Newfoundland & Labrador

BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

IN THE MATTER OF AN

INVESTIGATION AND HEARING

INTO

SUPPLY ISSUES AND POWER OUTAGES ON THE ISLAND INTERCONNECTED SYSTEM

INTERIM REPORT

MAY 15, 2014

BEFORE:

Andy Wells
Chair and Chief Executive Officer

Darlene Whalen, P.Eng.
Vice-Chair

Dwanda Newman, LL.B.
Commissioner

James Oxford
Commissioner

EXECUTIVE SUMMARY

Following a series of rotating power outages and supply disruptions on the Island Interconnected system over the period January 2-8, 2014, the Board initiated an investigation and hearing into the circumstances leading up to and surrounding these events. To date the Board has received significant information from the utilities and its consultant, The Liberty Consulting Group ("Liberty"). The Board continues to investigate the relevant issues and expects to release its final report in early 2015 following further investigation and public hearings.

Interim Report Scope

This interim report sets out the results of the Board's investigation to date with a view to identifying the immediate actions needed to reduce the risk of similar events on the Island Interconnected system over the period 2014-2016.

With the demands of next winter quickly approaching it was necessary that the investigation proceed on an expedited basis. The Board received the interim reports of Newfoundland and Labrador Hydro ("Hydro") and Newfoundland Power Inc. on March 24, 2014 and Liberty filed its interim report on April 24, 2014. Additional responses and submissions were filed on May 2, 2014. Given the timeframes involved this interim report addresses only those issues and actions which should be completed prior to the upcoming winter.

Causes and Contributing Factors

This interim report sets out initial findings as to the causes and contributing factors of the January 2014 outages and system events. Final conclusions as to causes and contributing factors will not be possible until the Board's final report following completion of the investigation and public hearing.

The January 2014 outages were the result of two separate issues on Hydro's system: i) lack of available generation capacity to meet customer demand resulting in a request for customer conservation and rotating power outages on January 2 and 3; and, ii) subsequent equipment failures on Hydro's bulk transmission system resulting in further widespread outages beginning on January 4. Liberty's interim report found that a continuing and unacceptably high risk of outages remains for 2015-2017.

The Board is able to conclude at this stage that the following caused or contributed to the outages:

- Hydro's deferral of scheduled preventive maintenance and testing of key transmission system equipment, including the 2013 scheduled and recommended testing and maintenance on the transformer and circuit breaker at Sunnyside, which failed.
- Hydro's failure to properly execute repairs and maintenance.
- Hydro's failure to ensure the availability of qualified resources and vendor support.
- Hydro's failure to procure critical spare parts for its generation assets.
- Hydro's decisions on timing of generation asset repairs, notably the Hardwoods and Stephenville gas turbines.

While it is not possible to determine whether the failures and outages of this past winter could have been avoided had different decisions been made by Hydro, the Board finds the number and nature of equipment failures that occurred is unusual, raising questions as to Hydro's operation and maintenance of its equipment especially given that this is the second consecutive winter that customers on the Island Interconnected system have experienced widespread outages. Additional investigation in this area will be an important part of the Board's ongoing review.

Key Priority Actions

The Board has identified the key priority actions that Hydro should complete by December 1, 2014 in relation to generation asset readiness, terminal station transformers, air-blast circuit breakers, protection and control systems, and inter-utility coordination. In particular Hydro will be required to give the highest priority to completion of preventive maintenance and testing on its transmission system and terminal stations. The Summary of Key Priority Actions is attached. Customer issues and utility response have not been addressed in this report as there is still work to be done in these areas.

An application from Hydro to proceed with the procurement of an additional 100 MW of gas turbine generation at the Holyrood Thermal Generation Station was approved by the Board in Order No. P.U. 16(2014). The Board notes that the schedule for the installation of this asset, which is planned to be in-service for December 2014, is ambitious and believes that Hydro should give priority to ensuring, to the extent possible, that required work on existing generation and transmission assets is completed by December 1, 2014.

The Board has set out significant reporting requirements for Hydro, the first of which are due to be filed on June 2, 2014. In addition, the Board will be establishing a process, with regular reporting, to monitor Hydro's progress on the priority action items that need to be completed before the upcoming winter.

Next Steps

The Board's investigation will continue through this year. The Board will hear public presentations later this spring and Liberty will file its final report in the fall. The Board will then hold public hearings to receive written evidence, testimony, and submissions from the utilities, experts, and the Intervenors. The Board's final report will address the outstanding issues including the implications for the reliability of the Island Interconnected system arising from interconnection with the Muskrat Falls generating station.

SUMMARY OF KEY PRIORITY ACTIONS

Load Forecasting and Generation Planning

By December 1, 2014 Hydro should:

i) Implement changes to its short-term forecasting process to appropriately incorporate impacts of weather conditions and any significant load changes, from losses or otherwise, resulting from varying system configurations.
ii) Incorporate sensitivity analyses to weather extremes in all forecasting and supply and planning decision evaluations.

Generation Availability

By December 1, 2014 Hydro should:

i) complete the work necessary to ensure winter readiness of its generation assets.
ii) address the issue of critical spares of its generation assets.
iii) complete negotiations in relation to interruptible load and, to the extent that it can secure economically available interruptible load, have a contract in place.
iv) complete the procurement and installation of the 100 MW (nominal) gas turbine.

Terminal Station Transformers

By December 1, 2014 Hydro should:

i) Complete all 2014 and outstanding prior year testing and maintenance on critical transformers.
ii) Take appropriate action in relation to critical transformers which have questionable levels of combustible gases.

Air-Blast Circuit Breakers

By December 1, 2014 Hydro should:

i) Properly exercise all air-blast circuit breakers.
ii) Complete all 2014 and outstanding prior year testing and maintenance on its critical air-blast circuit breakers.

Protection and Control Systems

By December 1, 2014 Hydro should check and modify slow trip coil connections on the air-blast circuit breakers.

Hydro Place Emergency Power

By December 1, 2014 Hydro should complete all reasonable and necessary work in relation to the emergency generation system and appropriate emergency lighting at Hydro Place.

Inter-Utility Coordination

By December 1, 2014 Hydro and Newfoundland Power should make improvements in operational and customer information and communications coordination in operational and customer information and communications coordination.

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1. BACKGROUND

During the period January 2 to 8, 2014 customers on the Island Interconnected system experienced widespread power outages, initially as a result of rotating power interruptions due to generation supply shortages, followed by extended outages due to major electrical system disruptions.

The events of January 2014 are especially concerning given that this is the second consecutive winter that customers on the Island Interconnected system experienced widespread outages. In January 2013 high winds and heavy snowfall from a severe winter storm in the eastern region of the island caused issues at the Holyrood Thermal Generating Station which resulted in island-wide power outages. Newfoundland and Labrador Hydro's ("Hydro") investigation of that outage event resulted in 56 recommendations for improvements to the power system in various areas.[1] Hydro states that these improvements helped to mitigate or lessen the customer impact resulting from the January 2014 events.[2] Newfoundland Power Inc. ("Newfoundland Power") also implemented a number of enhancements to its operational and customer response systems as a result of its experiences during the January 2013 outages.[3]

A detailed chronology of the system events leading to the January 2014 outages is described in Section 3 of this report. As a result of these outage events and the widespread impact the Board of Commissioners of Public Utilities ("Board") immediately initiated an investigation into the circumstances leading up to and surrounding the rotating power outages and the electrical system disruptions. The Board's first priority is whether load requirements on the Island Interconnected system can be met for the remainder of the 2014 winter season and to determine what immediate actions are needed to reduce the risk and impact of similar events on the Island Interconnected system in the upcoming 2014-2015 and 2015-2016 winter seasons. That work is the focus of this interim report.

[1] PUB-NLH-160

[2] Hydro Report, "Events of January 2013", March 24, 2014

[3] Newfoundland Power Interim Report, March 24, 2014, page 27

2. INVESTIGATION AND HEARING

2.1 Initial Investigation

The Board commenced its investigation on Monday, January 6, 2014 while power outages were still ongoing for many customers. Since the supply issues and outages originated on Hydro's system the Board wrote Hydro requesting they attend a meeting at the Board's office on January 8, 2014. The purpose of this meeting was to obtain timely information as to the sequence of events leading up to the public conservation request and rotating power interruptions, an update as to the situation in relation to capacity and load, repair efforts, and near term plans and alternatives.

To ensure timely monitoring of the Island Interconnected system's supply and demand status in the immediate term, on January 10, 2014 the Board directed Hydro to file system updates daily by 9 am on forecast generation availability and peak demand, and any changes in the status of generating units and capacity. These updates are available on the Board's website and on Hydro's website.

While the Board's investigation and information gathering was ongoing, on January 8 and January 9, 2014 the Board received two separate complaints under s. 84 of the *Public Utilities Act* in relation to the adequacy of service being provided by Hydro.

The Board determined that sufficient grounds existed to warrant an investigation and hearing into events and circumstances surrounding and leading up to the Island Interconnected system supply issues and power outages in late December 2013 and early January 2014. On January 10, 2014 the Board advised Hydro that it would be conducting an inquiry and hearing into the matter.

Newfoundland Power provided a briefing to the Board on January 16, 2014 on its response, restoration efforts and customer impacts of the system disruptions.

Hydro and Newfoundland Power were advised by letter dated January 17, 2014 that they would be considered parties to the proceeding. The Board also advised that, while its initial investigation would focus on whether load requirements on the Island Interconnected system can be met in the near term, the Board may also inquire into other issues such as asset readiness, maintenance practices, load forecasting, planning criteria and assumptions, equipment performance and reliability, emergency preparedness, system response and restoration efforts. Each utility was requested to present a list of issues which, in its view, should be addressed in the proceeding.

2.2 Procedural Matters

Beginning on January 17, 2014 the Board published a Notice of Hearing and Pre-hearing Conference in areas serviced by the Island Interconnected system.

Intervenor submissions were filed by: the Consumer Advocate, Thomas Johnson; Corner Brook Pulp and Paper Limited, North Atlantic Refining Limited and Teck Resources Limited (the "Industrial Customer Group"); and Danny Dumaresque.

Hydro, Newfoundland Power and the Consumer Advocate each filed a proposed list of issues in advance of the pre-hearing conference. Subsequently, Danny Dumaresque and the Industrial Customer Group filed issues lists.

On February 5, 2014 the Board engaged the services of The Liberty Consulting Group ("Liberty") to provide expertise and assist the Board in its investigation and hearing. Liberty is a comprehensive consulting firm that has extensive experience in management and operation audits of utilities and, in particular, post-outage assessments.[4]

The pre-hearing conference was convened at the Board's hearing room on February 5, 2014. The purpose of the pre-hearing conference was to identify intervenors, establish the process and rules of procedure, set a schedule of dates and address other matters that may be raised. At the pre-hearing conference the Board heard from the parties requesting intervenor status, registered presenters, as well as other persons who requested the opportunity to make a presentation.

On February 19, 2014 the Board issued procedural Order No. P.U. 3(2014), which established the intervenors, rules of procedure for the proceeding, timelines and set out the issues to be considered. The Board determined that it was necessary to address how Hydro and Newfoundland Power will ensure adequacy and reliability on the Island Interconnected system over the short, medium and long-term, which will require analysis of the adequacy and reliability of the system after the commissioning of the Muskrat Falls generating facility and the Labrador Island Link. The Board also determined that the process should ensure a comprehensive review with full opportunity for interested persons to participate and should also ensure that measures necessary to prepare for the 2014-2015 and 2015-2016 winter seasons are addressed on a priority basis.

Grand Riverkeeper Labrador Inc. filed a late request for intervenor status, which the Board granted in Order No. P.U. 15(2014).

2.3 Reports, Comments and Submissions

Due to the urgency associated with addressing any required actions in advance of the upcoming winter period the Board established an accelerated schedule focused on interim findings to be addressed by the Board by May 15, 2014. The Board commends the efforts and cooperation of both utilities to this end in assisting the Board in its investigation to date.

Reports from Hydro and Newfoundland Power were filed as directed on March 24, 2014. Liberty's report entitled "Supply Issues and Power Outages Review Island Interconnected System" ("Liberty Report") was filed on April 24, 2014.

[4] A description of the expertise and experience of Liberty's team involved in the outage investigation review can be found on pages 10-12 of the Liberty Report.

The Board requested comments from Hydro and Newfoundland Power on the findings contained in the Liberty Report. Comments were filed by the utilities on May 2, 2014. Written input and comments on the reports and other information filed to date were also received from the intervenors and other interested persons.

2.4 Liberty's Interim Findings

Liberty's initially focused on outage causes and the specific actions that should be taken by Hydro and Newfoundland Power to mitigate the risks of further system disruptions for the upcoming winter seasons. Longer term issues on system reliability after connection with Muskrat Falls are to be addressed in a further report from Liberty in the fall of 2014.

Liberty's work for this interim report included a review of the nature of the events contributing to the system outages, their immediate causes, and the management and operations issues underlying those events. This first review was focused on identifying management and operational issues that can and should be addressed in the short-term in order to reduce the risk for the upcoming winter season, and for the period leading up to interconnection with Muskrat Falls. Liberty also reviewed the utilities' responses to the supply issues and power outages. This included a review of service restoration efforts, customer service and communications, and inter-utility coordination.

As a result of its work to date Liberty found that the origins of both the January 2013 and January 2014 outages lie with Hydro's generation and transmission systems. Liberty concluded that the January 2014 outages resulted from two different causes – insufficiency of generating resources to meet customer demands and issues with the operation of key transmission equipment. Liberty also found that "*a continuing and unacceptably high risk of outages from such causes remains for the 2015-2017 winter seasons*".[5]

Based on its review Liberty identified the following concerns:[6]

i) The base level of generation that Hydro has to serve customers during winter peak seasons and the ability to ensure full availability of its resources as those seasons commence;
ii) Hydro's maintenance and operation of key equipment on its transmission system;
iii) Hydro and Newfoundland Power programs for addressing outage communications and for formally examining customer expectations and attitudes regarding reliability and outages; and
iv) Coordination between Hydro and Newfoundland Power regarding customer communications and operations in anticipation of and during outages.

Liberty set out 46 specific recommendations that identified priority actions that Hydro and Newfoundland Power should undertake prior to the in-service date of Muskrat Falls and the Labrador Island Link to reduce the risks of future outages and improve response to any outages that may occur. Hydro has confirmed that Liberty's findings are broadly consistent with the

[5] Liberty Report, page ES-1
[6] Ibid., page 3

findings from its own internal review and, with very few exceptions, Hydro agrees with Liberty's recommendations. Newfoundland Power also commented that each of Liberty's recommendations appears reasonable in the circumstances as described in the Liberty Report. While Newfoundland Power did not have any comments on the specific recommendations it did provide general comments on the implementation of the recommendations. These are addressed in the relevant sections of this interim report.

2.5 Interim Report Scope

The Board's interim report focuses on the Island Interconnected system events that occurred leading up to and during the January 2014 outages, an evaluation of possible system changes to enhance winter preparedness for the period 2014-2016, and an examination of each utility's response to the power outages and customer issues. This interim report incorporates the information and findings from Liberty's report, the reports and documentation of both utilities, and the comments received from intervenors and other interested persons. As indicated previously the primary purpose of this interim report is to identify specific actions that should be taken by Hydro and Newfoundland Power to enhance preparedness for the upcoming 2014-2015 and 2015-2016 winter seasons.

The recommendations set out by Liberty cover a wide range of issues including load forecasting, generation capacity planning, generation and transmission availability, asset management, customer service and inter-utility coordination. In this interim report the Board has focused on those action items which must be implemented prior to the 2014-2015 winter season to reduce the risk of a repeat of the supply issues and outage events that occurred the past two winters.

3. ISLAND INTERCONNECTED SYSTEM EVENTS AND OUTAGES

Hydro has provided considerable information and details in presentations, reports and responses to information requests about the system status and outage events on the Island Interconnected system as they unfolded over the period of late December 2013 and into the second week of January 2014. In addition, following the major outages in January 2014 there were other issues over the winter period, but further outages did not occur.

The events can be described in four separate periods with different underlying causes and customer impacts: i) the period December 2013 to January 1, 2014 leading up to the generation shortfall; ii) the period January 2 to January 3, 2014 during the period of rotating outages; iii) the period January 4 to January 8, 2014 during which a number of transmission system equipment failures resulted in further extended outages; and iv) the winter period after January 8, 2014 following restoration.

i) December 2013 to January 1, 2014

Hydro entered December 2013 with 1,520.5 MW of firm dependable energy available on its system. The forecast winter peak demand was 1,453.7 MW. On December 14 Hydro reported a record seasonal peak on its system of 1,501 MW. There were no outages as a result of this peak as Hydro was able to meet system load with available generation.

Generation availability issues in December 2013 involved five different generation plants and two different units at Holyrood. As of December 1 Hardwoods Gas Turbine was unavailable and Stephenville Gas Turbine rating was reduced from 50 MW to 25 MW. On December 15 Exploits generation capacity was reduced by 25 MW due to frazil ice and on December 16 Granite Canal generating station capacity was reduced by 8 MW because of axial vibration. On December 25 Unit 2 capacity at Holyrood was reduced by 25 MW due to a broken control valve. On December 26 Unit 3 at Holyrood experienced a failure of a forced draft fan motor, resulting in a capacity reduction from 150 MW to 50 MW.

