newfoundland labrador hydro
a nalcor energy company

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

April 30, 2019

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 Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: **The Board of Commissioners of Public Utilities Investigation and Hearing into Supply Issues and Power Outages on the Island Interconnected System – Rolling 12 Month Performance of Newfoundland and Labrador Hydro's Generating Units**

In accordance with item 2.8 of the Liberty Report Recommendations dated December 17, 2014 please find attached the original plus twelve copies of Newfoundland and Labrador Hydro's ("Hydro") "Quarterly Report on Performance of Generating Units for the Quarter Ended March 31, 2019" (the "Report").

On November 16, 2018 Hydro filed the Reliability and Resource Adequacy Study with the Board of Commissioners of Public Utilities (the "Board"). The Reliability and Resource Adequacy Study included Hydro's proposed planning assumptions for consultation and discussion with the Board and other stakeholders. For the Report, which covers the performance of Hydro's generating units for the quarter ending March 31, 2019, the assumptions that were reported in the previous 2018 quarterly reports have been maintained for clarity prior to the transition to reporting against the new assumptions.

We trust the foregoing is satisfactory. If you have any questions or comments, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Michael S. Ladha
Legal Counsel & Assistant Corporate Secretary
MSL/ls

Encl.

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey
Danny Dumaresque
Dennis Browne, Q.C. – Browne, Fitzgerald, Morgan & Avis
Dean Porter – Poole Althouse

ecc: Dennis Fleming – Cox & Palmer
Roberta Frampton Benefiel – Grand RiverKeeper® Labrador
Larry Bartlett – Teck Resources Limited

Quarterly Report on Performance of Generating Units

for the Quarter Ended March 31, 2019

April 30, 2019

A Report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro
a nalcor energy company

Table of Contents

1.0 Introduction

In this report, Newfoundland and Labrador Hydro ("Hydro") provides data on forced outage rates of its generating facilities. The data provided pertains to historical forced outage rates and assumptions used by Hydro in its assessments of resource adequacy. On November 16, 2018 Hydro filed its Reliability and Resource Adequacy Study (the "Study") with the Board of Commissioners of Public Utilities (the "Board"). The Study included Hydro's proposed planning assumptions for further discussion with the Board and intervenors. This quarterly report covers the performance of Hydro's generating units for the quarter ending March 31, 2019. The assumptions used throughout are the same as reported in the previous 2018 quarterly reports except where new assumptions are included and identified in Table 12. While the new assumptions form the basis of Hydro's current planning processes, this report includes the historic assumptions and style to maintain similarity to previous reports for clarity while the Board's assesses the Study.

The report contains forced outage rates for the current 12-month reporting period of April 1, 2018 to March 31, 2019 for individual generating units at hydraulic facilities, the Holyrood Thermal Generating Station, and Hydro's gas turbines. The report also provides, for comparison purposes, the individual generating unit data on forced outage rates for the previous period, April 1, 2017 to March 31, 2018. Further, total asset class data is presented based on a calendar year for the years 2006 – 2016.

The forced outage rates of Hydro's generating units are calculated using three measures: Derated Adjusted Forced Outage Rate ("DAFOR") for the hydraulic and thermal units; and Utilization Forced Outage Probability ("UFOP") and Derated Adjusted Utilization Forced Outage Probability ("DAUFOP") for the gas turbines.

DAFOR is a metric that measures the percentage of the time that a unit or group of units is unable to generate at its maximum continuous rating due to forced outages. The DAFOR for each unit is weighted to reflect differences in generating unit sizes in order to provide a company total and reflect the relative impact a unit's performance has on overall generating

performance. This measure is applied to hydraulic and thermal units; however, it is not applicable to gas turbines because of their operation as standby units and their relatively low operating hours.

UFOP and DAUFOP are measures used for gas turbines. UFOP measures the percentage of time that a unit or group of units will encounter a forced outage and not be available when required. DAUFOP is a metric that measures the percentage of time that a unit or group of units will encounter a forced outage and not be available when required; this metric includes the impact of unit deratings.

The forced outage rates include outages that remove a unit from service completely, as well as instances when units are derated. If a unit's output is reduced by more than 2%, the unit is considered derated under Canadian Electricity Association ("CEA") guidelines. CEA guidelines require that derated levels of a generating unit are calculated by converting the operating time at the derated level into an equivalent outage time.

In addition to forced outage rates, this report provides details for those outages that contributed materially to forced outage rates exceeding those used in Hydro's generation planning analysis for both the near- and long-term.

Note that the data for 2006 to 2016 in Figures 1 through 7 are annual numbers (January 1 to December 31), while the data for 2018 and 2019 are 12-month rolling numbers (April 1 to March 31 for each year).

As part of the Study, filed with the Board on November 16, 2018, Hydro detailed the process undertaken to determine the forced outage rates most appropriate for use in its near-term reliability assessments and long-term resource adequacy analysis. The revised forced outage rates, which resulted from this process, are included in Sections 8 and 9 of this report. The potential impacts of these revised forced outage rates on future performance reporting is also discussed.

2.0 Overview for Period Ending March 31, 2019

Table 1: DAFOR, UFOP, and DAUFOP Overview (%)

Class of Units	Apr 1, 2017 to Mar 31, 2018	Apr 1, 2018 to Mar 31, 2019	Base Planning Assumption	Near-Term Planning Assumption[1]
Hydraulic (DAFOR)	2.13	0.23	0.90	2.60
Thermal (DAFOR)	24.10	14.97[2]	9.64	14.00
Gas Turbine (Combined) (UFOP)	7.26	5.08	10.62	20.00
Gas Turbine (Holyrood) (UFOP)	0.07	0.00	5.00	5.00
Gas Turbine (Hardwoods/Stephenville) (DAUFOP)	20.93	23.39	-	30.00
Gas Turbine (Happy Valley) (DAUFOP)	20.87	0.00	-	15.00
Gas Turbine (Holyrood) (DAUFOP)	0.07	0.00	-	5.00

There was an improvement in hydraulic DAFOR and in thermal DAFOR performance for the current 12-month period ending March 31, 2019, compared to the previous 12-month period ending March 31, 2018 (see Table 1). The combined[3] gas turbine UFOP performance shows an improvement in performance for the current period compared to the previous period, while DAUFOP shows a slight decline in performance.

In the 10-year period prior to 2015, the hydraulic units showed a somewhat consistent DAFOR. The DAFOR of the current 12-month period compared to the previous 10 years is higher, primarily due to penstock issues experienced on Bay d'Espoir Units 1 and 2 in 2016 and 2017.

For the Holyrood thermal units, the forced outage rate of the current period ending March 31, 2019 is 14.97%, which is above the base planning assumption of 9.64%, the sensitivity of 11.64% (refer to Section 3), and slightly above the near-term planning assumption of 14.00%.

