

April 10, 2015

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

ATTENTION: Ms. Cheryl Blundon
Director of Corporate Services & Board Secretary

Dear Ms. Blundon:

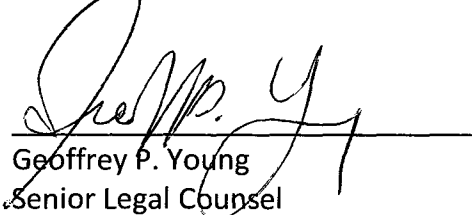
**Re: Newfoundland and Labrador Hydro – Power Outage/Incident Advisory
2015-H-062 - March 4, 2015**

Further to your letter of March 19, 2015 regarding the above referenced report, enclosed please find the original and 12 copies of Hydro's report entitled "March 4, 2015 Power Outage Report (*Power Outage/Incident Advisory 2015-H-062*)". This report is the result of Hydro's investigation of the March 4 event, identifying causes and enhancements to address them.

Should you have any questions or comments, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO



Geoffrey P. Young
Senior Legal Counsel

GPY/jc

**A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES**

March 4, 2015 Power Outage Report

(Power Outage/Incident Advisory 2015-H-062)

NEWFOUNDLAND AND LABRADOR HYDRO



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Stakeholder Advance Notification Protocol

1 **1.0 Events Overview**

2 On the morning of March 4, 2015, Newfoundland and Labrador Hydro (Hydro) was in the
3 process of returning Unit 1 at the Holyrood Thermal Generating Station (Holyrood TGS) to
4 service following a planned emergency maintenance outage. A contingency plan was in
5 place for the duration of that maintenance outage to ensure adequate electricity supply to
6 customers. The Island Interconnected System generation reserves in the days and hours
7 prior to the morning peak of March 4 were monitored and considered adequate for supply
8 to customers.

9

10 At 00:28 hours on March 4, the Holyrood TGS advised Hydro's Energy Control Centre (ECC)
11 that Unit 1 could be delayed coming on line. At 05:24 hours on March 4, the Holyrood TGS
12 confirmed to Hydro's ECC that Unit 1 would not be on for the morning peak. The
13 contingency plan to have the Holyrood Combustion Turbine (CT) on line for the morning
14 peak had been initiated the previous afternoon. However, shortly after 06:00 hours Hydro
15 experienced unanticipated starting issues with the Holyrood CT, affecting reserves on the
16 Avalon Peninsula.

17

18 The combination of both these units being unavailable as customers' morning demand
19 rapidly increased caused system voltages to decline on the Avalon to a point where the
20 Come by Chance capacitor banks low voltage trip setting was reached. This capacitor bank
21 trip further reduced voltages on the Avalon, which tripped Holyrood Unit 3. Customers
22 subsequently experienced power interruptions commencing at 07:14 hours. At the height of
23 the power interruption, at approximately 07:20, 83,000 customers were affected.

24

25 Hydro personnel, in conjunction with Newfoundland Power (NP), responded immediately to
26 restore power in a safe and efficient manner. The Holyrood CT was brought on line at 07:25,
27 and within 20 minutes approximately 20,000 customers were restored. By 08:15 hours a
28 total of over 50,000 customers had been restored. By 10:30 hours, the majority of
29 customers were restored. The remaining customers were restored by 12:32 hours.

1 Hydro is very aware of the customer impacts that resulted from this outage and is
2 committed to making necessary adjustments to ensure the provision of safe and reliable
3 electricity to customers in the province. Hydro has completed an investigation into the
4 primary causes of the event and enhancements have been implemented to address these
5 primary causes.

6

7 **2.0 System Status Prior to March 4, 2015**

8 Holyrood Unit 1 experienced an oil leak on a generator bearing that required a planned
9 emergency repair. The leak was first identified during routine inspection by plant operations
10 on February 17, 2015. The leak was then monitored to determine severity and manage the
11 risk to the Unit. As the leakage rate increased, planning for remedial repair was undertaken
12 which included identifying a suitable outage window in light of forecast system loads and
13 reserve generation levels. The most suitable timeframe for an outage to undertake the
14 repairs to Unit 1 was determined to be Friday, February 27, 2015 at 12:00 hours to Tuesday,
15 March 3, 2015, at 20:00 hours.

