newfoundland labrador hydro
a nalcor energy company

Hydro Place. 500 Columbus Drive.
P.O. Box 12400. St. John's. NL
Canada A1B 4K7
t. 709.737.1400 f. 709.737.1800
www.nlh.nl.ca

June 16, 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:

- Hydro Place Emergency Power Report;
- Protection and Control Systems Report;
- Terminal Station and P&C Resource Requirements Report;
- Terminal Station Transformers Report; and
- Generation Availability Report.

Should you have any questions, please contact the undersigned.

Yours truly,

***NEWFOUNDLAND AND LABRADOR HYDRO***

Geoffrey P. Young
Senior Legal Counsel

GPY/cp

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Sheryl Nisenbaum – Praxair Canada Inc.
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 PROTECTION AND CONTROL SYSTEMS

Newfoundland and Labrador Hydro

June 16, 2014

newfoundland labrador hydro
a nalcor energy company

# TABLE OF CONTENTS



**Appendices:**

# 1 BACKGROUND AND INTRODUCTION

The design and response of Hydro's protection and control (P&C) systems were a factor in the supply disruptions and power outages which occurred on the island interconnected system in January, 2014. Hydro's in-depth internal review of these events, which included an independent expert analysis of the Company's P&C systems, resulted in a number of recommendations which were later incorporated into an integrated action plan.

Liberty Consulting (Liberty), consultant to the Board of Commissioners of Public Utilities (PUB), also made recommendations relating to protection and control in their report to the PUB on April 24, 2014. In its response to the Liberty review, Hydro indicated its agreement with these recommendations, many of which were similar to those adopted by the Company as part of its internal review.

On May 15, 2014 the PUB issued its Interim Report in connection with the Board's investigation and hearing into the supply disruptions and power outages which occurred on the island interconnected system in January, 2014.

This Report is filed in response to the request made by the PUB in its Interim Report that Hydro file a report by June 16, 2014 in relation to each of the issues identified below, addressing schedule, estimated costs, the resources required, and how these requirements will be met:

a) A plan to redesign existing breaker failure relay protection schemes to provide that breaker failure will be activated with either a 138kV or 230 kV breaker malfunction after a transformer failure;
b) A plan for the installation of breaker failure relay protection for transformers in terminal stations where breaker failure relay protection is not in place;
c) A plan to include experienced protection and control technologists with response teams, where appropriate, beginning in 2014;

d) A plan to eliminate the use of slow trip coils in 2014;

e) A plan to complete work in relation to relay cards in terminal stations in 2014;

f) A plan to document its protection philosophy as a Protection and Control Engineering standard in 2014; and

g) A review of the recommendations in the previous 230 kV transmission line protection studies in light of priorities and requirements arising from the January 2014 events.

## 2 BREAKER FAILURE RELAY PROTECTION

Circuit breakers are used on the power system to interrupt the flow of power in the event of a fault. Protective relays continuously monitor the system and sense the inception of faults on equipment. In such events, the protection system selects and sends an open command to the circuit breakers to quickly open to isolate and minimize damage to the affected portion of the system. However, it is possible that a breaker will not respond to an open command. To protect against a breaker failing to open, a form of protection called "breaker failure" is introduced into the power system. Breaker failure protection activates after a prescribed time and, once activated, the affected portion of the power system is isolated by opening additional breakers to isolate the malfunctioning breaker. This generally involves a larger portion of the power system and a greater impact to customer service than if the problem breaker operated correctly.

During the January 4, 2014 incident at Sunnyside Terminal Station, a fault on transformer T1 resulted in a protection operation which sent trip signals to five breakers, two 230 kV breakers, B1L03, B1L02 and three 138 kV breakers, B2T1,B3T4 and L109T4 to isolate the transformer. Breaker B1L03 did not open. This breaker has breaker failure protection, however its breaker failure protection was not designed to detect a failure of the breaker to open for a transformer protection initiated trip signal. As a result, the fault remained on the transformer until the protection systems for transmission lines TL203 and TL237 at the Western Avalon Terminal Station operated to open the breakers for those lines at Western Avalon. The slow clearing of the T1 fault resulted in a fire and the destruction of the transformer. The opening of the lines at Western Avalon resulted in an outage to the Avalon Peninsula.

In order to prevent similar occurrences in the future, Hydro's internal review of the January, 2014 system events recommended that the implementation of transformer protection initiation of breaker fail protection at all stations that have breaker fail protection be considered. It was also recommended Hydro conduct a formal risk/reward review of the 230

kV breaker failure protection philosophy for transformers at stations that currently do not have breaker fail protection. Hydro is committed to acting on both recommendations, and its plans for doing so are outlined in the following sections.

### 2.1 Redesign of Existing Breaker Failure Relay Protection

As outlined below, all terminal stations which have existing breaker failure protection in place will be reviewed to determine if a failure of a breaker to open after a transformer protection operation is addressed by the existing breaker failure design. This is expected to involve only 230 kV stations[1] as none of the 138 kV and lower voltage stations have breaker failure relays.

An accurate estimate of the amount of work and the time required to complete design work in the stations will be available once the full review has been completed. Upon completion of the review, an estimate will be prepared with the scope defined and a schedule for implementation. The plan is to have the estimate and project plan completed by September 30, 2014 and if it meets the definition of capital work a capital budget proposal will be prepared for approval. Field modifications will begin in 2015 and will be scheduled with the completion of work on the 230 kV stations as the first priority.

