A REPORT TO  
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

<table>
<thead>
<tr>
<th>Department</th>
</tr>
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<tbody>
<tr>
<td>Electrical</td>
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<tr>
<td>Mechanical</td>
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<tr>
<td>Civil</td>
</tr>
<tr>
<td>Protection &amp; Control</td>
</tr>
<tr>
<td>Transmission &amp; Distribution</td>
</tr>
<tr>
<td>Telecontrol</td>
</tr>
<tr>
<td>System Planning</td>
</tr>
</tbody>
</table>

REPLACE STATIC EXCITATION SYSTEM FOR GENERATING UNITS AT

Upper Salmon, Hinds Lake and Holyrood

April 2010
# Table of Contents

1 INTRODUCTION ......................................................................................................................................................... 1
2 PROJECT DESCRIPTION ................................................................................................................................................... 3
3 EXISTING SYSTEM .......................................................................................................................................................... 4
  3.1 Age of Equipment or System ................................................................................................................................. 4
  3.2 Major Work and/or Upgrades .................................................................................................................................. 4
  3.3 Anticipated Useful life .................................................................................................................................................. 4
  3.4 Maintenance History .................................................................................................................................................... 5
  3.5 Outage Statistics ......................................................................................................................................................... 5
  3.6 Industry Experience .................................................................................................................................................... 5
  3.7 Maintenance or Support Arrangements .................................................................................................................... 5
  3.8 Vendor Recommendations ......................................................................................................................................... 5
  3.9 Availability of Replacement Parts ............................................................................................................................ 6
  3.10 Safety Performance .................................................................................................................................................. 6
  3.11 Environmental Performance ................................................................................................................................... 6
  3.12 Operating Regime .................................................................................................................................................... 6
4 JUSTIFICATION .............................................................................................................................................................. 7
  4.1 Net Present Value ......................................................................................................................................................... 8
  4.2 Levelized Cost of Energy .......................................................................................................................................... 8
  4.3 Cost Benefit Analysis ............................................................................................................................................... 8
  4.4 Legislative or Regulatory Requirements .................................................................................................................... 8
  4.5 Historical Information ............................................................................................................................................... 8
  4.6 Forecast Customer Growth ..................................................................................................................................... 9
  4.7 Energy Efficiency Benefits ....................................................................................................................................... 9
  4.8 Losses during Construction .................................................................................................................................. 9
  4.9 Status Quo ............................................................................................................................................................... 9
  4.10 Alternatives ............................................................................................................................................................ 9
5 CONCLUSION ................................................................................................................................................................. 10
  5.1 Budget Estimate ...................................................................................................................................................... 10
  5.2 Project Schedule ................................................................................................................................................... 11
1 INTRODUCTION

The Upper Salmon Hydroelectric Generating Station (Upper Salmon) and the Hinds Lake Hydroelectric Generating Station (Hinds Lake) are two of the nine hydroelectric generating sites owned and operated by Newfoundland and Labrador Hydro (Hydro). Upper Salmon is located in the Bay d’Espoir watershed area, approximately 52 kilometers from the Bay d’Espoir generating site. Upper Salmon has one generating unit rated at a capacity of 84 MW. Hinds Lake is located in the western part of the Island near Grand Lake, about 55 kilometers southeast of the Town of Deer Lake. Hinds Lake also has one generating unit rated at a capacity of 75 MW.

The Holyrood Thermal Generating Station (Holyrood) has three generating units. Units 1 and 2 are rated at 170 MW each and Unit 3 is rated at 150 MW.

A generator has two main components, a stator and a rotor. The stator is the stationary component of the generator. When a magnetic field passes through the stator windings a voltage is induced in the windings, creating power. The rotor is the rotating component of the generator. The purpose of the rotor is to supply the magnetic field required to induce a voltage in the stator windings. In order to create this magnetic field, copper coils are wrapped around a steel core and a direct current (DC) is applied to the coils creating an electromagnet. The purpose of the static excitation system is to supply the DC to the rotor to create this magnetic field.

