Q. On page 9 of Hydro's *Insulator Replacement TL-201 and TL-203* report, Hydro states:

"The testing is currently ongoing and a report will be provided from Kinectrics by the second quarter of2014."

Please provide a copy of the Kinectrics report.

A. The Kinectrics report is attached as NP-NLH-1 Attachment 1.

To: Dr. Asim Haldar
Newfoundland and Labrador Hydro (Nalcor)
Hydro Place, 500 Columbus Drive
St.John's, NL
A1B 4K7
Canada

CONDITION ASSESSMENT TESTS OF PORCELAIN INSULATORS REMOVED FROM NALCOR'S CIRCUITS

Kinectrics Inc. Report No.: K-419614-RC-0001-R00

July 18, 2014

Dmitry Ladin, Michael Kastelein, Prasanna Ravinuthala
Transmission and Distribution Technologies Business

1.0 INTRODUCTION

At the request of Mr. Dr. Asim Haldar of Newfoundland and Labrador Hydro (Nalcor), Visual Examination and Mechanical Strength Tests were performed on aged 25,000 lbf rated glass insulator bells removed from Nalcor's Circuits and shipped to Kinectrics in order to assess the existing insulator condition. A total of thirty-two (32) insulator samples were received. Several of these had severely corroded and bent pins, which precluded the performance of mechanical tests therefore those insulators were only examined visually. Visual Examination and Mechanical Strength Tests were performed on all the other insulator samples.

The tests were carried out between May 6-8, 2014 in accordance with Kinectrics ISO 9001 Quality Management System by Kinectrics Inc. personnel at 800 Kipling Avenue, Toronto, Ontario, M8Z 5G5, Canada, under Nalcor Purchase Order No. 20972-000 OB, dated May 5, 2014.

A copy of Kinectrics ISO 9001 Accreditation Certificate is included in Appendix B.

2.0 TEST OBJECTIVE

The purpose of the tests on the glass insulator samples was to assess the condition of the insulators with regards to the possibility of mechanical line drops involving insulators from the same batch which is still in service. Visual Examination and Mechanical Strength Tests were suggested to analyze insulator degradation mechanisms.

3.0 TEST SETUP FOR MECHANICAL STRENGTH TEST

Figures 1 and 2 show photos of the general setup for performing the Mechanical Strength Test. The top (cap) of the insulator under test was connected to the upper plate of a tensile testing machine using an appropriate fixture. The insulator pin was connected directly to the test machine's lower plate. A wooden box completely enclosed the insulator to contain fragments of the insulator during failure.

4.0 SAMPLE IDENTIFICATION AND VISUAL EXAMINATION

The insulator samples were numbered S1 through S32 by Kinectrics personnel. Each sample was also marked with line phase identifier (e.g., A-phase) by Nalcor. Kinectrics maintained this identification system for consistency. Mechanical Strength Testing was conducted on eighteen (18) test samples. Fourteen (14) remaining untested samples with damaged and/or bent pin on the underside section were not suitable for tensile testing since the insulator's original strength was obviously seriously compromised. Photographs of the insulators prior to and after the testing are shown in Figures 3 through 8. Each insulator was visually examined. The visual examinations of the insulators are summarized in Table 1.

5.0 TEST PROCEDURE FOR MECHANICAL STRENGTH TEST

The procedures used to perform the Mechanical Strength Test followed the most recent version of CSA 411.1. These procedures are equivalent to ANSI C29.2 for suspension insulators. The rate of tensile loading was 11,250 lbf/min for all tested insulators (25,000 lbf rated insulators). The tensile load was increased until the insulator failed mechanically.

6.0 TEST RESULTS FOR MECHANICAL STRENGTH TEST

The results of the tests are shown in Table 1. Almost all 25,000 lbf insulators failed at a load below their rated strength of 25,000 lbf. Only one insulator (Sample # 28) failed at a tensile load exceeding its rating. The mode of failure for all tested insulators involved necking of the pin which lead to eventual failure of the pin. This is illustrated in Figure 6.