#### 2.1.1 Evaluation of stations

Each station will be reviewed to determine the status of the breaker failure protection in that station. This will involve site visits and engineering drawing reviews. In all cases the result of a transformer trip will be incorporated into the breaker failure logic. Some of the stations will require that breaker failure operations initiate a transfer trip to a remote station in order to fully isolate the affected breaker. The level of complexity is variable among the stations on the power system and this will have an effect on the time and materials required to institute the necessary modifications.

[1] 230 kV stations are stations with the highest transmission voltage in the station rated at 230 kV.

A review of the 230 kV stations that have existing breaker failure protection will be completed by August 31, 2014 to determine the sites where the breaker failure protection does not operate with a 230 kV or 138 kV breaker malfunction after a transformer protection operation. This review will involve checking engineering drawings and making site visits, and will be done by a Protection and Control Engineer. A Protection and Control Technologist will also be involved in the site visits. The cost to complete this review is estimated to be $18,600, which includes $16,100 for labour and $2,500 for travel expenses.

### 2.1.2 Materials/Engineering Time

The time requirement to complete an engineering review of a station will depend on the station complexity and the number of breakers in that station. It is possible that a station may require new breaker failure relays or lockouts depending on the condition of the existing equipment. A conservative estimate is that one week will be required to complete the design work to implement additional breaker failure logic for each station that has an existing breaker failure scheme that does not include transformer initiated breaker failure.

### 2.1.3 Execution Plan

The design alterations recommended following an engineering design review will be implemented by the personnel assigned by Transmission and Rural Operations (TRO). In each affected terminal station, the work performed will be in accordance with the engineered drawings. This work will potentially involve replacement of relays and wiring of additional circuits to implement the new breaker failure logic. Higher priority will be assigned to completion of work in the 230 kV stations before implementation of a breaker failure design on the remainder of the power system. The schedule to have this completed will be outlined in a project plan to be completed by September 30, 2014.

## 2.2 Transformer Initiated Breaker Failure Relay Protection in Stations Which Do Not Presently Have Breaker Failure Protection

A review of all of Hydro's terminal stations in the province without breaker failure protection will be made. This will involve a review of 34 stations as none of the 138 kV and 69 kV stations have been equipped with a breaker failure protection scheme.

An accurate estimate of the amount of work and the time required to complete design work in the stations to implement breaker failure protection including that required for transformer protection will be available once the review has been completed. Field modifications will be scheduled with the completion of work on the higher voltage stations as the first priority.

### 2.2.1 Evaluation of stations

Stations without breaker failure protection will be reviewed using engineering drawings and site visits to assess what is involved to add breaker failure for a transformer trip. Some of the stations will require that breaker failure operations will initiate a transfer trip to a remote station in order to fully isolate the affected breaker. The level of complexity is variable among the stations on the power system and this will influence the time and materials required to institute the necessary modifications.

A review of the stations that do not have existing transformer initiated breaker failure protection will be completed by November 30, 2014. This review will determine what has to be done to provide transformer initiated breaker failure protection. This will involve checking engineering drawings and making site visits and will be done by a Protection and Control Engineer. A Protection and Control Technologist will also be involved in the site visits. The cost to complete the review is estimated to be $39,700, which includes $34,700 for labour and $5,000 for travel expenses.

### 2.2.2 Materials/Engineering Time

The intention is to employ a Schweitzer Engineering Laboratories SEL 501 relay to provide the breaker failure protection. Each relay can provide breaker failure protection for two transformers. A period of three months, commencing in August, has been allocated to complete the examination of the breaker failure protection in the stations. Subsequent to the engineering review of the breaker failure schemes in the stations, new breaker failure relays and additional lockout relays will be required to implement the design. In general, there will be a lockout relay for every breaker which has breaker failure protection. The time requirement to complete an engineering review of a station will depend on the station complexity and the number of breakers in that station. It is possible that a station will require a separate breaker failure panel to accommodate the additional relays and lockouts.

Upon completion of the engineering design work, a budget estimate will be prepared with scope defined and a schedule for implementation. The plan is to have the Capital Budget proposal completed by November 30, 2014.

### 2.2.3 Execution Plan

The design alterations following an engineering design review will be implemented in each affected terminal station. The work performed will be in accordance with the engineered drawings. This work will potentially involve new relays and wiring of additional circuits to implement the new breaker failure logic. Higher priority will be assigned to the completion of work in the 230 kV stations before implementation of a breaker failure design on the remainder of the power system. The schedule to have this completed will be outlined in a Capital Budget proposal which will be completed by November 30, 2014.

# 3 PROTECTION & CONTROL EMERGENCY RESPONSE

Hydro's internal investigation report identified the need to consider having an experienced protection and control (P&C) technologist available on site during times when restoration of power is required in emergency situations.

In its interim report the PUB required Hydro to provide a plan to include experienced protection and control technologists with response teams, where appropriate, beginning in 2014.

Hydro has implemented an interim Severe Weather Preparedness (please refer to Appendix A) protocol with the final version to be issued on October 1, 2014 after review with all pertinent stakeholders and departments. Operating personnel are currently following the interim protocol for severe weather events and will deploy experienced personnel as required. There is a requirement in the protocol to ensure that in advance of a severe weather event, work crews are deployed to strategic locations to reduce response time should the power system suffer an unplanned outage or equipment failure. The work crews will include one or more P&C Technologists depending on the location and severity of the forecasted weather event.