On December 29 and 30 Hydro implemented its 14-step Generation Loading Sequence Generation Shortage Protocol up to step 13. Corner Brook Pulp and Paper was asked to shed processing load and Newfoundland Power was asked to take action to reduce peak loading on the system, specifically by running its thermal generating units, implementing customer load curtailment, and carrying out system voltage reduction.

On December 31 Hydro reached a short-term capacity assistance agreement with Corner Brook Pulp and Paper for 20, 40 or 60 MW blocks of power. This arrangement provided an additional 40 MW of capacity on the system during the January 1 system peak of 1,440 MW.

ii) January 2 to January 3, 2014

The utilities discussed issuing a conservation request in the early morning of January 2 when the short-term forecast indicated that the evening peak would surpass available supply. At 2 pm Hydro issued a public advisory to request customers on the Island Interconnected system take steps to conserve electricity where possible.

Shortly after 4 pm on January 2 Hydro requested that Newfoundland Power commence rotating power outages. Rotating power outages commenced at 4:13 pm on January 2 and continued throughout January 3 with both Hydro and Newfoundland Power rotating feeders. Due to load concentrations and operational factors, the rotating outages had a greater impact on Newfoundland Power's customers.

iii) January 4 to January 8, 2014

A blizzard hit the Island overnight and into the morning of January 4. Both utilities implemented their storm preparedness plans. Hydro had 1,485 MW of firm dependable capacity on its system.

At approximately 9 am on January 4 a transformer fault and fire occurred at Hydro's Sunnyside Terminal Station resulting in the loss of all three Holyrood generating units and an outage to approximately 187,500 Newfoundland Power customers. Customers were restored as Hydro re-established the system.

At approximately 3:30 pm on January 4 a second major disruption at Hydro's Sunnyside Terminal Station resulted in an outage to approximately 165,000 Newfoundland Power customers. Units 2 and 3 at Holyrood were brought back online by 1:40 am on January 5. Power was substantially restored to customers by 8:30 pm January 5.

At approximately 9:30 pm on January 5 an electrical fault at Holyrood resulted in the loss of Units 2 and 3 again and an outage to over 100,000 Newfoundland Power customers. Power was substantially restored to customers by noon on January 6.

iv) January 8, 2014 onwards

On January 8 Hydro experienced a trip on a transformer at the Western Avalon Terminal Station which resulted in an outage to approximately 29,000 Newfoundland Power customers for approximately half an hour. On the same date Holyrood Unit 1 and other generation returned to service and the rotating outages ended.

At approximately 11 pm on February 17 a 230 kV Hydro transmission line tripped due to issues outside its Western Avalon Terminal Station. While no outage resulted there was reduced transmission capacity. Repairs were completed by Hydro as of 1 pm on February 18.

On March 2 Hydro's daily system status report filed with the Board indicated a forecast daily demand of 1500 MW on its system for the period March 4-6. Hydro's available system supply was 1575 MW with capacity reductions at the Holyrood, Bay d'Espoir, Stephenville and Hardwoods generating facilities. A public advisory was issued by Newfoundland Power on March 3 advising of possible supply shortages and requesting customers to conserve during peak periods. Newfoundland Power also notified Curtailable Service Option customers that they may be called upon to curtail load. There were no outages at this time.

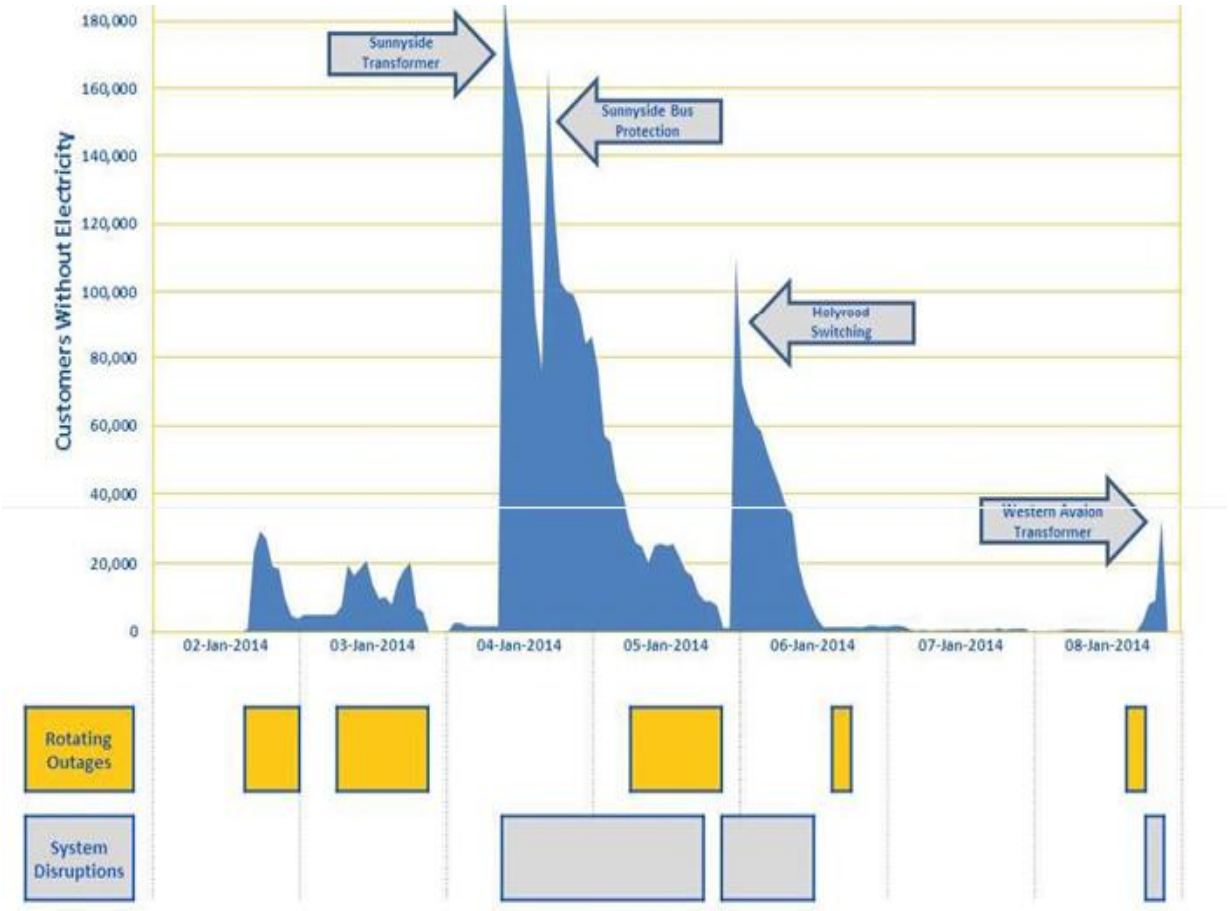
4. CAUSES AND CONTRIBUTING FACTORS

The outages of early January 2014 on the Island Interconnected system can broadly be considered as being two distinct events. The rotating power outages which began on January 2 were caused by generation unavailability whereas the widespread outages which began on January 4 were the result of equipment failure on Hydro's bulk transmission system.

On January 2 and 3 Hydro was unable to meet the full system load on the Island Interconnected system largely as the result of the unavailability of sufficient generation supply. Beginning in December 2013 there were both planned and unplanned outages of significant generation sources combined with sustained very cold temperatures and additional seasonal load. These circumstances combined so that available generation resources were inadequate to meet the load on the Island Interconnected system which led to the rotating outages beginning on January 2. This was the first time that rotating power outages were required on a sustained basis to respond to a forecast generation shortfall on the Island Interconnected system.

On January 4 events on Hydro's bulk transmission system led to further outages lasting several days and impacting the majority of customers on the Island. It is now clear that multiple equipment failures played a major role in this outage. While there was a winter storm during this period the storm was not a causal factor but did present additional challenges for the utilities in responding to the outage events.

The timing and impact of these outages on Newfoundland Power's customers is set out in the following figure:[7]



Liberty completed an analysis of the causes and contributing factors of these outages. Hydro also initiated its own internal reviews immediately following the outage events. Much of the analysis as to the specific causes of the equipment failures is still ongoing and will be addressed in the Board's final report. In this interim report the Board will address the causes and contributing factors to the extent that it is necessary and appropriate to assess what immediate actions should be taken to ensure winter preparedness in 2014.

The causes and contributing factors are discussed separately for each of the two distinct outage events: i) the generation shortfall which resulted in the request for conservation and rotating power outages; and, ii) the bulk transmission system issues which resulted in wide-spread system disruptions and outages.

[7] Liberty Report, page 56

4.1 Generation Capacity Shortfall

On January 2, 2014 at approximately 4 pm Newfoundland Power was requested by Hydro to commence rotating power outages. The need to implement these rotating outages was a result of a generation supply shortfall to meet expected customer load on the Island Interconnected system. Several potential causes and contributing factors were identified and investigated in relation to the generation supply shortfall, including load forecasting, generation and reserve planning, and generation availability. Liberty's examination focused on the events and factors that may have set the stage for the shortfall in generation asset availability, with emphasis on the underlying priority given by Hydro to reliability, supply policies and unit unavailability. Liberty found that the generation capacity shortfall experienced on the Island Interconnected system in late December 2013, which resulted in the need for a conservation request and subsequent rotating outages, resulted from three primary factors:

i) Hydro's existing generation planning criteria results in generation capacity reserves that are too low and, as such, the planning criteria for adding new generation capacity should be reviewed.
ii) Hydro's generation planning should be modified to meet more severe weather than it has assumed to date.
iii) Hydro failed to complete planned outage work needed to ensure maximum availability of generation facilities going into winter season.

The following sections discuss load forecasting, generation and reserve planning and generation availability.

4.1.1 Load Forecasting

On December 14, 2013 Hydro supplied a record-high system peak of 1,501 MW. The last record-high peak of 1,405 MW was met in February 2004. The forecast peak for December 2013 was 1,401 MW.[8] Hydro's operating load forecast for the winter of 2013-2014 was 1,478 MW with an anticipated peak in January. Hydro states[9]:

> *The 2013-14 winter period was not the norm in that the winter peak demand occurred sooner than usual, in mid December, and the temperatures experienced in the last half of December 2013, were more severe, and more sustained, than historical December weather patterns. Despite the December peak, Hydro was fully able to meet its load requirements at that time. Hydro's inability to meet its full load in early January 2014 was related to the unavailability of sufficient generation at that time. This was further exacerbated by other factors which increased load beyond what it otherwise would have been, including:*
>
> *a) the cumulative load effect associated with cold weather that sustained itself over several days and during day time hours;*
> *b) the incremental demand on the system associated with cold load pickup;*
> *c) additional transmission line losses in the area of 30 to 40 MW associated with the higher than normal transmission load being served on the Avalon Peninsula from*

[8] Hydro Report, March 24, 2014, Volume II-Schedule 3, page 3
[9] Ibid., Volume I; page 25

> *generation outside the Avalon Peninsula because of the unavailability of generation from Hardwoods and Holyrood; and*
>
> *d) The extra load related to higher residential use during the holiday season (approximately 30 MW).*

As a result of its review Hydro concludes that factors related to load forecasting did not result in decisions that contributed to the supply disruptions or rotating outages. There were, however, a number of recommendations for improvements in both the short-term and medium term load forecasting models. These include incorporating sensitivity testing to account for different extreme weather scenarios, review of model assumptions related to electric heat penetration and conversion, and updating the short-term forecasting model (Nostradamus) to account for colder temperatures. This latter issue could improve Hydro's ability to manage and communicate during outages and emergencies by providing operators with more accurate estimates of expected peaks.

Liberty reviewed Hydro's forecasting models and assumptions and its findings are generally consistent with Hydro's. Several issues in relation to load forecasting were raised and while Hydro has undertaken some changes the Board does not wish to identify Hydro's load forecasting to be a cause or contributing factor until there has been further review.

4.1.2 Generation and Reserve Planning

Liberty acknowledges that factors such as weather, concentration of load in one area and isolation from the rest of the North American grid can impact the ability to operate a reliable electric system on the Island. These factors are also important considerations in system planning and supply reliability decisions, since increased reliability generally comes at higher costs. However, Liberty did make several observations about Hydro's current planning standards and questioned whether Hydro's planning standards should be revisited:[10]

> *The planning standard that Hydro applies for supply reliability has existed for more than three decades. We do not question decisions across this long period. We do believe, however, as explained later in this report, that the suitability of continuing to apply this standard merits re-examination. The combination of: (a) rising customer expectations, (b) growing customer needs, (c) the level of supply reserves produced under the old standard, and (d) the lessons of the 2014 supply emergency, indicates that new criteria for reliability may have become appropriate.*

According to Liberty Hydro's current planning standards result in a risk of supply-related interruptions of roughly twice the level common in much of the rest of North America. Liberty notes that: *"Hydro plans its system with a higher expectation for interruptions than we have seen elsewhere"*.[11] In addition Liberty notes that the standard for the weather conditions Hydro assumes in estimating future peak loads is somewhat lower than expected, which produces a higher probability of supply related interruptions. Liberty also found that Hydro's past planning practices have tended to allow decisions at the margins to favour more versus less reliability risk, stating:[12]

[10] Liberty Report, page 18
[11] Ibid., page 19
[12] Ibid, page 19

> *An example of this third finding is that Hydro has forecasted supply deficiencies in the recent past (for example 2012). Nevertheless, favourable variances between forecasted and actual circumstances enabled Hydro to avoid taking action on them, without suffering adverse consequences. Forecasted new load failed to materialize, thus eliminating the previously predicted 2012 deficiency. Not spending money to increase reserves has saved money. The favourable gaps between forecasts and actual conditions may still be influencing decisions. One must not forget, however, (just as in purchasing insurance) that the failure of an insured event to materialize does not make paying the premium unreasonable.*

Liberty found that Hydro's generation and reserve planning standards, especially its LOLH (loss of load hours) criterion, were a contributing factor to the January 2014 outage events, as they result in generation capacity reserves that are too low. Liberty states:[13]

> *We found that Hydro's practices, vis-a-vis reliability standards did influence the supply conditions that contributed to the January 2014 interruptions, indirectly through a culture more tolerant of rotating outages and directly through the long-established reserve criteria and how the company has implemented them.*

Hydro concludes that there were no issues with respect to generation planning which contributed to the supply disruptions or rotating outages.[14] However, Hydro's internal review did identify a number of recommendations to enhance its generation planning process, including completing sensitivity analyses of forced outage rates for various generation classes and incorporating a more formal risk assessment approach into its future generation planning. The issue of generation and reserve planning involves long-term considerations such as appropriate reliability standards for the Island Interconnected system. This requires further investigation and analysis before a determination on this issue can be made in relation to causes and contributing factors.

4.1.3 Generation Availability

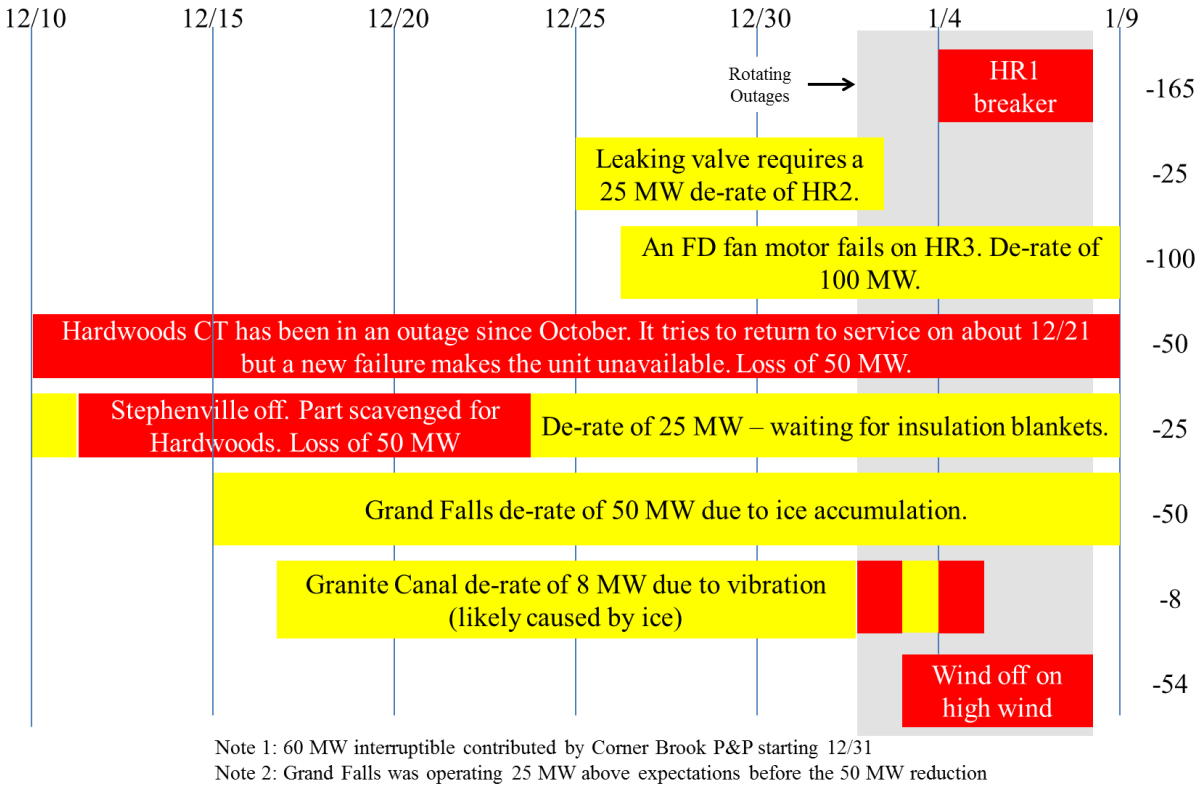
Lack of available generation caused initial supply issues that resulted in the need for rotating outages to balance system load and available supply. Rotating outages involve the planned and systematic disconnection and reconnection of distribution feeders and the customers served by them. In the case of the Island Interconnected system the 14-step operating instruction T-001, which is Hydro's generation shortage protocol, identifies a request by Hydro to Newfoundland Power to rotate its distribution feeders as step 14 in the protocol.[15] This means that this action is only invoked after all other steps have been implemented and not been successful in addressing a generation shortfall. As indicated by Liberty rotating outages are rarely invoked on North American electric systems. This is the first time such an action has been necessary on the Island Interconnected system to respond to a forecast generation shortfall.

