CABLE TECHNOLOGY LABORATORIES, INC.

REPORT

ELECTRICAL TESTS ON NOVINIUM 200 A

LOAD BREAK INJECTION ELBOWS

INVESTIGATION PERFORMED FOR

NOVINIUM

Kent, WA

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CONTENTS

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ELECTRICAL TESTS ON NOVINIUM 200 A
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1.0 PURPOSE

1) To determine if modifications made by Novinium to the Elastimold direct test elbow interfere with the elbow's compliance to the requirements set forth in IEEE 386.

2) To perform partial discharge and flashover tests on modified and non-modified elbows and to compare the results.

2.0 BACKGROUND

Exhibit A to this report is a letter from Thomas & Betts to Novinium, which states in short that the Direct Test elbow supplied by Thomas & Betts is in accordance with the IEEE 386 requirements.

While IEEE 386 does not directly address injection elbows, it does provide some guidance by analogy on safe distances between energized and grounded components.

To reduce the likelihood of fluid leaks from an elbow into the bushing interface and to reduce the likelihood of a flashover from an open injection port, two modifications were recently made by Novinium to the Elastimold 200 A load break direct test elbow:

a) A ring seal was placed on the compression connector,

b) A proprietary reticular flash preventer (RFP) was placed in the elbow injection channel.

No attempt was made to measure the sealing performance of the elbow with the second seal during this experiment. However, the impact of the modifications were examined relative to the partial discharge (PD) test promulgated by section 7.4 of IEEE 386. The goal was to determine if the modifications interfered with the PD performance or improved or detracted from the flashover potential of an open port.

3.0 TEST SPECIMENS

Elastimold direct test elbows* (Figure 1) were mounted at one end of a seven foot long, 15 kV cable. The cable had a 1/0 AWG stranded aluminum conductor, extruded conductor shield, 0.175 inch of TR-XLPE insulation and extruded insulation shield. The other cable end was terminated in a partial discharge-free manner, using water terminals.

Figure 1: Elbow with the injection port capped.

* Inscribed on the elbow: 168 DELR LOADBREAK 200 AMP 8.3/14.4 KV

Six specimens (numbered from 1 to 6) were tested. The odd numbered specimens did not have any modifications done to the elbow. The even numbered specimens had a reticular flash preventer (RFP) inserted at the bottom of the injection channel in addition to a ring seal at the top of the compression connector. As per Novinium, these two modifications had been introduced to improve injection elbow performance.

4.0 PERFORMANCE OF TESTS AND RESULTS

Step 1

The free end of each specimen was inserted into a water terminal tube, as illustrated in Figure 2. A standoff bushing was inserted into the elbow with the insulation cap in place. The elbow was secured in such a way that the injection port was facing directly upward.

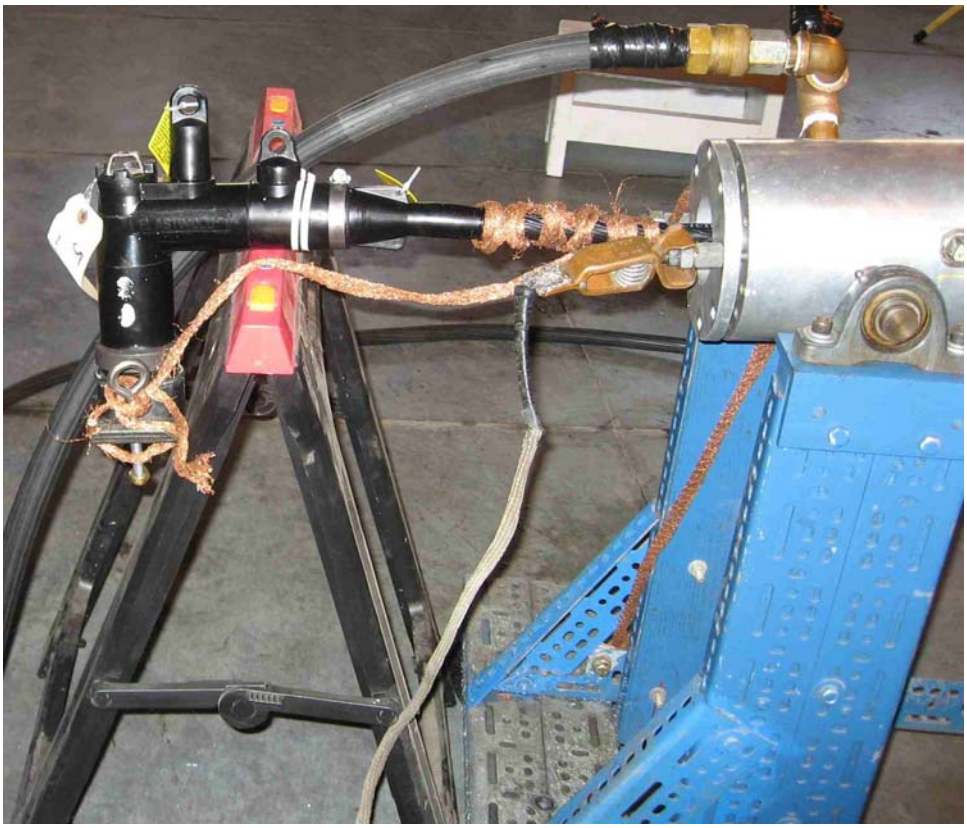

Figure 2: Test specimen inserted into water terminals.