Over the past 15 years Hydro has replaced static excitation systems due to three factors; end of service life, limited availability of spare parts, and limited engineering support from the original equipment manufacturer. To date, Units 1 through 7 at the Bay d’Espoir Hydroelectric Generating Station (Bay d’Espoir), Units 1 and 2 at Holyrood and Unit 1 at the Cat Arm Hydroelectric Generating Station (Cat Arm) have had the static excitation systems replaced. There are three remaining excitation systems that are beyond their useful service
Replacement of Static Excitation System for Upper Salmon, Holyrood Unit 3 and Hinds Lake

lives and require replacement. These are the systems for the generators at Upper Salmon, Hinds Lake, and Holyrood Unit 3.

The Westinghouse static excitation systems in operation for the Upper Salmon, Hinds Lake, and Holyrood Unit 3 generators were installed in 1982, 1980 and 1979 respectively. These systems have now exceeded their 25 year useful service lives, and are due for scheduled replacement.

This report describes the justification for the replacement of the Westinghouse static excitation systems for the Holyrood Unit 3, Hinds Lake, and Upper Salmon generators.
2 PROJECT DESCRIPTION

This project is required to remove the existing static excitation systems, and design, supply and install new static excitation systems for the Holyrood Unit 3, Hinds Lake, and Upper Salmon generators. Additionally, all power and control cabling and connections between the excitation systems and the generators will be replaced.

Hydro intends to tender the supply of the three static excitation systems under a single tender as these systems are very similar in design. The existing excitation systems will be removed from service and disposed of, as they have no salvage value.
3 EXISTING SYSTEM

The existing static excitation systems for the Upper Salmon, Hinds Lake, and Holyrood Unit 3 generators were manufactured by Westinghouse, and installed during construction of the generators. These systems have provided service for 28 to 31 years but have come to the end of their service lives and will not receive further engineering support from the original manufacturer. The original manufacturer, Westinghouse, has been dissolved and sold to other companies. Siemens Canada Limited (Siemens) provides support for Westinghouse static excitation systems, however, due to the age of the systems, replacement parts are no longer stocked by Siemens, and the systems are no longer directly supported by Siemens. Siemens has contracted with a retired former Siemens employee to provide support to these older excitation systems. This individual is currently working under a one-year contract as a consultant. Siemens has stated that due to the ages of the excitation systems, there will be no more in house training for their staff to support these excitation systems and after the consultant’s contract has expired, Siemens will no longer offer support.

3.1 Age of Equipment or System

The Westinghouse static excitation systems in operation for the Holyrood Unit 3, Hinds Lake, and Upper Salmon generators were installed in 1979, 1980 and 1982 respectively.

3.2 Major Work and/or Upgrades

Since their installation there have been no major upgrades performed on the static excitation systems for the Holyrood Unit 3, Hinds Lake, and Upper Salmon generators.

3.3 Anticipated Useful life

Static excitation systems have an anticipated useful service life of 25 years.
3.4 Maintenance History

Exact maintenance costs cannot be determined as Hydro does not track maintenance costs to the level of the components of the excitation systems. The costs are tracked for the generating units only.

3.5 Outage Statistics

In the last five years, there have been no outages which were the direct result of the static excitation systems of the Holyrood Unit 3, Hinds Lake, and Upper Salmon generators.

3.6 Industry Experience

Westinghouse manufactured the existing type of static excitation system from the early 1970s to the mid 1980s. Historically the useful life on this type of equipment has been 25 years however modern digital electronic equipment now in use tends to become obsolete within 10 to 15 years. After approximately 20 years, there is expected to be little manufacturer support remaining for the equipment and replacement parts are difficult to procure. For these reasons, the majority of Westinghouse static excitation systems of this vintage have already been replaced.

3.7 Maintenance or Support Arrangements

All maintenance performed on the static excitation systems has been done by Hydro personnel, with support and technical advice being provided by Siemens.