[1] Near-Term Generation Adequacy Report, November 15, 2017, see section 5.0 for further details.
[2] The thermal DAFOR is 7.74% with the air flow derating removed.
[3] Combined Gas Turbines include the Hardwoods, Happy Valley, and Stephenville units. The performance of the Holyrood unit was not included in the combined base planning or sensitivity numbers as these numbers were set prior to its in service date.

This is primarily caused by an air flow derating on all units that continued through most of 2018.

The Holyrood DAFOR for the current period shows significant improvement for the 2018 – 2019 winter season due to the work that was completed during the 2018 annual outages to improve the performance of all units with respect to air flow limitations. All three units were successfully tested to full load and have remained at that capability, with minor exceptions.

Hydro's combined gas turbines' UFOP in the 10-year period prior to 2015 was generally consistent at approximately 10%, until the year 2012 when the rate exceeded 50%. Since 2012, the UFOP has been improving each year.

Hydro began reporting DAUFOP performance in January 2018 for its gas turbines. For the current 12-month period, the combined gas turbines' DAUFOP (i.e. Hardwoods and Stephenville units only) performance is primarily impacted by a lengthy forced outage to the Stephenville unit.

3.0 Generation Planning Assumptions

The Reliability and Resource Adequacy Study submitted to the Board in November 2018 introduced new generation planning assumptions; however, the assumptions used throughout this report are the same as reported in previous quarterly reports. The potential impacts of these revised assumptions on reporting of generation unit performance are discussed in Section 9 of this report. While the new assumptions form the basis of Hydro's current planning processes, this report includes the historic assumptions and style to maintain similarity to previous reports for clarity while the Board assesses the Study.

Hydro produces reports based on comprehensive reviews of energy supply for the Island Interconnected System. This is part of Hydro's analysis of energy supply up to the Muskrat Falls interconnection. The Near-Term Generation Adequacy Report filed on May 22, 2018 contains analysis based on the near-term DAFOR and DAUFOP and the resulting implication for meeting

reliability criteria until the interconnection with the North American grid. The near-term analysis has been updated since that time to reflect changes in assumptions with respect to the in-service of the Labrador-Island Link ("LIL"). The results of this analysis were presented to the Board as part of the LIL In-Service Update submitted October 1, 2018.

Hydro's DAFOR and UFOP planning assumptions are provided in Table 2. The Holyrood Gas Turbine has a lower expected rate of unavailability than the older gas turbines (5% compared to 10.62%) due to the fact that the unit is new and can be expected to have better availability than the older units.[4]

Table 2: 2017[5] DAFOR and UFOP Long-Term Planning Assumptions

	DAFOR (%)		UFOP (%)	
	Base Planning Assumption	**Sensitivity**	**Base Planning Assumption**	**Sensitivity**
Hydraulic Units	0.90	0.90		
Thermal Units	9.64	11.64		
Gas Turbines – Existing			10.62	20.00
Gas Turbines – New			5.0	10.0

The DAFOR and DAUFOP assumptions used in developing Hydro's May 2018 Near-Term Generation Adequacy report are noted in Table 3.

[4] Hydro selected a 5% UFOP for the new Holyrood Gas Turbine following commentary on forced outage rates contained in the *Independent Supply Decision Review – Navigant (September 14, 2011).*

[5] Near-Term Generation Adequacy Report, November 15, 2017, see section 5.0 for further details.

Table 3: DAFOR and DAUFOP Near-Term Generation Adequacy Analysis Assumptions

	DAFOR (%) Near-Term Generation Adequacy Assumption	DAUFOP (%) Near-Term Generation Adequacy Assumption
All Hydraulic Units	2.6	
Bay d'Espoir Hydraulic Units	3.9	
Other Hydraulic Units	0.7	
Holyrood Plant	14.0	
Hardwoods & Stephenville Gas Turbines		30.0
Happy Valley Gas Turbine		15.0
Holyrood Gas Turbine		5.0

4.0 Hydraulic Unit DAFOR Performance

Detailed results for the 12-month period ending March 31, 2019 are presented in Table 4, as well as the data for the 12-month period ending March 31, 2018. These are compared to Hydro's short-term generation adequacy assumptions, as used in the May 2018 Near-Term Generation Adequacy Report, and Hydro's long-term generation planning assumptions for the forced outage rate.

Table 4: Hydraulic Weighted DAFOR

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending March 2018 (%)	12 months ending March 2019 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
All Hydraulic Units - weighted	954.4	2.13	0.23	0.90	2.60
Hydraulic Units					
Bay D'Espoir 1	76.5	8.86	0.07	0.90	3.90
Bay D'Espoir 2	76.5	13.79	0.64	0.90	3.90
Bay D'Espoir 3	76.5	0.01	0.00	0.90	3.90
Bay D'Espoir 4	76.5	0.29	0.16	0.90	3.90
Bay D'Espoir 5	76.5	0.00	0.19	0.90	3.90
Bay D'Espoir 6	76.5	0.00	0.64	0.90	3.90
Bay D'Espoir 7	154.4	1.80	0.10	0.90	3.90
Cat Arm 1	67	0.22	0.94	0.90	0.70
Cat Arm 2	67	0.09	0.00	0.90	0.70
Hinds Lake	75	0.87	0.07	0.90	0.70
Upper Salmon	84	0.05	0.15	0.90	0.70
Granite Canal	40	0.11	0.45	0.90	0.70
Paradise River	8	1.45	1.65	0.90	0.70

