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August 1, 2014

The Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, Newfoundland & Labrador
A1A 5B2

Attention: Ms. Cheryl Blundon
Director Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: The Board's Investigation and Hearing into Supply Issues and Power Outages on the Island Interconnection System

In accordance with the Board's Interim Report dated May 15, 2014, wherein the Board required the filing of reports on today's date with respect to the above noted matter, please find enclosed the original plus 12 copies of Hydro's:

- Alarms, Event Recording Devices, and Digital Relays
- Air Blast Circuit Breakers

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Tracey L. Pennell
Legal Counsel

TLP/cp

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Sheryl Nisenbaum – Praxair Canada Inc.
ecc: Roberta Frampton Benefiel – Grand Riverkeeper Labrador
Thomas Johnson – Consumer Advocate
Thomas O' Reilly – Cox & Palmer
Danny Dumaresque

Investigation and Hearing into Supply Issues and Power Outages on the Island Interconnected System

REPORT TO THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES RELATED TO ALARMS, EVENT RECORDING DEVICES, AND DIGITAL RELAYS

Newfoundland and Labrador Hydro

August 1, 2014

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1 BACKGROUND AND INTRODUCTION

Newfoundland and Labrador Hydro's ("Hydro") internal review and investigation of the supply disruptions and power outages which occurred on the Island Interconnected System in January, 2014 included an in-depth review of various aspects of transmission availability, and a root cause analysis of the failure of various transmission system components in Sunnyside and in other locations during these events. Alarms and data recording devices were not identified as factors contributing to the supply disruptions. However, Hydro's internal review did identify opportunities for improvement which led to recommendations that the company review and identify the key set of priority alarms to be reviewed during system disruptions, and that operators be provided with additional training as necessary. The Company also identified opportunities to improve its digital relay program through the installation of additional modern digital relays throughout its system, with a prioritized implementation for major equipment such as 230 kV transformers.

On May 15, 2014 the Newfoundland and Labrador Board of Commissioners of Public Utilities ("Board") issued its Interim Report in the matter of an investigation and hearing into supply issues and power outages on the Island Interconnected System ("Interim Report"). This Report is in response to a request by the Board that Hydro file by August 1, 2014 a report which sets out:

a) A plan to update its event and data recording devices and systems and procedures to identify the key set of priority alarms, provide for the monitoring of alarms, and address staff training and equipment repair; and
b) An analysis of the implementation of a program to install modern digital relays for all major equipment such as 230 kV transformers.

2 ALARMS AND EVENT RECORDING

Alarms are used to identify operational anomalies in the functioning of the electrical network and to notify appropriate personnel who then take action to rectify the situation. In Hydro's network, alarms are triggered from field devices on equipment such as power transformers and circuit breakers and will trigger for equipment anomalies. For example, if a transformer oil temperature rises above its acceptable level, it will trigger an alarm locally in the station as well as trigger an alarm at the Energy Control Centre (ECC). The ECC operator will then dispatch personnel to investigate the anomaly. As well, alarms are also configured from field devices to provide feedback to the operator to ensure the position of equipment matches controls that are initiated.

Alarms are important to understanding event sequences, which help technical staff analyze power system disturbances or events. Sequence of Events (SOE) type alarms are time stamped to a millisecond resolution. An example of this is the alarms that are generated due to the operation of a protective tripping devices and the opening of circuit breakers. Besides the change of state of tripping devices and circuit breakers, when events on the power system occur, the information gathered from waveforms (pre-event and post- event) are important to help determine the cause(s) and/or effect(s) of the event such that appropriate corrective actions can be determined and taken. To capture waveforms, Hydro has Digital Fault Recorders (DFRs) in various locations throughout the system, and the Company has also installed modern digital relays in recent new installations and protection upgrades which have the capability of capturing waveforms and other important historical data.