Table 1 Summary of Results of Visual Examination and Mechanical Tests

<table>
<tr><th>Sample No.</th><th>Insulator Identifier</th><th>Tensile Capacity, lbf</th><th>Visual Examination</th><th>Mechanical Failure Load, lbf</th><th>Ultimate Failure Mode</th></tr>
<tr><td>S1</td><td rowspan="11">B-phase, Centre</td><td rowspan="32">25,000</td><td rowspan="3">Cracks on grouting and pin base corrosion</td><td>23,702</td><td rowspan="3">Tensile failure: insulator pin failed at the base</td></tr>
<tr><td>S2</td><td>18,490</td></tr>
<tr><td>S3</td><td>22,498</td></tr>
<tr><td>S4</td><td colspan="3" rowspan="2">Pin is bent, no mechanical testing performed</td></tr>
<tr><td>S5</td></tr>
<tr><td>S6</td><td>Pin corrosion</td><td>16,677</td><td>Failed pin</td></tr>
<tr><td>S7</td><td colspan="3" rowspan="2">Pin is bent, no mechanical testing performed</td></tr>
<tr><td>S8</td></tr>
<tr><td>S9</td><td rowspan="10">Cracks on grouting and pin base penetrating corrosion (on underside)</td><td>18,410</td><td rowspan="10">Tensile failure: insulator pin failed at the base</td></tr>
<tr><td>S10</td><td>23,236</td></tr>
<tr><td>S11</td><td>23,729</td></tr>
<tr><td>S12</td><td rowspan="6">C-phase, back to source</td><td>22,248</td></tr>
<tr><td>S13</td><td>24,247</td></tr>
<tr><td>S14</td><td>16,924</td></tr>
<tr><td>S15</td><td>17,803</td></tr>
<tr><td>S16</td><td>22,538</td></tr>
<tr><td>S17</td><td>19,824</td></tr>
<tr><td>S18</td><td rowspan="13">A-phase, left phase</td><td>11,556</td></tr>
<tr><td>S19</td><td colspan="3" rowspan="9">Pin is bent, no mechanical testing performed</td></tr>
<tr><td>S20</td></tr>
<tr><td>S21</td></tr>
<tr><td>S22</td></tr>
<tr><td>S23</td></tr>
<tr><td>S24</td></tr>
<tr><td>S25</td></tr>
<tr><td>S26</td></tr>
<tr><td>S27</td></tr>
<tr><td>S28</td><td>Pin corrosion</td><td>25,208</td><td>Failed pin</td></tr>
<tr><td>S29</td><td colspan="3">Pin is bent, no mechanical testing performed</td></tr>
<tr><td>S30</td><td rowspan="3">Cracks on grouting and pin base corrosion</td><td>16,732</td><td rowspan="3">Tensile failure: insulator pin failed at the base</td></tr>
<tr><td>S31</td><td rowspan="2">C-phase, back to source</td><td>20,479</td></tr>
<tr><td>S32</td><td>14,250</td></tr>
</table>

7.0 VISUAL EXAMINATION DISCUSSION

All test samples exhibited visible cracks in the surface of the grouting for the pin on the underside of the insulators (see Figure 5). The grouting surface cracks may be a result of thermal cycling and temperature excursions the insulators experience during their lifetime.

With varying degrees, all test samples showed advanced pin corrosion as shown in Figure 7. There is an obvious complete loss of Zinc (galvanizing) which normally protects the steel parts from the environment. Due to severe weathering and probable extended service life, the pin base in many samples experienced significant loss of material as a result of penetrating metal corrosion. The reduced cross-section de-rates the insulators' mechanical strength, which is evident from the mechanical test data.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the Visual Examination and Mechanical Strength Tests performed on the Nalcor glass insulator bells, removed from Nalcor's Circuits, the following conclusions are made:

- Only one of the tested insulators met the tensile strength requirement given in the standard specification. All of the remaining insulators failed to meet the standard tensile test requirements.
- The failure of the insulators to meet the standard tensile strength requirements is due to advanced corrosion of the pin which leads to significant reduction of the pin cross-section.
- Visible cracks on grouting surface of the insulator underside most likely display advanced weathering effects.

Based on the test results, we would strongly recommend that the insulators of which the tested units are representative be removed from service as soon as possible. Failure to do so will lead to a continually increasing probability of line drops due to mechanical failure of the insulator pins.