# 4 2014 PLAN FOR ELIMINATION OF SLOW TRIP COILS

Hydro's internal review recommended that all 230 kV air blast circuit breaker trip circuits should be modified to eliminate the exposure and risk of slow breaker operation. The application of slow trip coils will be reviewed in detail for all of Hydro's terminal stations that have 230 and 138 kV air blast circuit breakers. It is estimated that there are approximately 32 breakers where this exposure may exist.

The plan for completing this work is outlined in Table 4.1 below.

**Table 4.1 – Plan For Elimination of Slow Trip Coils**

| Activity | Plan Completion Date |
|---|---|
| Engineering work to validate the number of breakers having a slow second trip coil and then modify drawings to eliminate the exposure from the slow operating speed of this trip coil. Update drawings for 50% of the identified breakers. | July 31, 2014 |
| Field modifications for first 50% of the breakers. | September 30, 2014 |
| Engineering work to modify the drawings for the remaining breakers . | September 30, 2014 |
| Field modifications for the remaining breakers | November 30, 2014 |

# 5 2014 PLAN FOR TERMINAL STATION RELAY CARDS

Hydro's internal review identified that the relay information cards located in terminal stations should be reviewed and updated as needed. This will ensure up to date relay cards are on hand and utilized after system events to capture relay targets.

Hydro will update all relay cards located on the protective relay panels in each of the terminal stations by December 1, 2014. All protective relay panels will be audited to ensure that the relay cards match the installed protective relays. The relay cards will be re-designed or modified, if necessary, and placed back in to the respective terminal stations.

Hydro is also updating its Operating Instruction 002 to incorporate the importance of completing the relay cards in a timely fashion and to ensure the resetting of the relays are documented on the card.

Hydro plans to have its audit completed by September 30, 2014 and new relay cards in place by November 30, 2014. The updates to the Operating Instruction 002 will be completed by September 30, 2014 and reviewed with all Protection and Control (P&C) Technologists by no later than November 30, 2014. These activities are summarized in Table 5.1 below.

**Table 5.1 – Plan For Updating Terminal Station Relay Cards**

| **Activity** | **Plan Completion Date** |
|---|---|
| Audit All Terminal Station – Relay Card Verification | September 30, 2014 |
| Up to date Relay Cards in All Terminal Stations | November 30, 2014 |
| Review Operating Instruction 002 with P&C Technologists | November 30, 2014 |

Hydro also plans to update the Protective Relay Maintenance Procedure to include the review of the relay cards during the six year relay maintenance PM.

# 6 PROTECTION AND CONTROL STANDARD

A recommendation from Hydro's internal review was that the Company document its P&C philosophy as a Protection and Control engineering standard.

Hydro's existing Protection and Control standards cover mostly standards for equipment. Standards related to Protection and Control design philosophy are documented in drawings and are applied consistently within the Company. However, they are not documented in the same manner as other engineering standards.

The development of P&C philosophy standards will require a review of the following areas:

- 230 kV transmission line protection;
    - With single pole tripping and reclosing; and
    - With three pole tripping and reclosing.
- 138 kV transmission line protection;
- 66/69 kV and 46 kV line protection;
- Distribution line protection including 25 kV and 12.5 kV;
- Generating unit protection;
    - Hydro;
    - Thermal;
    - Gas Turbine; and
    - Diesel.
- Transformer protection including 2 and 3 winding transformers and autotransformers;
- Shunt capacitor bank protection;
- Bus protection;
- Breaker failure application;
- Terminal Station Control (breakers, disconnects, transformers, synchronizing);
- Fault recorders and sequence of events recorders;
- Relay Data Acquisition; and

- Substation Automation including relay communications and operator interface.

A Protection and Control Standards Committee is being formed to oversee the development and upkeep of these standards. This committee will have responsibility to establish the process for preparing, updating, reviewing and approving the standards.

Hydro's plan for completing this work is outlined in Table 6.1 below.

**Table 6.1 – Plan for Establishing a P&C Philosophy**

| **Activity** | **Plan Completion Date** |
|---|---|
| Complete the implementation of the Protection and Control Standards Committee and its Terms of Reference. | July 15, 2014 |
| Develop a prioritized list of standards to be prepared. | July 31, 2014 |
| Assign standards for preparation (top two priorities) in 2014. | July 31, 2014 |
| Drafts completed for first two standards. | September 30, 2014 |
| Initial standards approved. | November 30, 2014 |
| Schedule for development of standards in 2015 and beyond. | December 15, 2014 |

# 7 PREVIOUS 230 kV TRANSMISSION LINE PROTECTION STUDIES

In its review Hydro recommended a review of the status of implementation of recommendations in previous 230 kV transmission line protection studies and the development of an action plan to implement as many of the recommendations as practical. In its interim report, the PUB required Hydro to complete a review of the recommendations in the previous 230 kV transmission line protection studies in light of priorities and requirements arising from the January 2014 events.

Henville Consulting Inc., a protection consultant, prepared reports covering the protective relay performance and relay settings for the ten 230 kV transmission lines east of Bay d'Espoir. Henville Consulting made a total of 34 recommendations with 11 common to both reports, or essentially 23 recommendations to complete. The common recommendations involve modelling electrical parameters, relaying schemes, collecting event reports and relay settings.

