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May 15, 2015

The Board of Commissioners of Public Utilities
Prince Charles Building
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St. John's, NL
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ATTENTION: Ms. Cheryl Blundon
Director of Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: March 4, 2015 Power Outage Report (*Power Outage/Incident Advisory 2015-H-062*)

Further to your letter of April 21, 2015 regarding the above referenced report, the following are Hydro's responses to the Board's questions.

Q1. In its March 19, 2015 correspondence the Board requested, upon completion of the investigation into the March 4 outage, a copy of the report of the investigation, including the root cause analysis.
a. Did Hydro complete a root cause analysis of the incidents causing the power outage? If so, when will a report be filed with the Board? If not, why not?
b. Is Hydro's investigation into the March 4 outage complete or are there areas of investigation ongoing?
c. Does Hydro intend to file further reports detailing the events leading up to the outage and Hydro's responses to those events?

A1.

a. Hydro did conduct detailed root cause field investigations of the events causing the under voltage situation that were summarized in a report, *March 4, 2015 Power Outage Report- Power Outage/Incident Advisory 2015-H-062* (the "Power Outage Report"), which was filed with the Board on April 10, 2015. Specifically, sections 4.1 and 4.2 of the Power Outage Report identify the two primary causes of the March 4 outage:

> **4.1 Primary Cause 1**
> Unit 1 at Holyrood was delayed in returning to service. The hydrogen cooled generator had been degassed to air to make it safe for repair work to proceed. The process of gassing up again for normal operation involves displacing the air with carbon dioxide, then the carbon dioxide with hydrogen. Hydrogen purity has to meet the 90% purity target before the unit can be released for safe and reliable service. In this instance, this process took longer than normally

anticipated. (See Q5 answer for why the process took longer than normally anticipated)

4.2 Primary Cause 2

The Holyrood CT had operated successfully in the days leading up to March 4. There were no failures to start. The failure to start on March 4 was due to the incorrect flow rate of fuel from a fuel valve. When the unit was called to start, the flow rate was too high.

The original design of the fuel valve and its surroundings did not include protection from inadvertent bumping or protection from movement through vibration. It has been determined that no changes to the fuel valve position were made by the construction, commissioning, or operations staff. The possible reasons for the fuel valve coming out of proper adjustment include inadvertent contact with the valve or through a means such as vibration. (See Q6 answer for modifications to this valve.)

The detailed reports containing these analyses (in relation to (i) Holyrood Unit 1 and (ii) the Holyrood combustion turbine ("CT")) are being finalized and will be filed with the Board in May 2015.

Hydro is also undertaking reviews of the contributing factors relating to the March 4 event, from which various changes in practice are being contemplated, as further stated in item (b) below.

b. As noted in Hydro's Power Outage Report, Hydro is completing an ongoing review of the broader impacts of the low voltage condition for additional opportunities to improve the system and customer service, namely:
    1. Hydro's Protection and Control and the Hydro Generation Operations groups are reviewing the resultant trip of the Star Lake generating unit to determine if any changes are warranted to the protection configuration of that unit;
    2. Holyrood Plant engineering personnel are reviewing the resultant protection operation and trip of Holyrood Unit 3 to confirm proper protection; and
    3. Hydro's System Operations personnel are reviewing the protection operation trips of transmission line TL208 and transformer T2 at the Vale (Long Harbour) terminal station to determine whether adjustments are necessary.

c. Hydro will report the conclusions and any additional changes being implemented as a result of the ongoing reviews noted above.

Q2. On the morning of March 4, 2015, despite the Island Interconnected System not being in an N-1 situation, widespread outages resulted from a lack of generation on the Avalon which led to deterioration in system voltage. Given the outcome please provide your comments as to whether or not an N-1 contingency continues to be appropriate for the Island Interconnected System and in particular, for the Avalon Peninsula.

A2. In the days leading up to March 4, the Island Interconnected System was not forecast to be in an N-1 situation from an overall Island generation reserve perspective. This means there would be no sustained customer load interruption for the loss of the single largest unit, barring any transmission limitations. Similarly, the transmission and generation network supplying the Avalon Peninsula was not forecast to be in an N-1 situation for any single contingency for a generation or transmission element as all lines were in service, Holyrood Unit 1 was scheduled to be online prior to the morning peak and the CT was to be available as required. However, as the morning approached two contingencies occurred, the first contingency event was Holyrood Unit 1 not coming online for the peak and the second being the CT failing to start before the peak occurred. With these two contingencies, other small standby generation start-up was initiated. However, as there was insufficient time to have these online, adequate system voltages could not be maintained.

Increasing the system design to an N-2 criterion whereby there would be no customer impact for the two large contingencies such as those experienced would result in increased capital cost for items such as additional generation, transmission lines and voltage control equipment. The benefit to moving to such a criterion would have to be assessed against the future probability of such events and the cost to prevent customer interruptions. Hydro is committed to operate and maintain the assets in a manner to meet the current reliability criterion.

Hydro is therefore of the opinion that an N-1 transmission contingency design criterion continues to be appropriate for the Island Interconnected System and in particular, for the Avalon Peninsula but as indicated above, if equipment performance or condition indicates the probability of service interruptions are too high, least cost mitigating investment should be investigated and proposed. Due to the nature of the recent events and the solutions being implemented, Hydro is not recommending capital investments to meet an N-2 reliability criterion at this time. Hydro regularly reviews operations under an N-1 contingency and is committed to working with Newfoundland Power ("NP") and its other customers to develop strategies which minimize the customer impact, such as the automatic tripping of feeders under low voltage conditions, for rare multiple contingency events.

Q3. ***If the N-1 contingency remains appropriate, what protections has Hydro put in place to ensure similar events and outages will not occur?***

A3. Hydro has placed several protections in place to ensure similar events do not occur.

- As indicated in the March 4 Power Outage Report, Hydro has taken corrective action addressing the starting problem with the new CT. (see Q6 answer)
- Hydro has also expanded its daily reviews and reporting of reserves to include a dedicated assessment of system conditions on the Avalon Peninsula.
- System security assessments of both the Island Interconnected System and the Avalon Peninsula are now performed daily based on current load forecasts for the next seven days. The assessments allow for advance coordination of primary generation, standby

generation, and sources of reactive support, such as capacitor banks. These assessments are used in concert with the customer and stakeholder communications protocols described in the report.

- As discussed on page 10 of the March 4 Power Outage Report, under voltage protection settings for the CBC banks have been changed to help ensure that capacitor banks do not trip for transient disturbances or during steady-state operation outside of acceptable voltage limits, as per the events of March 4. This will have the effect of reducing the impact on customers.
- The Power Outage Report also discusses an investigation of the application of an under voltage load shedding scheme. This analysis, performed in cooperation with NP, will involve the specification of a protection system that will trip feeders when voltages drop below prescribed thresholds. Such an automated scheme would help to ensure that the system operates within specified voltage limits that will prevent the consequential tripping of generators that caused a larger customer impact in terms of the number and duration of customer interruptions.

Q4. ***At page 2, line 20 Hydro indicates it performed an Avalon Load Flow Analysis in support of the N-1 Contingency. Provide a comparison of how the actual events of March 4, 2015 deviated from the modeled events of the Avalon Load Flow Analysis.***

A4. System load flow studies were completed on February 27 that modelled Unit 1 out of service and the Holyrood CT and Hardwoods gas turbine fully available. The purpose of the load flows was to determine whether there was a requirement to change the system load levels at which standby units should be dispatched, because of Avalon transmission constraints, to cover an N-1 contingency.

An additional load flow was performed on March 2. As per the response to Question 13, this analysis indicated that a total Gross Avalon[1] Load of 755 MW could be supported with Unit 1 at Holyrood, the Hardwoods Gas Turbine and the Holyrood Combustion Turbine all off line. Of the two load flows performed in advance of March 4, the most representative load flow analysis of the March 4 events is discussed below.

The actual events of March 4 deviated from the modeled events primarily due to the following:

- Hardwoods Gas Turbine was available at 25 MW as opposed to unavailable; and
- The power factor of load on the Avalon Peninsula was approximately 0.99 as opposed to 0.975.

As discussed in the report, system voltages were within acceptable ranges until approximately 07:09. At this time, Gross Avalon Loads reached a peak value of approximately 827 MW. At this threshold, system voltages declined as reactive power limits were reached. It may therefore be

[1] The Gross Load is the sum of all the generators operating on the Avalon and the load transferred from TL203 and TL237 at Western Avalon.

concluded that the increased power factor and the availability of the Hardwoods Gas Turbine as a synchronous condenser allowed for the support of additional Gross Avalon Load above 755 MW.