This section of the report outlines Hydro's plans for improving its alarm and event recording and related operator training

2.1 Updates to Event and Data Recording Devices and Procedures

Hydro plans to update its event and data recording devices and procedures by completing the following:

1. A review of its existing digital fault recording devices;
2. A review to identify key priority alarms;
3. A review to address monitoring of alarms and staff training; and
4. A repair of the failed Digital Fault Recorder (DFR) at Western Avalon.

2.1.1 Review of Existing Digital Fault Recorders

Hydro's plan for completing a review of its existing fault recording devices is summarized in Table 2.1 below.

Table 2.1
Plan To Review Fault Recording Devices

Activity	Completion Date
Hire External P&C Resource	September 12, 2014
Complete an inventory of Digital Fault Recorders (DFR) installed throughout the Island Interconnected System.	September 19, 2014
Check with the OEM to determine if any in-service DFRs are obsolete. Confirm availability of spare parts for existing units, and prepare the spare parts list that Hydro should have on hand for existing DFRs.	September 26, 2014
Review industry practices and document a standard for DFRs including provision for spare parts with the P&C Engineering group.	October 3, 2014
Develop a multi-year replacement plan and capital budget proposal for obsolete DFRs, with a priority on 230 kV stations, and then followed by 138 kV and 69 kV stations.	October 17, 2014

2.1.2 Identification of Key Priority Alarms

Hydro's plan for identifying key priority alarms is summarized in Table 2.2 below.

Table 2.2 **Plan To Identify Key Priority Alarms**	
Activity	**Completion Date**
Hire external P&C resource.	August 29, 2014
Review the current standard for points naming and grouping to identify improvement opportunities.	October 31, 2014
Review the listing of points for five existing 230 kV stations and one of Hydro's newer stations (e.g., Vale Terminal Station) to identify improvement opportunities. [1]	November 7, 2014
Review any issues or suggested improvements with P&C Engineering, ECC, Work Execution and Long Term Asset Planning for input.	November 14, 2014
Develop 2014/15 plan for updating Hydro's naming standard.	November 21, 2014
Develop a 2015 plan for updating alarm point naming on drawings and in the ECC, with an expected completion of the implementation by October 31, 2015.	November 28, 2014

2.1.3 Monitoring of Alarms and Staff Training

Hydro delivers operator refresher training two to three times each year using its operator training simulator. Hydro plans to augment its regular program of training with a specific module tailored to the topic of alarm monitoring which will be integrated into operator training planned for 2014. This presentation will review the existing alarm priorities and ensure operators know how to evaluate the required response for each type of alarm. This module will be updated following the company's review of priority alarms discussed in Section 2.1.2 above. The schedule of activities to be completed in 2014 is outlined in Table 2.3 below.

[1] Five stations will be selected as a representative sample for comparison against Hydro's latest standard in one of its new stations.

Table 2.3 Plan To Address Monitoring Of Alarms And Staff Training	
Activity	**Completion Date**
Develop a presentation specific to the monitoring of alarms and integrate into the existing operator refresher training program to ensure that priority alarms are reviewed and acted upon in a timely manner.	September 10, 2014
Complete training with ECC operators.	September 30, 2014
Update alarm monitoring training consistent with results of the 2014 review of key priority alarms.	November 30, 2014

2.1.4 Repair of Failed DFR at Western Avalon

Hydro experienced a failure of a fault recorder at Western Avalon during the events of January 2014. The following is a timeline of items completed and items to be completed relating to this failure and fault recorder repair.

Table 2.4 Plan to Repair Failed DFR at Western Avalon	
Activity	**Completion Date**
Review components required for repair with Engineering and vendor (completed).	May 2014
Order components (completed).	June 2014
Delivery of new unit.	August 8, 2014
Install repaired unit.	August 31, 2014

2.2 Implementation Schedule

The implementation schedules for all items have been included in the tables in Section 2.1.

2.3 Resources and Costs

Table 2.5 below presents a summary of the resource requirements and estimated costs associated with each of the activities discussed in Section 2.1 above.