All six specimens, with the insulating plug inserted into the injection channel, were tested for partial discharge in accordance with ANSI/ICEA T-24-380-2007 Standard for Partial Discharge Test Procedure.

According to the Standard “The partial discharge level of the cable under test shall be the maximum continuous or repetitious apparent charge magnitude, measured in pC occurring at the voltage.”

The IEEE 386 Standard requires that the partial discharge of the 8.3/14.3 kV rated elbow shall not exceed 3 pC at a voltage of 11 kV to ground.

On all six samples the partial discharge level at 13.2 kV was less than 1 pC, meeting the requirement of the IEEE 386 Standard.

On all six elbows, at voltages in the 13.2 to 20 kV range, no continuous or repetitious partial discharge exceeding 3 pC were observed.

Step 2

With one end of the specimen still in the water terminal, the insulating plug was removed from the elbow (Figure 3) and 2.5 ml of Ultrinium 732 fluid were introduced through the elbow injection channel, followed by 2.5 ml of tap water. If the sample was even numbered, the introduction of the liquids was followed by inserting a reticular flash preventer (RFP), described in Novinium Rejuvenation Instruction (NRI) 36, Step 6. After the insertion of the RFP, 0.2 ml of Ultrinium 732 fluid was introduced through the opening of the injection port to wet the RFP. The injection channel remained open; no insulating plug was installed. Voltage was then applied to the elbow to measure partial discharge.

Figure 3: Elbow with insulating plug removed.

The results of the partial discharge measurements were similar to those obtained with the “dry” elbow (Step1) with the insulating plug used. All six now “wet” elbows passed the IEEE 386 requirement of partial discharge not exceeding 3 pC at 11 kV.

Step 3

After the partial discharge measurements of Step 2 were concluded on each elbow, the applied voltage was increased by 1 kV each minute starting at 14 kV. This one minute step voltage increase was continued until a flashover from the open port to the grounded surface of the elbow was noticed (Figures 4 and 5). The air temperature, pressure and relative humidity were recorded during the test of each elbow.

The results of the partial discharge and flashover tests are given in Table No. 1 and Figure 6.

Table No. 1

Partial Discharge and Flashover Test

Specimen Number	PD Magnitude * (pC) At 13.2 kV	Flashover Voltage (kV)	Ambient Air		
			Temp (°C)	Pressure (in)	Relative Humidity (%)
1	<1	39	31	30.13	31
2	<1	53	24	30.16	28
3	<1	40	26	30.13	30
4	<1	51	28	30.10	28
5	<1	29	19	29.54	66
6	<1	46	29	29.21	63

* Partial discharge magnitude on elbows, both with the insulating cap on and off.

Mean Flashover Voltage
Modified Elbows 50 kV
Original Elastimold Elbows 36 kV

Figure 4: Flashover during high voltage test.

Figure 5: Flashover during another high voltage test.