In summary, the events of March 4 deviated from previous analysis in that additional load on the Avalon Peninsula above 755 MW was supported as a result of (1) a higher actual power factor that was experienced compared to that which was modelled and (2) the availability of the 25 MW at the Hardwoods Gas Turbine.

As loads increased, there was insufficient reactive and real power on the Avalon Peninsula and for the system voltages to stay within operational limits. While operating outside of specified voltage limits, an additional contingency occurred involving the trip of the CBC capacitor banks.

Q5. ***At Section 4.1, Primary Cause 1, the primary cause of the outage is identified as being the delayed return to service of Unit 1 due to a longer than normally anticipated gassing up of the unit.***
a. How long does the gassing up process normally take?
b. When did gassing up of Unit 1 commence?
c. When was the process completed?
d. Why did the process take longer than normally anticipated?

A5.

a. The full gassing up process normally takes approximately 16-24 hours.

b. Gassing up of Unit 1 commenced at 9:00 p.m. on March 2.

c. The gassing up of Unit 1 was completed at 4:30 a.m. on March 4[2].

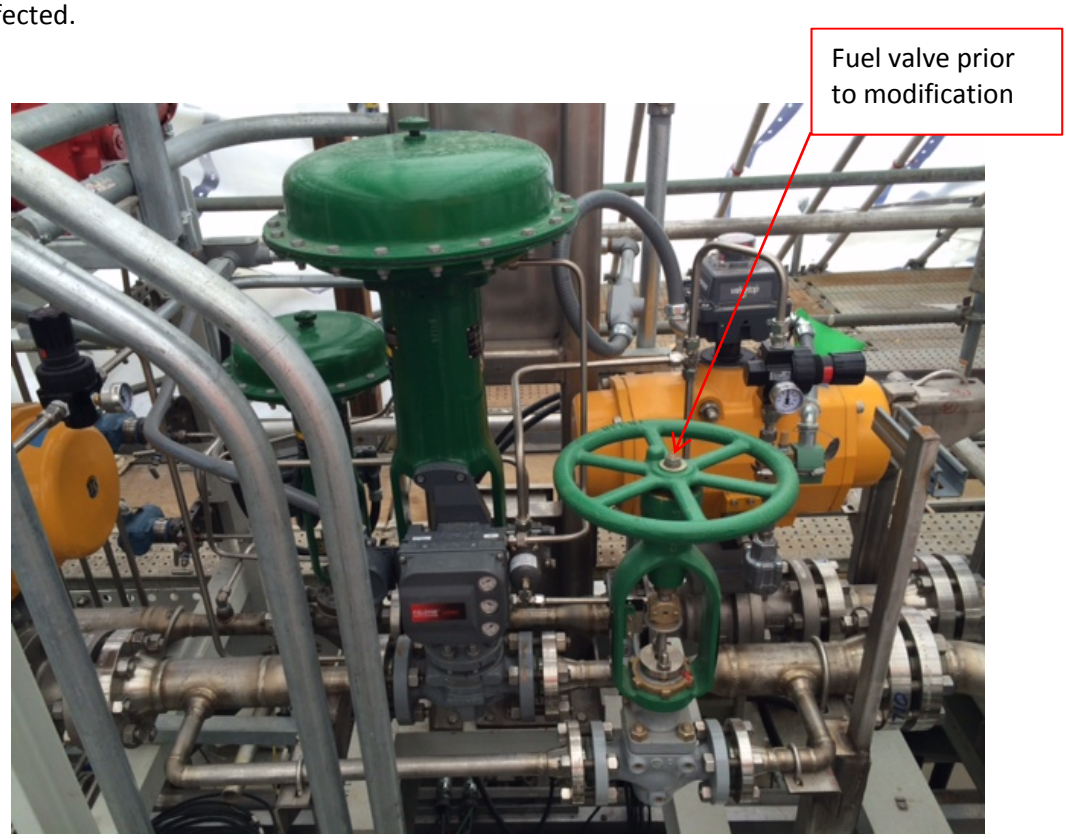
d. The gassing up process on Unit 1 extended beyond the normal range of time. The process involves purging the air with carbon dioxide, and then replacing the carbon dioxide with hydrogen gas. The injection of the carbon dioxide took longer than expected due to lower than typical carbon dioxide flow rates. The lower flow rates were subsequently discovered to be caused by a leak, which was repaired.

Q6. ***At Section 4.2, Primary Cause 2, a further cause of the outage is identified as being the incorrect flow rate of fuel from a fuel valve on the Holyrood Combustion Turbine.***
a. Provide pictures of the valve in question prior to any lock out modifications effected.
b. Provide pictures of the valve in question following lock out modifications effected.
c. Provide a clear indication either through photographs or diagrams as to the location of the valve on the unit and its accessibility for inadvertent contact.

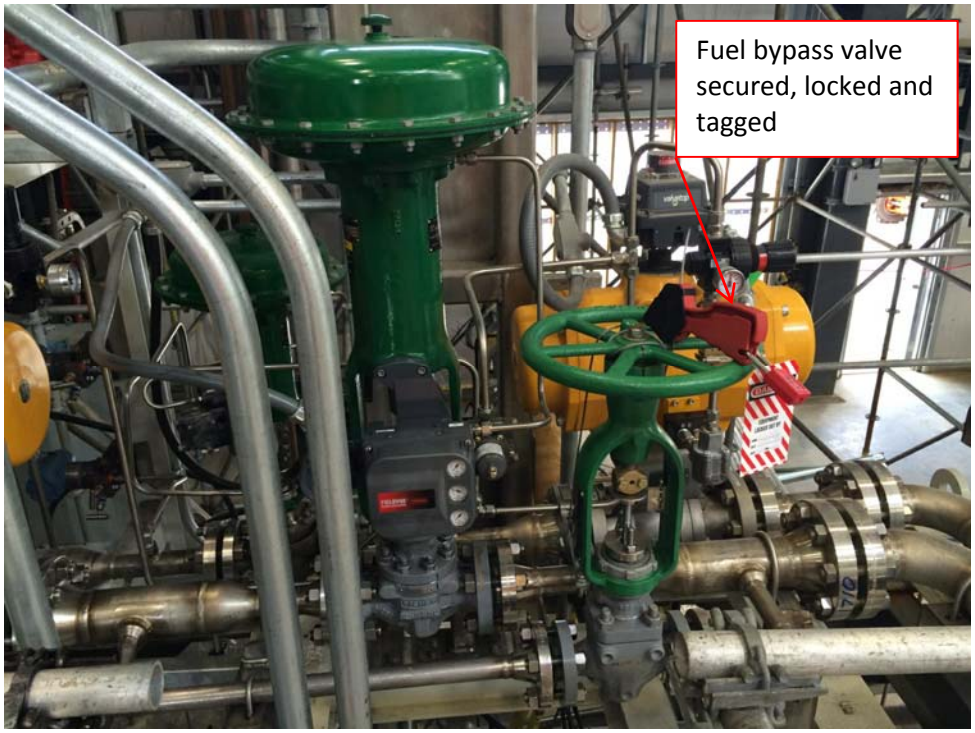
[2] Following successful gassing up of the unit, there are several remaining activities to complete before the unit is online and generating. These activities typically take 8-12 hours.

A6.

a. Please see the photo below showing the fuel valve prior to any lock out modifications being affected.



b. Please see the photo below showing the valve following lock out modification. The valve has been secured, locked and tagged. While it is not visible in the photograph, the valve has also been marked to indicate the valve set position and a pre-start up verification of the valve position has been instituted.



c. Please see the photos below showing the location of the valve. The valve is not located on the turbine itself, it is located on the fuel, oil, and water injection skid, on an elevated platform within the plant. As can be seen in the photos, scaffolding is in place to facilitate access to the area.

Q7. ***At 00:28 Hydro's Energy Control Centre (ECC) knew that Unit 1 return to service would be delayed. At 05:24 the EEC knew Unit 1 would not be available to meet morning peak demand. At 06:30 Hydro knew the Holyrood Combustion Turbine was not available and likely would not be available to meet morning peak demand. At 07:01 Hydro advised Newfoundland Power of system generation issues and that Holyrood Unit 1 and the Combustion Turbine were unavailable. Why was notification of the system generation issues not provided to Newfoundland Power earlier than 7:01?***

A7. In referencing the joint timeline filed with the Board on March 27, by NP and Hydro, notification was given by the Energy Control Centre ("ECC") to the NP System Control Centre ("SCC") at 06:51 regarding the situation that the CT would not start and that the 230 kV system voltage was down to 216 kV. Shared SCADA information available also indicated to NP the real-time status of the Holyrood units. Notification prior to this time was not given as the system operator was anticipating the start-up of the CT at any moment to avoid manual load shedding of customers.