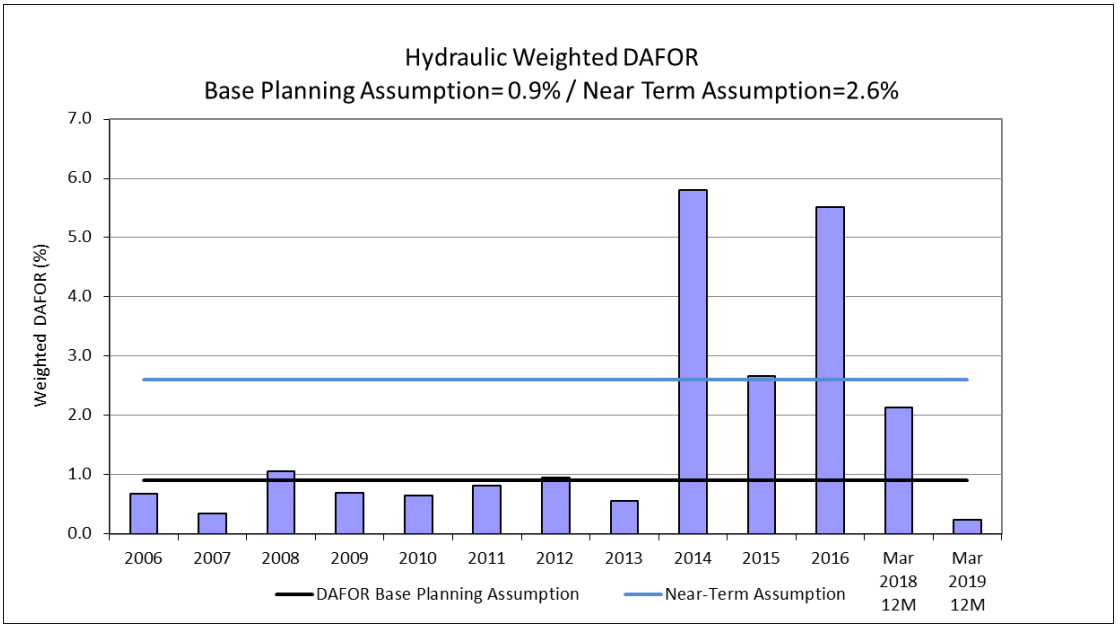

Figure 1: Hydraulic Weighted DAFOR

Considering individual hydraulic unit performance, the Hydro generation base planning DAFOR was exceeded for Cat Arm Unit 1 and the Paradise River unit for the current period. The Cat Arm Unit 1 DAFOR of 0.94% exceeded the base planning assumption of 0.9% and the near-term assumption of 0.7% for an individual Cat Arm unit. This was due to a forced derating of Cat Arm Unit 1 from 67 MW to 57 MW for the period of July 5, 2018 to August 6, 2018 as a result of an issue with Needle #1 transducer feedback. This issue has since been resolved by replacement of the needle feedback transducer during the annual maintenance outage for the unit.

The Paradise River unit DAFOR of 1.65% exceeded the base planning assumption of 0.9% and the near-term assumption of 0.7% for the Paradise River unit. This was due to a starting failure that occurred on January 13, 2019 resulting from a malfunctioning governor feedback transducer. The malfunctioning transducer was repaired and the unit was returned to service on January 16, 2019. This issue was resolved by replacing the transducer during a planned outage in February 2019.

5.0 Thermal Unit DAFOR Performance

Detailed results for the 12-month period ending March 31, 2019, are presented in Table 5, as well as the data for the 12-month period ending March 31, 2018. These results are compared to Hydro's short term generation adequacy assumptions, as used in the May 2018 Near-Term Generation Adequacy Report, and Hydro's long-term generation planning assumptions for the forced outage rate.

Table 5: Thermal DAFOR

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending March 2018 (%)	12 months ending March 2019 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
All Thermal Units - weighted	490	24.10	14.97	9.64	14.00
Thermal Units					
Holyrood 1	170	31.66	20.20	9.64	15.00
Holyrood 2	170	25.36	13.53	9.64	10.00
Holyrood 3	150	14.03	7.34	9.64	18.00

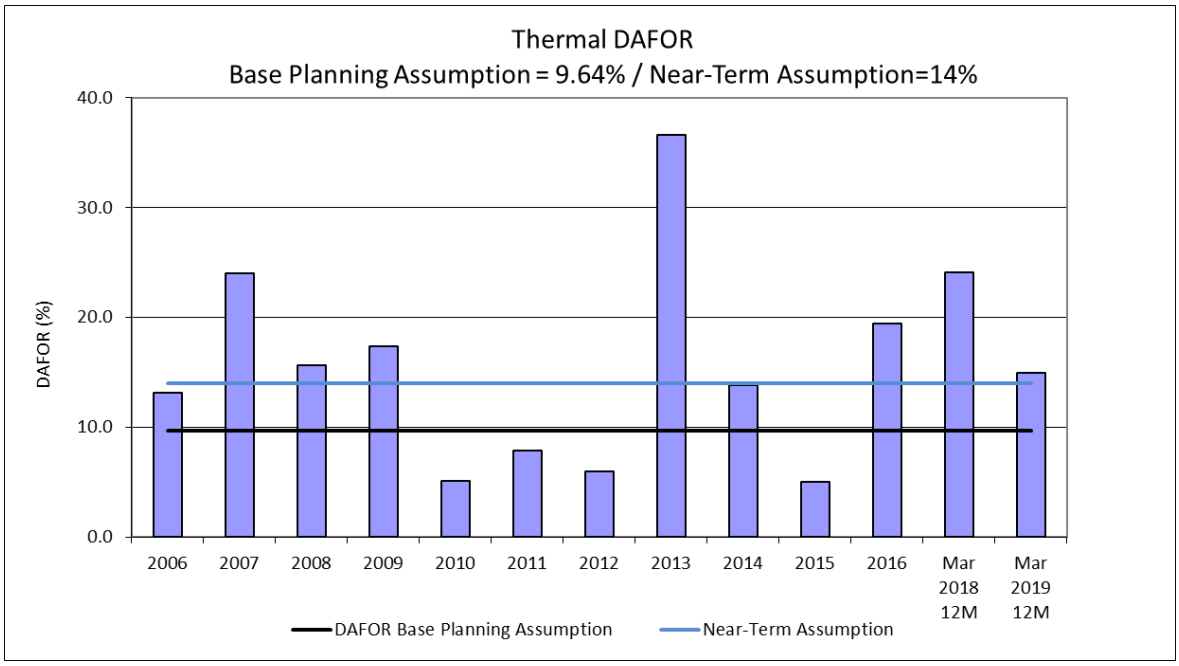

Figure 2: Thermal DAFOR

For the 12-month period ending March 31, 2019, the weighted DAFOR for all thermal units of 14.97% is above the assumed base planning DAFOR value of 9.64%, and slightly above the near-

term assumption of 14.00%. Unit 1 DAFOR was 20.20% and Unit 2 DAFOR was 13.53%. The performance for both Units 1 and 2 was above the base planning assumption of 9.64% and the near-term assumption of 15% (Unit 1) and 10% (Unit 2). Unit 3 DAFOR was 7.34%, which is below the base planning assumption of 9.64% and the near-term assumption of 18.0%. The current period DAFOR for all units is improved over the previous period.

The DAFOR performance for Holyrood Unit 1 (170 MW) was affected by the following events in the current 12-month to-date period:

- On April 12, 2018, the load was reduced to 126 MW, limited by high furnace pressure as a result of continued boiler and air heater fouling. The capability of the unit continued to decline for the same reason. On May 6, 2018, the capability was 122 MW and on May 15, 2018, it was 116 MW.

- On May 21, 2018, the unit tripped at 70 MW on high boiler drum level. The cause was determined to be a failure of a turbine control valve stem. The valve stem was replaced during the planned 2018 turbine valve outage.

