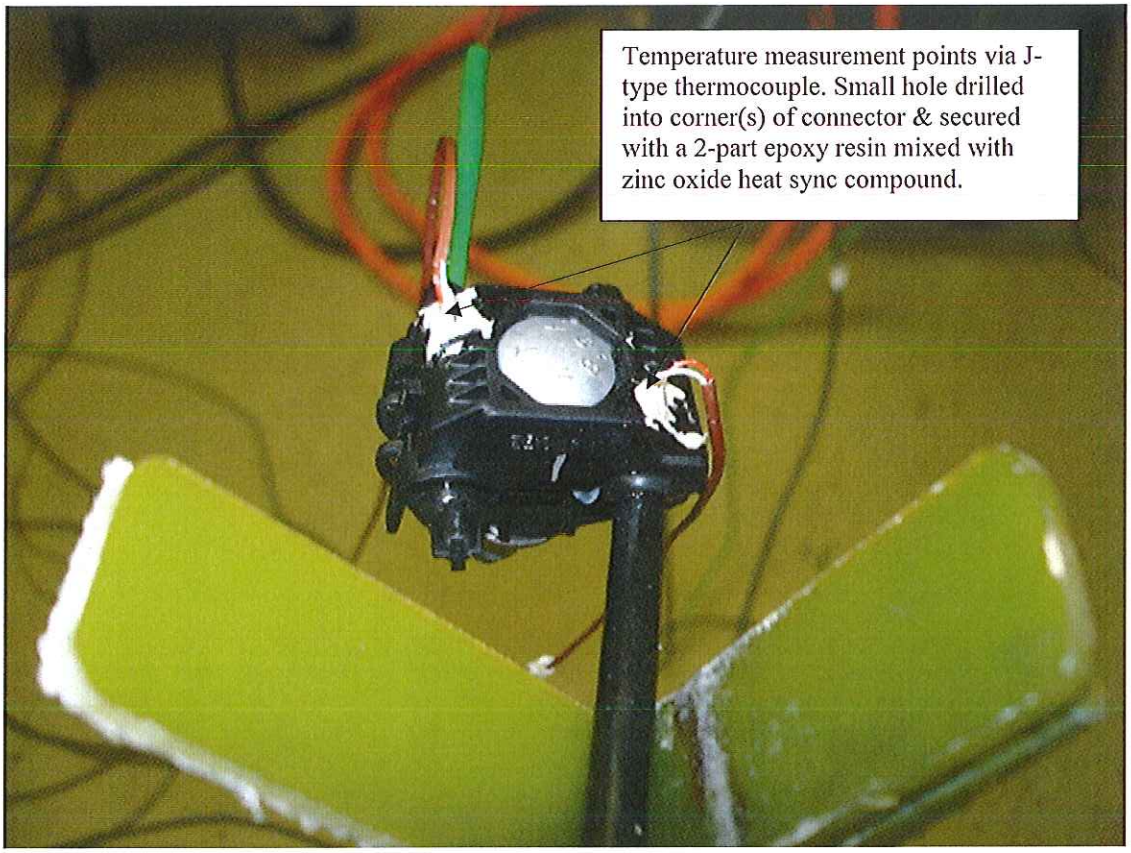
Representative photograph of KZEP 4/0 P/N 1-0708052-1 (4 of each assembled with #10 AWG Cu – #6 AWG Cu & #10 AWG Cu – #6 AWG AAC conductor) set-up for Current Cycling Test (Group 7) ANSI C119.5-2009

Fig. 9



Representative close-up view of volt-drop lead used to measure resistance values during Current Cycling Test (Group 7) ANSI C119.5-2009

Fig. 10



Representative photograph of KZEP 4/0 P/N 1-0708052-1 set-up for Current Cycling Test (Group 7) ANSI C119.5-2009

TEST EQUIPMENT LIST

(Markham Energy/Utility Products Test Laboratory)

TEST EQUIPMENT	CAL. SOURCE	MODEL NUMBER	SERIAL NUMBER	CORPORATE NUMBER	CALIBRATION DUE DATE
BLUE M OVEN	ML	OV-490A-2	OV3-13578	E0202-0042	14-Oct-10
BLUE M TEMP/RH CHAMBER	ML	CFR7652C-4-B	CFR-348	E0202-0069	20-Nov-10
CRITERION CONSTANT CURRENT POWER SUPPLY	ML	AVR-6-2000R	5424	E0202-0034	16-Mar-10
CRITERION HIGH VOLTAGE TEST SET	ML	AV/DV-150VA-100/5V	5528	E0202-0039	16-Mar-11
CRITERION INSULATION RESISTANCE TESTER	ML	BIRT-1000C	5476	E0202-0038	15-Mar-10
FLUKE GRAPHICAL MULTIMETER	ML	867B	6946036	E0202-0046	15-Mar-10
FREEZER, SCIENTEMP	ML	51-12	S8000728	E0202-0071	15-Mar-10
HYPOT II HIGH VOLTAGE AC/DC TESTER	ML	03565D	A091423	E0202-0057	13-Oct-10
INSTRON 1000 LBS LOAD CELL	ML	2518-805	545	E0202-0012	4-Nov-10
INSTRON 30000 LBS LOAD CELL	ML	2512-401	079	E0202-0013	4-Nov-10
MICRONTA DIGITAL STOP WATCH	ML	LCD QUARTZ	N/A	E0202-0026	14-Oct-10
MITUTUYO DIGITAL CALIPER	ML	500-421	0028504	E0202-0024	16-Mar-11
MITUTUYO DIGITAL CALIPER	ML	CD-6" CS	18151	E0202-0052	15-Oct-10
TORQUE WRENCH DIGITAL	M	502CF-II	1078022	E0202-0077	26-Aug-10
XANTREX DC POWER SUPPLY, STABILIZED	ML	XPD 7.5 - 67	941042	E0202-0068	16-Mar-10

ML - OUTSIDE SERVICE, TYCO LOCATION (ONSITE) M - OUTSIDE SERVICE, SERVICE LOCATION (OFFSITE)