Q8. ***At page 11 it is indicated that in the future inter-group communication between Holyrood Operations and Hydro's ECC will include the most likely return to service time as a well as a range of return to service time where such risk exists. What changes to inter-utility communications will Hydro implement to provide immediate notification to Newfoundland***

Power of delays in returning significant assets to service from the original scheduled return to service time and to provide regular updates to Newfoundland Power as to the status of the return to service of those assets such as hourly or every two hours if return is imminent?

A8. Since the March 4 power outage, Hydro has updated its capability assessment and notification protocols (including an operating instruction; currently in draft and pending approval) to include the communication of the Avalon capability and reserve to NP, similar to what is currently in place for the assessment and notification of Island capability and reserve. If the availability of assets on the Avalon changes, Hydro will perform reliability assessments in order to determine the Avalon capability and reserve for each of the upcoming seven days. If the reserve in any day is less than the impact on the Avalon capability of the largest contingency, plus a buffer of 35 MW, Hydro will communicate with NP at regular intervals until the Avalon reserve returns to normal levels, above the threshold that requires further notification.

Examples of this occurred on the weekend of April 18 to 19. On April 18, at 00:12, Holyrood Unit 2 came off line for a fuel leak. As a result, the Holyrood CT was requested to start at 01:02 but it failed to start as requested. With two assets on the Avalon potentially unavailable for the morning peak and the Avalon reserve forecast to be at levels that required notification (if the two units remained unavailable), NP was advised at around 03:00. At 03:33, the Holyrood CT became available for service and the forecast Avalon reserves returned to acceptable levels and another call was made to NP to advise them of the same. A similar event occurred the following day when Hydro issued a Power Watch[3] when there was a potential of having to take Holyrood Unit 2 off line for a steam leak. Later in the day, Hydro rescinded the Power Watch, as the unit did not need to be removed from service. Through this event, NP was kept abreast of the forecast reserve on the Avalon and the status of Holyrood Unit 2.

In addition to the aforementioned, the daily status updates[4] provided to NP now include the Avalon capability and reserve forecast.

Q9. ***At page 12, line 23 it is stated "The response of system operator personnel to declining voltages...has been improved"***
a. Provide details of the improvements in system operator response i.e. changes made, training provided, lessons learned.
b. What specific procedures will Hydro implement to give direction to system operators as to how to respond to a similar voltage deterioration event?

[3] Power Watch means the reserve on the Avalon was less than the impact to the Avalon capability of the single worst contingency event.
[4] The daily status updates originally included the status of major equipment, planned equipment outages and the Island capability and reserve forecast.

A9.

a. Hydro System Operations performed a lessons learned exercise shortly after the March 4 power outage and from this, a number of improvements were made to bring greater awareness to the system operators about the Avalon power system and its capabilities and vulnerabilities. The improvements are noted as follows:
    - The trip setting on the four CBC capacitor banks were reviewed and modified. This will help the system operators, by adding more time to deal with a potential voltage decline event;
    - The operating instructions relating to equipment ratings and bus limits were reviewed with system operators. The need for prompt and coordinated manual load shedding (with NP) was emphasized, to ensure acceptable delivery point bus voltages as system voltages decline to established limits;
    - Although the following would not have had any impact on March 4, as the units were already dispatched for Island reserve purposes, Hydro has since reviewed its transmission reliability criteria and has commenced the practice of operating standby generating units (that support the Avalon) in advance of Avalon transmission system contingencies, rather than starting them after the event has occurred. To support this improvement, beginning in late March 2015, system operators have been receiving standby generation requirements for supporting the Avalon transmission;
    - Beginning on April 8, 2015, a daily report has been prepared within System Operations that forecasts the Avalon capability, the impact on the capability of the system in the event of the largest single contingency and the Avalon reserve for the upcoming seven days. This report is used by the system operators to understand the Avalon capability with specified assets available and under the single worst contingency;
    - An Operator Training Simulator session is being planned that simulates the events of March 4. This session will allow all of the system operators to experience declining voltages on the Avalon power system and learn how best to respond; and
    - Hydro and NP are working on an automatic under voltage load shedding scheme for the Avalon power system that will essentially remove the need for system operators to perform manual load shedding in the face of declining voltages. This scheme will be similar to the existing under-frequency load shedding scheme, triggered typically by the loss of generation above the 50 MW level.

b. As stated in Question 8, Hydro System Operations has developed a new operating instruction (currently in draft and pending approval) to help the system operators better assess the Avalon power system capability and reserve, and to maintain greater online generation reserves on the Avalon. This instruction, together with existing instructions on equipment ratings and bus limits, will help the system operators deal with an event similar to the one experienced on March 4.

Q10. ***During the outage Hydro's website advised that no power outages were being experienced by Hydro customers. While technically accurate Hydro omitted to notify the public of a significant loss of supply to the system. What actions has Hydro taken to provide public notification on its***

website in the event of future significant loss of supply affecting other than Hydro Domestic and General Service Customers?

A10. There is currently a manual process in place for the Hydro web site to place a red alert banner on the main page advising of a system event. On the morning of March 4, this was done at 07:52. The red banner included a link to information on the Advance Notification Levels and effective ways to conserve electricity. Although the banner was at the top of the page in bright red, feedback was received that customers were not able to see the banner. As a result, Hydro has moved the banner to the centre of the main web page, right above the main navigation icons (see Appendix 1).

An additional communication feature has been added to the website, which allows a pop-up display to take over the main page of the website, advising customers of a power alert. Customers must close this pop-up before they can access the rest of the site, including the customer outages page. This is an added feature to ensure anyone visiting Hydro's website is made aware of a power alert in effect (see Appendix 2).

The "Outages" button on the front page of the Hydro's website links to the distribution customer Power Outage and Emergency System. This is a system developed for Hydro's own distribution customers. It is programmed by telephone exchange and area and is specifically coded to contain only Hydro's rural distribution systems. The system is near end of life and Hydro are currently reviewing options to replace this system this year. Hydro will assess whether potential systems have the ability to communicate broader system equipment outages and advisories, which may not directly affect its distribution customers.

Q11. ***Provide a graph(s) showing the relationship between the generation on the Avalon, the load on the Avalon, the load on the in-feed from Bay d'Espoir and the voltages on the Avalon.***

A11. The relationship between the generation, the load, the in-feed from Bay d'Espoir, and voltages on the Avalon Peninsula are demonstrated in the figures provided below. These figures were developed based on load flow analysis performed using Version 32 of PSS®E software from Siemens PTI.

Figure 1 includes illustrations of voltages[5] and reactive support on the Avalon Peninsula versus Gross Avalon Demand. Gross Avalon Demand is calculated as the sum of the following sources of supply:

- Thermal generation from Holyrood units;
- Generation from the CT;
- Generation from the Hardwoods Gas Turbine;
- Hydraulic generation from NP units;

[5] Voltages at the 230 kV bus at Oxen Pond Terminal Station are provided as representative system voltages for the purposes of this demonstration.

- Diesel generation at Vale Terminal Station; and
- Sum of power delivered from 230 kV transmission lines TL203 and TL237 at the Western Avalon Terminal Station.

As indicated, voltages are held above the minimum thresholds over the operating range. This is accomplished by increasing reactive support on the Avalon Peninsula through the operation of capacitor banks and by bringing additional generators online, as illustrated by the red line in the plot below.