The status of Hydro's supply assets leading into the winter period was a major contributing factor to the generation shortfall in late December 2013 and the resulting rotating power outages. Hydro's policy is to have its supply resources available by December 1 of each year to meet its

[13] Liberty Report, page 19
[14] Hydro Report, March 24, 2014, Volume I, page 28.
[15] PUB-NLH-033.

(n-1) criterion for system contingency reserve.[16] Hydro states that its "*annual plan is to complete all significant maintenance and capital project work by the end of November each year to ensure that electricity system assets are ready and available to meet winter season demands*".[17]

The December 2013 generation availability is shown below:[18]



Note 1: 60 MW interruptible contributed by Corner Brook P&P starting 12/31
Note 2: Grand Falls was operating 25 MW above expectations before the 50 MW reduction

Hydro agrees that unavailable generation was the main factor in Hydro's inability to meet full load on January 2. Hydro states that, with the exception of the Stephenville and Hardwoods gas turbines, its generation assets were considered to be winter-ready. The unplanned generation outages in December combined with the failure of the Hardwoods gas turbine during testing however, resulted in a capacity shortfall of 233 MW as of late December.

The 50 MW combustion turbine at Hardwoods was unavailable through December as the result of a planned outage. While the unit was scheduled to return to service by December 19 the new fuel control valve failed during testing on December 21 and Hydro did not have a spare. Liberty notes that Hydro scheduled a planned outage for Hardwoods to continue into December 2013. Liberty also found that Hydro did not ensure that personnel critical to getting the unit back on-

[16] The (n-1) criterion for system contingency reserve means that Hydro manages its generation assets so that total load can be met in the event of an unplanned loss of Hydro's largest available generating unit (a single 170 MW unit at Holyrood).
[17] Hydro Report, March 24, 2014, Volume I, page 22.
[18] Liberty Report, page 15

line were available throughout the planned outage.[19] Liberty concludes that the unavailability of Hardwoods contributed to the inability to maintain service in the first days of January. Liberty also comments that entering the month with a unit in a planned outage adds risk and further that failing to ensure that critical personnel were available created avoidable risk.

Hydro explains that the Hardwoods outage involved the unexpected failure of the new control valve and further that the service provider was unavailable during the holiday period.[20] Hydro further explains that the Hardwoods refurbishment was initiated in 2010 for completion in 2013 but that, due to resource issues, some plant work may not have been completed, including junction boxes and wiring termination upgrades.[21]

The 50 MW combustion turbine at Stephenville was returned to service in June 2013 after a 20-month forced outage to complete an alternator refurbishment. When the unit was put back in-service it was de-rated as the insulating blankets were worn on one end. Liberty comments that it is not clear why Hydro did not address the insulating blanket condition during the 20-month outage, noting that while the need for new blankets was identified in the summer of 2013 Hydro did not solicit bids until October 2013. Liberty states:[22]

> *The failure to deal with the blankets, first during the 20-month outage and second with a delayed procurement process, did not demonstrate sufficient concern with respect to the December 1 deadline, and became a contributor to the outage events of 2014.*

Hydro acknowledges that the timeliness of the procurement and delivery of the Stephenville insulating blankets is an issue that may have been recognized and addressed sooner to minimize the potential impact.[23] In relation to the need to replace insulating blankets on end B of the Stephenville gas turbine Hydro states:[24]

> *From an asset management process perspective, this is a project management/design issue that likely should have been picked up in a timely fashion. As far as the January 2014 system incident is concerned, this had no impact.*

Hydro acknowledges that the performance of gas turbines has been below CEA benchmarks but states that it is confident that reliability will be improved.[25]

In addition to the reduced generation capacity as a result of the outage and de-rating of the Hardwoods and Stephenville gas turbines, there were a number of additional outages and de-ratings at several other generating facilities. Cold weather and high winds resulted in a significant reduction of available generation capacity at hydro and wind facilities.

[19] Liberty Report, page 20
[20] Hydro Report, March 24, 2014, Volume II-Schedule 6, page 16
[21] Ibid., Volume II-Schedule 6, Appendix 2, page 1
[22] Liberty Report, page 21
[23] Hydro Report, March 24, 2014, Volume II-Schedule 6, Appendix 2, page 8
[24] Ibid., Volume II-Schedule 5, Appendix 1, page 31
[25] Ibid., Volume I, page 34

Equipment failures at the Holyrood Thermal Generating Station in later December resulted in significant loss of generation capacity over the period December 25-26. A control valve on Unit 2 at Holyrood failed on December 25 resulting in a loss of 25 MW, and on December 26 a forced draft fan motor on Unit 3 failed, resulting in a further loss of 100 MW.

Liberty found that Hydro was slow in implementing the required steps to allow for maintaining full steam flow during the Unit 2 control valve failure. An inability to obtain software vendor support over the holiday period also complicated repair efforts for Unit 2. There was also no spare motor available for the forced draft fan at Unit 3 and, even with an expedited repair, Hydro was not able to bring Unit 3 fully back on-line until January 12. According to Liberty the de-rating of the two units at the Holyrood Thermal Generating Station in late December may have been avoided or minimized.

Hydro acknowledges that the Unit 3 forced draft fan motor failure contributed significantly to the duration and extent of some of the rotating outages.[26] Hydro notes that the forced draft fan motors are subject to physical and operational aging and there was no spare motor at the station.[27]

Hydro explains that:[28]

> *A spare 4 kV FD motor had been suggested for procurement consideration in the 2011 Holyrood condition assessment. It was examined, costed and submitted as part of the 2012 capital approval process, but was not pursued further based on Hydro's capital prioritization process. The subsequent year, it was determined not to be a capital item and did not proceed further.*

Hydro explains that in 2011 Hydro undertook a three year, three phase asset criticality and critical spares program in recognition that its assets were later in their life cycle and that the critical spares program should be refreshed for improved response to equipment failure.

Hydro states:[29]

> *Hydro recognizes the importance of asset criticality and of managing critical spares, as part of the overall asset management plan and to ensure readiness. It has developed a strategy, framework, and process that are consistent with good practice.*

On the issue of generation asset readiness Liberty was critical of Hydro's commitment to December 1 as a meaningful deadline in light of a number of decisions by Hydro with respect to maintenance and repairs on key generation assets. As an example Hydro scheduled a planned outage for the Hardwoods combustion turbine well into the month of December. This was a considered decision by Hydro as it was deemed that the outage could not happen in the summer because of another outage at the Holyrood Thermal Generating Station. Liberty comments that

[26] Hydro Report, March 24, 2014, Volume II-Schedule 5, Appendix 1, page 32
[27] Ibid., Volume II-Schedule 6, Appendix 2, page 26
[28] Ibid., Volume II-Schedule 6, Appendix 2, page 11
[29] Ibid., Volume II-Schedule 5, Appendix 1, page 19

competing priorities may require compromise but Hydro should give more weight to the deadline in balancing priorities.

The unavailability of key generation assets and high load conditions resulted in a call for customers to conserve electricity on January 2, followed shortly by rotating outages. Generation availability was a key cause and contributing factor in the January 2014 outages.

4.2 Transmission System and Terminal Station Failures

On January 4, 2014 at 9:05 am a series of transmission system and terminal station events began causing widespread outages on the Island Interconnected system, which was already stressed with high loads and generation unavailability. Liberty describes these events and the impacts on the Island Interconnected system concisely:[30]

> *The initiating cause of the series of three major outage events on January 4 and 5, 2014 was a fault in one of two 230kV large power transformers at the Sunnyside terminal station. The transformer failure, however, should have had only a minimal and limited effect on customer numbers interrupted and the length of those interruptions. The three major outage events resulted from:*
>
> - *A malfunctioning (failure to open) 230kV air-blast circuit breaker in Hydro's Sunnyside terminal station*
> - *Insufficiency of a protective relay scheme design in the Sunnyside terminal station*
> - *Failure of personnel to understand fully the operation of that protective relay scheme at Sunnyside terminal station*
> - *A malfunctioning 230kv air-blast circuit breaker in Hydro's Holyrood plant's terminal station.*
>
> *These events caused a collapse of most of Hydro's transmission system and the separation of major generating units from the transmission system. The combination of these events and the length of time required to restart generator units at Holyrood generating station caused extended power interruptions for up to 187,500 customers, mostly on the Avalon Peninsula.*
>
> *A second transformer failure and air-blast circuit breaker malfunction also occurred at Hydro's Western Avalon terminal station. The Western Avalon event did not cause a major power outage event when it occurred. It did lead to delay of customer service restoration on January 4th and the interruption of Newfoundland Power customers on January 8th 2014.*

This section addresses each of the events beginning with the failure of the transformer at the Sunnyside Terminal Station which resulted in power interruptions for about 187,500 Newfoundland Power customers.

[30] Liberty Report, pages 41-42

4.2.1 Sunnyside Terminal Station

On January 4, 2014 at 9:05 am the T1 transformer at the Sunnyside Terminal Station failed and a delay in clearing the fault as a result of a breaker failure and the design of the breaker failure protection resulted in the explosion and destruction of the T1 transformer. The oil expelled by the explosion ignited causing a fire and collateral damage and ensuing system disruptions. The T1 transformer fault, the air-blast circuit breaker failure and issues with the design of the breaker failure protection are distinct events which contributed to the outage.

T1 Transformer Fault

The cause of the failure of the T1 transformer at Sunnyside remains under investigation though it is likely that the failure was due to a defect in a bushing or the windings. The root cause analysis completed by Hydro reports the root cause for the fault on this transformer as the lack of an online mechanism to detect combustible gases in the transformer which may have provided an early detection of the problem.[31]

The last scheduled maintenance of this transformer was in 2007 and according to Hydro's program schedule it should have had preventive maintenance and testing in 2013.[32] Hydro explains that there was a realignment of preventive maintenance on high voltage power transformers in 2010 which caused work on some equipment to be done on a different timeframe than originally planned. As a result of this realignment the preventive maintenance on Sunnyside T1, originally intended for 2013, was deferred.[33]

In addition laboratory analysis in September 2013 showed a significant increase in acetylene gas in this transformer and recommended that consideration be given to investigative sampling. Hydro did not intensify the testing as recommended, concluding that the elevated levels of acetylene gas found resulted from a leakage from the tap changer compartment into the transformer oil compartment. Hydro did not conduct an internal examination of the transformer or tap changer to confirm this theory. Liberty concludes that testing might have identified abnormal internal conditions.[34]

Hydro states:[35]

> *Hydro acknowledges that preventative maintenance and testing on the Sunnyside T1 transformer in 2013 may have identified abnormal internal conditions. However, there is no assurance that they would have, or that the transformer would have been taken out of service for corrective work. Variations in acetylene gas content in this particular transformer design (there are three sister transformers in Hydro's system) have been seen dating back to the early 1990's. Based on Hydro's long experience with this equipment and the expert input of the Original Equipment Manufacturer (OEM), there is a basis for believing that periodic acetylene readings in the transformer oil compartment*

[31] Hydro Report, March 24, 2014, Volume I, page 37
[32] Liberty Report, page 44, footnote 34
[33] Hydro Report, March 24, 2014, Volume II, Schedule B, Appendix 9, page 2
[34] Liberty Report, page 44
[35] Hydro's Submission, May 2, 2014, page 13

> *are linked to gas migration from a separate tap changer compartment, where high acetylene readings are common*.

Hydro further explains that it appears at this stage that the failure of the transformer was most likely related to a bushing failure which would not necessarily be related to, or predicted by, dissolved gas levels inside the transformer.[36]

No cause has yet been determined for the failure of the T1 transformer that initiated the widespread outages that began on January 4. However it is clear Hydro did not complete scheduled maintenance and recommended testing in relation to this transformer in 2013. Hydro explains that there was a long history of variations in acetylene gas levels for these types of transformers and further that it believes that this is the result of leakage from the tap changer compartment. However, Hydro did not do the necessary investigations and testing to confirm this theory. As noted by Hydro there is no certainty that the preventive maintenance and intensified testing would have avoided this transformer failure and explosion. However, this work might have identified an issue that could have been remedied before the transformer failed. Preventive maintenance and testing are important tools which allow Hydro to proactively manage its assets. Failing to conduct recommended maintenance and testing increases risk.

Air-Blast Circuit Breaker B1L03 Failure

When the T1 transformer at the Sunnyside Terminal Station failed one of the air-blast circuit breakers which serves to isolate this transformer from the system, B1L03, stuck and did not open. Had all the breakers functioned correctly it is likely that the T1 transformer failure at Sunnyside would have had only a minimal effect on customers. The explosion and destruction of the T1 transformer and fire and collateral damage and ensuing system disruptions likely would not have happened.

The cause of the failure of B1L03 has not yet been determined. Hydro explains that the findings are currently inconclusive and further investigation is required to determine whether high impedance paths exist in the control system which may affect the breaker.[37] The analysis done by ABB Power Products Service Group identified a possible voltage issue and determined that there could be some improvements in the lubrication used and adjustment checks verified on the pole control boxes.[38]

Like the T1 transformer the B1L03 breaker at Sunnyside was overdue for its scheduled six-year maintenance. It was last overhauled in 2007 and before that in 2003. Hydro explains that there was a realignment of preventive maintenance on high voltage breakers in 2010 which caused work on some equipment to be done on a different timeframe than originally planned. As a result of this realignment the preventive maintenance on B1L03, originally intended for 2013, was deferred.[39]

[36] Hydro's Submission, May 2, 2014, page 14
[37] Hydro Report, March 24, 2014, Volume I, page 37
[38] Ibid., Volume II, Schedule 8, Appendix 7, page 69
[39] Ibid., Volume II, Schedule 8, Appendix 9, page 6

In January 2013 there was a significant outage event which also involved Hydro's air-blast circuit breakers. Hydro's review following this event determined that Hydro's air-blast circuit breakers needed to be exercised regularly and required more intense maintenance. As noted by Liberty Hydro stated in its June 2013 review:[40]

> *There were many issues with breakers, particularly the 230kV class, during these events. A review of the preventive maintenance schedules and procedures for these breakers should be carried out to ascertain whether they are being carried out adequately. In addition, this review should address whether or not they are adequate for the age of the breakers. One issue is the failure to trip which is related to the auxiliary contact in the trip circuits and may be mitigated by the exercising of the breakers. A schedule for this "exercising" should be developed and monitored, possibly with the assistance of EMS data which reports the opening and closing of breakers, to identify "dormant" breakers.*

Liberty explains that when these breakers are not periodically operated conditions can arise that prevent them from opening. Hydro advises that from March 1, 2013 to March 31, 2014 most of Hydro's breakers were exercised, including the breakers that experienced problems in January, 2014.[41]

While the cause for the failure of the B1L03 breaker has not been determined it is significant that some scheduled maintenance work and other recommended work appears to not have been completed. This breaker has not been overhauled since 2007 despite the fact that it was scheduled for preventive maintenance in 2013. In addition Hydro determined in 2013 that maintenance schedules and procedures for its air-blast circuit breakers should be reviewed and further that these breakers should be exercised regularly. Liberty concludes that Hydro would likely have prevented the failure by having exercised the air-blast circuit breaker on an annual basis and by servicing and testing the breakers more regularly.[42]

It is significant that the performance of the air-blast circuit breakers was reviewed as a result of the January 2013 outage event and yet Hydro did not ensure that it completed the scheduled maintenance in 2013. In addition as a result of the review flowing from the January 2013 outage it was determined that these air-blast circuit breakers should be exercised as part of the annual breaker maintenance schedule. Hydro submits that this breaker was "exercised" sometime in the year ending March 31, 2014 but does not address whether it was exercised before the January 2014 events and does not describe what it means by "exercised". The Board believes that in light of the events of January 2013 Hydro should be able to demonstrate this breaker was properly exercised and the preventive maintenance was done before winter.

The Board notes that the investigation as to the cause of this failure is ongoing so it is not appropriate at this time to reach any final conclusions. There is no certainty that the completing the scheduled maintenance and the recommended exercising of the breaker would have avoided this failure. Nevertheless it is Liberty's opinion that the failure of B1L03 could likely have been avoided had Hydro completed the scheduled preventive maintenance and exercised the breaker. Hydro does not challenge this view. The Board finds that completion of the scheduled

[40] Hydro's Submission, May 2, 2014, page 15
[41] Ibid., May 2, 2014, page 15
[42] Liberty Report, page 46

maintenance and proper exercising of this breaker may very well have avoided the system disruptions that occurred on January 4, 2014.