16

17 Hydro plans for an N-1 contingency which means that adequate electricity supply to the
18 Island Interconnected System can be maintained even with the forced removal of the largest
19 generating unit in service at that time. As part of the planning process for the required
20 outage on Unit 1, Hydro's System Planning Department performed an Avalon load flow
21 analysis to support the appropriate use and associated unit loading of standby generation to
22 successfully cover N-1 contingencies. The scenarios tested in the load flows included using
23 Hydro's standby generation to cover single contingencies, such as the loss of transmission
24 lines TL202 or TL206,¹ or one Holyrood unit.² The results of the load flow analysis indicated
25 Hydro would plan to operate the Hardwoods, Stephenville and the new Holyrood
26 combustion turbines as required during peak demand periods during the planned Unit 1
27 outage. Consistent with this plan, the turbine units were operated successfully during the

¹ TL202 and TL206 are the two primary transmission lines feeding power from Bay d'Espoir into the Avalon electrical grid via the Sunnyside Terminal Station.

² Loss of a unit at Holyrood was tested as it would be the largest unit generating.

1 days of February 28 through March 3.³ Island Interconnected System reserves on these days
2 ranged from 363 MW to 565 MW. Further, voltages on the system were maintained within
3 normal ranges during the period Unit 1 was offline prior to the morning of March 4.

4
5 On March 3, the planned and expected available Island Interconnected System generation
6 reserves for the following morning peak of March 4, was 350 MW without Holyrood Unit 1
7 available and 520 MW with it available. Reserves for both situations were deemed to be
8 adequate and these reserve levels were well in excess of defined triggers for public
9 notification.⁴

10
11 The new combustion turbine at Holyrood was fully available leading up to the event and had
12 been started eight times without incident in the 14 days prior to March 4, with no failed
13 starts during that period.

14
15 Holyrood Unit 1 was planned to be back in service in the evening of March 3, prior to the
16 morning peak on March 4. The precise timing of the return could fluctuate based on how
17 much it had cooled down during repairs, as well as time to achieve required hydrogen
18 purity⁵ in the generator's cooling system. Further on March 3, in accordance with the
19 expected demand on March 4, the standby units of Hardwoods CT, Stephenville CT and the
20 Holyrood CT were scheduled to be placed online by approximately 06:00 hours on March 4,
21 in advance of the morning peak demand.

³ The peak on February 27 of 1,432 MW was experienced in the morning at 08:10, prior to Unit 1 being removed from service.

⁴ As outlined in the *Joint Storm/Outage Communications Plan for Newfoundland Power and Newfoundland and Labrador Hydro Appendix F –Island Interconnected System Forecast Supply Shortfall - Customer and Stakeholder Advance Notification Protocol*.

⁵ The process of gassing up involves first purging the air from the generator with carbon dioxide gas, and then purging the carbon dioxide gas with hydrogen gas until hydrogen the purity level reaches the specified target of 90%.

1 **3.0 March 4, 2015**

2 Unit 1 at Holyrood was delayed in returning to service in the overnight period of March 3
3 /March 4. This was due to a longer than expected process of obtaining the required
4 hydrogen gas purity inside the generator. Hydrogen gas is used to cool the unit's generator
5 during normal operation. In this case, the generator had to be initially degassed of hydrogen
6 to make it safe to work, and then gassed back up with hydrogen after the work was
7 completed. The delay in returning Unit 1 to service resulted in lower generation reserves for
8 the morning peak. However, the level of system generation reserves without Unit 1 at the
9 forecast morning peak did not require any communication as per the *System Forecast Supply*
10 *Shortfall - Customer and Stakeholder Advance Notification Protocol* (see Appendix B).

11
12 The Advance Notification Protocol was developed to communicate based on forecast
13 generation shortages for the entire Island Interconnected System. The events of March 4
14 resulted from events which unfolded quickly between 06:10 and 07:15, with no advance
15 warning of generation shortages, and therefore no opportunity to advise customers in
16 advance according to the Protocol.

17
18 System load generally grows at a similar rate each day, while the final peak varies as a result
19 of many factors. Preparation for the morning peak of March 4 began with Hydro's ECC
20 operators coordinating the generation plan that places adequate supply on line for the
21 peak.⁶ The preparations involved requesting NP to maximize its hydraulic generation and
22 placing the Hardwoods, Stephenville and Holyrood CTs on line.

23
24 The Holyrood CT failed to start at 06:12 hours and had other unsuccessful start attempts up
25 to 06:30 hours. Staff on site at the CT immediately began to troubleshoot the failed starts.
26 As the CT troubleshooting was ongoing, Hydro ECC operators implemented alternatives to
27 the Holyrood CT coming on line. This involved requesting NP to place its Greenhill and
28 Wesleyville CTs on line as well as requesting a 20 MW block of capacity assistance from

⁶ See Appendix A, which details the sequence of events for March 4, 2015.