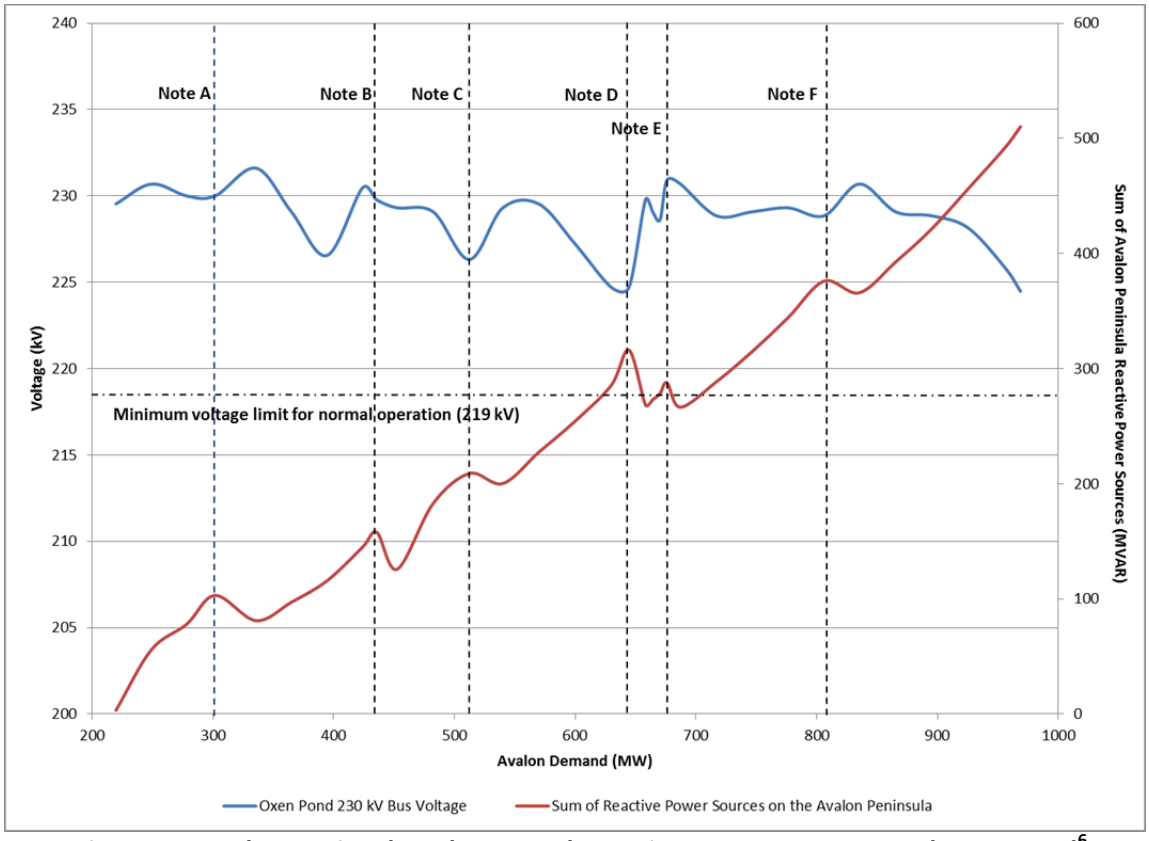


Figure 1 – Avalon Peninsula Voltages and Reactive Power vs Gross Avalon Demand[6]

[6] Note A: Below 305 MW, Avalon demand is met using hydraulic generation. Standby units (the CT and Hardwoods Gas Turbine) brought online as Gross Avalon Demand exceeds 305 MW.
Note B: One Holyrood unit online as Gross Avalon Demand exceeds 435 MW.
Note C: One Holyrood unit and standby units online as Gross Avalon Demand exceeds 515 MW.
Note D: Two Holyrood units online as Gross Avalon Demand exceed 645 MW.
Note E: Two Holyrood units and standby units online as Gross Avalon Demand exceed 675 MW.
Note F: Three Holyrood units and standby units online as Gross Avalon Demand exceed 810 MW.

Figure 2 includes illustrations of the sources of supply on the Avalon Peninsula versus Gross Avalon Demand associated with Figure 1. “Avalon Generation” includes the following sources of supply:

- Thermal generation from Holyrood units;
- Generation from the CT;
- Generation from the Hardwoods Gas Turbine;
- Hydraulic generation from NP; and
- Diesel generation at Vale Terminal Station.

Power flows from Bay d’Espoir over transmission lines TL202 and TL206 are also provided, as requested.

Exact system dispatches may vary based on operating conditions. For demonstration purposes, the load flow analysis was performed assuming that units are brought online at rated capacity.

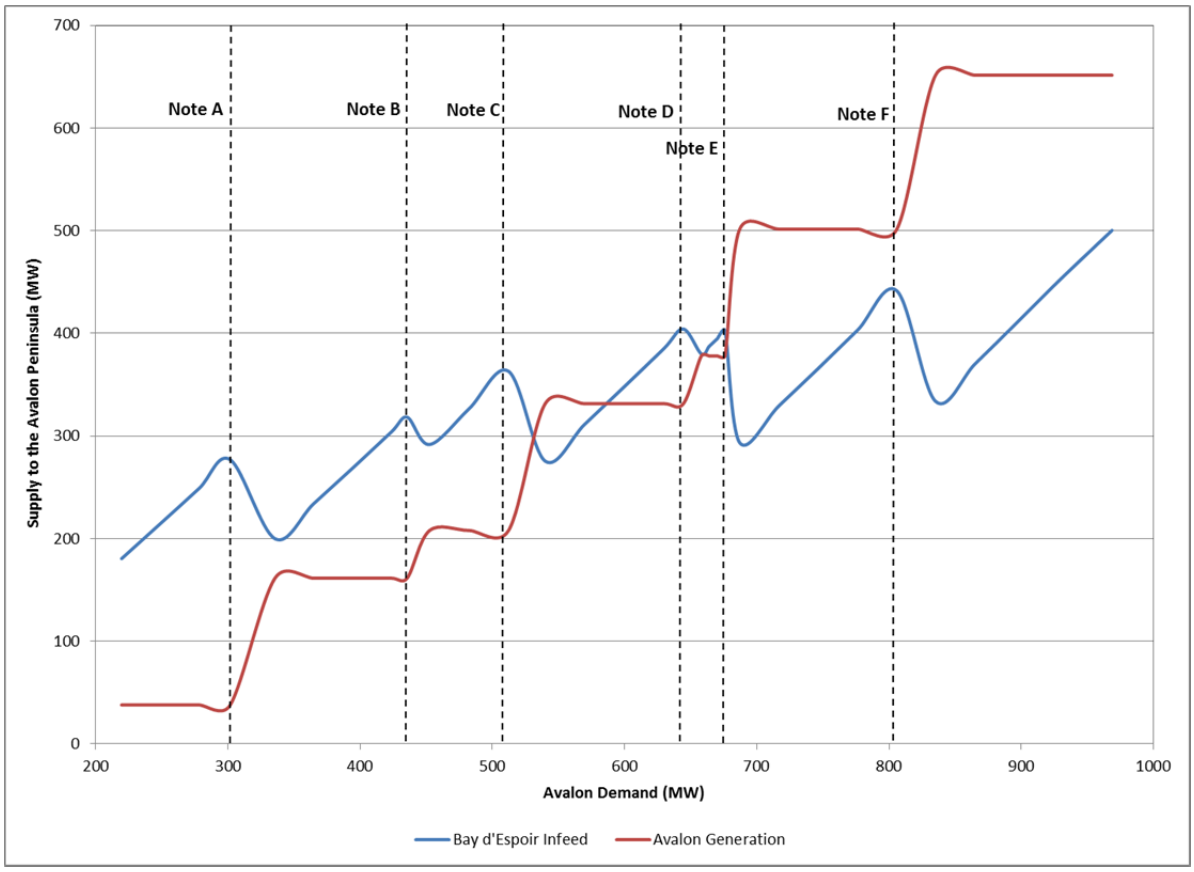


Figure 2 – Sources of Supply for the Avalon Peninsula[7]

Q12. ***Provide a description of the tools (e.g. load flow studies) available to system operators to determine system voltages as a result of generation or transmission outages. Include in the response the time required to carry out these studies and if they could have be carried out in the time between 06:12 and 07:04 on March 4, 2015.***

A12. Prior to approving equipment outages, Hydro System Operations engineers may perform, or ask the System Planning engineers to perform, load flow studies to determine the systems capability with the equipment outage and further unforeseen equipment outages during the planned

[7] Note A: Below 305 MW, Avalon demand is met using hydraulic generation. Standby units (the CT and Hardwoods Gas Turbine) brought online as Gross Avalon Demand exceed 305 MW.
Note B: One Holyrood unit online as Gross Avalon Demand exceeds 435 MW.
Note C: One Holyrood unit and standby units online as Gross Avalon Demand exceeds 515 MW.
Note D: Two Holyrood units online as Gross Avalon Demand exceed 645 MW.
Note E: Two Holyrood units and standby units online as Gross Avalon Demand exceed 675 MW.
Note F: Three Holyrood units and standby units online as Gross Avalon Demand exceed 810 MW.

equipment outage.[8] Once the outage has been approved and during day-to-day system operations, the system operators use an Energy Management System ("EMS") to monitor and control the power grid.