Breaker Failure Protective Relay Scheme

The fault caused by the failure of the T1 transformer at the Sunnyside Terminal Station could have been cleared more quickly if the fault had initiated the breaker failure protection scheme for B1L03.[43] Such a scheme may have cleared the fault fast enough to prevent the explosion and fire and ensuing system collapse. Liberty concludes that the lack of "breaker failure" protection contributed to the major outage event at the terminal station.[44] Hydro's protection and control consultants state the lack of breaker failure protections for the 230 kv breakers is a key causal factor in the spread of the impact of the T1 transformer fault beyond the Sunnyside Terminal Station.[45]

Hydro explains that during the design of the station the simultaneous failure of a transformer and a 230 kV breaker was considered to be too low of a risk to protect against.[46]

If the transformer protection design provided for it, breaker failure protection would likely have cleared the fault fast enough to prevent system disruptions and the transformer fire.

4.2.2 Western Avalon Tap Changer Restoration

At 12:22 pm on January 4, during Hydro's restoration efforts, the Western Avalon Terminal Station experienced an electrical fault in the T5 transformer tap changer diverter switch as well an air-blast circuit breaker malfunction.[47] Customers did not experience power interruptions but this event further delayed the restoration of service to customers by several hours.

No conclusive root cause has yet been determined for this failure. During restoration efforts one phase of the B1L37 air-blast circuit breaker at Western Avalon stuck and would not close. When operators closed another breaker the T5 transformer on-load tap changer faulted due to a flash over. This tap changer fault caused carbon-contaminated oil to enter the main tank of T5 transformer, putting this transformer out of service. Hydro notes the possibility of a transient overvoltage due to system harmonics and that further investigation has been recommended.[48]

Liberty also raised an issue in relation to alarms. The Western Avalon T5 transformer protective device alarm operated at the same time that the Sunnyside T1 transformer failed. However, several alarms are connected to the same alarm point on the data recorder so Hydro could not determine the exact cause of the alarm. It is also noted the digital fault recorder which would have verified the possible transient overvoltage was not fully functional as a result of a hard drive failure.

[43] Hydro Report, March 24, 2014, Volume II, Schedule 8, page 21
[44] Liberty Interim Report, page 48
[45] Hydro Report, March 24, 2014, Volume II, Schedule 8, page 16
[46] Ibid., Volume I, page 37
[47] Liberty Report, page 49
[48] Hydro Report, March 24, 2014, Volume I, page 38

This electrical fault at the Western Avalon Terminal Station did not result in further outages but delayed the restoration of power to customers for several hours. The cause of this failure continues to be investigated.

4.2.3 Sunnyside Terminal Station Restoration

At 3:33 pm on January 4 there was a bus fault at the Sunnyside Terminal Station when operators energized the station as a part of Hydro's restoration efforts. This led to power interruptions affecting 165,000 customers.

Liberty explains that as a result of incorrect wiring modifications made during restoration efforts after the initial T1 transformer fault the bus differential relays could not clear the bus fault. Liberty notes that an experienced protection and control technologist was not on-site and concludes that insufficient knowledge of the relay protection schemes at the Sunnyside Terminal Station was a causal factor. Liberty explains that had a knowledgeable protection and control technologist been on-site, Hydro would likely have identified the reason why the operators were having difficulty in re-energizing the terminal station. Hydro explains that protection and control technologists were not available to work on the day of the incident.[49]

Liberty also notes several other issues including two air-blast breakers at Bay d'Espoir that opened too slowly because the backup relays were connected to "slow trip" coils on those breakers.

Hydro's consultant agrees that "slow trip" coils are an important issue which should be addressed. Neither Liberty nor Hydro found that this was a causal factor.

4.2.4 Holyrood Air-Blast Circuit Breakers

At 9:27 pm on January 5 a fault occurred at the Holyrood Terminal Station causing an interruption for 110,000 Newfoundland Power customers. It was determined that the B1T1 disconnect switch was closed while attempting to synchronize Unit 1 at the Holyrood Terminal Station and B1L17, an air-blast circuit breaker, had previously failed to open. Liberty explains that one phase of B1L17 was closed but the position indicators showed it as open. Hydro found moisture and corrosion upon disassembling the breaker and determined that an inappropriate maintenance work practice caused the moisture contamination. Liberty explains that a control rod in the breaker stuck due to ice and corrosion.

In response to a flashover that occurred on the B1L17 breaker in the January 2013 outage Hydro undertook to work on this breaker to apply an RTV coating to its porcelain insulators to reduce the probability of flashover. During this work the breaker interrupters were planned to be removed for two weeks but due to a reprioritization of work they were removed for six weeks. Hydro concludes that the length of time the breaker was exposed without adequate coverage is

[49] Hydro Report, March 24, 2014, Volume II, Schedule 8, page 3

the most probable cause of the moisture contamination.[50] Hydro concludes that scheduling needs to be improved and states:[51]

> *As a result of maintenance personnel being rescheduled to perform high priority work, the reinstallation of breaker B1L17 interrupters was extended in early 2013.*

Hydro also notes that the work method did not contain instructions on how to prevent moisture contamination.

The Board finds that the failure of the B1L17 air-blast circuit breaker at the Holyrood Terminal Station was most likely the result of moisture contamination caused by exposure of equipment during delays in completing service due to reprioritization of work by Hydro.

4.2.5 Western Avalon Terminal Station

On January 8, 2014 at 5:45 pm approximately 29,000 Newfoundland Power customers experienced a 30-minute outage as a result of reduced transformer capacity. When Newfoundland Power added load to the T3 and T4 transformers at the Western Avalon Terminal Station because a second 138 kV transmission line was out of service the transformers became overloaded and tripped offline. Newfoundland Power had discussed the need to add the load with Hydro's Energy Control Center prior to this event but Hydro did not advise Newfoundland Power that the transformer capacity was reduced. This outage was the result of Hydro not notifying Newfoundland Power that the equipment was out-of-service.

4.2.6 Hydro Place Back-up Generation

During the outage on January 4 Hydro's back-up generation for Hydro Place failed which caused the loss of its energy management system. This did not cause any additional outages but Hydro's restoration efforts were extended by 43 minutes.

Hydro explains that the energy management system and administrative computing systems are protected against a loss of feeder power with batteries and two diesel generators at Hydro Place. Hydro states that despite regular testing and recent maintenance, the backup diesel generation did not perform as expected. These diesel generators are run-tested every two weeks, and are subject to an annual preventive maintenance inspection by an external contractor. The latest annual inspection was completed on December 27, 2013.[52] On January 3, 2014, while the emergency generation system was being started to reduce the Island Interconnected system load, one of the generators failed to synchronize and it was tagged out of service. A few minutes later the high temperature alarm was triggered on the other generator which forced its shutdown. This was the result of a mechanical failure of the ventilation louver activation system. A few hours later the air dryer for the pneumatic system was identified as the source of the issue and, as parts were not available to repair the air dryer, it was bypassed. The generator continued to operate for several hours. When Hydro attempted to start the generator the next day there was an under frequency

[50] Hydro Report, March 24, 2014, Volume II, Schedule 8, page 29
[51] Ibid., Volume I, page 39
[52] Ibid., Volume I, page 48

condition. Thereafter the generator shut down again as a result of a high-temperature alarm again as the result of a problem with the generator room cooling.

Hydro explains that, without power, the energy management system was not able to control and monitor activities at the generating and transmission facilities. However, Hydro's protocols allowed the management of the system during the power interruption. Hydro also explains that the administrative computing systems were unavailable for approximately four hours. Hydro also notes that there was limited emergency lighting to allow personnel to work and that there was no battery powered emergency lighting in key areas, including the stairwells.[53]

The failure of the emergency generation caused the extension of restoration efforts by 43 minutes, the unavailability of Hydro administrative computing systems for four hours, and issues with emergency lighting. Liberty concludes that Hydro's previous attempts to address the cooling issue on the generator were not sufficient.[54] While the Board acknowledges that the impacts of this failure were not long lasting the emergency power system is a critical aspect of Hydro's operations and due regard should be given to ensuring its continued reliable operation. The Board also notes that the loss of this system raised a potential safety issue given the impacts on emergency lighting at Hydro Place.

4.3 Board Comments - Causes and Contributing Factors

The outages of January 2014 should be considered as two separate events. Rotating power outages which began on January 2 were caused by generation unavailability. The second event began on January 4 and was the result of transmission system and terminal station failures.

<u>Generation Availability</u>

Generation shortages caused by unit outages and equipment failures led to rotating power outages on January 2 and 3. Hydro explains that the generation availability issues involved five different generation plants and two different units at Holyrood, stating:[55]

> *This would be highly unexpected given Hydro's focus on asset management, reliability and winter readiness.*

The Board finds that decisions related to the timing of generation asset repairs, the availability of critical spares and issues with resource availability affected the extent, timing and duration of the outage of key generation assets. The planned outage of the Hardwoods gas turbine was scheduled beyond the December 1 winter readiness date and timely decisions were not made to procure necessary parts for the Stephenville gas turbine. In addition, critical spare parts were not available when needed for Unit 3 at the Holyrood Thermal Generating Station. Key vendor support needed for repairs was also not available during the holiday period.

[53] Hydro Report, March 24, 2014, Volume II, Schedule 12, page 12
[54] Liberty Report, page 49
[55] Hydro Report, March 24, 2014, Volume I, page 33

The Board notes that Hydro has a December 1 deadline for winter readiness each year. While Hydro was within its reserve margin on December 1, 2013, even considering the unit outages of the Hardwoods and Stephenville gas turbines, these unit outages placed the Island Interconnected system in a vulnerable position. Because of the reduced generation availability the system did not have the capacity to deal with the subsequent generation issues and the increasing winter load. The purpose of having a December 1 target date for asset availability on the Island Interconnected system is primarily to ensure that the system capability is available going into the higher winter load period. The reality of the Island's winters drives this need for December 1 asset readiness. Maintaining appropriate reserve margins is critical to ensuring the system is able to withstand extreme or unexpected events affecting generation units. Lower margins in terms of reserve produce a system that will be, by design, more vulnerable to supply shortages similar to those seen in 2014. The system events that started on January 2 exposed this system vulnerability with significant impacts on customers on the Island Interconnected system.

It is noted that Hydro has forecasted shrinking reserve margins and a imminent supply deficit has been predicted for several years. Liberty's statement in this regard is pointed and concerning:[56]

> *"Hydro has elected to operate rather close to the edge, which raises the risk of adverse outcomes".*

The Board has concerns as to whether Hydro has sufficient generation capacity to meet customer demand over the next few years while at the same time maintaining adequate reserve capacity to deal with unplanned or unexpected system events, similar to those experienced in January 2014.

Transmission System and Terminal Station Failures

Multiple failures of key transmission system and terminal station equipment led to widespread power outages for customers beginning on January 4. Transformer failures, air-blast circuit breaker malfunction, protective relay design, and operator knowledge issues all contributed to the outages and, combined, these failures had consequences beyond what one would ordinarily expect to occur.[57]

The Board notes that there was deferred maintenance on the transformer and the air-blast circuit breaker that failed in Sunnyside on January 4. Hydro explains that a decision was made to exclude some terminal station six year preventive maintenance from the 2013 Execution Work Plan due to higher priority capital work programs and other longer backlogged preventive maintenance. Hydro explains:[58]

> *Historically some PM work has been deferred due to shifts in outages for system/economic reasons, or due to trade-offs between work programs. These kinds of decisions on trade-offs are normal practice in any utility, but given the age of much of the Hydro equipment the risks can be higher.*

[56] Liberty Report, page 19
[57] Ibid., page 5
[58] Hydro Report, March 24, 2014, Volume II-Schedule 5, page 22

The Board finds Hydro's explanations in relation to its failure to complete the scheduled preventive maintenance and testing to be inadequate.

The Board acknowledges Hydro's efforts to put in place a comprehensive asset management program in light of its aging asset base. As Hydro points out in its submission this asset management program was implemented in recognition of the needs for asset refurbishment and renewal and increased maintenance. Liberty notes that while asset management programs are becoming more widely used in industry, effective asset management programs must be well designed and implemented in terms of inspection and maintenance cycles, must recognize and account for aged equipment, and must have sufficient and qualified resources needed to get both proactive and reactive maintenance done in a timely manner. The Board notes that many of the contributing factors to the equipment failures in the January 2014 system events relate directly to asset management practices that may not align with these best practices.

Hydro states that the effective execution of its preventive maintenance program is a cornerstone of its asset management strategy. Hydro notes that it is continuing to improve its execution of project work and similar improvements are expected in preventive maintenance execution and in corrective maintenance. Liberty's review found that Hydro has deferred preventive maintenance on some key assets and backlogs are significant. Resources are also an issue. Liberty also notes that Hydro's maintenance standards are more aligned with younger assets. As a result of their review Liberty observes that Hydro's execution of its asset management program *"gives more visibility to cost effectiveness than to preventing the kinds of equipment failures that have caused widespread outages."* In the Board's view this gap between the intended goals of the asset management program and the actual results are concerning and must be addressed. The Board has asked Liberty to undertake further work and investigation on this area over the next number of months.

Conclusions

Hydro states in relation to the events of January 2014:[59]

> *Unplanned and unexpected system occurrences involving two unrelated series of events posed a significant challenge for Hydro and its employees in restoring operations in several different locations across Hydro's system, often in hazardous and challenging weather conditions.*

The Board acknowledges that the events of 2014 were unplanned and may have been unexpected to Hydro. However, as Liberty points out, these events are not outside the range of outcomes for which a utility should plan.

The status of Hydro's supply assets leading into the winter was a major contributing factor to the generation shortfall in December. Neither extreme weather nor other unusual events were significant factors in the January 2014 system events and outages. The number and nature of the equipment failures that occurred is unusual and raises questions about Hydro's operation and maintenance of equipment. The Board notes that:

[59] Hydro Report, March 24, 2014, Volume I, page 6

i) Hydro scheduled a planned outage for the Hardwoods gas turbine to continue to December 19, beyond Hydro's December 1 winter readiness deadline;
ii) Hydro did not address equipment issues at the Stephenville gas turbine in a timely fashion;
iii) Hydro did not follow a 2011 recommendation to procure a spare motor for the forced drive fan in Unit 3 at Holyrood and therefore had no spare when it failed;
iv) Hydro did not ensure that key vendor support was available for work completion on the Hardwoods gas turbine;
v) Hydro did not complete the 2013 scheduled preventive maintenance on the T1 transformer at Sunnyside which failed;
vi) Hydro did not do the recommended investigative testing on the T1 transformer at Sunnyside which failed;
vii) Hydro did not complete the 2013 scheduled maintenance on the B1L03 air-blast circuit breaker at Sunnyside which failed;
viii) Hydro did not have an experienced protection and control technologist onsite during the restoration efforts at Sunnyside and incorrect modifications were made;
ix) Hydro allowed the B1L17 air-blast circuit breaker to be exposed to weather for several weeks during maintenance work, resulting in moisture contamination and this breaker was one of the three that failed; and
x) Hydro did not follow the 2013 recommendation to properly exercise its air-blast circuit breakers and three of these breakers failed.

The Board is satisfied that Hydro's asset management decisions contributed to the nature, extent and duration of the outages. The Board has particular concerns in relation to the deferral of preventive maintenance and testing, especially given that at least two of the equipment failures in January 2014 are associated with deferred maintenance and testing. As noted by Hydro, there is no guarantee that this work would have identified the problems and resulted in the repair of this equipment. However, based on the information available and considering Liberty's findings, the Board believes that if this work had been carried out as planned and recommended, the system distributions and subsequent outages may have been avoided.

5. WINTER READINESS 2014-2016

The purpose of this report is to address those action items which should be undertaken immediately in preparation for the next two winter seasons. This section of the report addresses actions required to be undertaken by Hydro as the causes and contributing factors that have been identified to date in relation to the January 2014 outages were the result of issues on Hydro's system.

Liberty made 35 recommendations covering issues of Hydro's load forecasting and generation planning, generation availability, and transmission system and terminal stations. Hydro states that Liberty's key findings are broadly consistent with the findings of Hydro's internal review and that, with few exceptions, Hydro agrees with Liberty's recommendations.[60]

5.1 Load Forecasting and Generation Planning

Load forecasting and generation planning issues were addressed by Liberty as a part of its review in relation to the generation capacity shortfall that began on January 2. Liberty's recommendations in relation to these issues as well as Hydro's comments are discussed below.

Liberty's Recommendation:
1. Hydro should complete the modifications or replacement of Nostradamus by December 1, 2014 in order to enable improvements in the accuracy of short-term forecasts under extreme weather conditions.

Hydro agrees. Discussions have been initiated with Hydro's consultant, Ventyx, to work toward a solution. Based on its internal review Hydro identifies this as a priority action, stating it will review the updated version of the short-term, seven-day operating forecast to determine if it provides an improved correlation in extreme cold weather situations. If not Hydro will investigate other models and implement available enhancements prior to the 2014-15 winter season.