These recommendations have been prioritized and assigned a scheduled completion date. Of the 23 recommendations, 19 are Priority A (completion in 2014) and four are Priority B (completion in 2015). Four of the recommendations (three Priority A and one Priority B) have been completed to date, leaving 19 to be done. Table 7.1 below lists these recommendations by category.

**Table 7.1 – P&C Study Recommendations to be Completed**

| Category | # of Recommendations | Completed |
|---|---|---|
| Changes to software modeling program for relay coordination (Aspen Oneliner) | 2 | 1 |
| Assessment needed | 4 | 1 |
| Changes to specifications | 1 | 1 |
| Equipment performance | 2 | |
| Disturbance record retrieval | 2 | |
| Relay setting changes | 7 | 1 |
| Relay replacements | 5 | |

Protection and Control Technologists (TRO personnel) are required to install new settings issued by Engineering for the transmission line relays reviewed in the reports. The estimated labour requirement is 280 hours for 2 Technologists (total of 560 hours) at a cost of $35,000.

# 8 RESOURCES AND COSTS

## 8.1 Resources

### 8.1.1 Breaker Failure Protection

The assessment to determine what has to be done, modifications to existing designs and the addition of new designs to stations will be done by a Protection and Control Engineer from Protection, Control and Communications (PC&C) Engineering. This will require three months. Field changes and the installation of new relays and panels will be completed by personnel from Transmission and Rural Operations (TRO).

### 8.1.2 Protection and Control Emergency Response

Existing P&C Technologists will be used.

### 8.1.3 2014 Plan for Elimination of Slow Trip Coils

For the 2014 Plan for elimination of slow trip coils, an external P&C resource will be hired to complete the review and update the drawings , while the field work will be completed using internal P&C Technologist or an external contractor.

### 8.1.4 2014 Plan for Terminal Station Relay Cards

The relay card audits will be completed by Hydro internal resources. The new relay cards will be printed utilizing a local printing company. The placement of new relay cards back into the proper areas will be done by an internal Hydro resource.

### 8.1.5 Protection and Control Philosophy Standard

Personnel assigned will be from PC&C Engineering and Transmission and Rural Operations (TRO).

### 8.1.6 Recommendations from 230 kV TL Protection Studies

The engineering for the recommendations will be completed by a Protection and Control Engineer in the PC&C Engineering Department. Required field changes will be completed by Hydro P&C Technologists.

Table 8.1 below summarizes the expected 2014 resource requirements reviewed above.

**Table 8.1 – 2014 Resource Requirements**

| Activity | Engineering | TRO |
|---|---|---|
| Breaker failure relay protection | 450 Hours | 160hrs x 1 Tech |
| 2014 Plan for elimination of slow trip coils | External Resource (.5 FTE) | 1 Tech x 320 hrs. |
| 2014 Plan for Terminal Station Relay Cards | 0 hrs. | 80hrs x 2 Techs |
| P&C Philosophy Standard | 165 Hours | 80 Hours x 2 Techs |
| Recommendations from 230 kV TL Protection Studies | 338 Hours | 280 Hours x 2 Techs |
| **Total** | **953 Hours** | **1,360 Hours** |

## 8.2 2014 Costs

The costs indicated in the Tables presented below are 2014 operating costs.

### 8.2.1 Breaker Failure Protection

The cost to do the assessment of the stations will be covered by the operating budget as outlined in Table 8.2 below.

**Table 8.2 – 2014 Costs, Breaker Failure Protection**

| Item Description | Cost |
|---|---|
| P&C Engineering Resource (budgeted) | $ 40,800 |
| TRO Resource (incremental) | $ 10,000 |
| Travel (budgeted) | $ 5,500 |
| Travel (incremental) | $ 2,000 |
| **Total** | **$ 58,300** |

### 8.2.2 2014 Plan for Elimination of Slow Trip Coils

There will be a cost to hire an external P&C resource to complete this work as well as extra internal cost for travel and overtime. See Table 8.3 below for a summary.

| Table 8.3 – 2015 Costs, Elimination of Slow Trip Coils | |
|---|---|
| **Item Description** | **Cost** |
| External P&C Eng. Resource(Incremental) | $ 50,000 |
| Travel(Incremental) | $ 10,000 |
| Over time(Incremental) | $ 8,000 |
| **Total** | **$ 68,000** |

### 8.2.3 Protection and Control Philosophy Standard

PC&C Engineering and TRO labour costs will be covered by the respective existing operating budgets. The estimated costs are summarized in Table 8.4 below.

| Table 8.4 – 2014 Costs, P&C Philosophy Standard | |
|---|---|
| **Item Description** | **Cost** |
| P&C Eng. Resource (budgeted) | $ 15,000 |
| TRO Resource (budgeted) | $ 5,000 |
| TRO Travel (incremental) | $ 3,500 |
| **Total** | **$ 23,500** |

### 8.2.4 Recommendations from 230 kV TL Protection Studies

Engineering and field labour costs will be covered by the respective existing operating budgets. The estimated costs are summarized in Table 8.5 below.

| Table 8.5 – PC Study Recommendations | |
|---|---|
| **Item Description** | **Cost** |
| P&C Eng. Resource(Budgeted) | $ 30,700 |
| TRO Resource (Incremental) | $ 35,000 |
| TRO Overtime(Incremental) | $ 4,000 |
| **Total** | **$ 70,700** |

# Appendix A

Severe Weather Preparedness
Severe Weather Checklist

# NEWFOUNDLAND AND LABRADOR HYDRO

*Severe Weather Preparedness*

DRAFT March 10, 2014

newfoundland labrador hydro
a nalcor energy company

## Purpose

The severe weather preparedness document outlines NL Hydro's procedures and operational plans to be put in place during adverse weather conditions including snow, rain, freezing rain and wind. It is provided as a guide to follow during severe weather events and should be reviewed for each occurrence to determine applicability. The document focuses on maintaining individual unit reliability and preventing equipment downtime for electrical energy supply. As safety is the top priority for NL Hydro, it should be considered and incorporated into all aspects of work execution and storm preparation associated with this plan.