- On June 4, 2018, the unit was further de-rated to 100 MW, limited by high furnace pressure as a result of on-going boiler and air heater fouling. By the end of June 2018 this had further reduced to 88 MW.

- On June 16, 2018, while on a brief planned outage to change worn generator brushes, a pressure gauge failed on the fuel oil system resulting in a spill. Remediation was required before the unit could be safely returned to service. On June 17, 2018, while starting up the unit, a bearing failed on the east forced draft fan and had to be replaced. The unit returned to service on June 18, 2018 but the same bearing failed after only a few hours of operation. The bearing was again replaced and the unit was successfully returned to service on June 19, 2018. A field representative from the fan's original equipment manufacturer travelled to site to assist with the failure analysis of these

bearings. It was concluded that the bearing liner babbitted surface failed. Additional checks have been added to the Preventive Maintenance work for these bearings to prevent such a failure.

- The planned maintenance outage for Unit 1 started on July 27, 2018. Outage work included a chemical wash of the economizer and replacement of the hot end air heater baskets to address air flow and furnace pressure load restrictions.

- The unit was returned to service following the annual outage on October 20, 2018, with a load restriction of 140 MW pending completion of online safety valve testing. After completion of the valve testing, the available load was confirmed to be 162 MW on December 6, 2018 and this remained true through to the end of 2018. Boiler tuning was completed by a boiler tuning expert from December 17, 2018 to December 20, 2018. This improved the operation of the boiler, but did not increase the available load.

- On November 3, 2018, the unit tripped due to contamination in the turbine hydraulic system. A full overhaul was completed and the unit was returned to service on November 24, 2018. The observations on Unit 1 triggered the same refurbishment of the Unit 2 turbine hydraulic system, which was completed in December 2018.

- On December 9, 2018, the unit tripped due to a failure of a potential transformer ("PT"), which led to the immediate failure of a second PT. The PTs were replaced with available spares. Electrical testing was completed on the remaining four PTs and the generator windings before returning the unit to service on December 14, 2018. No further issues were identified.

- Unit 1 was derated to 162 MW for the month of January 2019. Load was limited by high opacity at loads above 162 MW, indicating insufficient combustion air at the burners. On January 29, 2019 the unit was taken off-line to replace a fuel oil pump and mass flow meter. The unit was returned to service on February 1, 2019. Replacement of the mass

flow meter corrected the combustion fuel/air mixture issue. On February 5, 2019, a load test confirmed the unit capability to be 173 MW. This was further improved to 175 MW on February 13, 2019.

The DAFOR performance for Holyrood Unit 2 (170 MW) was primarily affected by the following events:

- At the beginning of April 2018 the unit was rated at 80 MW due to high furnace pressure as a result of boiler and air heater fouling. This capability further reduced to 70 MW on April 24, 2018 and remained at this level until the unit was taken off-line for the annual outage.

- On April 3, 2018 the unit was taken off-line on a forced outage to repair a leak in the turbine control valve hydraulic ram. The ram was rebuilt and the unit returned to service on April 4, 2018; however, once installed the seals required additional adjustment. The unit was returned to service April 5, 2018. Return to service after this outage was delayed by approximately eight hours on April 5, 2018 due to an issue in the switchyard. Transmission and Rural Operations replaced the B2T2 breaker during the 2018 annual outage, which resolved this issue.

- Unit 2 was available but not operating from April 26, 2018 to May 18, 2018, with the available load de-rated to 70 MW due to high furnace pressure as a result of boiler and air heater fouling. During this time the unit was kept in hot standby, maintaining an eight-hour return to service time if recalled. On May 18, 2018 the unit was taken off-line to address a suspected stress failure, not a thinning failure, of a tube in the lower water wall (not in the area of previous boiler tube issues). At the time of the failure, Hydro determined that the unit was no longer required for system reliability reasons prior to the scheduled planned outage and could be placed on planned outage in preparation for the annual overhaul.

- The tube leak was corrected during the overhaul. Two adjacent leaking tubes were found in the lower front wall. Through investigation and laboratory failure analysis it was determined that the original failure occurred at a butt welded joint in the tube and that this weld was part of the original construction and of relatively poor quality. Other welds in the area were inspected with no damage found. The leak had been present for an unknown period of time underneath the boiler casing and impinged upon the adjacent tube, which also failed as a result. Several other tubes in the immediate area were corroded due to the presence of the leak, but had not failed. A total of seven tube sections were replaced.

- Also during the planned overhaul, work was completed to correct the air flow and furnace pressure issues in the boiler. A chemical wash of the economizer was completed and the hot end air heater baskets were replaced. The unit was returned to service on September 15, 2018 with the fuel additive system in service and it was immediately noted that the furnace pressure and air flow conditions had been materially improved. Equipment issues related to start up caused a number of short forced outages and derates during the first few days of operation. On September 21, 2018, the unit was load tested to 140 MW, limited to this level because the online safety valve testing had not been completed. However, it was clear from the boiler performance that full load should be achievable. This was later confirmed on October 11, 2018 when the unit was tested to 171 MW and was capable of more. Unit 2 remained capable of operating at full load of 175 MW throughout the winter availability period, from December 2018 to the end of March 2019.

- On September 26, 2018 there was a boiler trip related to starting a boiler feed pump. The fan was in vane control and it was demonstrated that this trip would not occur in Variable Frequency Drive air flow control. The fans were switched to VFD control mode, which ensures that the drives are more reliable, and that the savings on auxiliary power use can be realized.

- On October 16, 2018, there was a bypass of a power cell in one VFD drive, which caused a fan to trip resulting in a short derating to 70 MW until the fan could be restarted.

6.0 Gas Turbine UFOP Performance

The combined UFOP for the Hardwoods, Happy Valley and Stephenville Gas Turbines was 5.08% for the 12-month period ending March 31, 2019 (see Table 6 and Figure 3). This performance is better than the base planning assumption of 10.62% and the near-term assumption of 20.00% and is improved over the previous period. The Hardwoods UFOP for the current period is 7.77%, as compared to the base planning assumption of 10.62%. The Stephenville UFOP for the current period is 0.98%, as compared to the base planning assumption of 10.62%. The Happy Valley UFOP is 0.00% for the current period, as compared to the base planning assumption of 10.62%. On an individual unit basis, gas turbine performance for the Stephenville and Happy Valley units for the current period are improved over the previous period. The UFOP for Hardwoods for the current period is increased over the previous period. Hydro's combined gas turbines' UFOP in the 10-year period prior to 2015 was generally consistent at approximately 10%, until 2012 when the rate exceeded 50%. Since 2012, the gas turbines combined UFOP has improved each year.