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DL:MK:PR:JK:ZsP:JC

DISCLAIMER

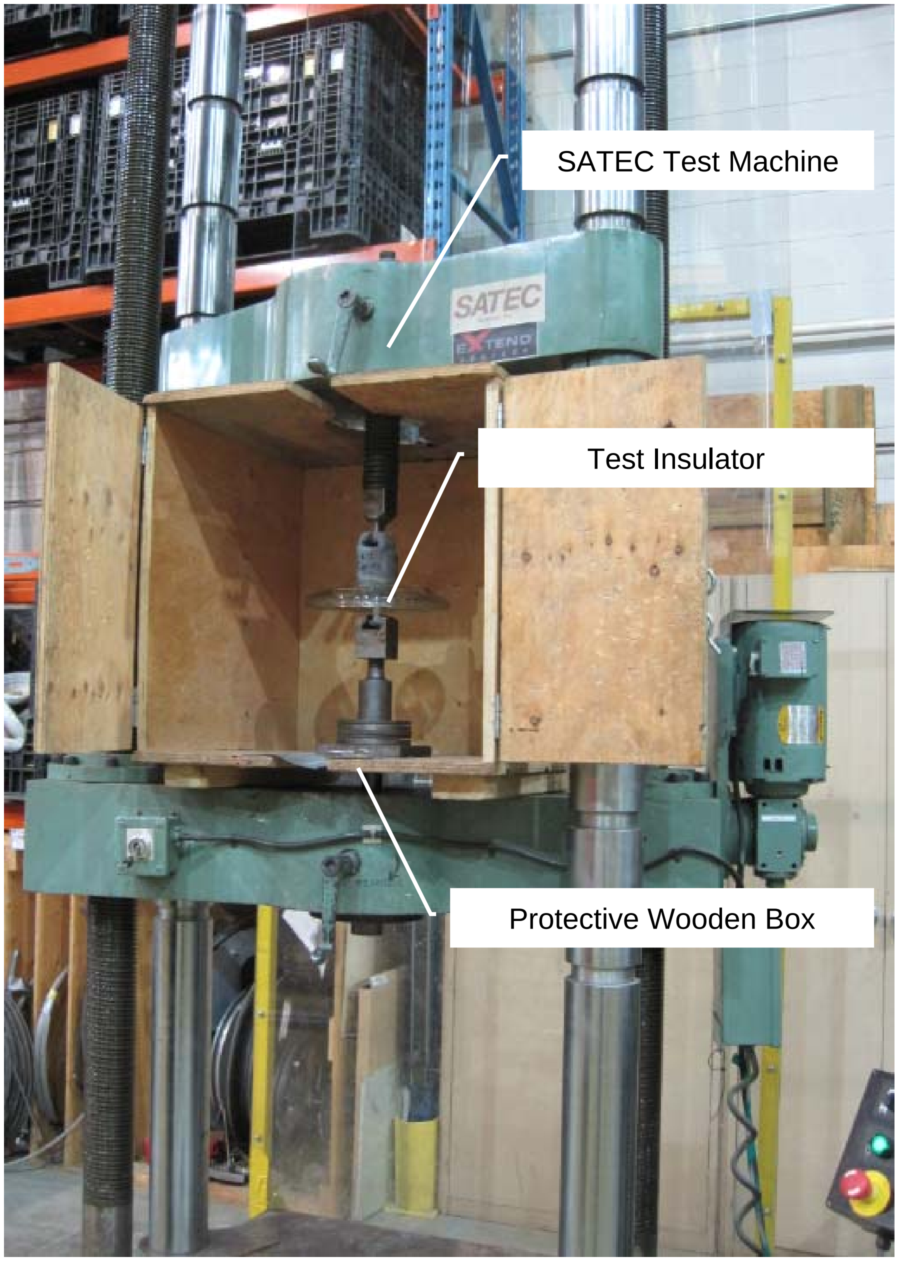

Figure 1 Typical Test Setup for Mechanical Testing on Glass Insulators

Figure 2 Insulator Sample Prepared for Mechanical Testing

Figure 3 Typical Insulator Sample as received, Side View

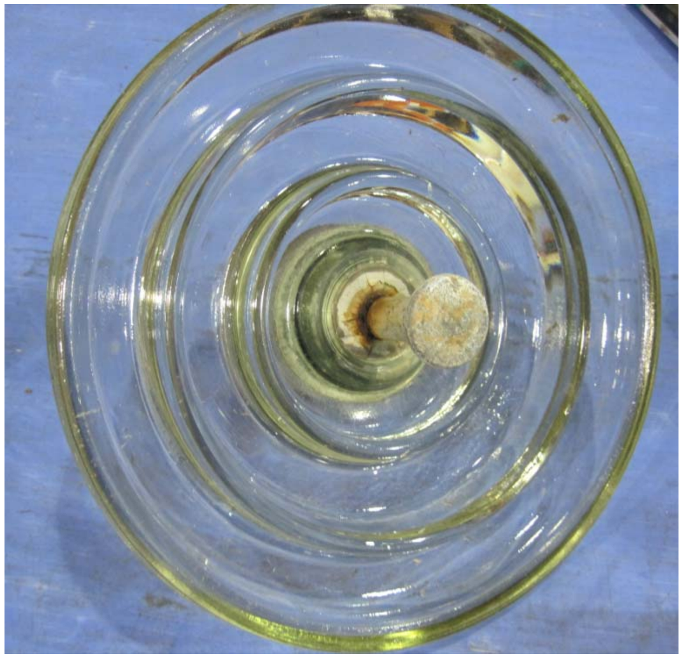

Figure 4 Typical Insulator Sample as received, Bottom View

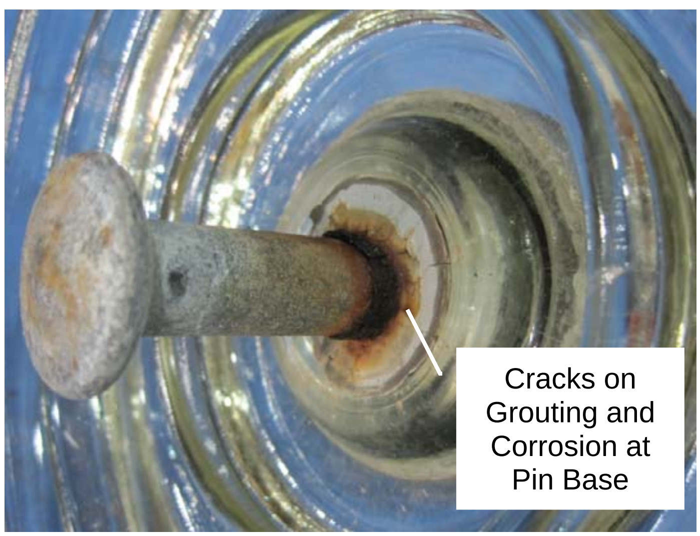

Figure 5 Typical Insulator Sample as received, Bottom View, Magnified View of Cement Grouting near Pin

Figure 6 Typical Insulator Sample after Mechanical Test (failed at Pin Base)

Figure 7 Typical Insulator Sample as received, Bottom View, Magnified View of Pin with Severe Corrosion

Figure 8 Typical Insulator Sample as received, Bottom View, with Bent Pin (not suitable for Mechanical Testing)

ISO-9001 Form: QF11-1 Rev 0, 97-10	**APPENDIX A INSTRUMENT SHEET**

Test Description:	CONDITION ASSESSMENT TESTS OF GLASS INSULATORS REMOVED FROM NALCOR'S CIRCUITS	**Test Start Date:**	May 6, 2014
Project Number:	K-419614	**Test Finish Date:**	May 8, 2014

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MAKE	MODEL	ASSET # or SERIAL #	ACCURACY CLAIMED	CALIBRATION DATE	CALIBRATION DUE DATE	TEST USE
M&E Test	Universal Test Machine-Load	Interface	1232 AF	KIN-01288	±0.1% of reading	September 20, 2013	September 20, 2014	Load