The document is broken down into the following sections:

- Introduction
- Health, Safety, Security and Environment
- Roles and Responsibilities
- Processes and Procedures
- Evaluation of Potential Problem Areas
- Testing of Equipment
- Training
- Communications

# Table of Contents



Acronyms

ECC – Energy Control Centre
HSSE – Health, Safety, Security and Environment
NERC – North American Electric Reliability Corporation
TRO – Transmission and Rural Operations

# EXECUTIVE SUMMARY

- To be added after document is complete

# 1 INTRODUCTION

Newfoundland and Labrador Hydro is dedicated to delivering safe, reliable, least-cost power to industrial, utility and residential customers in Newfoundland and Labrador. One of the major factors that influence Hydro's efforts is Newfoundland and Labrador's ever changing weather. Ranging from the mild to the extreme, weather events within the province can have a disrupting effect on the service Hydro provides to its electrical energy consumers. In order to effectively respond to severe weather events, Hydro must be prepared throughout the year to deal with the unpredictable nature of Newfoundland and Labrador's weather.

Regardless of weather type or severity, plans need to be in place to deal with potential disruptions in Hydro's service to customers. Hydro recognizes that a dependable source of electricity is an essential part of daily life. To ensure that Hydro can continue to provide a stable and reliable source of electricity preparations and adjustments to routine operations must be made.

In the following sections Hydro's Severe Weather Preparedness plan is defined in detail, outlining the necessary steps Hydro takes to deal with extreme weather conditions. A Severe Weather Checklist has also been created that should be reviewed and implemented before each impending storm.

# 2 HEALTH SAFETY AND ENVIRONMENT

At Hydro, safety is the number one priority and they are committed to keeping employees and the public safe. To ensure work is completed safely Hydro has developed a wide range of safety tools that are used to identify and mitigate the hazards and risks associated with the task at hand. These tools, such as the Tailboard and step back 5x5, should be used during the completion of any work, whether or not the task is to be completed during adverse weather. Extra precaution should be taken when completing work during severe weather conditions. Adverse weather increase the hazards associated with any job. If the hazards and risks are found to be too great a discussion should be had with the supervisor and other coworkers to improve the overall safety of the job for all those involved.

Corporate wide and job safety briefings should be considered during the preparation for and in response to a severe weather event. This will provide personnel time to plan and prepare for the anticipated working conditions so that they can complete the job safely. Safety briefings can be administered by all levels of management and through supervisor to their crews in their respective areas.

Hydro maintains a high standard of environmental responsibility and performance through the implementation of the ISO 14001 comprehensive environmental management system. This system outlines environmental principals that guide Hydro's environmental actions and decision-making, whether faced with adverse or ideal weather conditions. Hydro is

committed to helping sustain a healthy environment for present and future Newfoundlanders and Labradorians and will follow the ISO 14001 system during its severe weather response to ensure no negative effects are felt by the environment.

# 3 ROLES AND RESPONSIBILITIES

In order to effectively administer a severe weather preparedness program clear and definitive roles most be outlines for all personnel involved. Contributions from all levels of employees are necessary and play a vital role in the overall success of Hydro. A unified group effort is required to promote and achieve the highest level of reliability for high impact weather events. The following provides a general list of responsibilities for different levels of Hydro employees. Each area of operation should tailor these roles and expectations to fit within their own structure.

1. Senior Management/Executives
    a. Set expectations for safety, reliability and operational performance
    b. Ensure that a winter weather preparation procedure exists for each operating location
    c. Consider a fleet wide annual winter preparation meeting, training exercise or both to share best practices and lessons learned from the previous year
    d. Share insights across the fleet and through industry associations
2. Regional/Plant Manager
    a. Ensure On-Call supervisors are made aware of pending storm
    b. Evaluate the storm forecast and determine if employees need to be stationed in critical locations
    c. Ensure contact information is available for Protection and Controls Engineering for possible evaluation of fault traces.
    d. Develop a winter weather preparation procedure and consider appointing a designee responsible for keeping this procedure updated with industry identified best practices and lessons learned.
    e. Ensure the site specific winter weather preparation procedure includes processes, staffing plans, and timelines that direct all key activities before, during and after severe winter weather events.
    f. Ensure proper execution of the winter weather preparation procedure.

g. Conduct a plant readiness review prior to an anticipated severe winter weather event.

h. Encourage plant staff to look for areas at risk due to winter conditions and bring up opportunities to improve readiness and response.

i. Following each winter, conduct an evaluation of the effectiveness of the winter weather preparation procedure and incorporate lessons learned

j. Ensure additional inspections of equipment and vehicles are completed prior to the forecasted event to ensure full functionality and full gas tanks