1 Corner Brook Pulp and Paper (CBPP) at 06:36 hours. At this time voltages were starting to
2 decline but were still within acceptable operating ranges.⁷ At 06:45 hours generation
3 reserves were adequate at 259 MW.

4
5 From 06:48 to 07:14 hours Hydro continued to implement additional measures in advance of
6 the peak to stabilize the system; including adding more capacity assistance⁸ and ensuring
7 generating units were at maximum voltage support. At 07:04 hours, Hydro was
8 communicating with NP on the system conditions and indicated that load would soon have
9 to be shed due to declining voltages. Voltages were within acceptable ranges up to
10 approximately 07:09 hours.

11
12 Generation reserves leading up to the moment of the outage remained adequate. At 07:10
13 hours, reserves were 230 MW.

14
15 Prior to the System Operators undertaking any load shedding, at 07:14 hours the four
16 capacitor banks at Come by Chance Terminal Station tripped when the voltage at the
17 terminal station fell below 85%, causing the operation of the under voltage protection relays
18 on all four banks. This resulted in further and sudden decline in the voltage resulting in the
19 concurrent trip of a number of units and systems between 07:14 and 07:15 hours,⁹ including
20 Holyrood Unit 3, Hardwoods GT, Stephenville GT and Star Lake.

21
22 The low voltages on the system and subsequent loss of generation resulted in under-voltage
23 protection mechanisms to trigger power interruptions at various substations and
24 transmission lines. Therefore, approximately 57,000 customers lost power. With the
25 shutdown of the Hardwoods GT, and Holyrood Unit 3, system voltages remained low and
26 therefore, Hydro requested NP to shed more load. At 07:19, NP shed load at an additional

⁷ Acceptable normal steady state voltage range is 95%-105%, emergency range is 90% to 110%.

⁸ 07:00 hours – requested 10 MW from Vale, 07:08 hours – CBPP capacity assistance increased to 60 MW.

⁹ See Appendix A for details on the various trips and specific times.

1 31 feeders resulting in the voltage recovering. At this time, the total number of customers
2 experiencing a power interruption was 83,000.

3

4 **3.1 Communication**

5 Hydro's Corporate Communications was advised of the events at 07:18 hours on March 4.
6 Due to the uniqueness of the situation, there was time required to gather information,
7 connect with appropriate parties and communicate accurately with the public.

8

9 As previously noted, the generation reserves in the days and hours prior to the morning
10 peak of March 4 were monitored and considered adequate for supply to customers.
11 Reserves on these days ranged from 363 MW to 565 MW.

12

13 With these generation reserves there was no communication required as per the *System*
14 *Forecast Supply Shortfall - Customer and Stakeholder Advance Notification Protocol*. The
15 Advance Notification Protocol was developed to communicate based on forecast generation
16 shortages for the entire Island Interconnected System. The events of March 4 unfolded
17 quickly between 06:10 and 07:15 hours, with no advance warning of generation shortages,
18 and therefore no opportunity to advise customers in advance according to the Protocol.

19

20 However, at 07:29 NP's Director of Operations advised NP Communications to ask customers
21 to conserve and prepare for rotating outages. The rotation of power to customers equated
22 to a Power Emergency, as per the *System Forecast Supply Shortfall - Customer and*
23 *Stakeholder Advance Notification Protocol*. A Power Emergency occurs during a generation
24 shortfall when conservation and power rotation is in effect.

25

26 The first communications statement was made on Twitter at 07:53. This was followed by
27 subsequent posts identifying the Power Emergency alert and requesting conservation.
28 Information was posted to Hydro's website and interviews were conducted with local media
29 outlets. A press conference was held jointly with NP at 13:30 hours.

1 The new Joint Storm/Outage Communications Plan, finalized with NP in December 2014 was
2 followed on March 4. All timelines outlined in the report for communications activities were
3 met.

4

5 **3.2 Restoration**

6 The restoration process began immediately. At 07:25 hours, the Holyrood CT was
7 successfully placed on line. Newfoundland Power restored power to 20,000 customers
8 between 07:27 and 07:41. At 07:29 hours Hydro confirmed with NP that a loss of supply
9 would remain until Unit 3 was returned to service. At this point Hydro expected Unit 3 to be
10 returned to service within a couple of hours.