Table 6: Gas Turbine UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2018 (%)	12 months ending March 2019 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Combined Gas Turbines	125	7.26	5.08	10.62	20.00
Stephenville	50	5.57	0.98	10.62	20.00
Hardwoods	50	1.09	7.77	10.62	20.00
Happy Valley	25	20.87	0.00	10.62	20.00

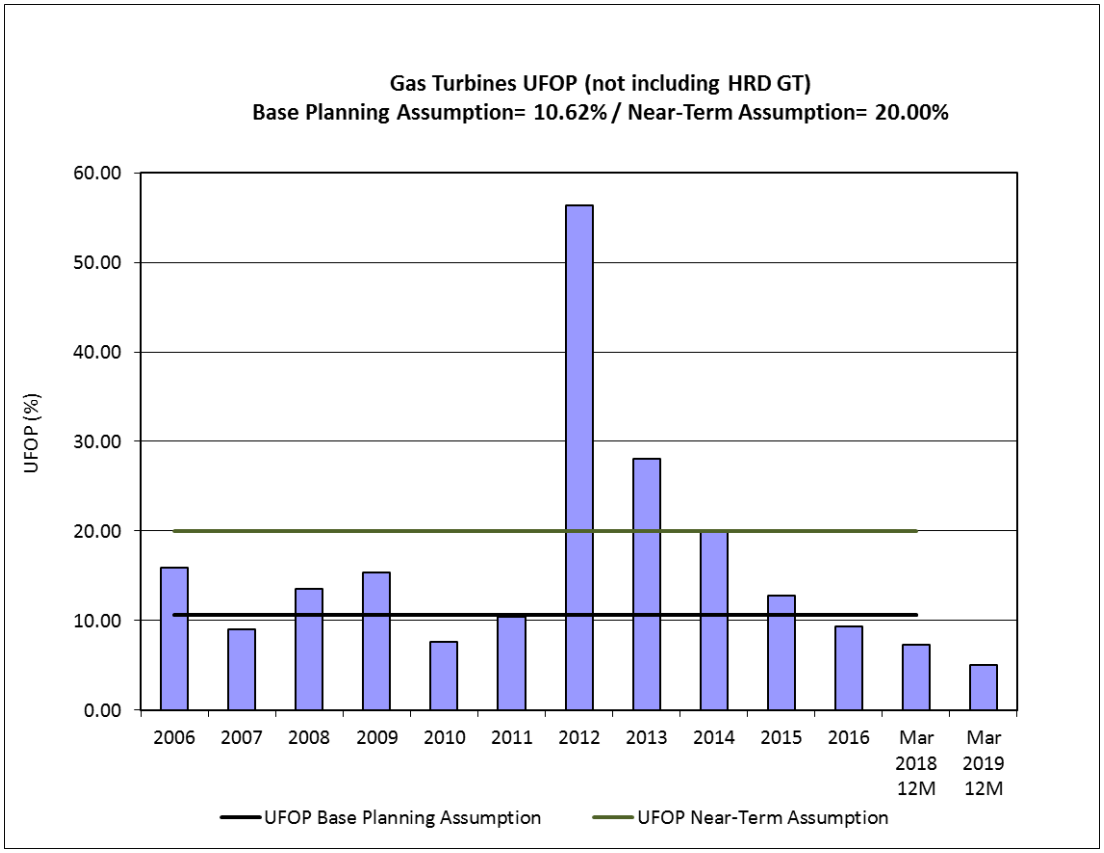

Figure 3: Gas Turbine UFOP – Hardwoods/Happy Valley/Stephenville Units

The Holyrood GT UFOP of 0.00% for the current period is better than the base and near-term planning assumptions of 5.00% (see Table 7 and Figure 4) and is slightly improved over the UFOP for the previous period.

Table 7: Holyrood GT UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2018 (%)	12 months ending March 2019 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	0.07	0.00	5.00	5.00

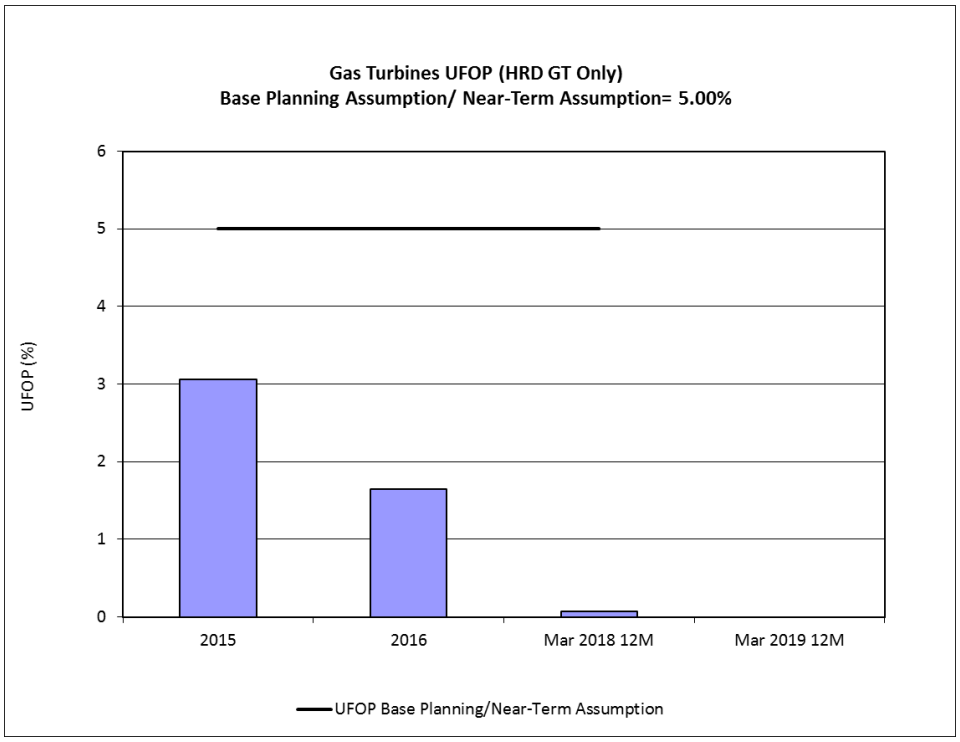

Figure 4: Gas Turbine UFOP – Holyrood Unit

7.0 Gas Turbine DAUFOP Performance

The combined DAUFOP for the Hardwoods and Stephenville Gas Turbines was 23.39% for the 12-month period ending March 31, 2019 (refer to Table 8 and Figure 5). This is below the near-term planning assumption of 30.00%. The Hardwoods DAUFOP for the current period is 14.08%, which is below the near-term planning assumption of 30.00% and above the DAUFOP for the previous period. The Stephenville DAUFOP for the current period is 34.68%, which is above the near-term planning assumption of 30.00%, and improved over the previous period.