3. Energy Control Center

a. Communicate storm forecast to all operational managers. Follow up with field operations staff depending on the severity of the event or system condition to discuss the need for additional preparations for pending weather

b. Test Run Stand by Generation

c. Contact NF power for generation status update

d. Determine if stand by generation will be started prior to peaks and consult with TRO to determine if Operators need to be on site

e. Enhance staffing levels at the ECC and other control rooms as needed

# 4 PROCESSES AND PROCEDURES

Hydro's severe weather preparedness program begins five days prior to any adverse weather. As a part of normal operations, Hydro forecasts a five day outlook of the expected demand the electrical system will need to provide. In order to provide an accurate estimate Hydro analyzes the forecasted weather conditions. Through this process any possible severe weather conditions are flagged and monitored to ensure Hydro is prepared to deal with any potential disruptions to its ability to meet system requirements.

In the days leading up to the severe weather event or forecasted system problem ECC issues an advisory to field operations staff concerning the adverse weather or potential generation shortfall. With this notification Hydro begins the process of preparing for the adverse weather event. While a number of tasks need to be completed to prepare solely for the expected weather, everyday operational tasks completed by field operations help Hydro prepare. These include, but are not limited to:

- Fleet vehicles are fueled up at the end of each working day.
- On call Supervisors are equipped with all emergency plans, employee contact information

and a corporate vehicle.

- Cell phones are issued to various shops and the gas turbine operators.
- All line shop and offices are stocked with critical spare parts and consumables.
- Distribution line trucks are stocked with critical spare parts and consumables.
- Distribution line workers and distribution front line supervisors have vehicles at home for quicker response times

While these everyday tasks go a long way to preparing Hydro for severe weather conditions, other activities are necessary to ensure an effective response. For potential generation shortfall, Hydro ensures that staff is dispatched to certain remote Hydro plants and standby generation locations. In addition, in the case of a severe weather event, Hydro's response includes any or all of the following activities, depending on the expected severity of the event:

1. Pre-event coordination call to coordinate response activities

   System Operations (upon receipt of warnings from Environment Canada) issues notices of weather warnings to regional and plant managers. Once the notification has been sent out, System Operations will follow up with field operations staff depending on the severity of the event or system conditions to discuss the need for additional preparations for the pending weather. As part of standing practice, field staff will make further coordination calls when necessary to secure the power system.

2. Enhanced staffing levels at the ECC and other control rooms as needed

   During significant disruptions to the power system or during times of high call volume to the ECC, it is regular practice to bring in extra staff. This is especially necessary when incidents occur outside of the normal working hours to reduce the delay in mobilizing the Customer Service Call Centre. Additional staffing may also be brought in to help manage complex issues.

3. Deployment of work crews to reduce response time in the event of an unplanned outage or equipment problems

   Advanced deployment of crews (including P&C Technologists) to specific sites prior to a storm provides benefits when the storm is predicted to occur in a particular geographical area or there are known system equipment issues at those sites which may require attention during a storm. Most often, the benefits of keeping crews at their home base and close to the center of operations outweighs the risk of having them located at a remote location where there may not be problems. In the case of generating stations, the majority of Hydro's large generating units are located in the Bay

d'Espoir area or in Cat Arm and Hinds Lake, close to the home base location of the work crews that support those facilities. Similarly, for Transmission and Rural Operations, Hydro's crews' home office or depot are purposely located throughout the province in central locations with facilities to provide fast response to interruptions. For these reasons, the deployment of work crews to specific sites other than their home offices in advance of a weather event is not a common activity, but is one that is considered in advance of each major forecasted weather event.

4. Additional inspections of equipment and vehicles (four wheel drive trucks; snowmobiles, ATVs and specialized vehicles) to ensure full functionality and full gas tanks

   This is routinely done for TRO areas; however, since 2013, this has been expanded to include all of Hydro operations in advance of any significant weather event. Having full fuel tanks and fully operational vehicles and equipment ensures no delay in crew mobilization should the need arise.

5. Additional communication with on-call personnel to ensure readiness to respond if needed

   This occurs routinely in accordance with the operating instruction: A-003 Notification of Weather Warnings and Lightning Activity. This heightened sense of awareness ensure that on-call personnel are ready to mobilize should the need arise.

6. Scheduling of additional snow removal to ensure ongoing access to critical infrastructure during storm events

   A new addition to Hydro's normal pre-storm planning activities is requesting additional or priority snow clearing. Hydro has snow clearing arrangements in place for all of its facilities where it is prudent to do so. By maintaining safe access to key facilities travel time is greatly reduced.

7. <u>Test run of standby diesels and gas turbines</u>

   1. Standby diesels and gas turbines are tested monthly to ensure availability in accordance with the following operating instructions:
      - T-051 – Diesel Testing; and
      - T-054 – Gas Turbine Testing.

   These instructions are attached in appendix B and C respectively. In addition to the testing of standby generation, the ECC also contact Newfoundland Power for a generation status update as well as schedule when standby generation will be needed and consult with TRO to determine if operators need to be on location to access this

additional energy.

Hydro has also started the practice of running up the gas turbines in Stephenville and Hardwoods and the standby diesels in Hawke's Bay and St. Anthony in advance of all significant forecasted weather events. By testing and proving the full operating capability of standby generating units in advance, it allows Hydro to ensure that these assets will provide reliable service under peak load or generation shortfall conditions and during power system emergencies.