11

12 Various systems, generators, transmission lines/distribution lines were started to be placed
13 back in service, including affected NP feeder lines and distribution systems. As this was
14 accomplished, customers' power was restored. At 07:36, NP started restoring customers off
15 the Avalon Peninsula as there was adequate generating capacity off the Avalon. NP also
16 decided to begin rotating feeder interruptions in St. John's between 08:05 and 10:30 hours,
17 affecting 17 feeders for an average of 41 minutes each.

18

19 Holyrood Unit 3 returned to service at 10:14 hours, and all customers in St. John's were
20 restored at 10:16 hours. All customers were restored in Placentia Bay and St. Mary's Bay at
21 10:30 hours and the remaining customers in Conception Bay North were restored by 12:32
22 hours. Holyrood Unit 1 was back in service at 16:00 hours on March 4.

23

24 Service to Vale (Long Harbour facility) was restored at 07:45 hours, while North Atlantic
25 Refining was informed that it could resume normal operations at 10:30 hours by Hydro's ECC
26 Supervisor.

1 **4.0 Event Observations and Analysis**

2 Throughout the planning stages for the Holyrood Unit 1 maintenance outage, generation
3 reserves were expected to be adequate, and Unit 1 was expected to be back on line for the
4 morning peak of March 4. If Unit 1 did not come back on line in time for that morning peak,
5 reserves would be reduced and would still remain adequate with the utilization of other
6 generation resources which included the Holyrood CT. As generation reserves were
7 adequate with or without Holyrood Unit 1, Hydro did not notify customers of any system
8 vulnerability in accordance with the *System Forecast Supply Shortfall - Customer and*
9 *Stakeholder Advance Notification Protocol* previously filed with the Board.

10

11 **4.1 Primary Cause 1**

12 Unit 1 at Holyrood was delayed in returning to service. The hydrogen cooled generator had
13 been degassed to air to make it safe for repair work to proceed. The process of gassing up
14 again for normal operation involves displacing the air with carbon dioxide, then the carbon
15 dioxide with hydrogen. Hydrogen purity has to meet the 90% purity target before the unit
16 can be released for safe and reliable service. In this instance, this process took longer than
17 normally anticipated.

18

19 **4.2 Primary Cause 2**

20 The Holyrood CT had operated successfully in the days leading up to March 4. There were
21 no failures to start. The failure to start on March 4 was due to the incorrect flow rate of fuel
22 from a fuel valve. When the unit was called to start, the flow rate was too high. The original
23 design of the fuel valve and its surroundings did not include protection from inadvertent
24 bumping or protection from movement through vibration. It has been determined that no
25 changes to the fuel valve position were made by the construction, commissioning, or
26 operations staff.¹⁰ The possible reasons for the fuel valve coming out of proper adjustment
27 include inadvertent contact with the valve or through a means such as vibration.

¹⁰ The fuel valve is manually adjusted, not adjusted through a computer program.

1 The generation reserves for the Island system were adequate leading into the morning of
2 March 4. However, the load on the Avalon Peninsula was demanding increased power from
3 the transmission lines into the Avalon. More power had to be transmitted across the
4 transmission lines due to the reduced generation on the Avalon.¹¹ This increased load on
5 the transmission lines resulted in low voltage on the system, which initiated system
6 equipment protection to operate.

7

8 Voltages normally fluctuate and therefore, there are acceptable ranges of which the voltage
9 can reside and still provide a stable system. The voltage was declining in the 30-45 minutes
10 prior to the series of concurrent interruptions at 07:14 hours. Hydro operators were
11 coordinating adjustments to the system throughout this period to accommodate the
12 Holyrood CT not coming on line as well as for the voltage decline. The voltage levels did not
13 reach unacceptable levels until five-ten minutes before 07:14, at which time the interruption
14 started.

15

16 Hydro operators and NP operators worked to manage the declining voltage by adding as
17 much generation as was available and ensuring the generation that was on line was at
18 maximum voltage support. They also planned to shed load to prevent further decline of the
19 voltage.

20

21 Prior to taking manual action to shed load, the system voltage dropped to a level where the
22 four capacitor banks at Come By Chance tripped on low voltage protection. This occurred
23 when the voltage reached 85%. It was immediately following the moment that the capacitor
24 banks tripped, that the majority of the unit and system trips occurred.