Liberty's Recommendation:
2. By December 1, 2014, Hydro should incorporate into its short-term forecasting process any significant load changes, from losses or otherwise, resulting from varying system configurations.

Hydro agrees and has identified this item as an "other priority item" arising from its internal review. This recommendation is being addressed in conjunction with recommendation #1.

Liberty's Recommendation:
3. In the interim, Hydro should implement the Ventyx recommendation to consider weather extremes via sensitivity analysis in all forecasting and supply planning evaluations and decisions.

Hydro agrees and has identified this item as a "key action" arising from its internal review. In its Integrated Action Plan Hydro states that the load forecasting process should incorporate

[60] Hydro's Submission, May 2, 2014, page 1

sensitivity analysis, including sensitivity to extreme weather conditions, particularly in making near-term investment decisions. The sensitivity analysis should be used to provide more detailed information on the variability of the forecast to stakeholders. Hydro advised that this recommendation will be incorporated in the next load forecasting cycle and has already been applied in its analysis in relation to the 100 MW (nominal) combustion turbine application filed with the Board.

Liberty's Recommendation:
4. By September 1, 2014, Hydro should: (a) evaluate and reach resolution on a formal change to the planning process to use a greater than 50 percent probability weather variable, (b) propose that criterion to the Board for use in future capacity decisions, and (c) continue to conduct sensitivity analysis for extreme weather, but around the new weather variable.

Hydro agrees and has identified this item as a "key action" arising from its internal review. Concepts have already been applied in the analysis for the 100 MW (nominal) combustion turbine and will be formalized as part of the generation planning process by September 1, 2014.

Liberty's Recommendation:
5. Before December 1, 2014, Hydro should: (a) re-evaluate the deviations between its forecasted winter peak and the multiple times it was exceeded during the winter of 2014, and (b) determine what, if any, common factors were responsible and what changes, if any, they suggest for the forecasting process.

Hydro agrees. This will be completed as part of the next load forecasting cycle prior to Fall 2014.

Liberty's Recommendation:
6. Before September 1, 2014, Hydro should: (a) strengthen its ability to reconstruct the peak load when peaks have been significantly affected by artificial means such as those employed by the generation shortage protocol, and (b) use those improved techniques in the recommended evaluation of 2014 forecast deviations.

Hydro agrees. This will be completed as part of the next load forecasting cycle prior to Fall 2014.

Liberty's Recommendation:
7. Hydro should follow through on its plans to assure consistency in future reliability analyses by focusing on the Island Integrated system, as opposed to the Hydro system alone.

Hydro agrees. Hydro states that future reliability analyses should incorporate a focus on the total island system. This will be incorporated into the reliability analyses by Fall 2014. Implications for other aspects of the business may be addressed into 2015.

Liberty's Recommendation:
8. For the near-term, Hydro should abandon the LOLH of 2.8 criterion, and the associated low reserve requirements, in favor of an "as low as practical" objective.

Hydro does not agree. Hydro states that it agrees that current generation planning assumptions may result in generation reserve margins that are too low and that measures need to be taken to ensure a more robust reserve margin during the period leading up to the interconnection with the Muskrat Falls generating station. Hydro believes a more practical approach to generation planning in the interim period is to maintain the current LOLH criterion of 2.8 hours and more closely evaluate low probability/high impact scenarios through the use of more conservative assumptions related to generation reliability and weather severity.

Liberty's Recommendation:
9. For the long-term, Hydro should evaluate, taking account of stakeholder input a new supply reliability criterion with a logically associated level of reserves, and seek Board concurrence to use that criterion as a basis for long-term supply planning.

Hydro agrees with this recommendation to the extent that a review and update of the generation planning criterion to be used post-Muskrat Falls interconnection is warranted. However, Hydro states that this should not presume that the criterion would not continue to be LOLH-based. The evaluation will be initiated in 2015.[61]

Required Key Actions - Load Forecasting and Generation Planning

Many of the issues raised in relation to Hydro's load forecasting and generation planning do not relate to immediate concerns associated with the coming winters and will therefore not be discussed in this report. The Board notes that many of the recommendations related to forecasting and generation planning are already being actioned by Hydro. For the purposes of this interim report the Board believes that the issues relating to Hydro's short-term load forecasting tool, Nostradamus, should be addressed this year. This may improve Hydro's response in emergency and outage situations. In addition the Board believes that Hydro should make changes in relation to the way temperatures are reflected in its medium-term forecast. The Board also notes that Hydro's LOLH criterion is a long-term issue which requires consideration of facts and circumstances yet to be reviewed and will therefore not be addressed until the final report. Any outstanding issues will be evaluated fully throughout the remainder of this proceeding and will be addressed in the Board's final report.

The Board believes that the following key actions in relation to forecasting and generation planning should be undertaken by Hydro in the immediate term in preparation for the next two winter seasons.

1. **By December 1, 2014 Hydro should:**
   - i) **Implement changes to its short-term forecasting process to appropriately incorporate impacts of weather conditions and any significant load changes, from losses or otherwise, resulting from varying system configurations.**
   - ii) **Incorporate sensitivity analyses to weather extremes in all forecasting and supply and planning decision evaluations.**

[61] Hydro's Submission, May 2, 2014

2. By October 31, 2014 Hydro should file a status report in relation to the changes to its short-term forecasting and the incorporation of sensitivity analyses.

5.2 Generation Availability

In light of the events of December 2013 and January 2014 and the concerns identified in relation to load forecasting and generation planning it is critical for the immediate term and up to the Muskrat Falls interconnection that Hydro ensure that the Island Interconnected system has suitable reserve capacity available. In the near-term Liberty recommends specific initiatives related to ensuring availability of existing assets, reducing load (via interruptibles), and procurement of new supply.

Liberty's recommendations in relation to generation availability as well as Hydro's comments are set out below.

Liberty's Recommendation:
10. By June 15, 2014, Hydro should formalize its established plan to implement an aggressive availability improvement program focused on all generating assets, especially focusing on the Holyrood units and the two combustion turbines.

Hydro agrees and identified this item as a "key action" arising from its internal review. A number of key action items to address gas turbine availability are identified including reviewing gas turbine maintenance practices, assessing effects of test starts and run-ups prior to severe weather, identifying repeat failure events and addressing root causes, identifying a plan for additional plant and equipment refurbishment not already completed, and reviewing fuel storage processes and procedures. According to Hydro implementation of these actions is in progress. As an example Hydro advises that, since the January 2014 events, it has implemented a protocol for running up the gas turbines in Stephenville and Hardwoods in advance of all significant forecasted weather events. In addition Hydro advises that it has created a senior position whose accountability includes the oversight of asset management plans, maintenance standards, and capital submissions related to gas turbines.

Liberty's Recommendation:
11. Hydro should formalize its maintenance program for Holyrood generating station and the combustion turbines in a submittal to the Board by June 15, 2014, covering the period through November 30, 2014, with the submittal to include, at least: (a) a listing of all key maintenance activities planned for each unit, (b) a critical path schedule for each planned outage of a unit including major work items, (c) a sequencing plan for planned outages showing the relationships among planned outages and how, if at all, an outage at one unit restrains an outage at another, and (d) bulk production curves for maintenance activities at each unit by number of work orders or whatever measure Hydro finds preferable.

Hydro agrees and has identified this item as a "key action" arising from its internal review.

Liberty's Recommendation:
12. Hydro should formalize by June 15, 2014, a generation master plan for winter preparation, including the above availability improvement activities and tasks addressing emergency preparedness.

Hydro agrees and has identified this as an "other priority action" arising from its internal review. Hydro states that it will review its current winter readiness program in reference to industry best practices and formally implement/document for Hydro operations. Hydro advises that it will complete a master plan with emergency preparedness tasks and those activities in 10 and 11 above.

Liberty's Recommendation:
13. Hydro should, on a monthly basis, and starting no later than June 30, 2014, formally provide updates of the plans under the three preceding recommendations, and meet with the Board Staff to review and observe progress.

Hydro agrees.

Liberty's Recommendation:
14. No later than June 15, 2014, Hydro should provide to the Board a detailed report on decisions and pending actions regarding spare parts for the Holyrood generating station and the combustion turbines, including: (a) a listing of all critical plant components, (b) the results of risk analyses of such critical components, (c) the decisions on which parts should have spares, either on site or at a vendor, and (d) the action plan to procure any unsecured such parts before November 30, 2014.

Hydro agrees and has identified this item as a "key action" arising from its internal review. Hydro states it will complete the planned initiatives in its Integrated Critical Spares Strategy as well as implement improvements identified by the Critical Spares Council in 2013. In the process Hydro advises it will revisit the critical spares philosophy for the Holyrood Thermal Generating Station and other generation assets within Hydro's system and implement any changes in time for the 2014-15 winter season. Hydro also advises that it will provide a report on its ongoing activities in relation to critical spares for the Holyrood plant. Hydro's Integrated Action Plan advises that a request for proposals has been issued for an experienced consultant to assist in completing the work required for this recommendation.

Liberty's Recommendation
15. Hydro should treat the securing of new generation as a first priority; reach a prompt decision on a preferred option and proceed expeditiously towards an in-service date of December 1, 2014 or, if not possible, by December 1, 2015 at the latest.

Hydro agrees. On April 10, 2014 Hydro filed an application seeking approval of a capital expenditure in the amount of $119,000,000 for the purchase and installation of a 100 MW (nominal) combustion turbine to be installed at the Holyrood Thermal Generating Station. Hydro states:[62]

[62] Hydro's Gas Turbine Application, April 10, 2014, page 2

> *Due to its experiences in January 2014, Hydro has revisited its LOLH guidelines and has run sensitivity analyses with additional customer electrical loads and higher than expected forced outage rates at its generating stations. Those analyses indicate that it would be prudent, if practicable, to advance the installation of the combustion turbine and to increase the generating capacity of the combustion turbine it installs.*

Given the expedited time frame proposed by Hydro to procure this unit and in light of Liberty's comments in relation to the need identified for new generation sources to meet anticipated capacity deficits the Board approved the proposal to proceed with the supply and installation of the 100 MW (nominal) combustion turbine but determined that the issue of costs and cost recovery from ratepayers would be considered in a separate process and order of the Board.

Liberty's Recommendation:
16. Hydro should continue discussions with appropriate industrial customers who might make a material contribution to interruptible load with a goal of securing economically available interruptible loads.

Hydro agrees. Hydro advises that discussions with Industrial Customers are ongoing.

Required Key Actions - Generation Availability

Actions required in the area of generation availability include ensuring existing generation assets are available and ready by December 1 as well as increasing generation supply, either through new generation and/or by reducing load through the use of interruptible contracts with industrial customers.

Liberty states that Hydro must give priority to meeting the December 1 deadline for winter asset readiness and also to ensuring that key vendor resources and support personnel are not released until all work is completed.

The Board has given Hydro approval in Order No. P.U. 16(2014) to proceed with the purchase and installation of a 100 MW (nominal) combustion turbine to be installed at the Holyrood Thermal Generating Station. The schedule proposed by Hydro to meet an in-service date of December 1, 2014 is, in the Board's view, ambitious. If the additional generation is not in place at the start of the coming winter the risk of further outages due to supply shortages may not be reduced. This would suggest that Hydro should ensure that resources that would, in the normal course, be deployed on asset readiness efforts not be redirected. To that end the Board believes that Hydro should direct its priority efforts to ensuring that existing generation assets are available as of December 1 and that all efforts to secure interruptible contracts have been pursued. The Board will also put in place, by separate letter as set out in Order No P.U. 16(2014), a monitoring plan to track the progress of the combustion turbine procurement and installation, in conjunction with the generation asset readiness monitoring.

The Board believes that the following key actions in the area of generation availability should be undertaken by Hydro in the immediate term in preparation for the next two winter seasons.

1. **By December 1, 2014 Hydro should:**
   i) **Complete the work necessary to ensure winter readiness of its generation assets.**
   ii) **Address the issue of critical spares of its generation assets.**
   iii) **Complete negotiations in relation to interruptible load and, to the extent that it can secure economically available interruptible load, have a contract in place.**
   iv) **Complete the procurement and installation of the 100 MW (nominal) gas turbine.**

2. **By June 16, 2014 Hydro should file a report in relation to each of the following issues addressing schedule, estimated costs, the resources required, and how these requirements will be met:**
   i) **A generation master plan for winter preparation, including a plan to implement an availability improvement program on all generating assets and its maintenance program for the Holyrood Thermal Generating Station.**
   ii) **A plan in relation to critical spares for the Holyrood Thermal Generating Station and the Hardwoods and Stephenville gas turbines.**
   iii) **A plan in relation to securing economically available interruptible loads.**

3. **By October 1, 2014 and December 1, 2014 Hydro should file status reports with the Board in relation to winter readiness of its generation assets.**

5.3 Transmission System and Terminal Stations

Liberty made numerous recommendations in relation to Hydro's transmission system and terminal stations (Recommendations 17-35). Newfoundland Power and the Intervenors commented generally in relation to the transmission system and terminal stations without reference to any specific Liberty recommendation.

Newfoundland Power submits that the effectiveness of protection and control systems in ensuring the continued integrity of the Island Interconnected system is a prominent issue.[63]

> *Further, the series of major system disruptions which occurred on the Island Interconnected System in January 2014 raise potential questions concerning the adequacy of protection and control at the bulk system level. Protection and control systems are intended to operate in a way that isolates defective or malfunctioning electrical equipment and prevents widespread system impacts. The series of major system disruptions during January 2-8, 2014 suggest that protection and control systems may not have operated as they should.*

[63] Newfoundland Power Interim Report, March 24, 2014, page 46

5.3.1 Terminal Station Transformers

The failure of terminal station transformers played a significant role in the January 2014 events. The failure of the T1 transformer at the Sunnyside Terminal Station was the precipitating cause of the January 4 outage and the failure of the T5 transformer at the Western Avalon Terminal Station delayed restoration efforts after the initial outage.

Both of these transformers are now out of service. The T1 transformer at Sunnyside was destroyed by the explosion and fire and after the failure the T5 transformer at Western Avalon suffered extensive damage. In the interests of time, Hydro plans to repair the damaged T5 transformer on-site rather than sending it to a repair facility or securing a new transformer. Liberty explains that failure to remove carbon contamination completely, which will be more difficult in the field, will increase the risk of the transformer failing. Once the T5 transformer is repaired Hydro plans to install it at Sunnyside. Liberty concludes that loss of the T5 transformer at Western Avalon combined with the loss of T1 at Sunnyside substantially reduces the transformer capacity on Hydro's system and the impacts of this loss should be studied. Liberty further recommends that Hydro investigate acquiring another transformer.

Liberty's recommendations in relation to transformers as well as Hydro's findings and comments are discussed below.

Liberty's Recommendation:
17. Hydro should intensify DGA testing of its critical transformers exhibiting questionable levels of combustible gases, and take actions necessary to minimize failures, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and has identified this as an "other priority action" arising from its internal review. Hydro notes however that variations in acetylene gas levels have been seen since the 1990s for this type of transformer and explains that it believes that acetylene levels are linked to gas migration. Hydro advises that it plans to complete pressure testing to confirm this. Hydro also explains that it appears that the failure of the T1 transformer was most likely related to a bushing failure which would not necessarily be related to or predicted by the increased acetylene levels. Hydro agrees that more regular monitoring of dissolved gases in its critical transformers is warranted and is developing a plan to install continuous on-line gas monitors on critical transformers.

Liberty's Recommendation:
18. Hydro should catch up on overdue testing and maintenance on its critical transformers, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and has identified this as an "other priority action" arising from its internal review. Hydro states that it is addressing overdue maintenance on its critical transformers. Hydro comments in its submissions that there is no assurance that preventive maintenance and testing on T1 at Sunnyside would have identified abnormal internal conditions or that the transformer would have been taken out of service for corrective work. Hydro's Integrated Action Plan states: "*When practicable, complete PMs in accordance with normal scheduling."*

Liberty's Recommendation:
19. Hydro should complete system studies to verify that its plan to relocate the repaired T5 transformer from Western Avalon terminal station to replace the failed Sunnyside T1 transformer will not unduly reduce the reliability of the Western Avalon terminal station and of the transmission system as a whole, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and states that it has completed studies and is completing plans to secure reliable service to the affected areas.

Liberty's Recommendation:
29. Hydro should complete the studies being conducted to determine whether abnormal system disturbances could have caused the T5 transformer failure at Western Avalon terminal station, and report whether any changes need to be made in systems operations or configuration as a result of these studies, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and states that this study is in progress with completion targeted by May 31, 2014.

Liberty's Recommendation:
30. Hydro should seek to locate for Western Avalon T5 a replacement transformer that can be purchased in case: (a) the field repairs are not successful, (b) the repaired transformer fails again later, or (c) the transformer is moved to Sunnyside terminal station, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and states that it will be assessing this as part of its repair plan.

In addition to the Liberty recommendations in relation to terminal station transformers discussed above Hydro concluded, based on the results of its own review, that its long-term plans for transformer replacement and upgrade should be reviewed. In particular, Hydro sets out in its Integrated Action Plan that it will commission an engineering consultant to conduct a formal life assessment of Hydro's power transformers and use the results to revise the long-term plans for power transformer upgrades and replacements.