# 5 EVALUATION OF POTENTIAL PROBLEM AREAS

Identify and prioritize components, systems, and other areas of vulnerability which may experience freezing problems or other cold weather operational issues.

1. This includes equipment that has the potential to:
    1. Initiate an automatic unit trip,
    2. Impact unit start-up,
    3. Initiate automatic unit runback schemes and/or cause partial outages,
    4. Cause damage to the unit,
    5. Adversely affect environmental controls that could cause full or partial outages,
    6. Adversely affect the delivery of fuel or water to the units,
    7. Cause other operational problems such as slowed or impaired field devices, or
    8. Create a weather related safety hazard

2. Based on previous cold weather events, a list of typical problem areas are identified below. This is not meant to be an all inclusive list. Individual entities should review their plant design and configuration, identify areas with potential exposure to the elements, ambient temperatures, or both and tailor their plans to address them accordingly.

    1. Level transmitters
        i. Drum level transmitters and sensing lines
        ii. Condensate tank level transmitters and sensing lines
        iii. De-aerator tank level transmitters and sensing lines
        iv. Hotwell level transmitters and sensing lines
        v. Fuel oil tank level transmitters / indicators
    2. Pressure Transmitters
        i. Gas turbine combustor pressure transmitters and sensing lines
        ii. Feed water pump pressure transmitters and sensing lines
        iii. Condensate pump pressure transmitters and sensing lines
        iv. Steam pressure transmitters and sensing lines
    3. Flow Transmitters
        i. Steam flow transmitters and sensing lines
        ii. Feed water pump flow transmitters and sensing lines
        iii. High pressure steam attemperator flow transmitters and sensing lines

4. Instrument Air System
5. Motor-Operated Valves, Valve Positioners, and Solenoid Valves
6. Drain Lines, Steam Vents, and Intake Screens
7. Water Pipes and Fire Suppression Systems
    i. Low/no water flow piping systems
8. Fuel Supply and Ash Handling
    i. Coal piles and coal handling equipment
    ii. Transfer systems for backup fuel supply
    iii. Gas supply regulators, other valves and instrumentation (may require coordination with gas pipeline operator)
    iv. Ash disposal systems and associated equipment

3. Potential vulnerabilities associated with emergency generators, including Blackstart generators, should be evaluated when developing the site specific winter weather preparation procedure as they may provide critical system(s) backup.

# 6 TESTING OF EQUIPMENT

In addition to the typical problem areas identified above, Hydro places emphasis on the testing of low frequency tasks such as the startup of emergency generators. As mentioned previously, Hydro has started the practice of running up the gas turbines in Stephenville and Hardwoods and the standby diesels in Hawke's Bay and St. Anthony in advance of all significant forecasted weather events. Please see appendix B and C for the system operating instructions for Gas Turbine and Diesel testing.

# 7 TRAINING

Coordinate annual training in winter specific and plant specific awareness and maintenance training. This may include response to freeze protection panel alarms, troubleshooting and repair of freeze protection circuitry, identification of plant areas most affected by winter conditions, review of special inspections or rounds implemented during severe weather, fuel switching procedures, knowledge of the ambient temperature for which the freeze protection system is designed, and lessons learned from previous experiences or the NERC Lessons Learned program.

1. Consider holding a winter readiness meeting on an annual basis to highlight preparations and expectations for severe cold weather.

2. Operations personnel should review cold weather scenarios affecting instrumentation readings, alarms, and other indications on plant control systems.

3. Ensure appropriate NERC Generation Availability Data Systems (GADS) coding for unit derates or trips as a result of a severe winter weather events to promote lessons learned, knowledge retention, and consistency. Examples may include NERC GADS code 9036 "Storms (ice, snow, etc.)" or code 9040 "Other Catastrophe."

# 8 COMMUNICATIONS

During adverse weather conditions Hydro follows A-003 Notification of Weather Warnings and Lightning Activity. The prime objective of the system operating instruction is to provide early warning of lightning activity and adverse weather. This information is to be used to improve power system security and reliability. A copy of this document may be found in appendix D of this report.

Clear and timely communication is essential to an effective program. Key communication points should include the following:

1. Before a severe winter weather event, plant management should communicate with their appropriate senior management that the site specific winter weather preparation procedure, checklists, and readiness reviews have been completed.
2. Before and during a severe winter weather event, communicate with all personnel about changing conditions and potential areas of concern to heighten awareness around safe and reliable operations.
3. Before and during a severe winter weather event, the affected entity(ies) will keep the Balancing Authority up to date on changes to plant availability, capacity, or other operating limitations.
4. After a generating plant trip, derate, or failure to start due to severe winter weather, Plant Management, as appropriate, should conduct an analysis, develop lessons learned, and incorporate good industry practices.
    1. This process should include a feedback loop to enhance current winter weather readiness programs, processes, procedures, checklists and training (continuous improvement).
    2. Sharing of technical information and lessons learned through the NERC Event Analysis Program or some other method is encouraged.