There are a number of operational tools as a part of the EMS, such as load flow studies that the system operators use to support the safe and reliable operation of the transmission system. One such application on the EMS is Network Analysis. This application provides system operators with the ability to perform studies of the power system using real time data. Network Analysis contains a model of the power system and its associated equipment, including generators, transmission lines, transformers and busses. It also includes the majority of NP's equipment. Using the features of the application, system operators can take a snapshot of the current power system using the most recent power flow data. Once the current real time data has been captured into the power system model, the system operator can simulate changes on the power system, including equipment outages and load variations, to determine impacts resulting from those changes. From power system simulations, the system operators are able to determine the impact of changes on the transmission voltages. The time required to perform a typical power system study is generally between 30 and 45 minutes, depending on the complexity of the simulation.

Another application on the EMS is Contingency Analysis ("CA"). This application indicates to the system operators the single worst-case contingency on the power system at the time the application runs. It does not work with forecast loads. CA has a number of equipment outages defined and will run a load flow for each contingency. The application then ranks each contingency in the order of severity and the results are displayed to the system operators. The severity is rated both from a voltage and thermal overload perspective. CA runs on the EMS automatically and is updated every five minutes. On the morning of March 4, the CA application would not have provided any new information to the system operators as the contingencies of Holyrood Unit 1 and the CT not being available were already reflected in the real time power system model and all mitigating actions short of directing the shedding of feeders to reduce load had been implemented.

Q13. ***Were there system studies completed at any time prior to March 4, 2015 that simulated the conditions of or similar conditions of March 4, 2015?***

A13. System load flow studies were completed on February 27 that modelled Unit 1 out of service and the Holyrood CT and Hardwoods gas turbine fully available. The purpose of the load flows was to determine whether there was a requirement to change the system load levels at which standby units should be dispatched because of Avalon transmission constraints to cover an N-1 contingency.

[8] These are the studies referenced in the response to Question 4 and in the Power Outage Report.

An additional load flow was performed on March 2. This analysis was updated as one end at Hardwoods became unavailable the previous day. In response to this request, an analysis was performed to assess the impacts of additional Avalon contingencies. These contingencies included the loss of an additional generating unit at Holyrood, the loss of transmission line TL202, or the loss of the CT.

The analysis for the scenario involving outages to Unit 1 at Holyrood, the Hardwoods Gas Turbine, and the CT is summarized as follows:

- Holyrood Unit 1: out of service;
- Holyrood Unit 2: available for 170 MW;
- Holyrood Unit 3: available for 150 MW;
- CT: out of service;
- Hardwoods Gas Turbine: out of service;
- NP Generation on the Avalon Peninsula available in accordance with firm supply of 38 MW;
- No generation from wind farms;
- All capacitor banks available;
- No generation from Holyrood mobile diesels, Vale, Greenhill, or Wesleyville units; and
- Load power factor of 0.975 on the Avalon Peninsula.

The results of this analysis indicated that the Holyrood CT should be dispatched prior to the Avalon load reaching 755 MW with Holyrood unit 1 off line. Consistent with this, the Holyrood CT was scheduled to be online by 06:00 on March 4.

Q14. ***Provide load flow study results for March 4, 2015 in diagrammatic form in 15 minute intervals commencing at 06:15 until 07:14 for the Island Interconnected System.***

A14. Please see Appendix 3 for load flow plots for the interval commencing at 06:15 until 07:14 for the Island Interconnected System. The plots illustrate system bus voltages, real power flows (provided above the line) and reactive power flows (provided below the line) on the Avalon Peninsula.

System elements are coloured to represent operating voltages as per Hydro convention:

- 230 kV elements: Red
- 138 kV elements: Green
- 66/69 kV elements: Blue
- Low voltage elements: Brown

If the voltage of a bus drops below 95% of nominal value, the colour is changed to grey. For example, the Oxen Pond 66 kV bus is coloured blue at 07:00 and grey at 07:14. As per the events described in the Power Outage Report, the plots contained in the appendix detail the system conditions over the specified timeframe. As indicated, system voltages are acceptable

prior to 07:00. At 07:00, low voltage conditions are noted at 230 kV buses at Western Avalon Terminal Station, Voisey's Bay Nickel (Vale Inco) Terminal Station, Hardwoods Terminal Station, and Oxen Pond Terminal Station. Extensive low voltage conditions are noted at 07:14.

It should be noted that the load flow plots are simulated results that may have minor deviations from measured values on the day of the system events.

Q15. ***Provide a description of training provided to system operators regarding voltage requirements on the Avalon Peninsula for various generation and load configurations.***

A15. A component of the EMS is the Operator Training Simulator ("OTS"). This is used to train the system operators in both normal and emergency operation of the power system. Scenarios are developed which simulate various generation and load configurations. System operators can operate on the OTS as it simulates real time operation. They can see the impact of contingencies, learn how to respond and complete restorations.

OTS training is scheduled three times each year. There are many different scenarios that have been developed but the several current scenarios relevant to the Avalon Peninsula and voltage requirements are:

- East coast restoration with the loss of TL202 and TL206;
- East coast restoration with the loss of TL201 and TL217;
- Trip of a Holyrood unit which would cause under-frequency load shedding;
- Restoration of Hardwoods and Oxen Pond terminal stations; and
- Black start of the Holyrood Plant from the Hardwoods Gas Turbine.

Each of these scenarios has components of voltage requirements and monitoring. As the system operators go through the simulation of restoration, they learn how load restoration impacts system voltages. The system operators must maintain these voltages within acceptable levels. As well, there are system operating instructions that are relevant to these scenarios and they would be used as part of the training. These instructions are procedures for restoration and maintaining acceptable operating criteria. In essence, the OTS training would also keep the system operators up to date on these operating instructions.

System operators have also been given training in alarm monitoring and management. This was completed as part of an OTS training session and was developed to ensure the system operators understand what is required if there is an alarm at a terminal station. Essentially, it is an understanding of what needs to be completed before restoration can commence.