25

26 Hydro does not currently have an under-voltage load shedding scheme that automatically
27 drops a controlled amount of load in the event of a system under-voltage condition. The
28 method of managing system under-voltage would be the method employed on March 4,

¹¹ Holyrood Unit 1 and the CT were not available as the load increased for the morning peak.

1 where operators monitor voltage and intervene to drop load as required. An automated
2 scheme, such as the one that exists for system under-frequency, removes the manual
3 intervention.

4
5 Operators and field staff continued to work safely and efficiently to restore power as quickly
6 as possible following the power interruption. The delayed restoration of power to customers
7 following the return to service of Unit 3 was related to some feeders having no remote
8 SCADA control and other feeders being challenged with cold load pickup.¹²

10 **5.0 Electrical System Enhancements**

11 The Holyrood CT fuel valve has been temporarily mechanically secured to prevent any future
12 unintentional movement from the set position due to inadvertent contact or mechanical
13 vibration. Therefore, the fuel flow rate is secure. An engineered device to lock the valve
14 adjustment in position has been procured from the manufacturer and will be installed when
15 received.

16
17 The under-voltage protection settings for the Come By Chance capacitor banks have been
18 reviewed by Hydro's System Planning, Protection and Control Engineering, and System
19 Operations groups, as well as with NP's Operations and Engineering staff in light of the
20 March 4 incident. The result was a recommendation to change the under voltage time delay
21 protection setting of 60 cycles at 85% voltage to a new setting of 16,000 cycles (4.4 minutes)
22 at 50% voltage. The previous settings were conservative and based on System Planning
23 recommended settings in the context of a transmission line disturbance. The March 4
24 incident was a different scenario involving low voltages driven by reduced generation on the
25 Avalon specifically. The new settings of 16,000 cycles at 50% voltage have been reviewed
26 and confirmed technically appropriate for this specific installation by Hydro's System

¹² Cold load pick up occurs when a distribution feeder is restored after an extended outage. The demand is greater than before the outage. Attempting to restore the feeder can be difficult because the initial load demand after an outage can exceed the load demand that would have been observed at any time before the outage.

1 Planning, and Protection and Control Engineering groups and were implemented on March
2 12, 2015.

3
4 A draft report on the feasibility of applying an under voltage load shedding scheme to NP's
5 66 kV transmission system is being reviewed by Hydro's System Operations group and
6 Newfoundland Power. A follow up meeting will be held to finalize any feasible actions. An
7 implementation plan of feasible actions will follow.

8

9 **6.0 Customer Communications Enhancements**

10 Hydro has reviewed the communication processes for the March 4 event. Although the
11 existing Advance Notification Protocol did not apply to the situation as the generation
12 reserves were adequate up until a few minutes prior to the event occurring, Hydro has
13 identified an opportunity to review its communication protocols to ensure all system
14 vulnerabilities are identified and appropriately communicated to the public. This may
15 include, but not be limited to, (in planned or unplanned circumstances) when large
16 generators are out of service, when major transmission lines are out of service, or when
17 other related equipment is out of service and posing significant system risk. Hydro has taken
18 action and enhanced communications protocols have been drafted and are currently
19 undergoing final review. In addition, although the Joint Storm/Outage Communications Plan
20 was followed, and timelines were met, Hydro is recommending that adjustments should be
21 made to some of the targets. During the development of the Joint Storm/Outage
22 Communications Plan, it was identified and recognized that the plan may evolve. Any
23 adjustments to the Plan will be made in coordination and agreement with NP.

24

25 Holyrood Operations and ECC Operations have reviewed the inter-group communications
26 relating to the return to service of Unit 1 and determined that future communications will
27 include the most likely return to service time, as well as the range of return to service times
28 where such risk exists. This will enable greater awareness by the ECC to prepare for potential
29 reliability issues and potentially earlier alert notifications for customer communications.

1 **7.0 Non-Contributory Operational Reviews**

2 While not contributory to initiating the events of March 4, Hydro is reviewing the broader
3 impacts of the low voltage condition for additional opportunities to improve the system and
4 customer service, namely:

- 5 1. Hydro's Protection and Control and the Hydro Generation Operations groups are
6 reviewing the resultant trip of the Star Lake generating unit. The purpose of this
7 review is to determine if any changes are warranted to the protection configuration
8 for the unit.
- 9 2. Holyrood plant engineering personnel are reviewing the resultant protection
10 operation and trip of Holyrood Unit 3. This review will confirm proper protection
11 operation.
- 12 3. Hydro's System Operations personnel are reviewing the protection operation trips of
13 transmission line TL208¹³ and transformer T2 at the Vale (Long Harbour) terminal
14 station to determine whether adjustments are necessary.