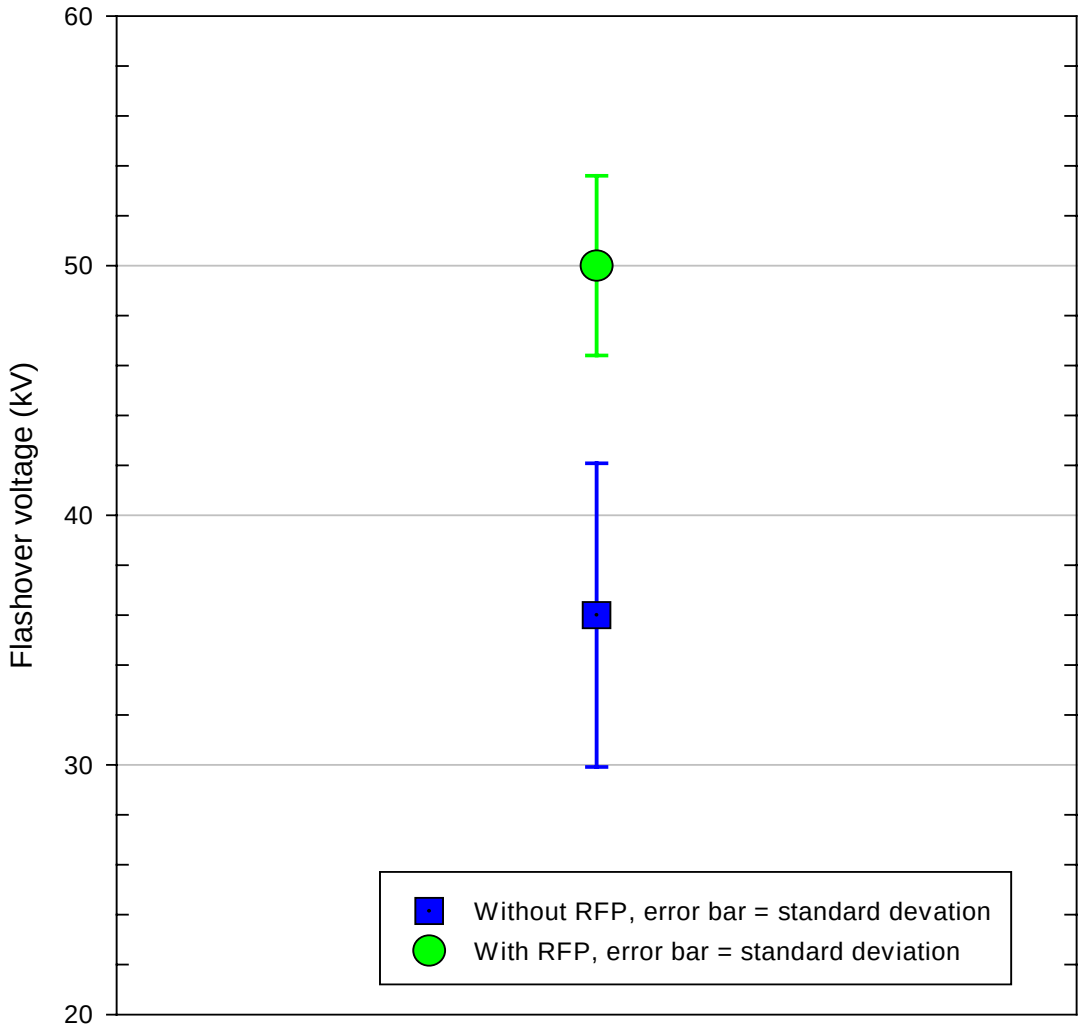

Figure 6: Mean value of flashover voltage data for elbows without aend with RFP.

Statistical analysis was performed on these two groups of data. A paired t-test yielded a p-value of 0.01. The p-value of 0.01 confirms the real

performance superiority of elbows with RFP over elbows without RFP in the flashover test*.

5.0 CONCLUSIONS

1) Based upon the assertion by Thomas & Betts that the direct test elbows it supplies are in accordance with IEEE 386, the same elbows would remain in accordance with IEEE 386 after the Novinium modifications.

2) Both non-modified and modified "direct test elbows", with the insulating plug inserted and with the insulating plug removed, comply with the IEEE 386 Standard requirement to be partial discharge-free at voltages of 11 kV to ground.

3) Novinium injection elbows, made as a modification of the Elastimold direct test elbows, type 168 DELR, with a ring seal at the compression connector and reticular flash preventer, show superior performance over the original direct test elbows in the voltage flashover test.

* The determination of whether statistically there is a significant difference between the mean value of two data sets is reported as a p-value. Typically, if the p-value is below certain level (usually 0.05), the conclusion is that there is a real difference between the means of two groups. The lower the p-value, the greater is the evidence that the mean of the two groups is different.

APPENDIX 1

Thomas&Betts
8155 T&B Boulevard
Memphis, Tennessee 38125
(901) 252-5000
Utility Group

November 26, 2008

Mr. Glen Bertini
CEO and President
Novinium
541 Pine Street
Edmonds, WA 98020-4028, USA

Re: 200A Loadbreak and Deadbreak Direct-Test Elbows

Dear Glen:

This letter is to confirm that Thomas & Betts does offer a direct-test elbow in accordance with IEEE 386 to the utility industry, that is similar to the inject elbow. The direct test elbow has a different nameplate, instruction sheet and warning tag from the inject elbow. The direct-test elbow does not include the o-ring probe, o-ring, or hose clamp that are included with the inject elbow, and the 15kV direct test elbow does not include a probe support. In addition, the direct-test elbow is not subjected to the factory pressure test that the inject elbow is subjected to.

It may be possible to modify the direct test elbows for use in fluid injection applications. However, the decision to use a modified direct-test elbow for fluid injection purposes is strictly between you and your end-users since we do not verify the suitability of these elbows for this purpose when they leave our factory.

Please call if you wish to discuss.

Sincerely,

Mike Jackson
Product Manager, Cable Accessories