The Stephenville Gas Turbine DAUFOP for the period is impacted by the unavailability of End A. Stephenville End A was unavailable in December 2017 due to issues with the power turbine rear bearing, which required the bearing to be replaced. As a result of an exhaust bellows failure at Hardwoods Gas Turbine End A on December 28, 2017, Hydro removed the bellows from End A at Stephenville, as it was already out of service, and installed it at Hardwoods End A to return Hardwoods to full capacity. End A at Stephenville was returned to service on November 28, 2018 following replacement of the power turbine rear bearing, replacement of

1 the bellows, and upon resolution of vibration monitoring system issues. This unit has operated
2 reliably since its return to service.

Table 8: Hardwoods/Stephenville Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2018 (%)	12 months ending March 2019 (%)	Near-Term Planning Assumption (%)
Gas Turbines (HWD/SVL)	100	20.93	23.39	30.00
Stephenville	50	52.11	34.68	30.00
Hardwoods	50	5.01	14.08	30.00

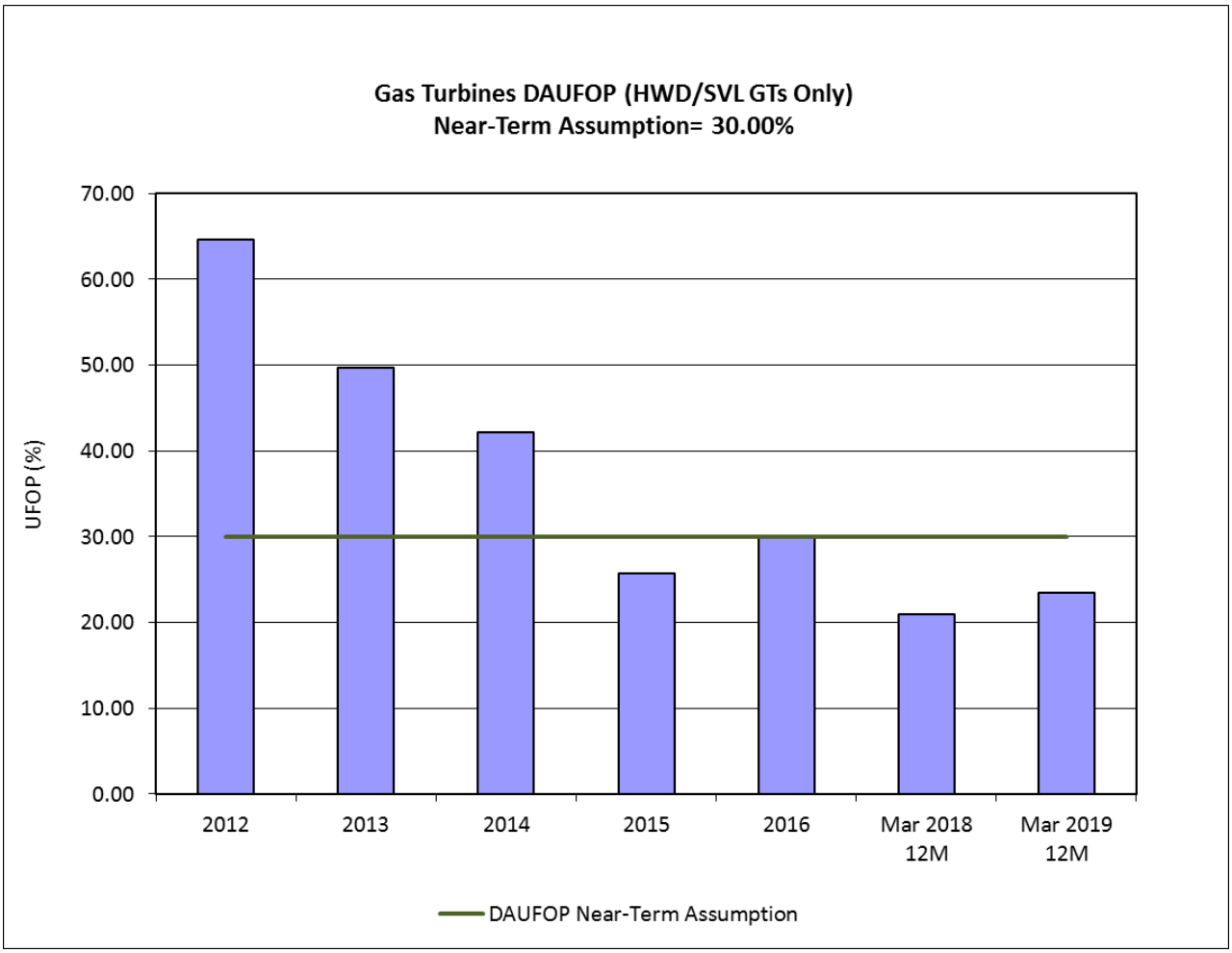

Figure 5: Gas Turbine DAUFOP – Hardwoods/Stephenville Units

The DAUFOP for the Happy Valley gas turbine was 0.00% for the 12-month period ending March 31, 2019 (refer to Table 9 and Figure 6). This is below the near-term planning assumption of 15.00%, and improved over the previous period.

Table 9: Happy Valley Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2018 (%)	12 months ending March 2019 (%)	Near-Term Planning Assumption (%)
Happy Valley	25	20.87	0.00	15.00