16 **8.0 Summary**

17 Hydro has completed a review of the events leading up to the initiation of customer load
18 interruptions on March 4 that affected many customers on the Island Interconnected
19 System. Hydro has implemented enhancements to improve system reliability and customer
20 service in such situations. It has addressed the root cause of the Holyrood CT failure to start
21 on time and improved the trip settings on the Come by Chance capacitor banks for increased
22 system robustness. Communications are being improved to better inform customers in such
23 situations. The response of system operator personnel to declining voltages as well as
24 communications between system and plant operators on unit return to service timing has
25 been improved. Finally, a draft report of an under-voltage load shedding scheme is being
26 reviewed by Hydro and NP.

¹³ TL208 is the transmission line supplying Voisey's Bay Nickel Terminal Station near Long Harbour from the Western Avalon Terminal Station.

APPENDIX A

Newfoundland Power & Newfoundland and Labrador Hydro
March 4th, 2015 Power Outage Timeline, March 27th, 2015



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P.O. Box 8910
St. John's, NL A1B 3P6
Business: (709) 737-5600
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DELIVERED BY HAND

March 27, 2015

Board of Commissioners
Of Public Utilities
P.O. Box 21040
120 Torbay Road
St. John's, NL A1A 5B2

Attention: G. Cheryl Blundon
Director of Corporate Services
and Board Secretary

Ladies and Gentlemen:

Re: Power Outage - March 4, 2015 – Request for Timeline

In its letter of March 19, 2015, the Board requested that Newfoundland Power and Newfoundland and Labrador Hydro jointly develop and file an agreed timeline of all significant events leading up to and to the conclusion of the March 4, 2015 outage.

Please find enclosed the original and 12 copies of the requested timeline, which is submitted by Newfoundland Power on behalf of both utilities.

We trust that the enclosed is found to be in order.

If you have any questions please feel free to contact the undersigned at 737-5609 or Mr. Geoffrey Young for Hydro at 737-1277.

Yours very truly,

Gerard M. Hayes
Senior Counsel

Enclosures

- c. Geoffrey Young
Newfoundland and Labrador Hydro



**Newfoundland Power &
Newfoundland and Labrador Hydro**

March 4th, 2015 Power Outage Timeline

March 27th, 2015



**Newfoundland Power &
Newfoundland and Labrador Hydro
March 4th, 2015 Timeline**

Time	Event
February 27th, 2015	Hydro's Holyrood 170 MW Unit 1 taken out of service until March 3 rd , 2015 at 2000 hours.
Time	Event
March 3rd, 2015	Hydro's Holyrood 170 MW Unit 1 not returned to service as planned.
Time	Event
March 4th, 2015	
5:23 AM	Hydro's ECC requests NP's SCC to maximize all available hydro production.
6:10 AM	Stephenville CT (50 MW) online.
6:12 AM	Holyrood CT initial unsuccessful start.
6:17 AM	Hardwoods CT (25 MW) online.
6:19 – 6:30 AM	Additional unsuccessful start attempts on Holyrood CT.
6:28 AM	Hydro's ECC requests NP's SCC to operate Greenhill and Wesleyville gas turbines.
6:30 AM	Voltage at Come by Chance 223.1 kV (97%); at Oxen Pond 67.3 kV (102%).
6:30 AM	Available Island reserves 301 MW.
6:32 AM	Between 6:32 and 7:00 AM Greenhill gas turbine started twice from NP's SCC but unit would not synchronize to system and shut down.
6:36 AM	Hydro requested 20 MW block from Corner Brook Pulp & Paper Capacity Assistance.
6:37 AM	Voltage at Western Avalon 218 kV (95%).
6:45 AM	Voltage at Come by Chance 221.4 kV (96%); at Oxen Pond 66.5 kV (101%).