Table 2.5 **Summary of Resource Requirements and Costs For Event and Data Recording**		
Plan/Activity	**Resources**	**Estimated Cost [2]**
Review of Fault Recording Devices	External P&C Resource to lead (5 weeks) P&C Supervisor, P&C Technologist, ECC System Operations Engineer, Equipment Engineer (3 days) P&C Engineer (5 days)	$32,500 External $2,000 internal travel
Identification of Key Priority Alarms	External P&C Resource to lead (5 weeks) P&C Supervisor and Equipment Engineer (3 days) ECC System Operations Engineer and P&C Engineer (5 days)	$32,500 External $2,000 internal travel
Monitoring Of Alarms And Staff Training	System Operations Engineer (3 days) ECC Operators (1 day)	$0
Repair of Failed DFR at Western Avalon	P&C Engineer (2 days) P&C Technologist (3 days) Material $6000	$6,000

[2] Cost estimates reflect the cost of external resources and additional internal costs for travel and materials. They do not include additional labour costs that will be absorbed in the current operating budget.

3 DIGITAL RELAYS

Modern digital relays produce fast acting alarm outputs, they communicate easily with external devices and, importantly, they are capable of being time synchronized so as to enable the capture and recording of digital fault information to recreate waveforms that can be analyzed (remotely) after system events such as those that occurred on the island interconnected system in January, 2014. This digital fault information becomes critical in determining the true sequence of events and helps engineers and technologists evaluate how the system responded relative to its intended design. This information can also be used to help make improvements in protection settings and help minimize the impact on customers during system events.

Hydro recognizes the benefits of modern digital relays and has started deploying this technology in its installations in recent years, and plans to continue with this technology in all its current planned protection upgrades. Following the events of January, 2014, improvement opportunities have been identified in Hydro's current plan in relation to the use of modern digital relays for its critical equipment, and particularly for the protection of its power transformers. Hydro plans to revise its plan for transformer, bus and line protection as appropriate to ensure a priority implementation plan to add modern digital relays.

3.1 Review of Updates and Changes to Existing Digital Relay Program

Hydro is presently reviewing it philosophy and design and relay requirements for breaker failure protection utilizing an internal Protection and Control (P&C) resource. Hydro's plan and schedule in this regard was outlined in the Protection and Control Systems report filed with the Board on June 16, 2014.

Hydro also plans to review it existing transformer, bus and line protections in an effort to develop plans for future implementation of modern digital relays with data storage and fault recording capabilities. This plan is summarized in Table 3.1 below.

Table 3.1 **Plan For Updates and Changes To Digital Relay Program**	
Activity	**Completion Date**
Hire External P&C resource.	August 29, 2014
Complete an inventory of transformer, line and bus protections for all stations to determine the stations requiring upgrades.	Sept 12, 2014
Review industry practices and work with the P&C Engineering group to document a standard for modern digital relays with data storage and fault recording capabilities that Hydro should deploy on its system for transformer, bus and line protection.	Sept 26, 2014
Develop a plan for implementation in future years with a priority in the first part of the plan being 230 kV transformer , bus and line protection, then 138 kV transformer, bus and line protection, then 69 kV transformer , bus and line protection	October 17, 2014
Develop capital budget proposal for projects to purchase and install modern digital relays.	October 24, 2014

3.2 Implementation Schedule

The schedule for Hydro's review of the updates and changes required in Hydro's digital relay program is outlined in Section 3.1. A schedule for the implementation of necessary changes and the installation of new digital relays will follow as an output from this review.

3.3 Costs and Resources

Table 3.5 below summarizes the resources and estimated costs associated with this work.

Table 3.5 **Resources and Costs For Updates and Changes To Digital Relay Program**		
Plan/Activity	**Resources**	**Estimated Cost** [3]
Review of Updates and Changes To Digital Relay Program	External P&C resource to lead (8 weeks) P&C Engineer, P&C Supervisor, P&C Technologist, ECC System Operations Engineer (2 weeks) Equipment Engineer (1 week)	$50,000 External $2,500 Internal travel

[3] Cost estimates reflect the cost of external resources and additional internal costs for travel and materials.