Tyco Electronics

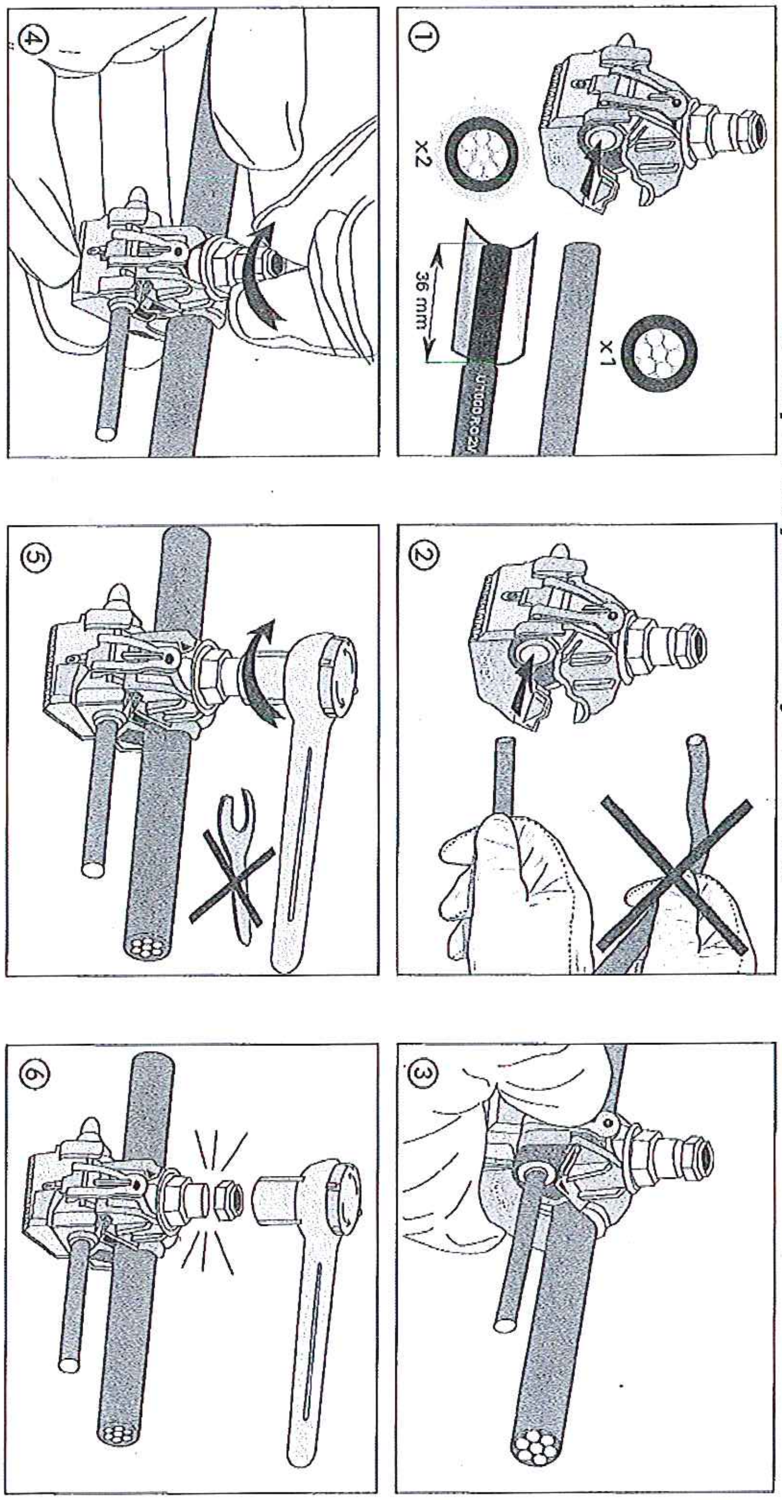
Energy Division

SIMEL products

KZEP; KZEP13; CES/CT70
EP35; EP95; EP35-13; EP95-13

Notice de mise en oeuvre
Installation Instructions

PN: 1727087-1 - Code: 659422 - Indice A - EQ00-0366-03 - 27/11/03



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Tyco Electronics

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SIMEL LABORATORY

TEST REPORT

N° D10008R Page: 1/7
Date: 19/03/2010

TEST PURPOSE

CONNECTOR BOLT TIGHTENING TEST ON IPC TAP CONNECTORS
TYPE KZEP 4/0.
MAIN CABLE CROSS SECTION : 4/0 AAC AND # 6 AAC.
TAP CABLE CROSS SECTION : # 10 CU AND # 14 CU.

All the tests results are in accordance with the specification.
See test results page 5 and 6.

Test request number:20100018
Test carried out by: J-C FALEMPIN
Test completion date: 18/02/2010
Customer or applicant: TE Canada
(address if the applicant is other than SIMEL)

SPECIFICATION(S)

ANSI C119.5 (2009)
§6.2.4

The tests results and tables, accompanied by drawings, graphs and photographs, if necessary, are recorded in the following pages.

This document consists of 7 pages and 0 appendice.

VISA: Head of Product Management & Engineering	Laboratory Manager	Test Technician
G.PORCHERAY	P. BASTIANCIG	J-C FALEMPIN

DIFFUSION: **T.E SIMEL:** G.NEDELLEC
Others: TE Canada

Réf: 00ILK0074L

Tyco Electronics SIMEL SAS
Locataire gérant Raychem
S.A.S au Capital de 1600 000€
R.C. Dijon – 017050410b
Siret – 017 050 410 000 12
N° d'identification T.V.A
FR 38 017 050 410

SUMMARY

1. TEST PURPOSE:

To check the bolt tightening behaviour of the connectors.

2. EQUIPMENT UNDER TEST:

2.1 Connectors:

Connector type : *through connector, branch connector, terminal lugs*	Branch connector
References	KZEP 4/0
Number of connectors	24
Type of jointing : *crimping, mechanical, insulation piercing connector*	Insulation Piercing Connector
Batch number	4709B
Drawing number	708052 REV T
Any other identification of the connector	KZEP 4/0 AWG SIMEL AWG 14-10 [10] 6-4/0

2.2 Conductors:

Nominal cross section (AWG)	4/0 AAC	# 6 AAC
Material	Aluminium	Aluminium
Type of conductor: *solid, stranded*	Stranded	Stranded
Shape of conductor: *sectoral, circular ....*	Circular	Circular
Stranded conductor : *flexible, rigid*	Rigid	Rigid
Diameter on conductor (mm)	12,20	4,50
Number of strands	19	7
Diameter on insulation (mm)	15,10	9,0
Material of insulation *(only for test on Insulation Piercing Connector)*	XLPE	XLPE
Marking and lettering appearing on the sheath, or on the drum	MADE IN USA BY PRYSMIAN X VOLTALENE RW 90 XLPE 4/0 AWG <107MM²> AL ACM 600 VOLTS (-40C) SR CSA 2009 008321	ALCATEL F EXELENE 6AWG ALUM ACM RW90 XLPE (-40C) 1000v OUTDOOR
Manufacturer name	PRYSMIAN	ALCATEL
Normative reference	Not determined	Not determined