**Newfoundland Power &
Newfoundland and Labrador Hydro
March 4th, 2015 Timeline
(Cont'd)**

Time	Event
6:45 AM	Available Island reserves 259 MW.
6:48 AM	Holyrood Units 2 and 3 at maximum voltage support.
6:50 AM	Voltage at Come by Chance 220.4 kV (96%); at Oxen Pond 65.7 kV (100%).
6:50 AM	Available Island reserves 253 MW.
6:51 AM	Hydro's ECC advises NP's SCC that the Holyrood CT would not start and 230 kV system voltage was down to 216 kV.
7:00 AM	Vale Capacity Assistance requested (10 MW).
7:01 AM	NP's Director of Operations advised by Hydro's Manager System Operations that Holyrood Unit 1 did not get back in service, unable to start 123 MW Holyrood CT and system spinning reserves were dropping and currently around 70 MW.
7:04 AM	Hydro's ECC advises NP's SCC that St. John's 66 kV infeed voltages down to 64.6 kV (98%) and soon will have to start shedding load.
7:04 AM	Hardwoods CT at maximum voltage support.
7:08 AM	Corner Brook Pulp & Paper Capacity Assistance increased to 60 MW.
7:09 AM	Rocky Pond hydro plant tripped due to low voltage.
7:10 AM	Voltage at Come by Chance 209.6 kV (91%); at Oxen Pond 62.5 kV (95%).
7:10 AM	Available Island reserves 230 MW.
7:14 AM	Voltage at Come by Chance 199.8 kV (87%); at Oxen Pond 61.9 kV (94%).

**Newfoundland Power &
Newfoundland and Labrador Hydro
March 4th, 2015 Timeline
(Cont'd)**

Time	Event
7:14 AM	Hydro's capacitor banks (4) at Come by Chance tripped, removing voltage support.
7:14 AM	All NP hydro plants on the Avalon and Bonavista Peninsulas tripped off line.
7:14 AM	Between 7:14 and 7:15 AM, NP's transmission lines trip on under voltage protection and 35 substations lost power. Areas affected include Clarenville area and Bonavista Peninsula, Gander Bay and Bonavista North areas, Placentia Bay and St. Mary's Bay areas, Conception Bay North area, Southern Shore and parts of west end St. John's. 57,000 customers without power.
7:15 AM	Holyrood Unit 3, Hardwoods CT, Stephenville GT and Star Lake generation tripped.
7:15 AM	Transmission Line TL208 supplying Vale tripped. North Atlantic Refining at partial load.
7:17 AM	Hydro's ECC advises NP's SCC that Unit 3 tripped at Holyrood, and requested NP to shed additional load as the 66 kV system voltages were down to 52.9 kV.
7:19 AM	NP's SCC asks Hydro's ECC how much more load to shed. Hydro's ECC advises voltages still down to 52 kV and to shed additional load. NP's SCC load sheds a total of 31 feeders in the St. John's area by 7:23 AM (total of 83,000 customers without power).
7:23 AM	Hawke's Bay diesels started.
7:25 AM	Holyrood CT started.
7:27 – 7:41 AM	NP's SCC restores power to 16 feeders in St. John's (approx. 20,000 customers).
7:29 AM	NP's Director Operations confirms with Hydro's Manager System Operations a significant loss of supply outage will remain until Holyrood Unit 3 returned to service. Advises NP's Corporate Communications staff to get message to customers to conserve energy and prepare for rotating power outages.
7:31 – 7:32 AM	Come by Chance Capacitor Banks 2 and 3 back in service.

**Newfoundland Power &
Newfoundland and Labrador Hydro
March 4th, 2015 Timeline
(Cont'd)**



Time	Event
7:36 AM	NP starts restoring power to customers off the Avalon as there is generation available off the Avalon.
7:37 – 7:39 AM	Come by Chance Capacitor Banks 1 and 4 back in service.
7:40 AM	Stephenville GT re-started.
7:44 AM	TL208 (Vale restored).
7:47 AM	NP's Greenhill gas turbine switched to manual voltage control and placed on line.
7:52 AM – 10:05 AM	Fermeuse Wind and NP Southern Shore hydro generation re-started.
8:04 AM	St. Anthony diesels started.
8:05 – 10:30 AM	NP starts rotating outages in the St. John's area. Rotated 17 feeders at an average of 41 minutes power off time.
8:07 AM	Power restored to Clarenville, Bonavista Peninsula, Gander Bay and Bonavista North areas (25,000 customers).
8:44 AM	Vale Capacitors placed in-service.
8:44 – 9:16 AM	Vale generation on line.
8:54 AM	Power restored to Southern Shore.
9:13 AM	Holyrood Black Start diesels started.
9:13 AM	NP Wesleyville started.
9:27 AM	Hardwoods CT re-started.