Required Key Actions - Terminal Station Transformers

The Board notes that Hydro does not include transformer work in its "Key Actions" list. Terminal station transformers are a critical aspect of the Island Interconnected system and it is notable that there were two transformer failures in the January 2014 events. Based on the investigation to date the Board believes that Hydro's failure to complete the 2013 scheduled preventive maintenance and the recommended testing on the T1 transformer at Sunnyside was critical. While there is no certainty, completion of the scheduled preventive maintenance and testing may have identified abnormal internal conditions. Liberty believes that even more frequent testing should be undertaken and Hydro is considering online monitoring of gas levels.

The Board notes that Hydro qualifies the completion of preventive maintenance with the words "when practicable". The Board believes that preventive maintenance should be completed as scheduled and where it cannot be done it should be immediately rescheduled to proceed as soon as possible. In the Board's view the highest priority should be given to the completion of preventive maintenance and testing as it offers the best, if not the only, opportunity for Hydro to proactively manage its assets.

The Board believes that the following key actions in relation to terminal station transformers should be undertaken by Hydro in the immediate term in preparation for the next two winter seasons.

1. **By December 1, 2014 Hydro should:**
   - i) **Complete all 2014 and outstanding prior year testing and maintenance on critical transformers.**
   - ii) **Take appropriate action in relation to critical transformers which have questionable levels of combustible gases.**

2. **By June 2, 2014 Hydro should file a report in relation to the work required to be done in 2014 with regard to transformers, addressing schedule, estimated costs, the resources required, and how these requirements will be met, setting out:**
   - i) **A list of critical transformers and an explanation as to how this determination was made;**
   - ii) **A list of all transformers showing gas analysis results for the period 1993-2013;**
   - iii) **A plan for testing in 2014 for all transformers with questionable levels of combustible gases;**
   - iv) **A plan to complete the 2014 and overdue testing and maintenance on critical transformers in 2014; and**
   - v) **A plan to complete the 2014 and overdue testing and maintenance on the remaining transformers.**

3. **By June 16, 2014 Hydro should file reports with the Board in relation to the following transformer issues:**
   - i) **System studies in relation to the relocation of the repaired T5 transformer from Western Avalon to Sunnyside, including a plan to address potential further failures.**
   - ii) **A study in relation to the availability and necessity of a replacement transformer for T5 at Western Avalon, addressing schedule, estimated costs, the resources required, and how these requirements will be met.**
   - iii) **A plan for the study to determine if abnormal system disturbances may have caused the T5 failure at Western Avalon.**

5.3.2 Air-Blast Circuit Breakers

Air-blast circuit breaker failures played an important role in the January 2014 events and also in the January 2013 outage. Hydro acknowledges the prevalence of 230 kV breaker failures during the events and that the age and maintenance-intensive nature of this terminal station equipment indicate that action is needed to mitigate against future failures. Hydro concludes that the air blast circuit breakers appear to be an issue:[64]

> *Equipment failures, particularly 230 kV air blast circuit breakers (ACB) and their associated air systems, contributed significantly to the extent of the outages and to delays in restoration. Three similar type air blast circuit breakers built between 1966 and 1973 have been associated with the incidents described in this report and failed to operate properly during the 2-day event. The failure modes are different for each so the failures cannot be traced to a single cause factor. However, a thorough review is recommended to assess the acceleration and modification of the existing ACB refurbishment/replacement program, particularly the continued use of these breakers in critical areas on the bulk power system.*

Liberty's recommendations in relation to air-blast circuit breakers as well as Hydro's findings and comments are discussed below.

Liberty's Recommendation:
20. Hydro should conduct operation tests (exercise) all air-blast circuit breakers in 2014, preferably in cold weather, and continue exercising them on an annual basis, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and identified this recommendation in its "key action" list. Hydro explains that following the January 2013 outage Hydro completed a comprehensive review which resulted in 56 recommendations. Thereafter Hydro reviewed its preventive maintenance program for air-blast circuit breakers and breaker exercising as part of the annual breaker maintenance cycle that was implemented. Hydro states it has established a schedule for exercising these breakers and that in 2014 all breakers will be exercised.

Liberty's Recommendation:
21. Hydro should catch up on overdue testing and maintenance on its critical air-blast circuit breakers, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and identified this recommendation in its "key action" list. Hydro states that it is addressing overdue maintenance on its critical breakers: "*When practicable, complete PMs in accordance to normal scheduling.*"

[64] Hydro Report, March 24, 2014, Volume II, Schedule 7, page 3

Liberty's Recommendation:
22. Hydro should change its air-blast circuit breaker proactive maintenance program cycle from six to four years, until retirement of these breakers, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and identified this recommendation in its "key action" list. Hydro states that it will review the existing preventive maintenance program for the 230 kV breakers and identify any changes required, including the preventive maintenance cycle, and that it will consider breaker seal risks associated with cold weather effects. Hydro also states that it agrees with this recommendation subject to a review of the impact on resources, and that an execution plan will be provided.

Liberty's Recommendation:
23. Hydro should periodically operate each of its circuit breakers from protective relays, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and identified this recommendation in its "key action" list. Hydro states it will review including such operations in the routine maintenance cycle to ensure it is carried out in a manner which will not impact service reliability.

Liberty's Recommendation:
33. Hydro should prepare a maintenance practices document addressing the new procedure for applying the protective coating to its air-blast circuit breakers and describing how the new procedure will prevent moisture contamination, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and identified this recommendation in its "key action" list.

In addition to the Liberty recommendations in relation to air-blast circuit breakers discussed above, Hydro concluded, based on the results of its own review, that the following work should also be undertaken:

1. The existing 230 kV breaker replacement plan should be reviewed and revised for accelerated replacement, with a priority on identifying the activities and areas to be completed during the 2014 maintenance season.
2. A number of additional specific technical activities should be carried out in relation to the air-blast circuit breakers:
    i) When system conditions allow, conduct an in-depth analysis of the DC system for breaker B1L03 to determine if any high impedance paths exist that may affect its operation.
    ii) Consider adding the following clause to the Terminals Engineering Standard TS09-0001 entitled "Outdoor Power Circuit Breaker": "the breaker shall not give false indication of the open/close state of any of its phases under any failure mode".

iii) Conduct a review of the annual air system leak check preventive maintenance to ensure that it is adequate in both scope and timing of execution to accurately identify leaks at the Sunnyside Terminal Station.
iv) State a specific pass/fail criteria for the timing test of the air blast breaker preventive maintenance check sheet.
v) Review the current approach to DCF/DCVF air-blast breaker re-lubrication.
vi) Determine why the DOW 55 grease was not removed during the 2007 re-lubrication and implement the appropriate corrective action.

Required Key Actions - Air-Blast Circuit Breakers

The Board believes that Hydro's air-blast circuit breakers pose an ongoing risk for the Island Interconnected system and that measures should be taken to reduce the risks associated with this equipment. It is notable that one of the recommendations made following the January 2013 outage was that the air-blast circuit breakers be exercised regularly and that the preventive maintenance schedules and procedures for these breakers be reviewed to ascertain whether they are being carried out adequately and whether they are adequate for the age of the breakers. Liberty concluded that, had these breakers been exercised before winter as recommended, the failures likely would not have occurred. In relation to B1L03, had Hydro serviced and tested B1L03 at Sunnyside in 2013 in accordance with its preventive maintenance schedule and exercised it properly as recommended, it may have worked. In relation to B1L17 at Holyrood, had proper maintenance practices been followed the failure may also have been avoided.

The Board believes that it is imperative that Hydro complete all overdue and scheduled maintenance and testing on its critical air-blast circuit breakers in 2014. The Board notes that, as in the case of the transformer maintenance, this work must be done. If it is not possible to complete it as scheduled it should be done as soon as possible. The Board also believes that the critical air-blast circuit breakers should be properly exercised which would be done from the local control panel with maintenance personnel present to observe and listen and to check for proper indication of breaker position.

The Board believes that the following key actions should be undertaken by Hydro in relation to its air-blast circuit breakers in the immediate term in preparation for the next two winter seasons.

1. **By December 1, 2014 Hydro should:**
   i) **Properly exercise all air-blast circuit breakers.**
   ii) **Complete all 2014 and outstanding prior year testing and maintenance on its critical air-blast circuit breakers.**

2. **By June 2, 2014 Hydro should file a report in relation to the work required to be done in 2014 with regard to its air-blast circuit breakers, addressing schedule, estimated costs, the resources required, and how these requirements will be met, setting out:**
   i) **A plan for the proper exercise, preferably in cold weather, of all air-blast circuit breakers annually beginning in 2014;**

ii) A list of critical air-blast circuit breakers and an explanation as to how this determination was made;
iii) A plan to complete 2014 and overdue testing and maintenance on critical air-blast circuit breakers in 2014;
iv) A plan to complete 2014 and overdue testing and maintenance on the remaining air-blast circuit breakers;
v) A plan to periodically operate air-blast circuit breakers from protective relays;
vi) A plan to conduct an in-depth analysis of the DC system for B1L03 to determine if any high impedance paths exist that may affect its operation;
vii) A plan to conduct a review of the annual air system leak check preventive maintenance to ensure that it is adequate in both scope and timing of execution to accurately identify leaks at the Sunnyside Terminal Station; and
viii) A plan to review the current approach to air-blast circuit breaker re-lubrication, addressing why the DOW 55 grease was not removed during the 2007 re-lubrication.

3. By August 1, 2014 Hydro should file a report in relation to each of the following issues in relation to its air-blast circuit breakers addressing schedule, estimated costs, the resources required, and how these requirements will be met:
i) Acceleration of the preventive maintenance cycle for air-blast circuit breakers.
ii) Acceleration of the replacement of air-blast circuit breakers.
iii) Changes to internal procedures and documents addressing: the application of the protective coating to air-blast circuit breakers; false indications of the open/close state; and a specific pass/fail criteria for the timing test of the air-blast circuit breaker preventive maintenance check sheet.

5.3.3 Protection and Control Systems

Protection and control design issues contributed to the January 2014 outages. Breaker failure protection design contributed to the January 4 event at the Sunnyside Terminal Station. During the design of the station, the simultaneous failure of a transformer and a 230 kV breaker was considered to be too low of a risk to require protection against.[65] During the restoration efforts an incorrect wiring solution resulted in the failure of the bus differential relays to clear the bus fault. In addition, at 3:33 pm on January 4 as a result of the connection of back-up relays to "slow trip" coils, two air-blast circuit breakers at Bay d'Espoir opened too slowly. Liberty recommends that Hydro not employ "slow trip" coils and Hydro's consultant recommends modifications by July 30, 2014, commenting that until this is done the integrity of the Island Interconnected system is at risk.

Hydro's transmission system protective relay schemes were reviewed in three separate reviews in 2010, 2011 and 2013.[66] Hydro has ongoing work resulting from these studies but has concluded that the outstanding recommendations from the 2010 and 2011 reviews had no

[65] Liberty Report, Page 44
[66] Liberty Report, page 59

contributory impact on the January 2014 events. Hydro advises that it has hired an additional protection and control engineer in 2014 to focus on the outstanding recommendations from the 2010 and 2011 reports. The Board believes that, given the events of January 2014, it is appropriate to review the work that is outstanding and reconsider and prioritize the outstanding work in the context of the required key priority actions arising from this review.[67]

Liberty's recommendations in relation to protection and control systems as well as Hydro's findings and comments are discussed below.

Liberty's Recommendation:
24. Hydro should redesign its existing breaker failure relay protection schemes to provide that breaker failure will be activated whenever a transformer fails coincidentally with either a 138kV or a 230kV breaker malfunction, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees. Hydro sets out in its Integrated Action Plan that it will begin engineering design for this work in the second quarter of 2014 and begin implementation in 2015. Hydro also sets out that: i) it is conducting a formal risk/reward review of system design to determine whether 230 kV transformers require their own 230 kV breaker in all terminal stations; ii) a review is in progress of breaker failure protection applications of all transformer protection designs at stations using the same breaker failure relay as Sunnyside; iii) post 2014 consideration will be given to replacing Sunnyside T1 protection at the same time that the transformer is replaced; and iv) a review of applications of breaker failure protection will be completed to ensure all transformer protection systems initiate breaker failure protection for breakers tripped by the transformer protection.

Liberty's Recommendation:
25. Hydro should formally examine the installation of breaker failure relay protection for transformers in terminal stations where breaker failure relay protection is not in place, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and identified this issue as an "other priority action" arising from its internal review. Hydro sets out in its Integrated Action Plan that a formal risk/reward review of the 230 kV breaker failure protection philosophy for transformer stations that currently do not have breaker failure protection is in progress with planned implementation post-2014.

Liberty's Recommendation:
31. Hydro should include experienced protection and control technologists with its response teams when addressing Hydro termination station events involving investigating and modifying complicated protective relay schemes, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and identified this issue as an "other priority action" arising from its internal review.

[67] PUB-NLH-164

Liberty's Recommendation:
32. Hydro should not employ any "slow trip" coils where used by backup relay tripping in its air-blast circuit breakers, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and identified this issue as an "other priority action" arising from its internal review. Hydro sets out in its Integrated Action Plan that it will check and if necessary modify protection connections to all air-blast circuit breakers that have slow trip coils.

In addition to the Liberty recommendations in relation to Hydro's protection and control systems discussed above, Hydro concluded based on the results of its own review that certain other activities should be undertaken, including:

i) begin work in relation to relay cards at terminal stations in the second quarter of 2014 with completion in 2015;
ii) document protection philosophy as a Protection and Control Engineering Standard for post 2014; and
iii) review the status of the implementation of recommendations in previous 230kV transmission line protection studies and develop an action plan to implement as many of the recommendations as possible by the end of 2014. Hydro reports that this review was completed in April 2014 and the action plan will be reviewed in May 2014.

Required Key Actions – Protection and Control Systems

Protection and control issues were significant in the January 2014 events. In addition several other issues regarding protection and control systems which should be addressed at this time. Based on the available information the Board believes that the following key actions in relation to protection and control processes and relays should be undertaken by Hydro in the immediate term in preparation for the next two winter seasons.

1. **By December 1, 2014 Hydro should check and modify slow trip coil connections on the air-blast circuit breakers.**

2. **By June 16, 2014 Hydro should file a report in relation to each of the following issues, addressing schedule, estimated costs, the resources required and how these requirements will be met:**
   - **i) A plan to redesign existing breaker failure relay protection schemes to provide that breaker failure will be activated with either a 138 kV or 230 kV breaker malfunction after a transformer failure.**
   - **ii) A plan for the installation of breaker failure relay protection for transformers in terminal stations where breaker failure relay protection is not in place.**
   - **iii) A plan to include experienced protection and control technologists with response teams, where appropriate, beginning in 2014.**
   - **iv) A plan to eliminate the use of slow trip coils in 2014.**
   - **v) A plan to complete work in relation to relay cards in terminal stations in 2014.**

vi) A plan to document its protection philosophy as a Protection and Control Engineering Standard in 2014.

vii) 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.

5.3.4 Alarms and Recording Devices

Hydro advises that many of the alarms that come back to the Energy Control Center from various terminal stations throughout the system are grouped alarms (i.e. multiple devices trigger the same alarm). According to Hydro some of these grouped alarms are inconsistent in naming, and in some cases, consistently named alarms are triggered by inconsistently grouped devices. These inconsistencies created problems during Hydro's investigation, including the ability to identify root causes.[68] The T5 transformer protective device alarm was ineffective because several devices are attached to the same alarm point. Further, the digital fault recorder was not fully functional because of a hard drive failure.[69] In addition Hydro notes that, in the face of the overwhelming volume of data that occurs in an event of this nature, some information was available but not acted upon that could have enabled operations staff to potentially reduce the impact of the outages.[70]

Liberty's recommendations in relation to alarms and recorders as well as Hydro's comments are discussed below.

Liberty's Recommendation:
27. Hydro should update its event and data recording devices and systems to give each type of transformer alarm its own alarm point, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and will evaluate and prioritize alarm points. Hydro sets out in its Integrated Action Plan that it will identify the key set of priority alarms that must be available and reviewed by the operator even during events of this magnitude. Work is to begin immediately but is expected to take several months with implementation beginning in 2015. Also Hydro plans to conduct a review of the alarms that are generated from the various stations and, where practicable, ensure that alarms from the various stations are consistent, with implementation post 2014. In its Integrated Action Plan Hydro sets out that it has established a process for monitoring critical alarms from the Hydro Place UPS on a 24-hour basis. Hydro also sets out that it will provide additional training to operators on the importance of alarms as part of normal training beginning in the third quarter of 2014.

Liberty's Recommendation:
28. Hydro should develop a priority procedure to repair immediately a malfunctioning digital fault recorder (DFR), beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

[68] Hydro Report, March 24, 2014, Volume II, Schedule 8, Appendix 9, page 3
[69] Liberty Report, page 50
[70] Hydro Report, March 24, 2014, Volume II, Schedule 7, page 17

Hydro agrees and sets out in its Integrated Action Plan that it will implement a program to install modern digital relays that are able to store time-synchronized fault data post-2014.

Required Key Actions – Alarms and Recording Devices

The Board believes that the following key actions in relation to its alarms and recording devices should be undertaken by Hydro in the immediate term in preparation for the next two winter seasons.