Nominal cross section (mm²)	# 14 Cu	# 10 Cu
Material	Copper	Copper
Type of conductor: *solid, stranded*	Stranded	Stranded
Shape of conductor: *sectoral, circular ....*	Circular	Circular
Stranded conductor : *flexible, rigid*	Rigid	Rigid
Diameter on conductor (mm)	1,70	2,80
Number of strands	7	7
Diameter on insulation (mm)	3,40	4,50
Material of insulation *(only for test on Insulation Piercing Connector)*	XLPE	XLPE
Marking and lettering appearing on the sheath, or on the drum	PIRELLI –G 14 AWG TW75 600V ft1 CSA	ALCAN B 10 AWG COPER TW 75 600V ft1 CSA
Manufacturer name	PIRELLI	ALCAN
Normative reference	Not determined	Not determined

3. TEST ARRANGEMENT:

Preparation		
Cable preparation before installation: *dry brushing, brushing under neutral grease, no brushing, conditioning of insulated cables, ...*	Without preparation.	
Checking shear heads and mechanical behaviour of the connector		
Cross section of conductors (AWG).	**Cross sections on Main side (mm²)**	**Cross sections on Tap side (mm²)**
	Max : 4/0 AAC	Max : # 10 Cu
	Min : # 6 AAC	Min : # 14 Cu
	Min : # 6 AAC	Max : # 10 Cu
Required range of the minimum and maximum breaking torques of the share heads (N.m)	**Mini**	**Maxi**
	6,6	8,0
Maximum tightening torque required without any breaking of the connector (N.m)	120% of nominal torque (7 N.m) : 8,4	
The tightening is carried out approximately one quarter of a turn during 1s to 3s. Approximately 2s are counted between two tightening operations.		
Tooling: *torque wrench, crimping dies, jack....*	Torque wrench	

The test conditions and the arrangement conditions are carried out according to § 6.2.4 of the standard.

4. TEST INSTRUCTION:

The test instruction associated to ANSI C119-5 standard is the following: 00ILV0020A.

.

5. RESULTS:

Connector Nr Cross sections configuration	**Breaking values of shear heads (N.m)** 6,6 N.m ≤ C ≤ 8,0 N.m	***Tightening up to breaking. Observations**
1 4/0 AAC / 10 Cu	7,41 N.m	15,2 N.m : Breaking of the plastic upper body of the connector.
2 4/0 AAC / 10 Cu	7,24 N.m	15,5 N.m : Breaking of the thread nut.
3 #6 AAC / #14 Cu	7,36 N.m	15,4 N.m : Breaking of the plastic upper body of the connector.
4 #6 AAC / #14 Cu	7,59 N.m	17,9 N.m : Breaking of the nut head.
5 #6 AAC / 10 Cu	7,28 N.m	18,9 N.m : Breaking of the screw.
6 #6 AAC / 10 Cu	7,07 N.m	14,7 N.m : Breaking of the plastic upper body of the connector.

.

The uncertainties on tightening torques are estimated to ±0,01 N.m at 5 N.m; ±0,02 Nm at 8 N.m; ± 0,08 N.m at 12 Nm (coverage factor k = 2).

6. ANALYSIS OF RESULTS:

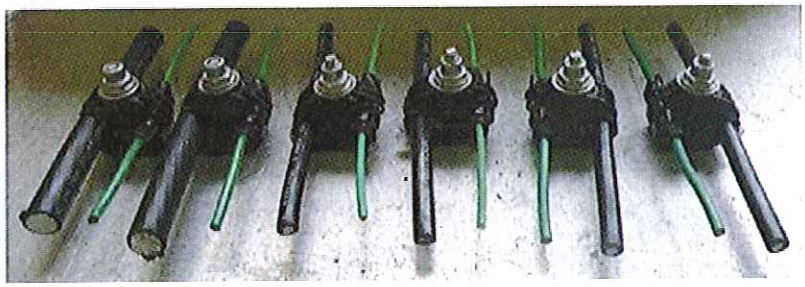
A bolted connector shall withstand 120% of the manufacturer's recommended tightening torque without cracking, rupture, or permanent distortion of any connector component that impairs its proper functioning when subjected to bolt tightening test .

The results meet the criteria.

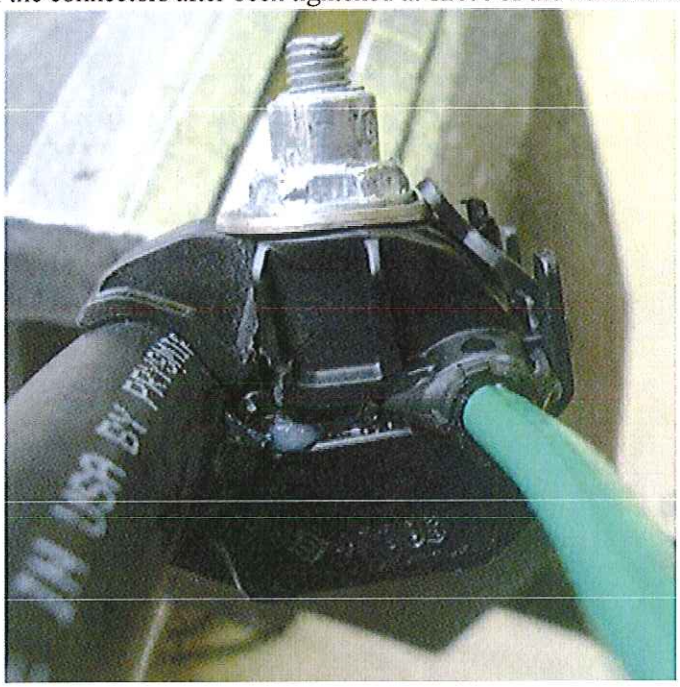
7. TEST EQUIPMENT:

Identification number	Type of apparatus	Uncertainties
D00000042	Slide calliper	Class 0.
M00000023	Torque wrench	± 0,01 Nm at 5 Nm ; ± 0,02 Nm at 8 Nm; ± 0,08 Nm at 12 Nm.
M00000015	Torque wrench	± 0,4 Nm at 15 Nm; ± 0,2 Nm at 20 Nm.

8. PHOTOGRAPHS:



View of the connectors after been tightened at 120% of the nominal torque.



View of the breaking of the plastic upper body of the connector.