3.8 Vendor Recommendations

Siemens has supported Westinghouse static excitation systems since the Westinghouse generation division was taken over by Siemens in the mid 1990s. Approximately ten years
ago, Siemens began to phase out parts and service support for this type of Westinghouse system. Siemens no longer stocks parts or trains staff to service the systems. It is the recommendation of Siemens that the systems be replaced.

3.9 Availability of Replacement Parts

Siemens no longer guarantees parts or technical support. All parts have been discontinued and are obsolete. Hydro’s inventory has only one spare of most critical parts remaining. After all spare parts are exhausted, Hydro would have to get custom manufactured parts by a third party.

3.10 Safety Performance

There are no specific safety issues related to this project.

3.11 Environmental Performance

There are no specific environmental issues related to this project.

3.12 Operating Regime

The Westinghouse static excitation systems for the Holyrood Unit 3, Hinds Lake and Upper Salmon generators operate whenever the generating unit is running. The systems in Hinds Lake and Upper Salmon are in near continuous operation, while the Holyrood Unit 3 system has been cyclical depending on seasonal load requirements.
4 JUSTIFICATION

This project is justified on the requirement to maintain system reliability by strategically replacing the static excitation systems for Holyrood Unit 3, Hinds Lake, and Upper Salmon generators before failure which would impair Hydro's ability to provide least-cost, reliable electrical service. In the case of Holyrood, if an infeed is brought on to Newfoundland, from Labrador, the Holyrood plant will be utilized as a synchronous condenser to support system stability for the Island Interconnected system. Regardless of whether the plant is operating in generation mode, or in synchronous condense mode, the DC excitation system will be required. Therefore, when the infeed is realized, these upgrades will still be required.

The Westinghouse static excitation systems in operation in the Holyrood Unit 3, Hinds Lake, and Upper Salmon generators were installed in 1979, 1980 and 1982 respectively. These systems have now exceeded their 25 year useful service lives and are obsolete. They are due for scheduled replacement.

The excitation systems have been supported by Siemens. However, approximately ten years ago, Siemens began phasing out the stocking of parts for these systems because of technology changes. Over the past ten years, the availability of spare parts has declined to the point where Siemens no longer stocks replacement parts. If the excitation system fails and replacement parts are not available, the generating unit will become inoperable.

Siemens has ceased training employees to provide service for these systems. Within a year Seimens will no longer support the existing technology of the excitation systems. The static excitation systems for Holyrood Unit 3, Hinds Lake, and Upper Salmon must be replaced in order for Hydro to ensure reliable least cost power to its customers.
4.1 **Net Present Value**

A net present value calculation was not performed as there is no viable alternative to replacing the excitation systems.

4.2 **Levelized Cost of Energy**

The replacement of these static excitation systems will have no direct effect on the levelized cost of energy.

4.3 **Cost Benefit Analysis**

A cost benefit analysis is not applicable for this project as there are no quantifiable benefits.

4.4 **Legislative or Regulatory Requirements**

There are no specific legislative or regulatory requirements which affect this project.

4.5 **Historical Information**

Hydro has replaced the excitation systems on other generating units. Table 1 provides the replacement dates and costs.

<table>
<thead>
<tr>
<th>Excitation Systems Replaced</th>
<th>Year</th>
<th>Cost ($000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bay d’ Espoir Unit 7</td>
<td>2003</td>
<td>648.7</td>
</tr>
<tr>
<td>Cat Arm Unit 1</td>
<td>2002</td>
<td>600.2</td>
</tr>
<tr>
<td>Holyrood Unit 1</td>
<td>2000</td>
<td>671.3</td>
</tr>
<tr>
<td>Holyrood Unit 2</td>
<td>1999</td>
<td>790.2</td>
</tr>
<tr>
<td>Bay d’ Espoir Unit 1 and 2</td>
<td>1998</td>
<td>661.2</td>
</tr>
<tr>
<td>Bay d’ Espoir Unit 3 and 4</td>
<td>1997</td>
<td>667.2</td>
</tr>
<tr>
<td>Bay d’ Espoir Unit 5 and 6</td>
<td>1994</td>
<td>808.1</td>
</tr>
</tbody>
</table>
4.6 Forecast Customer Growth
The forecasted customer load on the system has no affect on this project.