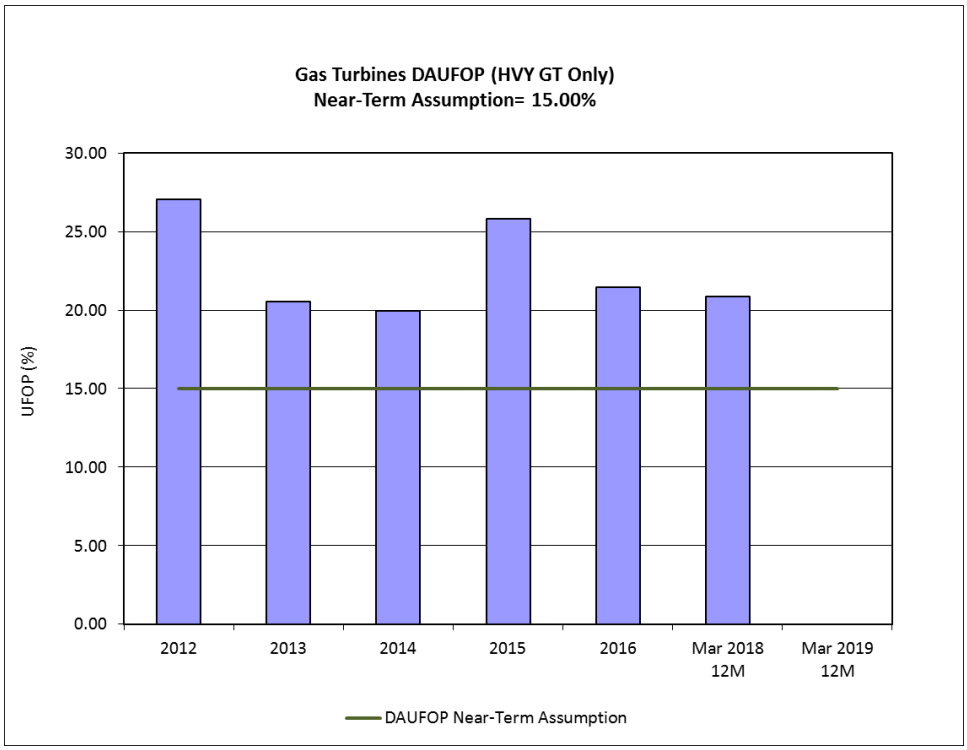

Figure 6: Gas Turbine DAUFOP – Happy Valley Unit

The Holyrood Gas Turbine DAUFOP of 0.00% for the current period is better than the near-term planning assumption of 5.00% (see Table 10 and Figure 7) and slightly improved over the previous period.

Table 10: Holyrood Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2018 (%)	12 months ending March 2019 (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	0.07	0.00	5.00

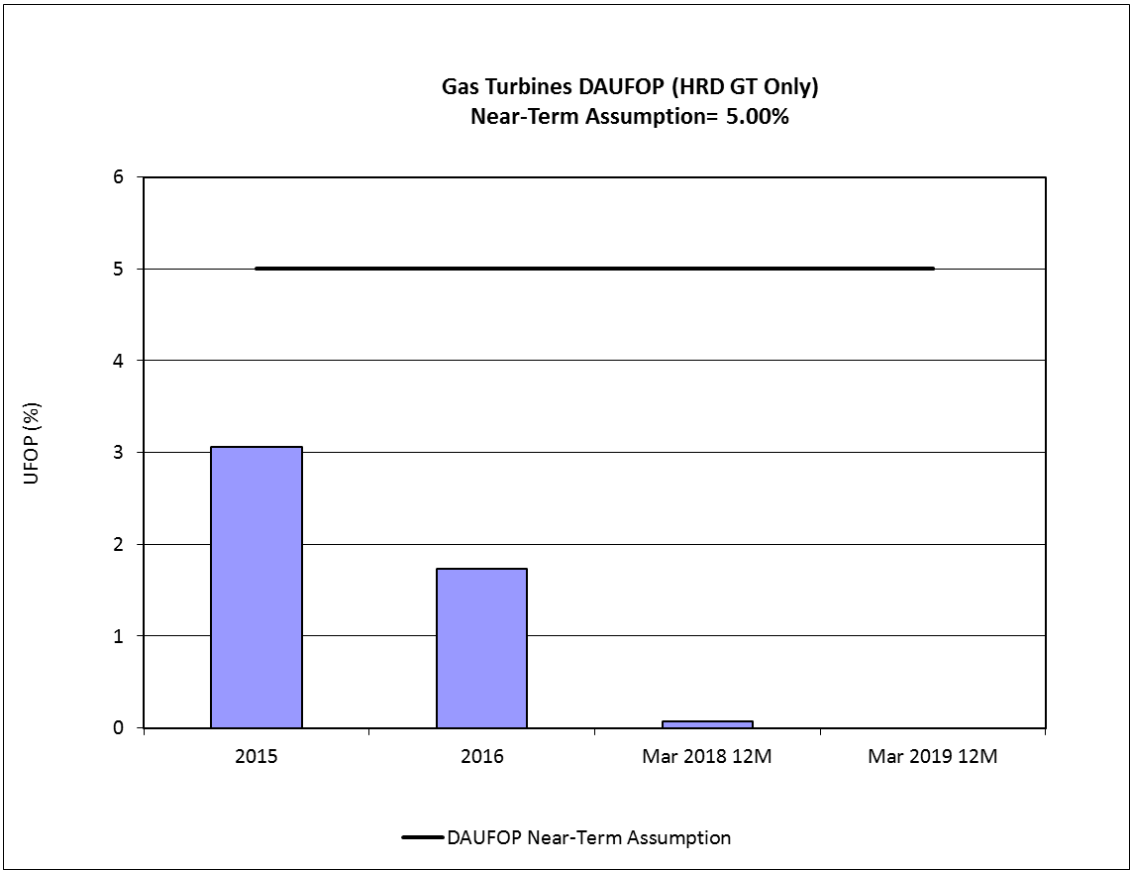

Figure 7: Gas Turbine DAUFOP – Holyrood Unit

8.0 Updated Planning Assumptions/Analysis Values

As part of the Study filed with the Board in November 2018, Hydro detailed the process undertaken for determining the forced outage rates most appropriate for use in its near-term reliability assessments and long-term resource adequacy analysis. Table 11 summarizes the analysis values that were utilized in the study.

Table 11: Hydro's Reliability and Resource Adequacy Study Analysis Values

Unit Type	Measure	Near-Term Analysis Value (%)	Resource Planning Analysis Value (%)
Hydraulic	DAFOR	3.50	1.93
Thermal	DAFOR	15	N/A
Gas Turbines: Happy Valley	DAUFOP	13.92	12.59
Hardwoods, Stephenville	DAUFOP	30	N/A
Holyrood	DAUFOP	3.06	2.24

For the hydroelectric units (Bay d'Espoir, Cat Arm, Hinds Lake, Granite Canal, Upper Salmon, and Paradise River) a three-year capacity-weighted average was applied for the near-term analysis, resulting in a DAFOR of 3.50%, while a ten-year capacity-weighted average was applied for use in the resource planning model, resulting in a DAFOR of 1.93%. The DAFOR value was based on historical data, which is reflective of Hydro's maintenance program over the long-term.

DAFORs of 15, 18, and 20% were applied to the Holyrood Thermal Generating Station to determine the sensitivity of the system to Holyrood availability in the near-term. This is consistent with the May 2018 Near-Term Generation Adequacy Report. As the Holyrood units are being retired from generation mode in 2021, the units were not included in the long-term analysis and thus there is no resource planning analysis value listed for these units. For the total plant, an all units weighted value of 15.00% is used for the near-term.