Tyco Electronics

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SIMEL LABORATORY

TEST REPORT

N° D10004R Page: 1/8
Date: 17/03/2010

TEST PURPOSE

SHEAR HEAD FUNCTION TEST ON IPC TAP CONNECTORS
TYPE KZEP 4/0.
MAIN CABLE CROSS SECTION : 4/0 AAC, # 6 AAC, 4/0 CU AND # 6 CU.
TAP CABLE CROSS SECTION : # 10 CU AND # 14 CU.

All the tests results are in accordance with the specification.
See test results page 5,6.

Test request number:20100026
Test carried out by: J-C FALEMPIN
Test completion date: 10/03/2010
Customer or applicant:TE Canada
(address if the applicant is other than SIMEL)

SPECIFICATION(S)

ANSI C119.5 (2009).
§6.2.5

The tests results and tables, accompanied by drawings, graphs and photographs, if necessary, are recorded in the following pages.

This document consists of 8 pages and 0 appendices.

	Laboratory Manager	Test Technician
VISA: Head of Product Management & Engineering		
G.PORCHERAY	P.BASTIANCIG	J-C FALEMPIN

DIFFUSION: **T.E SIMEL**:G.NEDELLEC
Others: TE Canada

Réf: 001LK0074L

SUMMARY

1. TEST PURPOSE:

To ensure that the bolt head shearing will occur within the specified torque.

2. EQUIPMENT UNDER TEST:

2.1 Connectors :

Connector type : *through connector, branch connector, terminal lugs*	Branch connector
References	KZEP 4/0
Number of connectors	24
Type of jointing : *crimping, mechanical, insulation piercing connector*	Insulation Piercing Connector
Batch number	4709B
Drawing number	708052 REV T
Any other identification of the connector	KZEP 4/0 AWG SIMEL AWG 14-10 [10] 6-4/0

2.2 Conductors:

Nominal cross section (AWG)	4/0 AAC	# 6 AAC	# 14 CU
Material	Aluminium	Aluminium	Copper
Type of conductor: *solid, stranded*	Stranded	Stranded	Stranded
Shape of conductor: *sectoral, circular ....*	Circular	Circular	Circular
Stranded conductor : *flexible, rigid*	Rigid	Rigid	Rigid
Diameter on conductor (mm)	12,20	4,50	1,70
Number of strands	19	7	7
Diameter on insulation (mm)	15,10	9,0	3,40
Material of insulation *(only for test on Insulation Piercing Connector)*	XLPE	XLPE	XLPE
Marking and lettering appearing on the sheath, or on the drum	MADE IN USA BY PRYSMIAN X VOLTALENE RW 90 XLPE 4/0 AWG <107MM²> AL ACM 600 VOLTS (-40C) SR CSA 2009 008321	ALCATEL F EXELENE 6AWG ALUM ACM RW90 XLPE (-40C) 1000v OUTDOOR	PIRELLI –G 14 AWG TW75 600V ft1 CSA
Manufacturer name	PRYSMIAN	ALCATEL	PIRELLI
Normative reference	Not determined	Not determined	Not determined

Nominal cross section (AWG)	# 10 CU	# 6 CU	4/0 CU
Material	Copper	Copper	Copper
Type of conductor: *solid, stranded*	Stranded	Stranded	Stranded
Shape of conductor: *sectoral, circular ....*	Circular	Circular	Circular
Stranded conductor : *flexible, rigid*	Rigid	Rigid	Rigid
Diameter on conductor (mm)	2,80	4.5	12,5
Number of strands	7	7	19
Diameter on insulation (mm)	4,50	6.8	15,5
Material of insulation *(only for test on Insulation Piercing Connector)*	XLPE	XLPE	XLPE
Marking and lettering appearing on the sheath, or on the drum	ALCAN B 10AWG COPPER TW 75 600V ft1 CSA	ALCATEL F EXELENE #6AWG	GENERAL CABLE – BICC 5R° BRAND SQ (2009) 1C # 4/0 AWG CU XLPE RW 90 CSA 600V (-40 C) SR
Manufacturer name	ALCAN	ALCATEL	GENERAL CABLE
Normative reference	Not determined	Not determined	Not determined

3. TEST CONDITIONS AND ARRANGEMENT CONDITIONS:

Preparation		
Cable preparation before installation: *dry brushing, brushing under neutral grease, no brushing, conditioning of insulated cables, ...*	Without preparation.	
Connectors installation	**Shear head function test**	
Cross section of conductors (AWG).	**Cross sections on main side**	**Cross section on tap side**
	Max : 4/0 AAC	Max : # 10 Cu
	Min : # 6 AAC	Min : # 14 Cu
	Max : 4/0 Cu	Max : # 10 Cu
	Min : # 6 Cu	Min : # 14 Cu
Required temperature in the chamber for three samples of each cross section combinations (°C)	$-10^{(\pm 3)}$	
	$50^{(\pm 3)}$	
Minimum required time for exposure	Minimum 1 hour	
Required transition time between connector installation and removal from the conditioning chamber (min).	2	
Real time of exposure of the samples at the required temperature.	1 hour	
The tightening is carried out approximately one quarter turn during 1s to 3s. Approximately 2s are counted between two tightening operations.		
Tooling: *torque wrench, crimping dies, jack....*	Torque wrench	
Required range of the minimum and maximum breaking torques of the shear head (N.m)	Minimal torque	Maximum torque
	6,6	8,0

The test conditions and the arrangement conditions are carried out according to § 6.2.5 of the standard.

4. TEST INSTRUCTION:

The test instruction associated to ANSI C119-5 standard is the following: 00ILV0020A.

5. RESULTS :

Real value in the chamber at the low temperature and time of exposure.	-12,4°C / 1 hour.
Real value in the chamber at the high temperature and time of exposure.	51°C / 1 hour.

Nr of connector Cross sections configurations	**Temperature measured on the fittings when tightening outside enclosure** (-10 ±3)°C	**Breaking values of shear heads (N.m)** Specified torque range Mini : 6,6 Nm Maxi : 8,0 Nm	**Observations**
1 4/0 AAC/ #10 Cu	-11,1°C	7,20 Nm	N.T.R
2 4/0 AAC/ #10 Cu	-11,2°C	7,00 Nm	N.T.R
3 4/0 AAC/ #10 Cu	-11,1°C	6,75 Nm	N.T.R
4 #6 AAC/#14 Cu	-11,3°C	7,59 Nm	N.T.R
5 #6 AAC/#14 Cu	-11,1°C	7,27 Nm	N.T.R
6 #6 AAC/#14 Cu	-11,0°C	7,53 Nm	N.T.R
7 4/0 Cu / #10 Cu	-11,4°C	7,66 Nm	N.T.R
8 4/0 Cu / #10 Cu	-11,1°C	7,27 Nm	N.T.R
9 4/0 Cu / #10 Cu	-11,3°C	7,52 Nm	N.T.R
10 #6 Cu / #14 Cu	-11,1°C	7,43 Nm	N.T.R
11 #6 Cu / #14 Cu	-11,2°C	7,62 Nm	N.T.R
12 #6 Cu / #14 Cu	-11,3°C	7,45 Nm	N.T.R

*N.T.R : Nothing To Report.