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

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

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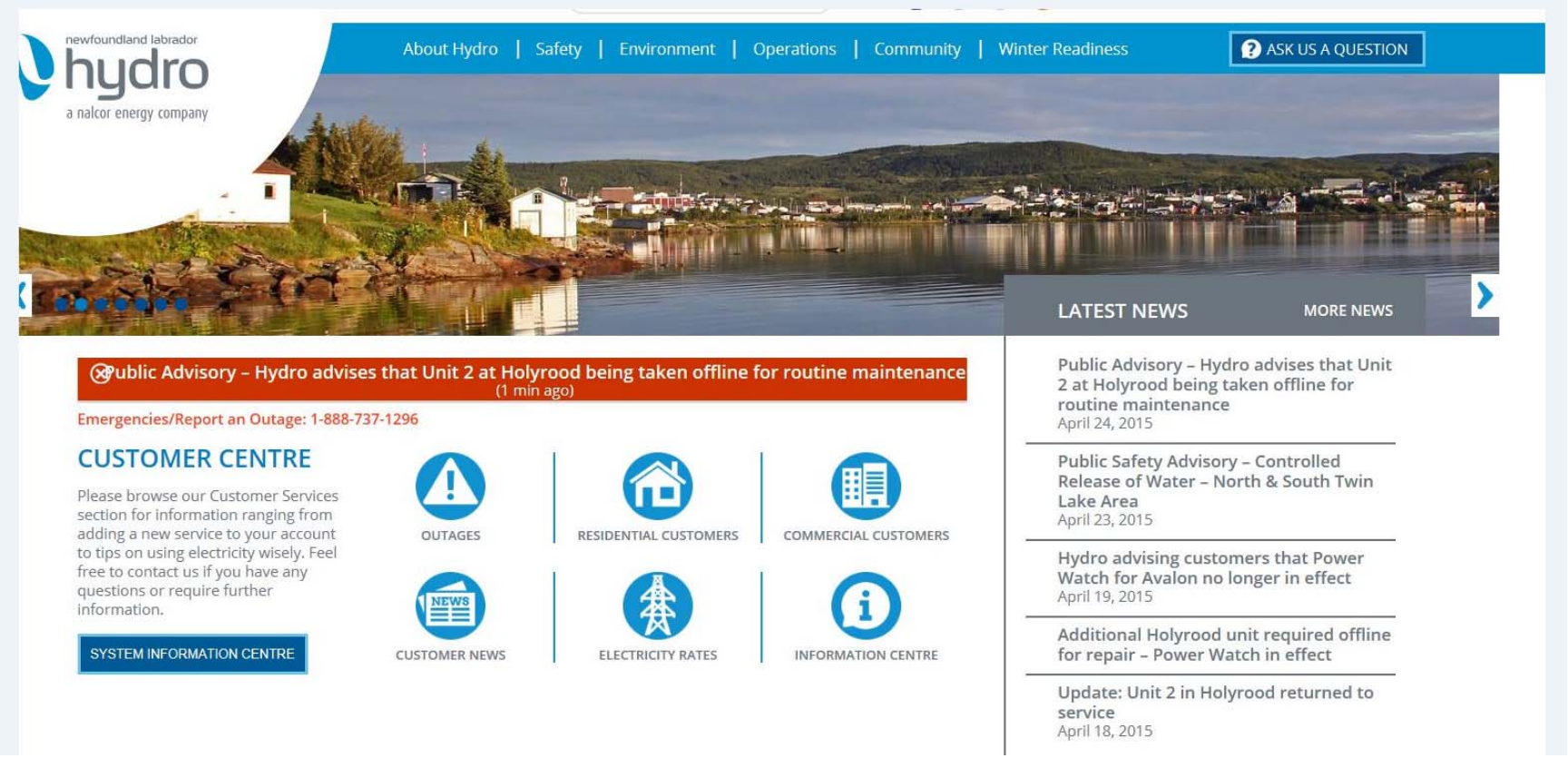
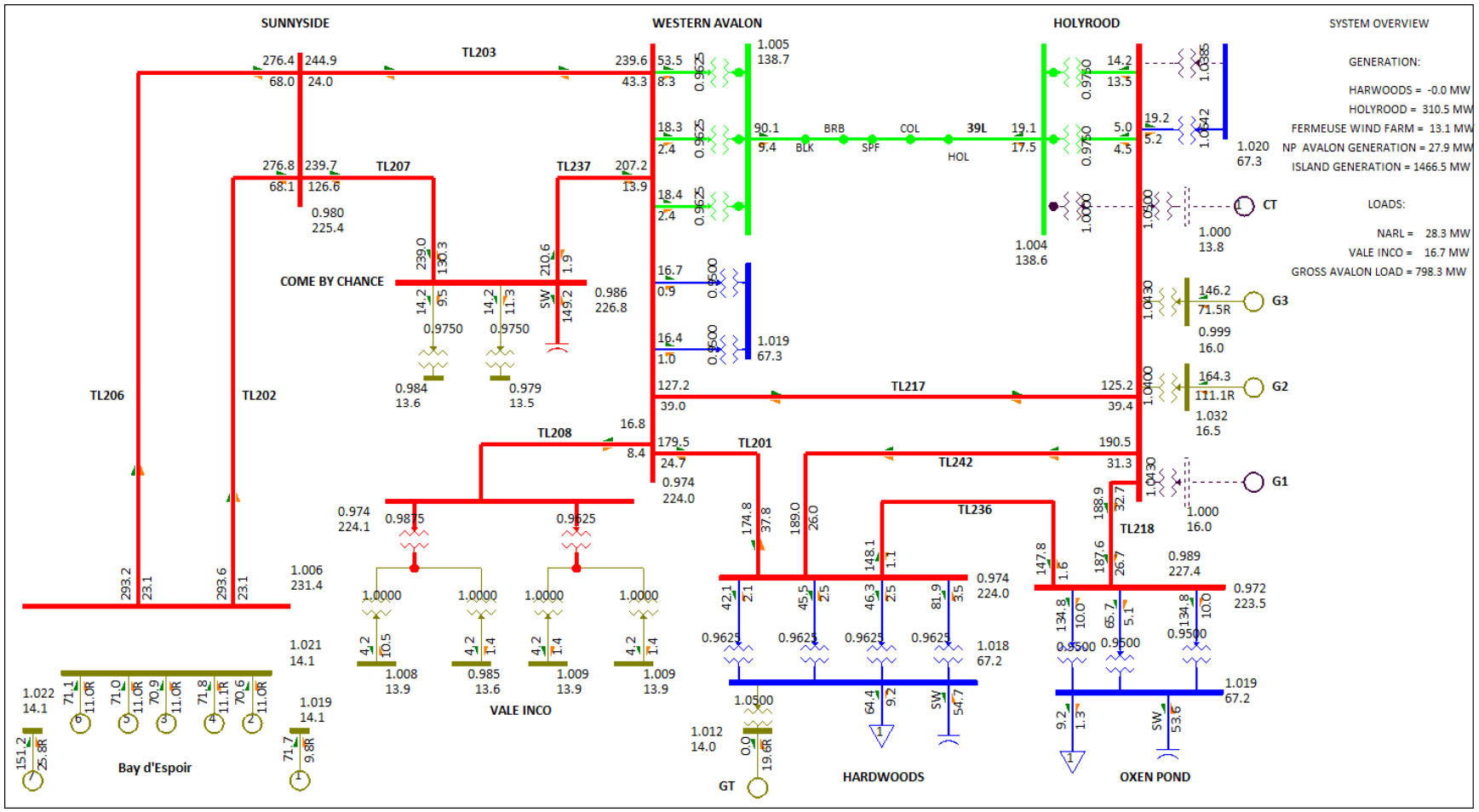
Geoff P. Young
Senior Legal Counsel