**Newfoundland Power &
Newfoundland and Labrador Hydro
March 4th, 2015 Timeline
(Cont'd)**

Time	Event
10:14 AM	Holyrood Unit 3 re-started.
10:16 AM	All power restored to customers in St. John's area.
10:30 AM	All power restored to Placentia Bay and St. Mary's Bay areas.
12:32 PM	All power restored to Conception Bay North area.
3:17 PM	Star Lake re-started.
4:00 PM	Holyrood Unit 1 – back in service.

APPENDIX B

Island Interconnected System Forecast Supply Shortfall
Customer and Stakeholder Advance Notification Protocol


Island Interconnected System Forecast Supply Shortfall¹
Customer and Stakeholder Advance Notification Protocol


Alert Levels	Generation Reserves ²	Stakeholder Notifications	NLH Actions	NP Actions	Customer Notifications
Normal Conditions (T-001 ³ Level 0)	7-Day Generation Reserve Forecast indicates available reserves greater than the largest generating unit plus minimum spinning reserves	Daily Supply and Demand Status Report and 7-Day Forecast for the <i>Island Interconnected System</i> sent to Public Utilities Board (PUB) and Newfoundland Power.	Normal Operations	Normal Operations	None
Stage 1 Power Advisory (T-001 Level 1)	7-Day Generation Reserve Forecast indicates available reserves less than the largest generating unit plus minimum spinning reserves	Stage 1 - Power Advisory Notifications: Hydro System Operations notifies Newfoundland Power System Operations.	Follow System Operating Instruction T-001 as required to maintain minimum spinning reserves	Support Hydro with implementing T-001 measures	None
Stage 2 Power Watch (T-001 Level 2)	24-Hour Generation Reserve Forecast indicates available reserves less than the largest generating unit	Stage 2 - Power Watch Notifications: Hydro System Operations notifies Newfoundland Power, Hydro Regulatory Affairs notifies PUB and Hydro Communications notifies Newfoundland Power Communications and FES.	Follow System Operating Instruction T-001	Support Hydro with implementing T-001 measures	NP gives advance notification to its curtailable customers Utilities <u>may</u> issue ⁴ press release, update website, engage social media (or other communications tools) stating: "Power Watch in Effect - Conservation Request Likely" - Specify when conservation may be required. - Indicate what is the most effective ways for customers to conserve.
Stage 3 Power Warning (T-001 Level 3)	Current Day Generation Reserve Margin less than half the largest generating unit	Stage 3 - Power Warning Notifications: Hydro System Operations notifies Newfoundland Power, Hydro Regulatory Affairs notifies PUB and Hydro Communications notifies Newfoundland Power Communications and FES.	Follow System Operating Instruction T-001	Support Hydro with implementing T-001 measures	Utilities <u>will</u> issue press release, update website, engage social media (or other communications tools) stating: "Power Warning in Effect - Customers Requested to Conserve Electricity; Rotating Outages Likely" - Request NP curtailable customers to curtail. - Specify when conservation is required. - Indicate the most effective ways for customers to conserve.
Stage 4 Power Emergency (T-001 Level 4)	⁵ Generation Shortfall Imminent - No reserves margin	Stage 4 - Power Emergency Notifications: Hydro System Operations notifies Newfoundland Power, Hydro Regulatory Affairs notifies PUB and Hydro Communications notifies Newfoundland Power Communications and FES.	Follow System Operating Instruction T-001	Support Hydro with implementing T-001 measures and implement Newfoundland Power SRP-001 ⁶ for Rotating Power Outages	Customers to be notified immediately if a generation shortfall is anticipated. Utilities <u>will</u> issue press release, update website, engage social media (or other communications tools) stating: "Power Emergency in Effect - Conserve Electricity-Rotating Power Outages in Effect" - Inform customers of the actual impact (MW) conservation efforts are having on the electricity system. - Indicate what are the most effective ways for customers to conserve.

¹ Island Interconnected Supply Shortfall refers to *all* Firm Generating Capacity on the Island Electricity System.
² Operating Reserves = ((Island Interconnected System Available Generation / Island Interconnected System Forecast Peak) - 1) x 100%
³ NLH System Operating Instructions for Generation Reserves
⁴ Where desirable, utilities may undertake joint communications; however, each utility will communicate with its respective customers and key stakeholders directly according to its established protocols.
⁵ In the event of an immediate loss of supply (unanticipated and unable to be forecast) this protocol will eliminate Stages 1-3 and begin with Stage 4: this applies to both a generation and transmission issue. Exception may be an underfrequency load trip that would result in a prompt power restoration.
⁶ NP System Restoration Plan for Rotating Power Outages