Nr of connector Cross sections configurations	Temperature measured on the fittings when tightening outside enclosure (50 ±3)°C	Breaking values of shear heads (N.m) Specified torque range Mini : 6,6 Nm Maxi : 8,0 Nm	Observations
13 4/0 AAC/ #10 Cu	50,0°C	6,86 Nm	N.T.R
14 4/0 AAC/ #10 Cu	49,8°C	6,69 Nm	N.T.R
15 4/0 AAC/ #10 Cu	49,8°C	6,89 Nm	N.T.R
16 #6 AAC/#14 Cu	49,9°C	7,36 Nm	N.T.R
17 #6 AAC/#14 Cu	49,8°C	6,72 Nm	N.T.R
18 #6 AAC/#14 Cu	49,9°C	6,61 Nm	N.T.R
19 4/0 Cu / #10 Cu	49,9°C	6,99 Nm	N.T.R
20 4/0 Cu / #10 Cu	50,1°C	6,90 Nm	N.T.R
21 4/0 Cu / #10 Cu	50,3°C	7,05 Nm	N.T.R
22 #6 Cu / #14 Cu	50,5°C	6,82 Nm	N.T.R
23 #6 Cu / #14 Cu	50,4°C	6,87 Nm	N.T.R
24 #6 Cu / #14 Cu	50,3°C	6,96 Nm	N.T.R

*N.T.R : Nothing To Report.

The uncertainties on tightening torques are estimated to ± 0,01 Nm at 5 Nm ; ± 0,02 Nm at 8 Nm (coverage factor k = 2).

6. ANALYSIS OF RESULTS:

For each of the test temperatures and cross section combination, the torque at which the bolt head shears, shall be within the tolerances of the manufacturer's specified torque range .

See results §5.

Comments:

All the results meet the required acceptance criterion.

7. MEASUREMENT AND TEST EQUIPMENTS:

Identification Nr	Apparatus Type	Uncertainties
D00000001	Slide calliper	Class 0.
M00000023	Torque wrench	± 0,01 Nm at 5 Nm ; ± 0,02 Nm at 8 Nm.
B000000013	Heat-cold chamber	± 2,0°C at -40°C and 70°C.
T00000072	Temperature sensor	± 1,2 °C at -10 °C ; ± 0,4 °C at 50 °C.

8. PHOTOGRAPHS

View of the connectors pre-fitted before placing in the hot-cold chamber.

View of the connectors pre-fitted inside the hot-cold chamber.

Overview of the tightening method after removal from the conditioning chamber.

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SIMEL LABORATORY

TEST REPORT

Date: 18/03/2010

TEST PURPOSE

LOW TEMPERATURE TEST ON IPC TAP CONNECTORS
TYPE KZEP 4/0.

All the tests results are in accordance with the specification.
See test results page 5.

Test request number:20100027
Test carried out by: J-C FALEMPIN
Test completion date: 24/02/2010
Customer or applicant:TE Canada
(address if the applicant is other than SIMEL)

SPECIFICATION(S)

ANSI C119.5 (2009)
§6.2.6

The tests results and tables, accompanied by drawings, graphs and photographs, if necessary, are recorded in the following pages.

This document consists of 6 pages and 0 appendices.

VISA: Head of Product Management & Engineering	Laboratory Manager	Test Technician
G.PORCHERAY	P. BASTIANCIG	J-C FALEMPIN

DIFFUSION: **T.E SIMEL**:G.NEDELLEC
Others: TE CANADA

Réf: 00ILK0074L

DIFFUSION NON CONTROLEE

UNCONTROLLED DISTRIBUTION

SUMMARY

1. TEST PURPOSE:

To check the aptitude of the connector to pierce the insulation at low temperature.

2. EQUIPMENT UNDER TEST:

2.1 Connectors :

Connector type : *through connector, branch connector, terminal lugs*	Branch connector
References	KZEP 4/0
Number of connectors	24
Type of jointing : *crimping, mechanical, insulation piercing connector*	Insulation Piercing Connector
Batch number	4709B
Drawing number	708052 REV T
Any other identification of the connector	KZEP 4/0 AWG SIMEL AWG 14-10 [10] 6-4/0

2.2 Conductors:

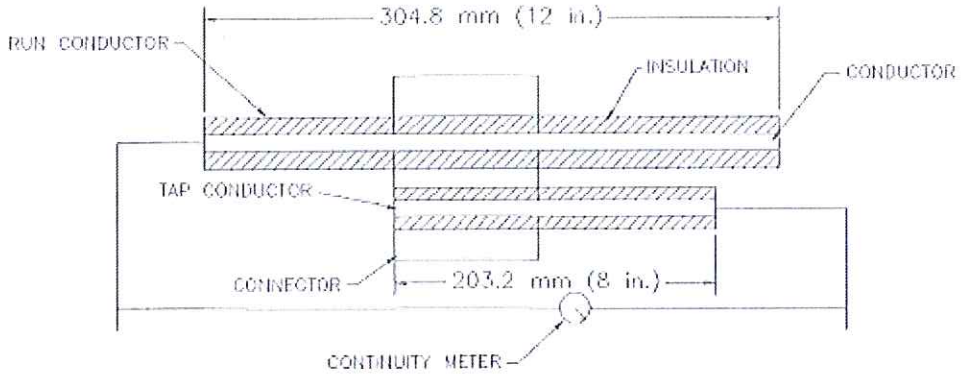
Nominal cross section (AWG)	4/0 AAC	# 6 AAC	# 10 Cu
Material	Aluminium	Aluminium	Copper
Type of conductor: *solid, stranded*	Stranded	Stranded	Stranded
Shape of conductor: *sectoral, circular ....*	Circular	Circular	Circular
Stranded conductor : *flexible, rigid*	Rigid	Rigid	Rigid
Diameter on conductor (mm)	12,20	4,50	2,80
Number of strands	19	7	7
Diameter on insulation (mm)	15,10	9,0	4,50
Material of insulation *(only for test on Insulation Piercing Connector)*	XLPE	XLPE	XLPE
Marking and lettering appearing on the sheath, or on the drum	MADE IN USA BY PRYSMIAN X VOLTALENE RW 90 XLPE 4/0 AWG <107MM²> AL ACM 600 VOLTS (-40C) SR CSA 2009 008321	ALCATEL F EXELENE 6AWG ALUM ACM RW90 XLPE (-40C) 1000v OUTDOOR	ALCAN B 10AWG COPPER TW 75 600V ft1 CSA
Manufacturer name	PRYSMIAN	ALCATEL	ALCAN
Normative reference	Not determined	Not determined	Not determined