As the gas turbines in the existing fleet are in varied condition, each was considered on an individual basis, rather than applying a weighted average across all units. For the Happy Valley gas turbine, a three-year capacity-weighted average was applied to the unit for the near-term analysis, resulting in a DAUFOP of 13.92%, while a ten-year capacity-weighted average was

applied for use in the resource planning model resulting in a DAUFOP of 12.59%. The DAUFOP values were based on historical data founded upon the unit's past reliable performance. As the Holyrood Gas Turbine has only been in operation for the past three years, the near-term analysis considered performance in the worst case year of its operational history.[6] For the long-term analysis, the average of the three years of operational data was applied for the unit, resulting in a long-term DAUFOP of 2.24%. For the Hardwoods and Stephenville Gas Turbines, a DAUFOP of 30% was used for the near-term analysis, consistent with the metrics that were considered in Hydro's May 2018 Near-Term Generation Adequacy Report. As the Hardwoods and Stephenville Gas Turbines are being considered for retirement in 2021, these units were not included in the longer term analysis and, thus, there is no resource planning analysis value listed for these units.

9.0 Comparison of Planning Assumptions/Analysis Values

As Hydro's reliability and adequacy planning assumptions have been historically used in reporting on the performance of Hydro's generating units, a comparison of the values used most recently (May 2018 Near-Term Generation Adequacy Report) to these new values (November 2018 Reliability and Resource Adequacy Study) is provided in Table 12 for clarity.

Hydro notes that the Study did not utilize UFOP in its analysis. The analysis utilized instead the DAUFOP measure with changes as shown in Table 12.

[6] The Holyrood Gas Turbine had a DAUFOP of 3.06% for 2015.

Table 12: Comparison of Hydro's Planning Assumptions

Generating Unit Type	Measure	Historical Planning Assumptions		Reliability and Resource Planning Assumptions	
		Base Planning Assumption (%)	Near-term Planning Assumption (%)	Near-term Analysis Value (%)	Resource Planning Analysis Value (%)
Hydraulic	DAFOR	0.9	2.60	3.50	1.93
Thermal	DAFOR	9.64	14.00	15.00	N/A
Gas Turbines: Happy-Valley	DAUFOP	-	15.00	13.92	12.59
Hardwoods, Stephenville	DAUFOP	-	30.00	30.00	N/A
Holyrood	DAUFOP	-	5.00	3.06	2.24

The generating unit performance presented previously in this report is again presented in Table 13 through Table 17 with comparison to the previous assumptions, as well as the recently revised values. No data is provided for the UFOP performance, as Hydro does not plan to use this metric in future for reliability assessments.

Table 13: Hydraulic Weighted DAFOR Performance Comparison

				May 2018		November 2018	
Generating Unit	**Maximum Continuous Unit Rating (MW)**	**12 months ending March 2018 (%)**	**12 months ending March 2019 (%)**	**Base Planning Assumption (%)**	**Near-Term Planning Assumption (%)**	**Near-Term Planning Analysis Value (%)**	**Resource Planning Analysis Value (%)**
All Hydraulic Units - weighted	954.4	2.13	0.23	0.90	2.60	3.50	1.93
Hydraulic Units							
Bay d'Espoir 1	76.5	8.86	0.07	0.90	3.90	3.50	1.93
Bay d'Espoir 2	76.5	13.79	0.64	0.90	3.90	3.50	1.93
Bay d'Espoir 3	76.5	0.01	0.00	0.90	3.90	3.50	1.93
Bay d'Espoir 4	76.5	0.29	0.16	0.90	3.90	3.50	1.93
Bay d'Espoir 5	76.5	0.00	0.19	0.90	3.90	3.50	1.93
Bay d'Espoir 6	76.5	0.00	0.64	0.90	3.90	3.50	1.93
Bay d'Espoir 7	154.4	1.80	0.10	0.90	3.90	3.50	1.93
Cat Arm 1	67	0.22	0.94	0.90	0.70	3.50	1.93
Cat Arm 2	67	0.09	0.00	0.90	0.70	3.50	1.93
Hinds Lake	75	0.87	0.07	0.90	0.70	3.50	1.93
Upper Salmon	84	0.05	0.15	0.90	0.70	3.50	1.93
Granite Canal	40	0.11	0.45	0.90	0.70	3.50	1.93
Paradise River	8	1.45	1.65	0.90	0.70	3.50	1.93

Table 14: Thermal Unit DAFOR Performance Comparison

				May 2018		November 2018	
Generating Unit	**Maximum Continuous Unit Rating (MW)**	**12 months ending March 2018 (%)**	**12 months ending March 2019 (%)**	**Base Planning Assumption (%)**	**Near-Term Planning Assumption (%)**	**Near-Term Planning Analysis Value (%)**	**Resource Planning Analysis Value (%)**
All Thermal Units - weighted	490	24.10	14.97	9.64	14.00	15.00	N/A
Thermal Units							
Holyrood 1	170	31.66	20.20	9.64	15.00	15.00	-
Holyrood 2	170	25.36	13.53	9.64	10.00	15.00	-
Holyrood 3	150	14.03	7.34	9.64	18.00	15.00	-

Table 15: Hardwoods/Stephenville Gas Turbine DAUFOP Performance Comparison

					May 2018		November 2018	
Gas Turbine Units	**Maximum Continuous Unit Rating (MW)**	**12 months ending March 2018 (%)**	**12 months ending March 2019 (%)**	**Near-Term Planning Assumption (%)**	**Base Planning Assumption (%)**	**Near-Term Planning Assumption (%)**	**Near-Term Planning Analysis Value (%)**	**Resource Planning Analysis Value (%)**
Gas Turbines (HWD/SVL)	100	20.93	23.39	30.00	N/A	30.00	30.00	N/A
Stephenville	50	52.11	34.68	30.00	N/A	30.00	30.00	N/A
Hardwoods	50	5.01	14.08	30.00	N/A	30.00	30.00	N/A

Table 16: Happy Valley Gas Turbine DAUFOP Performance Comparison

					May 2018		November 2018	
Gas Turbine Units	**Maximum Continuous Unit Rating (MW)**	**12 months ending March 2018 (%)**	**12 months ending March 2019 (%)**	**Near-Term Planning Assumption (%)**	**Base Planning Assumption (%)**	**Near-Term Planning Assumption (%)**	**Near-Term Planning Analysis Value (%)**	**Resource Planning Analysis Value (%)**
Happy Valley	25	20.87	0.00	15.00	N/A	15.00	13.92	12.59

Table 17: Holyrood Gas Turbine DAUFOP Performance Comparison

					May 2018		November 2018	
Gas Turbine Units	**Maximum Continuous Unit Rating (MW)**	**12 months ending March 2018 (%)**	**12 months ending March 2019 (%)**	**Near-Term Planning Assumption (%)**	**Base Planning Assumption (%)**	**Near-Term Planning Assumption (%)**	**Near-Term Planning Analysis Value (%)**	**Resource Planning Analysis Value (%)**
Holyrood GT	123.5	0.07	0.00	5.00	N/A	5.00	3.06	2.24