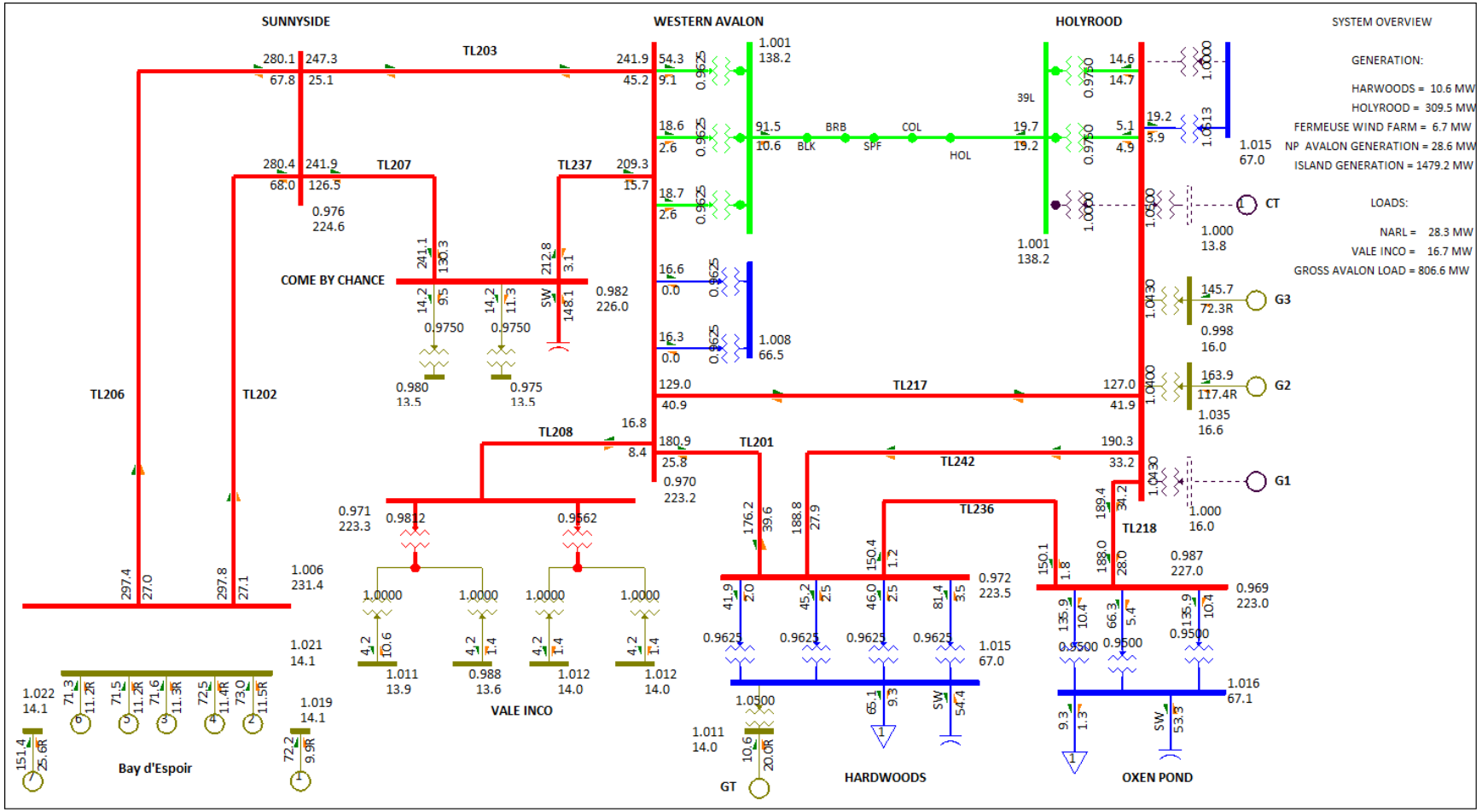
GPY/jc


newfoundland labrador
hydro
a nalcor energy company
About Hydro | Safety | Environment | Operations | Community | Winter Readiness
ASK US A QUESTION
LATEST NEWS
MORE NEWS
Public Advisory – Hydro advises that Unit 2 at Holyrood being taken offline for routine maintenance
(1 min ago)
Emergencies/Report an Outage: 1-888-737-1296
CUSTOMER CENTRE
Please browse our Customer Services section for information ranging from adding a new service to your account to tips on using electricity wisely. Feel free to contact us if you have any questions or require further information.
SYSTEM INFORMATION CENTRE
OUTAGES
RESIDENTIAL CUSTOMERS
COMMERCIAL CUSTOMERS
CUSTOMER NEWS
ELECTRICITY RATES
INFORMATION CENTRE
Public Advisory – Hydro advises that Unit 2 at Holyrood being taken offline for routine maintenance
April 24, 2015
Public Safety Advisory – Controlled Release of Water – North & South Twin Lake Area
April 23, 2015
Hydro advising customers that Power Watch for Avalon no longer in effect
April 19, 2015
Additional Holyrood unit required offline for repair – Power Watch in effect
Update: Unit 2 in Holyrood returned to service
April 18, 2015

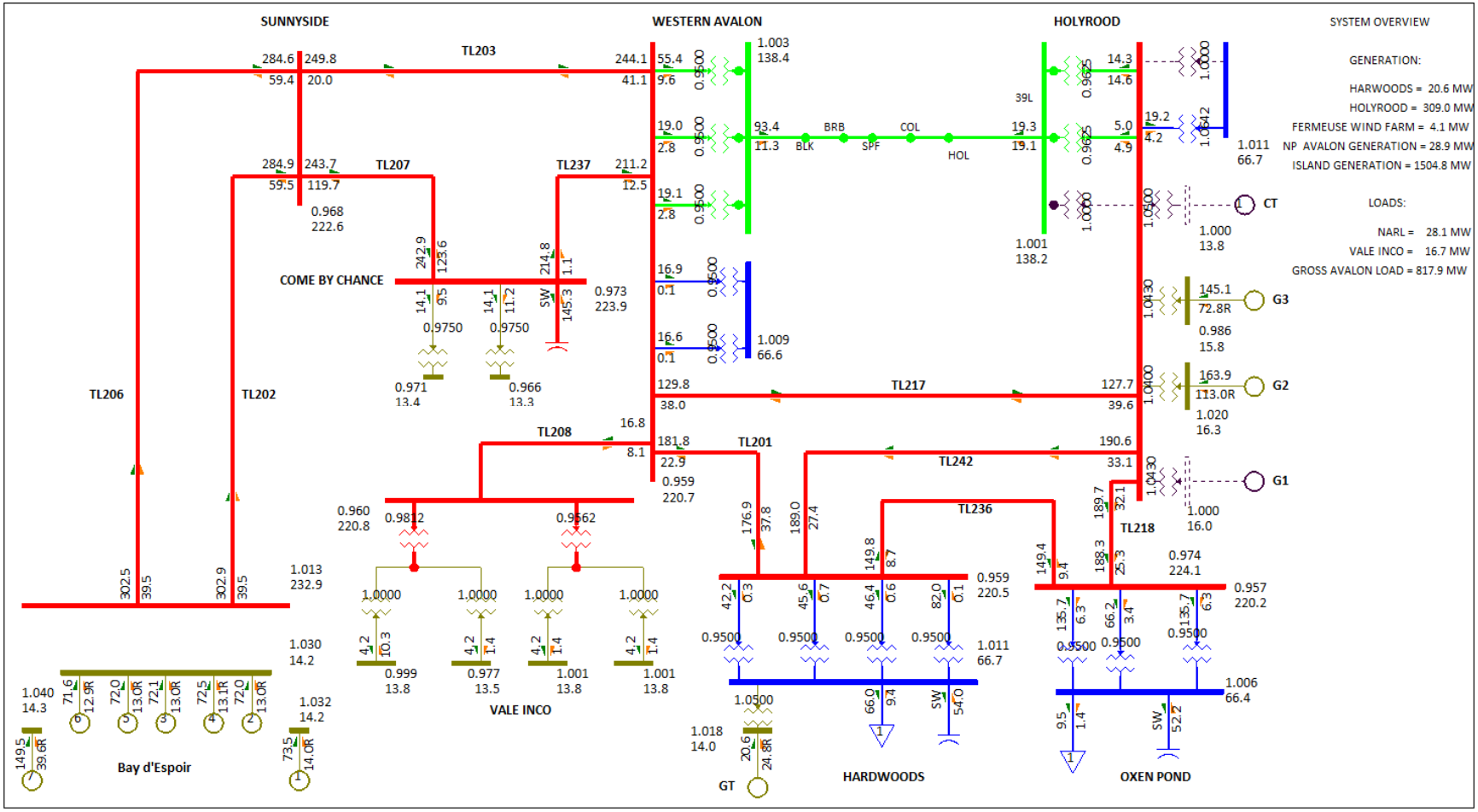

ATTENTION RESIDENTS OF NEWFOUNDLAND & LABRADOR, WE ARE NOW IN A
POWER WARNING
Our electricity supply is getting close to maximum demand. We need you to:
1. Conserve energy.
2. Be prepared for possible power outages.


SUNNYSIDE
WESTERN AVALON
HOLYROOD
SYSTEM OVERVIEW
GENERATION:
HARWOODS = -0.0 MW
HOLYROOD = 310.5 MW
FERMEUSE WIND FARM = 13.1 MW
NP AVALON GENERATION = 27.9 MW
ISLAND GENERATION = 1466.5 MW
LOADS:
NARL = 28.3 MW
VALE INCO = 16.7 MW
GROSS AVALON LOAD = 798.3 MW
TL203
TL207
TL237
TL206
TL202
TL208
TL201
TL217
TL242
TL236
TL218
39L
BRB
COL
BLK
SPF
HOL
COME BY CHANCE
VALE INCO
Bay d'Espoir
GT
HARDWOODS
OXEN POND
CT
G1
G2
G3