3. TEST CONDITIONS AND ARRANGEMENT CONDITIONS:

Preparation			
Cable preparation before installation: *dry brushing, brushing under neutral grease, no brushing, conditioning of insulated cables, ...*	Without preparation.		
Connectors installation Control of the electrical continuity			
Required temperature in the chamber (°C)	-10 (±2)		
Real temperature on connector, in the chamber, during installation (°C)	-11,2		
Minimum required time for exposure	Minimum of 1 hour		
Real time of exposure	1,25 hour		
Required transition time, between installation of connector and removal from conditioning chamber	Maximum of 2 minutes		
Real transition time	Installation of connector done inside the conditioning chamber		
Cross section of conductors (AWG).	**Cross sections on main side**		**Maxi cross section on tap side**
	Maxi 4/0 AAC	**Mini** #6 AAC	#10 Cu
The tightening is carried out approximately one quarter turn during 1s to 3s. Approximately 2s are counted between two tightening operations.			
Maximum piercing torque required to indicate the closing of the circuit: 0.7 x Cmin (N.m)	4,62		
Tooling: *torque wrench, crimping dies, jack....*	Torque wrench		

The test conditions and the arrangement conditions are carried out according to § 6.2.6 of the standard.

Set up diagram:



4. TEST INSTRUCTION:

The test instruction associated to ANSI C119-5 standard is the following: 00ILV0020A.

5. RESULTS :

Nr of connector Cross sections configurations	Torques to establish electrical contacts (N.m) Maxi torque : 4,62 N.m	Remarks
1 4/0 AAC/ #10 Cu	2,47	N.T.R
2 4/0 AAC/ #10 Cu	2,79	N.T.R
3 4/0 AAC/ #10 Cu	2,43	N.T.R
4 # 6 AAC/ #10 Cu	2,96	N.T.R
5 # 6 AAC/ #10 Cu	3,14	N.T.R
6 # 6 AAC/ #10 Cu	3,07	N.T.R

N.T.R : Nothing To Report.

The uncertainties on tightening torques are estimated to ± 0,01 Nm at 1,5 Nm and to ± 0,03 at 3 Nm (coverage factor k = 2).

6. ANALYSIS OF RESULTS: :

The test sample shall exhibit electrical continuity when subjected to the connector mounting test at low temperature.

See results §5.

Comments:

All the results meet the required acceptance criterion.

7. MEASUREMENT AND TEST EQUIPMENTS:

Identification Nr	Apparatus Type	Uncertainties
D00000042	Slide calliper	Class 0.
M00000023	Torque wrench	± 0,01 Nm at 1,5 Nm; ± 0,03 Nm at 3 Nm.
B00000007	Cold chamber	Accuracy: +1,0 °C / -4,0 °C
T00000072	Temperature sensor	± 1,2 °C at -25 °C; ± 1,2 °C at -10 °C.
I00000047	Indicator of closing circuit.	Indicator.

8. PHOTOGRAPHS

Without.

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SIMEL LABORATORY

TEST REPORT

N° I10006A Page: 1/5
Date: 19/02/2010

TEST PURPOSE

DIELECTRICAL WITHSTAND/LEAKAGE ON IPC TAP CONNECTOR

TYPE KZEP 4/0

CROSS SECTION : - 4/0 AAC , # 6 AAC AND 4/0 CU , # 6 CU CABLE ON MAIN
- # 14 CU CABLE ON TAP

Test request number: 20100028
Test carried out by: C.MONAMY
Test completion date: 19/02/2010
Customer: TE Canada

SPECIFICATION(S)

ANSI C119.5 (2009)
§6.3.3.1.1

CONCLUSION

THE TEST RESULTS MEET THE STANDARD REQUIREMENTS

VISA: Head of Product Management & Engineering	Laboratory Manager	Test Technician
G.PORCHERAY	P. BASTIANCIG	C.MONAMY

CIRCULATION: T.E SIMEL: G.NEDELLEC
Others: TE Canada

Réf: 00ILK0072K

SUMMARY

1. TEST PURPOSE:

To check the dielectrical behaviour of connectors.

2. EQUIPMENT UNDER TEST:

2.1 Connectors:

Connector type : *through connector, branch connector, terminal lugs*	Branch connector
Reference	KZEP 4/0
Type of jointing : *crimping, mechanical, insulation piercing connector*	Insulation Piercing Connector
Batch number	4709B
Drawing number	708052 rev T
Any other identification of the connector	KZEP 4/0 AWG 14-10 SIMEL [10] AWG 6-4/0

2.2 Conductors:

Nominal cross section (AWG)	4/0 AAC	4/0 CU
Material	Aluminium	Copper
Type of conductor: *solid, stranded*	Stranded	Stranded
Shape of conductor: *sectoral, circular ....*	Circular	Circular
Stranded conductor : *flexible, rigid*	Rigid	Rigid
Diameter on conductor (mm)	12,2	12.5
Number of strands	19	19
External diameter on insulation (mm)	15,1	15.5
Diameter of second insulation (mm)	XLPE	XLPE
Marking and lettering appearing on the sheath, or on the drum	MADE IN USA BY PRYSMIAN X VOLTALENE RW 90 XLPE 4/0 AWG <107MM²> AL ACM 600 VOLTS (-40C) SR CSA 2009 008321	GENERAL CABLE – BICC 5R° BRAND SQ (2009) 1C # 4/0 AWG CU XLPE RW 90 CSA 600V (-40 C) SR
Manufacturer name	PRYSMIAN	GENERAL CABLE
Normative reference	Not determined	Not determined