1. **By August 1, 2014 Hydro should file a report in relation to the following issues, addressing schedule, estimated costs, the resources required and how these requirements will be met, setting out:**
   - i) **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.**
   - ii) **An analysis of the implementation of a program to install modern digital relays for all major equipment such as 230kV transformers.**

5.3.5 Hydro Place Emergency Power

During the power outage on January 4 the generators that provide emergency power to Hydro Place failed. As a result Hydro's energy management system was inoperable for 43 minutes which extended the duration of the customer power outages. There were faults in both of the emergency generators. Hydro explains that the failure of the first generator on January 3 was caused by a faulty rectifier, which has been replaced, and a sticking breaker, which was due for service in April 2014. A cooling issue was the cause of the failure of the second generator. Hydro reports that to address this issue new louver actuators are scheduled to be installed in April 2014 replacing the pneumatic system with more reliable electronically controlled equipment. Hydro reports that it has also established a new protocol with Newfoundland Power so that the power feeder to Hydro Place is not dropped and, if it is dropped, it will be restored as soon as possible.

The Board believes that the emergency generation system for the energy management system is a critical aspect of Hydro's operations. The Board notes that Liberty found Hydro's previous attempts to address the cooling issue to be insufficient though it appears that since the January 2014 events Hydro has undertaken appropriate remedial actions.

Liberty's recommendations in relation to emergency generation at Hydro Place as well as Hydro's findings and comments are discussed below.

Liberty's Recommendation:
26. Hydro should prepare on a high priority basis a documented analysis of ECC emergency generator availability risk, and maintenance procedures, that address regular inspection and repair commensurate with the risks identified, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees. In its Integrated Action Plan Hydro sets out that it will:

i) identify and address the factors which caused under-frequency/synchronization and over-heating issues with the emergency generators;
ii) investigate and rectify problems with ventilation louver control. Hydro reports that the work should be completed by the end of May depending on weather and further that the defective air dryer on the existing pneumatic system has already been replaced; and
iii) investigate options for redundant operation of the Hydro Place diesel generation room cooling system and further that there is redundancy for the ventilation louvers.

Hydro also concluded based on the results of its own review that it should review the design of emergency lighting at Hydro Place.

Required Key Actions – Hydro Place Emergency Power

The Board believes that the following key actions in relation to emergency power for Hydro Place should be undertaken by Hydro in the immediate term in preparation for the next two winter seasons.

1. **By December 1, 2014 Hydro should complete all reasonable and necessary work in relation to the emergency generation system and appropriate emergency lighting at Hydro Place.**

2. **By June 16, 2014 Hydro should file a report in relation to:**
   i) The emergency generation system for Hydro Place addressing the outstanding work, availability risk, and maintenance procedures.
   ii) A plan to ensure that there is adequate emergency lighting at Hydro Place in 2014.

5.3.6 Staffing

Liberty explains that it has concerns that Hydro does not have the level of staffing resources necessary to complete all the work scheduled for 2014 and following. Liberty notes that Hydro has not increased substation full-time employees since 2009 and that Hydro advised that it has not considered using the services of qualified substation maintenance contractors.[71]

Liberty's recommendations in relation to staffing as well as Hydro's findings and comments are discussed below.

Liberty's Recommendation:
34. Hydro should review its substation and protection and control (P&C) staffing needs for the future, in light of the more intense maintenance needs on its aged transformers and circuit breakers, its protective relay replacement and modification work, and upcoming construction

[71] Liberty Report, pages 57-58

work on the new DC lines, beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro does not state that it agrees but explains that it will provide its plan as requested.

Liberty's Recommendation:
35. Hydro should use qualified substation contractor personnel, specializing in substation equipment testing and maintenance, to provide the skilled manpower required to assist with the transformer projects and to catch up with regular scheduled maintenance on transformers and circuit breakers, while crews conduct the air-blast circuit breaker operational tests (exercising), beginning with preparation by June 15, 2014 of a detailed plan and schedule for doing so.

Hydro agrees and explains that it uses qualified specialized contractors where necessary and is assessing this to ensure completion of the 2014 activities. Hydro agrees that a priority near-term focus must be placed on completing the various initiatives identified relative to critical transformers, and addressing any existing maintenance backlogs. Hydro commits to obtaining the right amount and quality of resources to get the necessary work done in a timely manner.

Required Key Actions - Staffing

The Board shares Liberty's concern in relation to the adequacy of Hydro's staffing resources to address the required transmission system and terminal station work. The Board believes that the following key action should be undertaken by Hydro in the immediate term to make sure that it is able to complete the incremental work required to prepare for the coming winters.

1. **By June 16, 2014 Hydro should file a report addressing associated costs in relation to how it will meet its substation and protection and control system resource requirements beginning in 2014.**

5.3.7 Transmission System and Terminal Station Safety

There were a number of transmission system and terminal station safety issues raised as a result of Hydro's reviews. Liberty did not address these issues in its report. Specifically, Hydro sets out that it will:

i) conduct a risk/reward review of the requirements for additional station service redundancy supply at all 230 kV terminal stations and install back-up station service supply where recommended for completion post 2014;
ii) relocate the Sunnyside Terminal Station transfer switch for station service to the control building with the design to be completed in 2014 and the work done in 2015;
iii) specify an engineering standard that the transfer switch should be remote to transformers at terminal stations to be done post 2014;
iv) review the location of other terminal station transfer switches to be done post 2014; and
v) make the PCB contents of all oil filled transformers and equipment available in hard copy locally and at an alternate location.

The Board agrees with Hydro's proposed actions in relation to these safety issues but believes that these items should be resolved in 2014 to the extent possible.

Required Key Actions – Transmission System and Terminal Station Safety

The Board believes that the following key actions should be undertaken by Hydro in the immediate term to address certain transformer and terminal station safety issues arising from the events of January 2014.

1. **By December 1, 2014 Hydro should file a report in relation to transmission system and terminal station safety issues.**

5.4 Board Comments - Winter Readiness 2014-2016

Following the January 2013 outage event at Holyrood, Hydro reviewed its winter readiness efforts with a view to ensuring electricity system readiness in advance of 2013-2014. Hydro explains:[72]

> *Following the January 11, 2013 outage event in Holyrood, Hydro completed a series of activities to assess and further ensure electricity system readiness in advance of the 2013-2014 winter season. In particular, Hydro engaged an external engineering consultant to complete a winter readiness review of the Holyrood generating station, and a number of terminal stations. Other actions taken included completing key winter readiness enhancements based on inspections by Hydro's insurance company; assessing preventative maintenance completion for generating and terminal stations and ensuring that high priority work was completed; and undertaking a boiler and high-pressure steam/water condition assessment at Holyrood to better assess operational and safety risks associated with those systems.*

Despite this deliberate effort toward winter readiness for 2013-2014, in January 2014, only a year later, the Island Interconnected system was again subjected to system-wide disruptions that resulted in widespread outages. While the 2013 outage event only involved the Holyrood Thermal Generating Station, the January 2014 events involved several key assets, both on the generation and transmission system. As discussed in the previous section the causes and contributing factors of this past winter's event relate to many of the same issues reviewed following the 2013 outages. In particular common issues include the areas of ensuring preventive maintenance completion for generating and terminal stations, and ensuring the completion of high priority work in advance of the upcoming winter season. The Board believes that unless Hydro makes significant changes to the operation and management of the equipment the Board believes that the outage events like those of the last two winters will continue to be a very real possibility.

Newfoundland Power commented that Liberty's report outlines serious shortcomings in Hydro's supply planning and equipment maintenance for the Island Interconnected system and that reducing the short-term risk to customers will require significant work to be done by Hydro on

[72] Hydro Report, March 24, 2014, Volume I, pages 22-23

its system prior to the next winter season.[73] The Board agrees that Hydro will have to complete an unprecedented amount of work in a very short time frame to minimize the likelihood of system disruptions like those of January 2013 and 2014. There is also considerable work required to be done by Hydro as part of its reporting requirements. A list of the required key actions and reports is set out in Section 8.

The Board has concerns in relation to Hydro's available resources to complete the required work. Over the last few years Hydro has experienced growing backlogs in several areas of its routine work. The Board has some concerns in relation to the adequacy of Hydro's staff and limited use of external resources. The Board notes Hydro's assurance that it is committed to obtaining the right amount and quality of resources to get the necessary work done in a timely manner. Nevertheless, the Board remains concerned and believes that an immediate priority focus on resources is required if there is to be any hope of substantial completion of the required key actions in advance of the upcoming winter season. As noted by Newfoundland Power *"While creation of such plans and schedules is reasonable, they will not ensure the necessary work is actually done."*

The Board believes that all of this work is critical and should be undertaken immediately. The procurement of the 100 MW (nominal) gas turbine is an important project which, when installed, should improve generation availability. Nevertheless there is a very real possibility that the unit will not be available for the coming winter as a result of the compressed schedule for installation. In addition the Board notes that the major system disruptions of January 2014 were mainly the result of transmission system and terminal station equipment failures. Therefore the Board believes that Hydro should direct its priority efforts to ensuring that existing generation assets are available, securing interruptible load and completing the required work on its terminal station transformers and air-blast circuit breakers.

The costs associated with this level of required work were raised by Hydro and the Consumer Advocate. The Board recognizes that it is important to ensure an appropriate balance between reliability and provision of service at the lowest possible cost. This often requires trade-offs in relation to customer expectations of reliability and costs. However, in the Board's view, the work that has been identified as necessary to be completed is not work that should be assessed in this context. The required key priority actions represent work that is essential to maintaining the integrity of the Island Interconnected system and must be done. For the most part the required work involves the completion of scheduled and recommended work which Hydro and its experts agree needs to be done. The Board expects that Hydro will identify any issues in relation to costs and resources which should be given further consideration and immediately take the appropriate steps to address these issues, which may include seeking further direction or an order of the Board.

[73] Newfoundland Power's Submission, May 2, 2014, page 1

6. COMMUNICATION, COORDINATION AND RESPONSE

Liberty examined a number of areas related to Hydro's and Newfoundland Power's customer service and communications as the utilities responded to the supply shortages and power outages. These areas included customer service accessibility and response as well as public and media communications. Inter-utility coordination was also examined to the extent it may have affected customer outage communications and emergency response. Some technical issues relating to Newfoundland Power's ability to restore power quickly in cold weather conditions were also addressed.

A number of recommendations are set out in Liberty's report addressing action items in the area of customer service and communications, inter-utility coordination and utility response. Many of the recommendations require joint action of both Newfoundland Power and Hydro, which recognizes the unique relationship between the two utilities on the Island Interconnected system. Both Hydro and Newfoundland Power have stated that they are in agreement with Liberty's recommendations in these areas and that action is already underway on a number of items.

The Board has not yet heard from customers. Public presentation sessions are planned to be held during which the Board hopes to hear from customers directly about the impact of the January 2014 outages and any specific customer issues. This input will be considered by the Board as part of its work for the final report. Given that the Board has not yet heard from customers the Board will not address all of Liberty's recommendations in this area at this time. There are some areas, however, that based on Liberty's review should be addressed in advance of the next winter season. These areas include communication issues surrounding the conservation request of January 2 and the rotating power outages as well as inter-utility coordination and information sharing between Newfoundland Power and Hydro.

6.1 Communication

Since it was Newfoundland Power's customers that were primarily affected by the power outages Liberty's review focused mostly on the Newfoundland Power customer experience in relation to communications and customer service.

6.1.1 Conservation Request – Timing and Effectiveness

A public advisory to customers to conserve electricity where possible was issued by Hydro at approximately 2 pm on January 2 when it was evident that there would be insufficient generation available to meet the forecast evening peak on the Island Interconnected system. According to Newfoundland Power it was not provided a copy of this media release and it had to retrieve the release from Hydro's website.[74] Newfoundland Power stated:[75]

> *Newfoundland Power's customers did not receive timely or complete information relating to the insufficiency of available generation on the Island Interconnected System commencing January 2nd, 2014. Two hours before the commencement of rotating power*

[74] Newfoundland Power Interim Report, March 24, 2014, page 33, footnote 83
[75] Ibid, page 44

> *outages on January 2nd, 2014, Newfoundland Power's customers were simply advised of the need to conserve electricity. Customers were not informed of the vulnerability of the Island Interconnected System or the likelihood of power outages later in the day.*

Liberty states that the request was not issued jointly with Newfoundland Power, was issued too late to be effective, and made no mention of potential outages:[76]

> *The decision to request customer conservation was made too late in the day on January 2nd to be actionable. The conservation request advisory was released in the mid-afternoon, when many Newfoundland Power customers were at work. In addition, Hydro did not incorporate Newfoundland Power's input into the advisory, nor did it provide a copy to Newfoundland Power prior to release.*

Liberty suggests that conservation requests should include specific instructions about the actions and timing that would be most beneficial. Liberty also suggests that the conservation request should be made to customers well enough in advance so that customers can take appropriate actions before leaving their residences. The advisory issued on January 2 contained no reference to rotating outages so customers were not aware of this possibility and were not prepared when the outages started 2 hours later.

The Board agrees that the timeliness of any conservation request would appear to be critical to ensuring positive customer response. In this case the urgency of the January 2 request is clear given that rotating power outages started within hours of the issuance of the conservation request. This would have been the first notice that customers would have had on the possibility of a generation shortfall. It could be that the urgency was not appreciated by customers at the time and, coupled with the fact that it was issued later in the day when people were likely not at home, the request may have simply been too late to have made a difference. It is impossible to know whether an earlier request to conserve based on the forecast and knowledge of operating constraints may have avoided or delayed rotating outages.

Specific details on actions and timing that should be undertaken by customers may also be helpful. Based on the media reporting there did seem to be some confusion about what customers should do and where they should go to get information. This information was posted on websites after the fact but was not contained in the initial request nor were there any details on where customers should obtain information. This can be contrasted with what happened on March 3 when an advisory was issued well in advance with information on what to do and when.

Liberty recommends that Hydro and Newfoundland Power should conduct customer research (primarily on a joint basis) in order to better understand customer outage-related informational needs and expectations, including requests for conservation. A customer survey conducted by Newfoundland Power in February 2014 indicated that many of its customers did conserve electricity during the January events. According to Newfoundland Power over 70% of its customers turned off lights but less than half turned off electric heat or delayed clothes or dish washing to off-peak periods.[77]

[76] Liberty Report, page 77

[77] Newfoundland Power's March 24, 2014 Report, page 37

No analysis or measurement of the effectiveness of the conservation requests made during the January outage events has been conducted by Hydro or Newfoundland Power. Liberty suggests that, considering the level of effort needed to effectively communicate the need for conservation, it makes sense to measure the impact, or at least estimate the potential impact, of these conservation requests. In the Board's view it seems reasonable that, if customers are asked to participate in addressing a potential generation shortfall by conserving electricity, then those customers should receive feedback and acknowledgment of the impact they had and whether it made a difference. This feedback may assist in encouraging participation and cooperation in future requests. Liberty also recommends that Newfoundland Power implement goals to communicate better with stakeholders in the aftermath of outages.

The Board notes that Newfoundland Power did not issue the January 2 customer conservation request. The request was made to customers on the Island Interconnected system by Hydro directly. Any future outage communication protocol should address the issue of who should be the responsible utility in the case of conservation requests. The utilities should also work together in research efforts and assessing where improvements should be made.

Hydro and Newfoundland Power have already started work on a number of customer service and communication improvements based on experience and feedback from the January 2014 outages. Hydro acknowledges that there is room for improvement in some areas, particularly with respect to the protocols to be followed for notifying Hydro customers, end users, and the general public in relation to pending supply issues and conservation requests. In its Integrated Action Plan Hydro identified a number of specific actions that are already underway in these areas. Newfoundland Power identified a number of areas for enhancements in its communications efforts based on the results of a customer survey conducted in February 2014. These include pursuing further partnerships with local radio stations to provide regular outage updates, increasing efforts in social media communications, and increased communications efforts on customer conservation in situations of electrical system distress.[78] Newfoundland Power also advised in its submission that it has already made changes to its website to increase speed, capacity and redundancy, and has increased its telephone capacity.

6.1.2 Rotating Power Outages

The rotating power outages in January significantly impacted customers. Many customers experienced multiple outages and there was no advance notification of when and where the outages would occur. While the average duration of the outages decreased over the feeder rotation period the apparent random nature of the outages did appear to be an issue for customers. The outages were especially problematic for businesses that relied on a continual electricity supply for such things as product cold storage or machinery processes. The Board heard from at least one presenter during the pre-hearing conference who described the significant impact of the rotating outages on business.

The issue of advance notice of the timing and location of rotating power outages to affected customers was addressed by Newfoundland Power in its March 24 report. Newfoundland Power acknowledges that this is an alternative, but such an approach would involve planning to remove

[78] Ibid, page 34

large blocks of customers based on the forecast peak load and generation for the planned rotation period. During the January 2014 rotating outages small blocks of customers were taken off-line in an effort to match load to available generation to maximize use of available supply. This minimized the number of customers off-line at one time. Newfoundland Power suggests that scheduling rotating power outages so prior notice is given to customers will result in a greater number of customers being affected by outages.

Liberty recommends that Newfoundland Power and Hydro aggressively pursue a joint process for delivering advance notification for planned rotating outages, in order to facilitate good initial communications with customers during an outage event. The Board agrees that any future communications protocols surrounding conservation requests and potential outages should address advance notification of the timing of any potential rotating outages. The Board notes Newfoundland Power's comments on the issue of scheduling and notice of rotating outages to affected customers. This issue may be one that the utilities might wish to canvass with customers. It may be that some customers, especially commercial operations, may prefer to lose power with notice to be able to plan rather than as part of random feeder rotations.