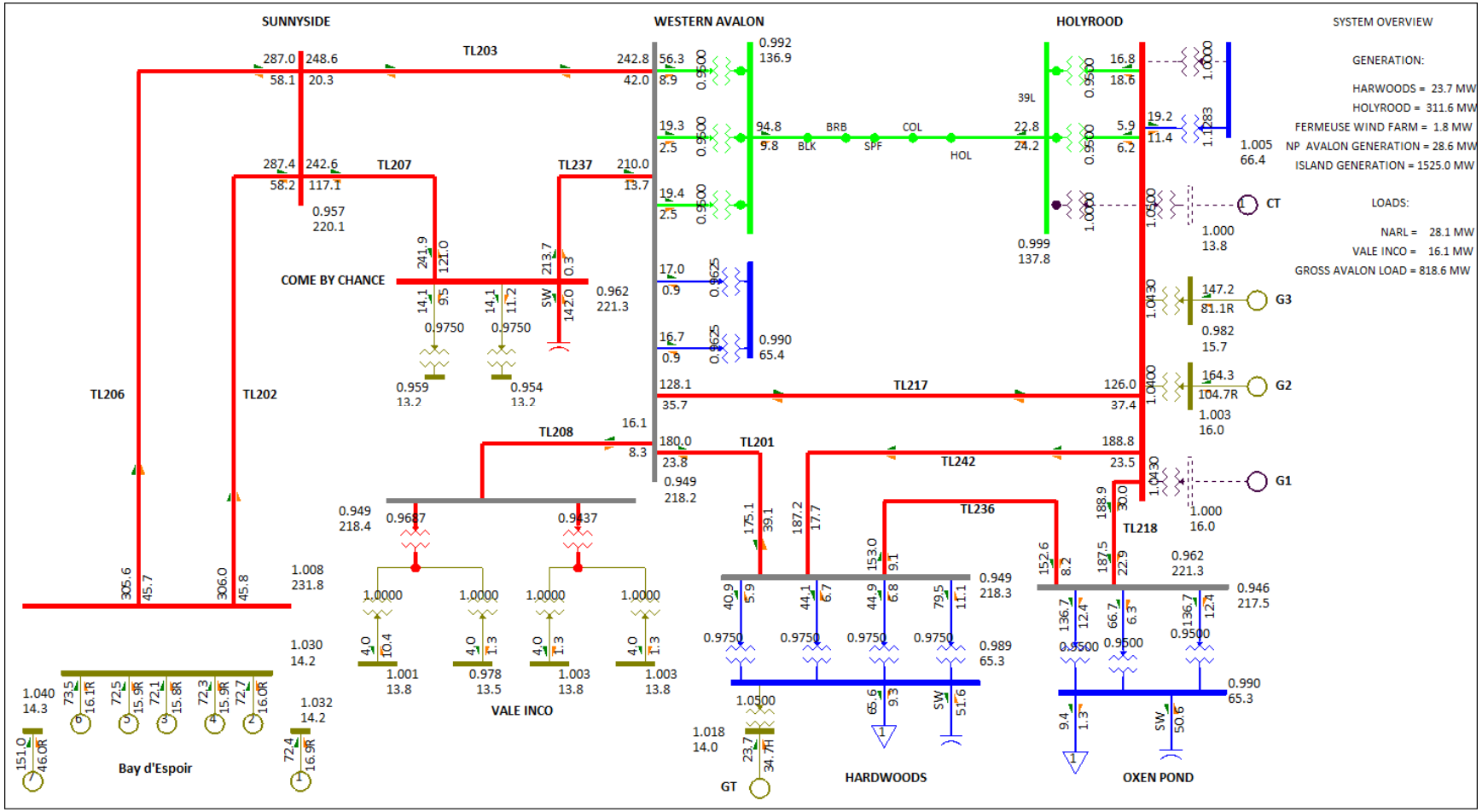
06:15:00 AM


SUNNYSIDE
WESTERN AVALON
HOLYROOD
SYSTEM OVERVIEW
GENERATION:
HARWOODS = 10.6 MW
HOLYROOD = 309.5 MW
FERMEUSE WIND FARM = 6.7 MW
NP AVALON GENERATION = 28.6 MW
ISLAND GENERATION = 1479.2 MW
LOADS:
NARL = 28.3 MW
VALE INCO = 16.7 MW
GROSS AVALON LOAD = 806.6 MW
TL203
TL207
TL237
TL206
TL202
TL208
TL201
TL217
TL242
TL236
TL218
COME BY CHANCE
VALE INCO
Bay d'Espoir
GT
HARDWOODS
OXEN POND
BRB
COL
BLK
SPF
HOL
CT
G1
G2
G3

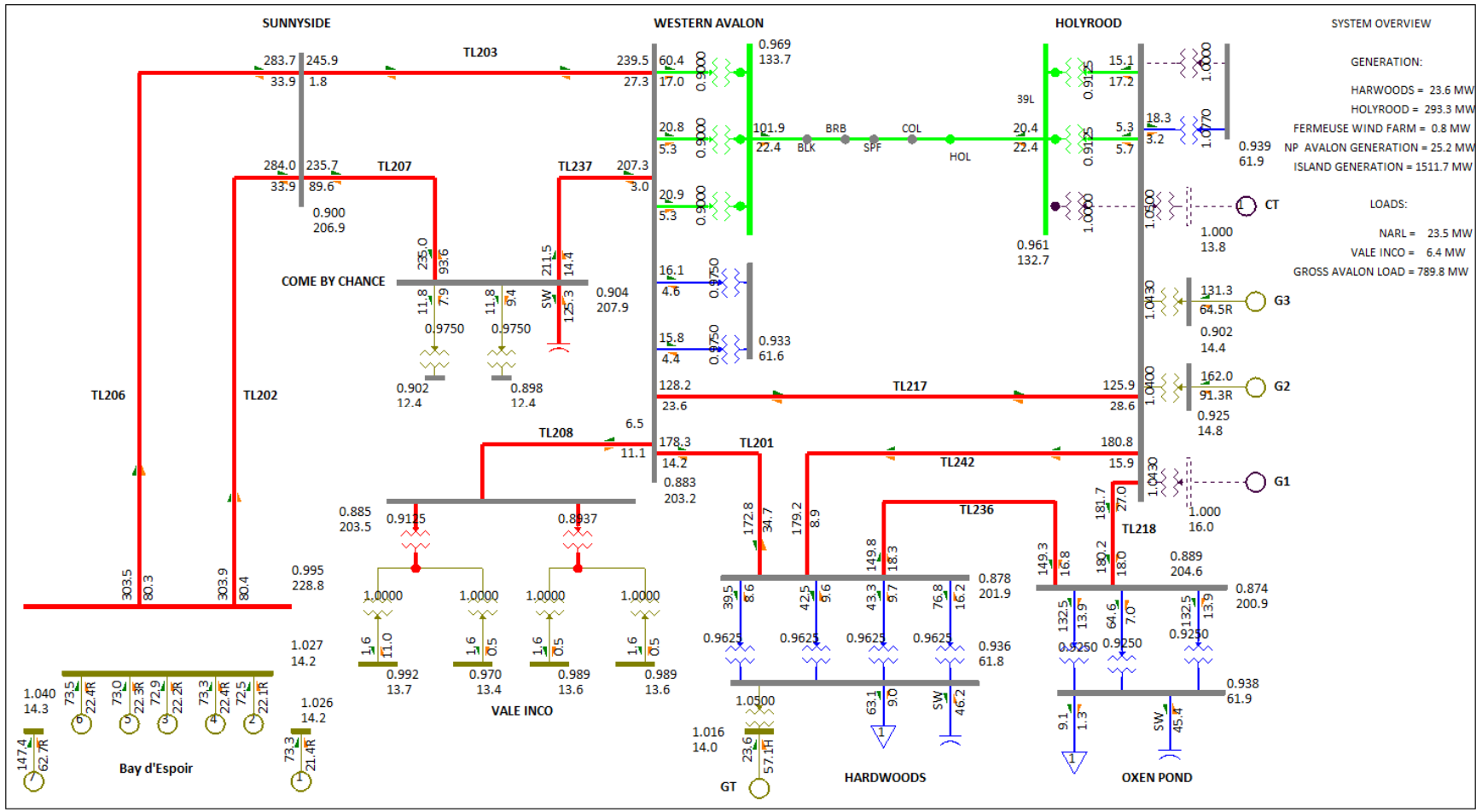
06:30:00 AM


SUNNYSIDE
WESTERN AVALON
HOLYROOD
SYSTEM OVERVIEW
GENERATION:
HARWOODS = 20.6 MW
HOLYROOD = 309.0 MW
FERMEUSE WIND FARM = 4.1 MW
NP AVALON GENERATION = 28.9 MW
ISLAND GENERATION = 1504.8 MW
LOADS:
NARL = 28.1 MW
VALE INCO = 16.7 MW
GROSS AVALON LOAD = 817.9 MW
TL203
TL207
TL237
TL206
TL202
TL208
TL201
TL217
TL242
TL236
TL218
COME BY CHANCE
VALE INCO
Bay d'Espoir
GT
HARDWOODS
OXEN POND
BRB
COL
BLK
SPF
HOL
CT
G3
G2
G1
SW

06:45:00 AM


SUNNYSIDE
WESTERN AVALON
HOLYROOD
SYSTEM OVERVIEW
GENERATION:
HARWOODS = 23.7 MW
HOLYROOD = 311.6 MW
FERMEUSE WIND FARM = 1.8 MW
NP AVALON GENERATION = 28.6 MW
ISLAND GENERATION = 1525.0 MW
LOADS:
NARL = 28.1 MW
VALE INCO = 16.1 MW
GROSS AVALON LOAD = 818.6 MW
TL203
TL207
TL237
TL206
TL202
TL208
TL201
TL217
TL242
TL236
TL218
COME BY CHANCE
VALE INCO
Bay d'Espoir
GT
HARDWOODS
OXEN POND
BRB
COL
BLK
SPF
HOL
CT
G3
G2
G1

07:00:00 AM


SUNNYSIDE
WESTERN AVALON
HOLYROOD
SYSTEM OVERVIEW
GENERATION:
HARWOODS = 23.6 MW
HOLYROOD = 293.3 MW
FERMEUSE WIND FARM = 0.8 MW
NP AVALON GENERATION = 25.2 MW
ISLAND GENERATION = 1511.7 MW
LOADS:
NARL = 23.5 MW
VALE INCO = 6.4 MW
GROSS AVALON LOAD = 789.8 MW
TL203
TL207
TL237
TL206
TL202
TL208
TL201
TL217
TL242
TL236
TL218
39L
BRB
COL
BLK
SPF
HOL
COME BY CHANCE
VALE INCO
Bay d'Espoir
GT
HARDWOODS
OXEN POND
CT
G1
G2
G3
SW

07:14:00 AM