Nominal cross section in AWG	# 6 AAC	# 6 CU	# 14 CU
Material	Aluminium	Copper	Copper
Type of conductor: *solid, stranded*	Stranded	Stranded	Stranded
Shape of conductor: *sectoral, circular ....*	Circular	Circular	Circular
Stranded conductor : *flexible, rigid*	Rigid	Rigid	Rigid
Diameter on conductor (mm)	4,5	4.5	1,7
Number of strands	7	7	7
External diameter on insulation (mm)	9,0	6.8	3,40
Diameter of second insulation (mm)	XLPE	XLPE	XLPE
Marking and lettering appearing on the sheath, or on the drum	ALCATEL F EXELENE 6AWG ALUM ACM RW90 XLPE (-40C) 1000v OUTDOOR	ALCATEL F EXELENE #6AWG	PIRELLI –G 14 AWG TW75 600V ft1 CSA
Manufacturer name	ALCATEL	ALCATEL	PIRELLI
Normative reference	Not determined	Not determined	Not determined

3. TEST CONDITIONS AND ARRANGEMENT CONDITIONS:

Preparation		
Cable preparation before installation: *dry brushing, brushing under neutral grease, no brushing, conditioning of insulated cables, ...*	No preparation and no conditioning.	
Connector installation		
Positioning of the connectors in the tank:	Vertical	
Measured Ambient Temperature (°C)	20.3 (26 %HR)	
Conditions		
Ambient Temperature measured during 24 h (°C)	Min	Max
	20,1	21,8
Required depth of water (mm)	300	
Measured depth of water (mm)	310	
Immersion time required (Hour)	24	
Immersion time measured (Hour)	24	
Conditions for dielectrical withstand/leakage test		
Test voltage required (V)	2200	
Required time of voltage application (min)	1	

The test conditions and the arrangement conditions are carried out according to § 6.3.3.1.1 of the standard. Except the network frequency of 50 Hz instead of 60Hz.

4. TEST INSTRUCTION:

The test instruction associated to ANSI C119.5 standard is the following: 00ILV0020A

5. RESULTS:

Set-up configuration	Reading voltage value (kV) Behaviour for 1 min	Leakage current (mA)	Shear head breaking torque value
Connector 1 4/0 AAC - # 14 CU	2.2	0.85	7.46 N.m
Connector 2 4/0 AAC - # 14 CU	2.2	0.85	7.26 N.m
Connector 3 # 6 AAC - # 14 CU	2.2	0.85	6.88 N.m
Connector 4 # 6 AAC - # 14 CU	2.2	0.85	7.21 N.m
Connector 5 4/0 CU - # 14 CU	2.2	0.90	7.27 N.m
Connector 6 4/0 CU - # 14 CU	2.2	0.90	7.34 N.m
Connector 7 # 6 CU - # 14 CU	2.2	0.90	7.25 N.m
Connector 8 # 6 CU - # 14 CU	2.2	0.90	6.84 N.m

6. ANALYSIS OF RESULTS:

Requirement:

Dielectrical withstand test

- *No breakdown or flashover occurred at 2.2 kV during 1 min.*
- *Leakage current did not exceed 1 mA.*

All the results obtained comply with each requested acceptance criterion.

7. MEASUREMENT AND TEST EQUIPMENTS:

Identification Nr	Apparatus Type	Uncertainties
D00000042	Slip calliper	Class 0
U00000070	Dielectric bench 15 kV	± (1.5% + 20 volts) in tension ± (2.5% + 0,2 mA) in current
M00000015	Torque Wrench	± 0.4 Nm at 15 Nm ± 0.2 Nm at 20 Nm
C00000026	Temperature sensor(min-max)	indicator

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SIMEL LABORATORY

TEST REPORT

Date: 23/03/2010

TEST PURPOSE

WATER PENETRATION QUALIFICATION TEST ON IPC TAP CONNECTORS
TYPE KZEP 4/0

MAIN CABLE CROSS SECTION : 4/0 AAC, # 6 AAC, 4/0 CU AND # 6 CU
TAP CABLE CROSS SECTION : # 14 CU

Test request number: 20100029
Test carried out by: Y. MANSUY
Test completion date: 04/03/2010
Customer: TE Canada

SPECIFICATION(S)
ANSI C119.5 (2009)
§ 6.3.3.2

CONCLUSION

THE TEST RESULTS MEET THE STANDARD REQUIREMENTS.

VISA: Head of Product Management & Engineering	Laboratory Manager	Test Technician
G. PORCHERAY	P. BASTIANCIG	Y. MANSUY

CIRCULATION: T.E SIMEL: G. NEDELLEC
Others: TE Canada

Réf: 00ILK0072K

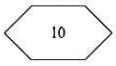
SUMMARY

1. TEST PURPOSE :

To check the water penetration in the connectors.

2. EQUIPMENT UNDER TEST :

2.1 Connectors:

Connector type : *through connector, branch connector, terminal lugs*	Branch connector
Reference	KZEP 4/0
Number of connectors	8
Type of jointing : *crimping, mechanical, insulation piercing connector*	Insulation Piercing Connector
Batch number	4709B
Drawing number	708052 rev T
Any other identification of the connector	KZEP 4/0 AWG SIMEL AWG 14-10  6-4/0
DI number *(only for EDF customer)*	Not Applicable

2.2 Conductors:

Nominal cross section (AWG)	4/0 AAC	# 6 AAC	4/0 Cu	# 6 Cu	# 14 Cu
Material	Aluminium	Aluminium	Copper	Copper	Copper
Type of conductor: *solid, stranded*	Stranded	Stranded	Stranded	Stranded	Stranded
Shape of conductor: *sectoral, circular ....*	Circular	Circular	Circular	Circular	Circular
Stranded conductor : *flexible, rigid*	Rigid	Rigid	Rigid	Rigid	Rigid
Diameter on conductor (mm)	12,3	4,5	12,7	4,5	1,7
Number of strands	19	7	19	7	7
Diameter on insulation (mm)	15,2	8,9	15,6	6,9	3,4
Material of insulation *(only for test on Insulation Piercing Connector)*	XLPE	XLPE	XLPE	XLPE	XLPE
Marking and lettering appearing on the sheath, or on the drum	MADE IN USA BY PRYSMIAN X VOLTALENE RW 90 XLPE 4/0 AWG <107MM²> AL ACM 600 VOLTS (-40C) SR CSA 2009	ALCATEL F EXELENE 6AWG ALUM ACM RW90 XLPE (-40C) 1000V OUTDOOR	General Cable – BICC ® Brand SQ 2009 # 4/0 AWG Cu XLPE RW 90 CSA 600V (-40C) SR	General Cable – BICC ® Brand SQ 2009 IC # 6 AWG Cu XLPE RW 90 CSA 600V (-40C) SR	PIRELLI –G 14 AWG TW75 600V ft1 CSA
Manufacturer name	PRYSMIAN	ALCATEL	General Cable	General Cable	PIRELLI
Normative reference	Not determined	Not determined	Not determined	Not determined	Not determined