	Universal Test Machine-Displacement	Celesco	DPT250-0025-X11-1230-8482A	KIN-01291	< 0.05% of Reading	September 20, 2013	September 20, 2014	Displacement
	Universal Test Machine-Speed	Celesco	DPT250-0025-X11-1230-8482A	KIN-01290	±1% of reading	September 20, 2013	September 20, 2014	Loading rate
	Digital Caliper	Mitutoyo	500-505 0-18 inches	6000288	±0.025 mm	September 5, 2013	September 5, 2014	Insulator dimensions

APPENDIX B

KINECTRICS ISO 9001 QUALITY MANAGEMENT SYSTEM REGISTRATION CERTIFICATE

CERTIFICATE OF REGISTRATION

This is to certify that

Kinectrics Inc.

operates a

Quality Management System

which complies with the requirements of

ISO 9001:2008

for the following scope of registration

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

Registered Sites:	Kinectrics Inc. 800 Kipling Avenue Unit 2 Toronto, Ontario M8Z 5G5 Canada	Kinectrics, Inc. 230 Richmond Street West, 10th Floor Toronto, Ontario M5V 1V6 Canada
Certificate Number:	CERT-0065775	CERT-0065775
File Number:	006555	1619845
Issue Date:	September 24, 2012	September 24, 2012
Original Certification Date:	July 7, 1998	March 10, 2011
Current Certification Date:	October 27, 2012	October 27, 2012
Certificate Expiry Date:	October 26, 2015	October 26, 2015

Chris Jouppi
President,
QMI-SAI Canada Limited

Guillaume Gignac, Ing.f
Vice President, Corporate Operations, Accreditation & Quality
QMI-SAI Canada Limited

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