4.7 Energy Efficiency Benefits
There are no energy efficiency benefits anticipated from this project.

4.8 Losses during Construction
As the static excitation systems will be replaced during scheduled outages during the summer months, there will be no losses during construction.

4.9 Status Quo
The status quo is not acceptable because the static excitation systems for Holyrood Unit 3, Hinds Lake and Upper Salmon generating units are beyond their useful service lives. All replacement parts have been discontinued and the systems are obsolete.

4.10 Alternatives
There are no viable alternatives to this project.
5  CONCLUSION

The static excitation systems for the Holyrood Unit 3, Hinds Lake, and Upper Salmon generators have been in service since their commissioning. These static excitation systems have now reached the end of their useful service lives, are obsolete, and are no longer supported by the manufacturer. For these reasons, these static excitation systems must be replaced.

5.1  Budget Estimate

The budget estimate for the project is shown in Table 2.

<table>
<thead>
<tr>
<th>Project Cost: ($ x 1,000)</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Supply</td>
<td>575.0</td>
<td>700.0</td>
<td>425.0</td>
<td>1700.0</td>
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<tr>
<td>Labour</td>
<td>187.0</td>
<td>187.0</td>
<td>187.0</td>
<td>561.0</td>
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<tr>
<td>Consultant</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Contract Work</td>
<td>250.0</td>
<td>280.0</td>
<td>250.0</td>
<td>780.0</td>
</tr>
<tr>
<td>Other Direct Costs</td>
<td>21.0</td>
<td>21.0</td>
<td>21.0</td>
<td>63.0</td>
</tr>
<tr>
<td>O/H, AFUDC &amp; Escln.</td>
<td>101.3</td>
<td>225.0</td>
<td>350.9</td>
<td>677.2</td>
</tr>
<tr>
<td>Contingency</td>
<td>80.0</td>
<td>115.0</td>
<td>132.9</td>
<td>327.9</td>
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<tr>
<td>TOTAL</td>
<td>1,214.3</td>
<td>1,528.0</td>
<td>1,366.8</td>
<td>4,109.1</td>
</tr>
</tbody>
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5.2 Project Schedule

The anticipated project schedule is shown in Table 3.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design of static excitation system for Upper Salmon</td>
<td>April 2011</td>
</tr>
<tr>
<td>Production of static excitation system for Upper Salmon</td>
<td>July 2011</td>
</tr>
<tr>
<td>Transportation of static excitation system to Upper Salmon</td>
<td>August 2011</td>
</tr>
<tr>
<td>Installation of static excitation system for Upper Salmon</td>
<td>October 2011</td>
</tr>
<tr>
<td>Design of static excitation system for Holyrood Unit 3</td>
<td>January 2012</td>
</tr>
<tr>
<td>Production of static excitation system for Holyrood Unit 3</td>
<td>April 2012</td>
</tr>
<tr>
<td>Transportation of static excitation system to Holyrood</td>
<td>May 2012</td>
</tr>
<tr>
<td>Installation of static excitation system for Holyrood Unit 3</td>
<td>July 2012</td>
</tr>
<tr>
<td>Design of static excitation system for Hinds Lake</td>
<td>February 2013</td>
</tr>
<tr>
<td>Production of static excitation system for Hinds Lake</td>
<td>May 2013</td>
</tr>
<tr>
<td>Transportation of static excitation system to Hinds Lake</td>
<td>June 2013</td>
</tr>
<tr>
<td>Installation of static excitation system for Hinds Lake</td>
<td>September 2013</td>
</tr>
</tbody>
</table>