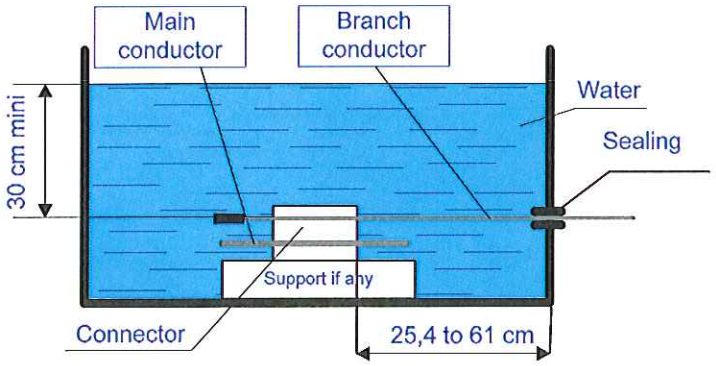
3. TEST CONDITIONS:

Preparation	
Cable preparation before installation: *dry brushing, brushing under neutral grease, no brushing, conditioning of insulated cables, ...*	Without preparation
Connector installation	
Tooling: *torque wrench, crimping dies, jack....*	Torque wrench
Tightening torque for mechanical connectors (N.m)	Tightening up to the breaking of shear head
Temperature recorded during connector installation (°C)	20,4
Relative Humidity recorded during connector installation (%)	31
Positioning of the connectors in the tank: *vertical, horizontal*	Horizontal
Measured Ambient Temperature (°C)	20,4
Conditions	
Water Temperature measured (°C)	18,3
Immersion time required (hours)	24
Minimal immersion time measured (hours)	24
Required depth of water (cm)	30 mini
Measured depth of water (cm)	34

4. TEST ARRANGEMENT:

The test conditions and the arrangement conditions are carried out according to § 6.3.3.2 of the standard.

Set up of diagram:



5. TEST INSTRUCTION:

The test instruction associated to ANSI C119-5 standard is the following: 00ILV0020A.

6. RESULTS:

Number of connectors Configuration des sections	Observations after 24 hours of immersion in water
1 4/0 AAC / #14 Cu	N.T.R
2 4/0 AAC / #14 Cu	N.T.R
3 # 6 AAC / #14 Cu	N.T.R
4 # 6 AAC / #14 Cu	N.T.R
5 4/0 Cu / #14 Cu	N.T.R
6 4/0 Cu / #14 Cu	N.T.R
7 #6 Cu / #14 Cu	N.T.R
8 #6 Cu / #14 Cu	N.T.R

N.T.R: Nothing To Report.

7. ANALYSIS OF RESULTS:

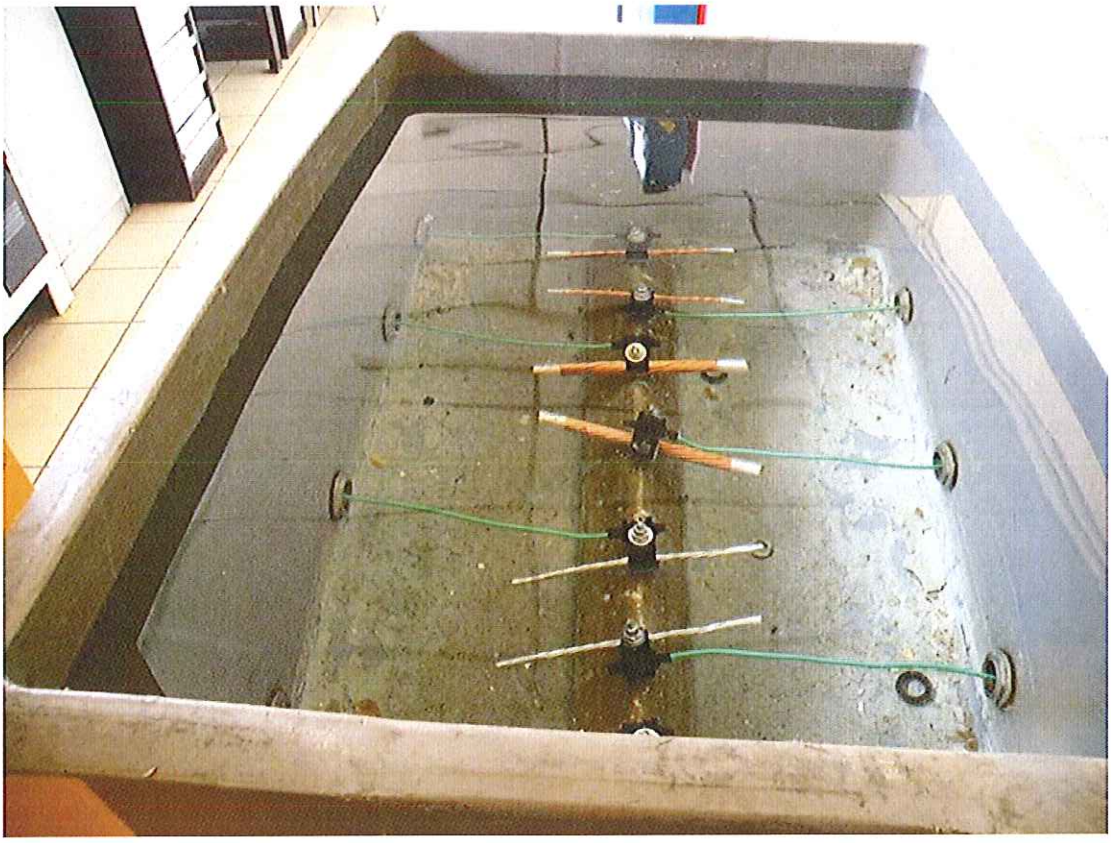
No evidence of water penetration shall be observed at the extremity of the insulated tap cable.

The results obtained meet the requirements of the standard.

8. TEST EQUIPMENT :

Identification number	Type of apparatus	Uncertainties
D00000001	Slide calliper	Class 0
M00000032	Torque wrench	± 4% of reading in tightening
T00000060	Thermometer	± 1,6°C at 20°C
C00000013	Wall thermometer	Indicator

9. PHOTOGRAPHS



View of connectors under water penetration test