The Board will make no findings at this time on priority actions in the area of customer communications. The Board believes that it is critical to hear from customers before any such findings are made. In addition the utilities appear to have undertaken a number of initiatives. The Board will request Liberty to review these initiatives and provide an update in its Fall 2014 report on the progress of both utilities in implementing enhancements, both jointly and company-specific, to customer communications protocols surrounding conservation requests and rotating outages as discussed above as well as other initiatives already underway.

6.2 Inter-Utility Coordination

Hydro and Newfoundland Power both share responsibility for serving customers on the Island Interconnected system. Liberty examined this area with a view to determining whether there were any issues with coordination and communication between the utilities that may have contributed to the system events and outages. Liberty found a number of areas where there is a need for improved operational coordination between Hydro and Newfoundland Power, specifically with respect to operational data exchanges and protocols and procedures.

6.2.1 Operational Coordination

Both Hydro and Newfoundland Power agree that routine operational coordination between the utilities is reasonable but acknowledge that the events of December 2013 and January 2014 were not routine. As Newfoundland Power points out January 2 was the first time coordination between the utilities was required to respond to a generation shortfall. Operational coordination between the utilities was required for initiating and executing rotating outages in response to this generation shortfall and opportunities for improvements were identified and implemented during the rotating power outages that resulted in shorter outage durations for customers.

Newfoundland Power raised specific concerns about access to real-time data about Hydro's system status. According to Newfoundland Power limited access to real-time information from

Hydro regarding available generation and customer demand on the Island Interconnected system can have a significant impact on Newfoundland Power's operational preparedness and decisions. As Newfoundland Power points out this is not an issue the majority of the time but in non-routine events such as January 2014 this lack of information effectively restricts its ability to provide information to its customers on the status of electricity supply. Newfoundland Power is in the position of having to rely on Hydro and that such information will be forthcoming as needed and in timely fashion.

Operational coordination is also critical during unplanned outage events. As discussed previously there was 30-minute interruption of power to about 29,000 Newfoundland Power customers on January 8, 2014 because Hydro did not make Newfoundland Power aware of issues with reduced transformer capacity. Newfoundland Power had discussed the need to add load to this line with Hydro's Energy Management Center prior to the event.

Liberty points out that discussions are ongoing between the utilities on these specific coordination matters. Several joint efforts have also been recommended by Liberty in areas of customer research and communication issues which will require further cooperation and coordination. Liberty acknowledges that each company demonstrates "conceptual commitments in a number of areas" where goals, structures, protocols, programs and activities should be common but suggests that this effort should be formalized. To that end Liberty recommends that Hydro and Newfoundland Power commit to a formal effort, sponsored at their most senior executive levels, to work together in formulating joint efforts to identify goals, protocols, programs, and activities that will improve operational and customer information and communications coordination, leading to the development of identified membership on joint teams, operating under senior executive direction and according to clear objectives, plans and schedules. The Board notes that Hydro states that this initiative is already underway and that an initial meeting has already taken place.

Liberty proposes to examine progress in this area as part of their work leading up the Fall 2014 report.

6.2.2 Information Sharing

Newfoundland Power suggests that provision of industry standard forward-looking information regarding supply and demand on the Island Interconnected system will contribute to improved transparency in situations of possible system generation shortage. Clear regulatory guidelines governing when and how customers will be advised of forecast generation supply would be consistent with sound public utility practice. Newfoundland Power acknowledges that this won't address the adequacy of generation issue but will provide customers with accurate and timely information concerning the reliability of that service.

The Board notes the information provided by Newfoundland Power on sample regulatory protocols in various jurisdictions for system shortages. A review of this information suggests that most jurisdictions develop their own protocols for customer notices and communications. The specific protocols depend on the system structure. Some include multiple communications

streams; others single public appeals. While the regulatory protocols differ all recognize that information flow between utilities is critical to reliable operation of electricity system.
On January 10 the Board required that Hydro file by 9 am each morning a 5-day forecast of its system supply and demand. These Supply and Demand Status Reports are provided to Newfoundland Power and made available publicly on the both the Board's and Hydro's website. The Board will continue to require these reports be filed. Newfoundland Power suggests that this information be expanded to include real-time information on generation availability and demand for the Island Interconnected system.

Newfoundland Power advises that it is currently in discussions with Hydro concerning better access to additional information including Hydro's load forecast and assessment of generation availability for the Island Interconnected system. The Board will monitor progress by the utilities in this area.

6.2.3 Feeder Restoration Issues

Newfoundland Power describes the difficulties encountered with cold-load pickup[79] during the evening of January 2 when it was re-energizing feeders to bring customers back on-line. This extended the outage duration for some customers. System control limitations on transmission and distribution systems, such as lack of automation on some feeders and the absence of transmission line breakers on certain systems, reduced Newfoundland Power's flexibility in implementing feeder rotations.

On April 4 Newfoundland Power filed a supplementary 2014 capital budget application with the Board for approval of several capital projects to address system capacity and control limitations identified during the system events of January 2014. The proposed work includes distribution feeder improvements and substation refurbishments. These projects will improve Newfoundland Power's ability to deal with cold-load pickup and reduce the risk of future extended outages. The Board approved the capital projects and the associated 2014 expenditure of approximately $2.9 million in Order No P.U. 14(2014). These projects will be completed in advance of the 2014-2015 winter season.

Liberty recommends that lessons learned about Newfoundland Power's service restoration issues, such as cold-load pickup, should be incorporated into emergency response procedures and training of employees.

Required Key Actions – Inter-Utility Coordination

1. **By December 1, 2014 Hydro and Newfoundland Power should make improvements in operational and customer information and communications coordination.**

2. **By December 1, 2014 Hydro and Newfoundland Power should file a joint report on progress towards enhancements and improvements in operational and customer information and communications coordination.**

[79] Cold load pickup is the additional electrical demand which occurs when a feeder is reconnected.

7. IMPLEMENTATION AND NEXT STEPS

In this interim report the Board has identified those key priority action items that it believes should be undertaken immediately to reduce the risk of a reoccurrence of the outage events of January 2014. These action items are for the most part those that, in the Board's view, can and must be done to ensure optimum system readiness in advance of the upcoming winter season. The majority of priority action items are related to Hydro's system. Timely completion will require a dedicated and focused effort by Hydro.

The Board's role in this investigation is to ensure the provision to consumers of service that is "reasonably safe and adequate and just and reasonable", as set out in the *Public Utilities Act*. The parameters of the Board's supervisory and oversight role do not extend to managing the actions of the utilities. The powers of the Board are regulative and corrective. The Board is not the manager of the utility and should not as a general rule substitute its judgment on managerial and business issues for that of the officers of the enterprise.

In exercising its oversight role in this matter, and given the interim findings in this investigation, the Board believes it will be necessary to put in place a reporting and monitoring process to track the progress of the key priority actions and reports required. The Board notes the comments and concerns of Hydro's largest customers, Newfoundland Power and the Industrial Customer Group, in relation to the need for oversight and monitoring.

The Industrial Customer Group submits that Hydro should be required to file monthly updates in relation to the schedules and implementation of testing with the aim of assuring maximum implementation of these recommendations by December 1, 2014. In relation to the recommendations that are viewed as longer term the Industrial Customer Group suggests that the detailed plans filed by Hydro should be made available to the parties and that Hydro should file periodic status updates with the Board.

Newfoundland Power submits:[80]

> *To mitigate the increased risk to customers which will exist for the next winter season will require action on the part of the utilities. Many Liberty recommendations call for the creation of plans and schedules by June 15, 2014. While creation of such plans and schedules is reasonable, they will not ensure the necessary work is actually done.*
>
> *Accordingly, following submission of these plans, the Board should consider (i) increased oversight and/or (ii) specifically ordering that certain work be done. This will reduce the risk to customers associated with current vulnerabilities on the Island Interconnected System for the upcoming winter season.*

As noted previously the Board is also concerned that Hydro's plan for the addition of new generation is ambitious and further this work should not impact completion of the key priority actions identified with respect to winter readiness of existing generation and transmission assets. It is critical that these key priority actions completed, and even more so if the new generation

[80] Newfoundland Power's Submission, May 2, 2014, page 2

addition is not completed within the planned time frame. To that end the Board will put in place an oversight framework to monitor Hydro's efforts and progress in completing all the priority actions identified by the Board in this interim report. This oversight framework will incorporate the plans and schedules to be provided by Hydro.

The Board acknowledges that in its Integrated Action Plan Hydro has identified a number of action items that arise out of its own internal review. Hydro explains that this is a "first cut" at prioritizing and there is a lot of commonality between Hydro's and Liberty's recommendations, although Liberty's recommendations are not referenced. This is a good first step. The Board believes that Hydro should complete this document by incorporating the key priority actions and reports and aligning action items with priorities, resources and schedules. This updated action plan should be filed with the Board.

Required Key Action – Implementation

1. **By June 2, 2014 Hydro should file an updated Integrated Action Plan.**

Over the next several months the Board will continue its investigation and hearing. Liberty will complete its review of the main areas of inquiry discussed in its Interim Report and will provide further conclusions and recommendations on Hydro's planning criteria, Hydro's forecasting methodology, Hydro's and Newfoundland Power's asset management strategies, the reliability and adequacy of the Island Interconnected system, the actions taken for winter season readiness, customer service strategies and emergency response strategies, and any other issues that arise in the course of the investigation.

A review and analysis of the implications for the reliability of the Island Interconnected system arising from interconnection with the Muskrat Falls generating station will be completed as a part of this work. Given the issues raised in Liberty's interim report related to work prioritization, resourcing and staffing, the Board will also request Liberty to undertake additional inquiry into these areas.

Public presentation sessions will be held in June to give customers an opportunity to present to the Board in relation to the January 2014 system events and outages and how they were impacted. The final report of the Board, which will be released in early 2015, will follow a full public hearing process and further public input and will set out any additional actions that will be required of the utilities to address any concerns or issues identified throughout.

8. SUMMARY OF KEY PRIORITY ACTIONS AND REPORTS

8.1 Key Priority Actions

Load Forecasting and Generation Planning

By December 1, 2014 Hydro should:

i) Implement changes to its short-term forecasting process to appropriately incorporate impacts of weather conditions and any significant load changes, from losses or otherwise, resulting from varying system configurations.

ii) Incorporate sensitivity analyses to weather extremes in all forecasting and supply and planning decision evaluations.

Generation Availability

By December 1, 2014 Hydro should:

i) complete the work necessary to ensure winter readiness of its generation assets.

ii) address the issue of critical spares of its generation assets.

iii) complete negotiations in relation to interruptible load and, to the extent that it can secure economically available interruptible load, have a contract in place.

iv) complete the procurement and installation of the 100 MW (nominal) gas turbine.

Terminal Station Transformers

By December 1, 2014 Hydro should:

i) Complete all 2014 and outstanding prior year testing and maintenance on critical transformers.

ii) Take appropriate action in relation to critical transformers which have questionable levels of combustible gases.

Air-Blast Circuit Breakers

By December 1, 2014 Hydro should:

i) Properly exercise all air-blast circuit breakers.

ii) Complete all 2014 and outstanding prior year testing and maintenance on its critical air-blast circuit breakers.

Protection and Control Systems

By December 1, 2014 Hydro should check and modify slow trip coil connections on the air-blast circuit breakers.

Hydro Place Emergency Power

By December 1, 2014 Hydro should complete all reasonable and necessary work in relation to the emergency generation system and appropriate emergency lighting at Hydro Place.

Inter-Utility Coordination

By December 1, 2014 Hydro and Newfoundland Power should make improvements in operational and customer information and communications coordination.

8.2 Key Priority Reports

Load Forecasting and Generation Planning

1. By October 31, 2014 Hydro should file a status report in relation to the changes to its short-term forecasting and the incorporation of sensitivity analyses.

Generation Availability

1. By June 16, 2014 Hydro should file a report in relation to each of the following issues addressing schedule, estimated costs, the resources required, and how these requirements will be met:
   i) A generation master plan for winter preparation, including a plan to implement an availability improvement program on all generating assets and its maintenance program for the Holyrood Thermal Generating Station.
   ii) A plan in relation to critical spares for the Holyrood Thermal Generating Station and the Hardwoods and Stephenville gas turbines.
   iii) A plan in relation to securing economically available interruptible loads.

2. By October 1, 2014 and December 1, 2014 Hydro should file status reports with the Board in relation to winter readiness of its generation assets.

Terminal Station Transformers

1. By June 2, 2014 Hydro should file a report in relation to the work required to be done in 2014 with regard to transformers, addressing schedule, estimated costs, the resources required, and how these requirements will be met, setting out:
   i) A list of critical transformers and an explanation as to how this determination was made;
   ii) A list of all transformers showing gas analysis results for the period 1993-2013;
   iii) A plan for testing in 2014 for all transformers with questionable levels of combustible gases;
   iv) A plan to complete the 2014 and overdue testing and maintenance on critical transformers in 2014; and
   v) A plan to complete the 2014 and overdue testing and maintenance on the remaining transformers.

2. By June 16, 2014 Hydro should file reports with the Board in relation to the following transformer issues:
   i) System studies in relation to the relocation of the repaired T5 transformer from Western Avalon to Sunnyside, including a plan to address potential further failures.
   ii) A study in relation to the availability and necessity of a replacement transformer for T5 at Western Avalon, addressing schedule, estimated costs, the resources required, and how these requirements will be met.
   iii) A plan for the study to determine if abnormal system disturbances may have caused the T5 failure at Western Avalon.

Air-Blast Circuit Breakers

1. By June 2, 2014 Hydro should file a report in relation to the work required to be done in 2014 with regard to its air-blast circuit breakers, addressing schedule, estimated costs, the resources required, and how these requirements will be met, setting out:
   i) A plan for the proper exercise, preferably in cold weather, of all air-blast circuit breakers annually beginning in 2014;
   ii) A list of critical air-blast circuit breakers and an explanation as to how this determination was made;
   iii) A plan to complete 2014 and overdue testing and maintenance on critical air-blast circuit breakers in 2014;
   iv) A plan to complete 2014 and overdue testing and maintenance on the remaining air-blast circuit breakers;
   v) A plan to periodically operate air-blast circuit breakers from protective relays;
   vi) A plan to conduct an in-depth analysis of the DC system for B1L03 to determine if any high impedance paths exist that may affect its operation;
   vii) A plan to conduct a review of the annual air system leak check preventive maintenance to ensure that it is adequate in both scope and timing of execution to accurately identify leaks at the Sunnyside Terminal Station; and
   viii) A plan to review the current approach to air-blast circuit breaker re-lubrication, addressing why the DOW 55 grease was not removed during the 2007 re-lubrication.

2. By August 1, 2014 Hydro should file a report in relation to each of the following issues in relation to its air-blast circuit breakers addressing schedule, estimated costs, the resources required, and how these requirements will be met:
   i) Acceleration of the preventive maintenance cycle for air-blast circuit breakers.
   ii) Acceleration of the replacement of air-blast circuit breakers.
   iii) Changes to internal procedures and documents addressing: the application of the protective coating to air-blast circuit breakers; false indications of the open/close state; and a specific pass/fail criteria for the timing test of the air-blast circuit breaker preventive maintenance check sheet.

Protection and Control Systems

1. By June 16, 2014 Hydro should file a report in relation to each of the following issues, addressing schedule, estimated costs, the resources required, and how these requirements will be met:
   i) A plan to redesign existing breaker failure relay protection schemes to provide that breaker failure will be activated with either a 138 kV or 230 kV breaker malfunction after a transformer failure.
   ii) A plan for the installation of breaker failure relay protection for transformers in terminal stations where breaker failure relay protection is not in place.
   iii) A plan to include experienced protection and control technologists with response teams, where appropriate beginning in 2014.
   iv) A plan to eliminate the use of "slow trip" coils in 2014.
   v) A plan to complete work in relation to relay cards in terminal stations in 2014.

vi) A plan to document its protection philosophy as a Protection and Control Engineering Standard in 2014.
vii) 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.

Alarms and Recording Devices

1. By August 1, 2014 Hydro should file a report in relation to the following issues, addressing schedule estimating costs, the resources required, and how these requirements will be met, setting out:
   i) 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.
   ii) An analysis of the implementation of a program to install modern digital relays for all major equipment such as 230 kV transformers.

Hydro Place Emergency Power

1. By June 16, 2014 Hydro should file a report in relation to:
   i) The emergency generation system for Hydro Place addressing the outstanding work, availability risk, and maintenance procedures.
   ii) A plan to ensure that there is adequate emergency lighting at Hydro Place in 2014.

Staffing

1. By June 16, 2014 Hydro should file a report addressing associated costs in relation to how it will meet its substation, and protection and control system resource requirements beginning in 2014.

Transmission System and Terminal Station Safety

1. By December 1, 2014 Hydro should file a report in relation to transmission system and terminal station safety issues.

Inter-Utility Coordination

1. By December 1, 2014 Hydro and Newfoundland Power should file a joint report on progress towards enhancements and improvements.

Implementation

1. By June 2, 2014 Hydro should file an updated Integrated Action Plan.

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