# APPENDIX A

# APPENDIX B

# APPENDIX C

# APPENDIX D

# Severe Weather Preparedness Checklist

| **Date:** | **Location:** |
|---|---|
| **Current and Forecasted Weather:** | |
| | |
| | |
| | |
| **Things to think about before preparing** | |
| ☐ Do workers know and understand the tasks?<br>☐ Have all workers been given orientations? (Is there an orientation or training for working in severe weather?)<br>☐ Ensure Tailboards are completed prior to start of work<br>☐ Communicate forecasted weather conditions to all employees. Keep employees updated on changing conditions<br>☐ Are all proper tools available for job?<br>☐ Ensure employees have Proper PPE for working in extreme weather conditions<br>☐ Will employees be working alone? If yes, circulate the working alone procedure for review.<br>☐ Have environmental aspects been considered? | |
| **Emergency Information** | |
| **Emergency response plan(s) in place? ☐ Yes** | |
| Has it been communicated to all required personnel ? **☐ Yes** | |
| Nearest medical facility: | |
| **Emergency Contact Numbers** | |
| **1.** | **3.** |
| **2.** | **4.** |

| **Severe Weather Preparedness** | |
|---|---|
| | |
| **Safety** | **Trucks** |
| ☐ Consider holding safety briefings with available staff<br>☐ Ensure workers are familiar with the safety tools and procedures associated with severe weather<br>☐ Tailboard<br>☐ Step Back 5x5<br>☐ Proper PPE for Weather conditions | ☐ Fuel all vehicles<br>☐ Ensure Distribution line trucks are stocked with critical spare parts and consumables<br>☐ Equip trucks with special tools and equipment as required<br>☐ Ensure distribution line workers and distribution front line supervisors have company vehicles at home<br>☐ Provide on call supervisors with a company vehicle<br>☐ Consider having other staff take company vehicles home<br>☐ Ensure truck radios are working |
| **Tools and Equipment** | **Buildings** |
| ☐ Test portable generators, standby duiesels and gas turbines<br>☐ Test tools as required<br>☐ Ensure fuel supply available | ☐ Schedule additional snow removal<br>☐ Consider renting portable generators for buildings not equipped with a backup<br>☐ Check ability to alter temperature controls in buildings to override normal after-hour temperature settings |
| **Substation and Generation** | **Stores – Not sure this applies to us (or maybe diff name)** |
| ☐ Consider location and availability of portable generation and portable substations. Re-deploy as required<br>☐ Ensure fuel Supply for system generators | ☐ Ensure all stores have proper staffing levels<br>☐ Check stock levels for items likely needed during storms<br>☐ Consider confirming the supply of poles on the island |

| **Operations Staff** | **Transportation** |
|---|---|
| ☐ Notify Staff of forecasted storm. Consider scheduling staff to work outside of normal working hours to ensure quick response<br>☐ Equip Supervisors with up to date staff listings and contact information<br>☐ Consider re-deploying staff to areas most likely impacted by the severe weather<br>☐ Put technical staff on notice of pending storm<br>☐ Ensure support and costumer service staffs are aware if the forcasted weather<br>☐ Consider enhancing staff levels at ECC and other control rooms<br>☐ Ensure IS support team is in place<br>☐ Ensure Protection and Control Engineering are aware of the pending weather and that contact information is available | ☐ Where possible, put a rush on maintenance or repair work for any company vehicle<br>☐ Complete inspections of additional equipment and vehicles (four wheel drive trucks, snowmobiles, ATVs and specialized vehicles)<br>☐ Notify garages and mechanics of forecasted storm<br>☐ Confirm after hour contacts with government departments in the event that permits are required to re-locate portable equipment, or obtain permits in advance<br>☐ Confirm the availability of tractors or other equipment to relocate portable equipment<br>☐ Arrange for any necessary escorts |
| **Communications** | **System Security** |
| ☐ Hold a pre-event coordination call to coordinate response activities<br>☐ Consider additional communication with on-call personnel to ensure rediness to respond<br>☐ Contact NF Power for generation Status<br>☐ Check availability of Satellite Phones, ensure they are charges and working<br>☐ Ensure appropriate staff have cell phones. Ensure adequate cell phone chargers and spare batteries are available<br>☐ Charge and test portable radios<br>☐ Test area office base station radios | ☐ Make extra effort to correct any adnormal system conditions<br>☐ Where practical consider suspending construction on capital jobs to return the system to normal<br>☐ Consider developing a contingency plan for any abnormal conditions that cannot be corrected<br>☐ Consider protection changes above normal settings |
| **Contractors** | **Customer Service and Communications Hub** |
| ☐ Put contractors on notice of pending storm and ask that they prepare<br>☐ Confirm Contractor's emergency contact information<br>☐ Confirm their available resources and their ability to assist<br>☐ Ensure Snow clearing contractors are on alert and available | ☐ Confirm area connections to the communications hub. Ensure an area person is assigned to communicate with the hub<br>☐ Consider assigning a communications hub member to the ECC<br>☐ Communicate with Customer Service to determine their requirement for remote<br>☐ Check the availability of local Costumer Service Staff |
| **Accommodations** | **Finance** |
| ☐ Contact local hotels to determine availability of rooms in the event that crews are moved into the area. Consider reserving a block of rooms. | ☐ Arrange for numbers to be used for charging the storm. Communicate to staff |
| **Government** | **Other Utilities** |
| ☐ Prior to the storm, confirm contacts for emergency snow clearing with the Department of Transportation<br>☐ Ensure updates contact lists are available for surrounding municipalities | ☐ Coordinate response with Newfoundland Power |