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

October 31, 2018

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

In accordance with item 2.8 of the Liberty Report Recommendations dated December 17, 2014, please find attached one (1) original plus twelve (12) copies of the quarterly *Rolling 12 Month Performance of Hydro's Generating Units report* (the "Report").

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

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Shirley Walsh
Senior Legal Counsel – Regulatory
SW/kd

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 September 30, 2018

October 31, 2018

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[1] of its generating facilities. This data provided pertains to historical forced outage rates, and assumptions used for system planning purposes.

The report contains forced outage rates for the current 12-month reporting period of October 1, 2017 to September 30, 2018 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 October 1, 2016 to September 30, 2017. 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

[1] This report provides data on outage rates for forced outages, not planned outages.

encounter a forced outage and not be available when required, but this metric includes 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 state to calculate derated levels of a generating unit a 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 2017 and 2018 are 12-month rolling numbers (October 1 to September 30 for each year).

2.0 Overview for Period Ending September 30, 2018

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

Class of Units	Oct 1, 2016 to Sept 30, 2017	Oct 1, 2017 to Sept 30, 2018	Base Planning Assumption[2]	Near-term Planning Assumption[3]
Hydraulic (DAFOR)	4.17	1.79[4]	0.90	2.60
Thermal (DAFOR)	13.77	29.77[5]	9.64	14.00
Gas Turbine (Combined) (UFOP)	7.06	7.03	10.62	20.00
Gas Turbine (Holyrood) (UFOP)	2.10	0.08	5.00	5.00
Gas Turbine (Hardwoods/ Stephenville) (DAUFOP)	22.30	24.83	-	30.00
Gas Turbine (Happy Valley) (DAUFOP)	12.25	15.39	-	15.00
Gas Turbine (Holyrood) (DAUFOP)	2.10	0.08	-	5.00

There was an improvement in hydraulic DAFOR and a decline in thermal DAFOR performance for the current 12-month period ending September 2018, compared to the previous 12-month period ending September 2017 (see Table 1). The combined[6] gas turbine UFOP performance shows an improvement in performance for the current period compared to the previous period, while DAUFOP shows a decline in performance.

[2] Hydro is reviewing all base planning assumptions as part of its reliability criteria and supply adequacy assessment, to be submitted to the Board in November 2018.
[3] Near-term Generation Adequacy Report, November 15, 2017, see section 5.0 for further details.
[4] The Hydraulic DAFOR is 0.20% with the Penstock issues removed.
[5] The Thermal DAFOR is 13.53% with the Airflow derating removed.
[6] Combined Gas Turbines include the Hardwoods, Happy Valley, and Stephenville units. The performance of the Holyrood GT was not included in the combined base planning or sensitivity numbers as these numbers were set prior to the Holyrood GT's in service date.

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 September 2018 is 29.77%[4], which is above the base planning assumption of 9.64%, the sensitivity of 11.64% (refer to Section 3), and above the near-term planning assumption of 14.00%.[7] This is primarily caused by an airflow derating on Unit 1 and Unit 2 that continued in 2017 and 2018 and an extended forced outage on Unit 1 in February 2018.

The current Holyrood period DAFOR is not an indicator of what to expect for the 2018/2019 winter season due to the work being completed to improve the unit's performance for Air Flow limitations. Unit 2 has been successfully tested to 175 MW.[8]

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. For the current 12-month period ending September 30, 2018, performance was affected by forced outages to the Hardwoods, Happy Valley, and Stephenville units.

Hydro began reporting DAUFOP performance beginning in January 2018, but for the purpose of this report, data over the full 12-month period ending September 30, 2018 is included. For the current 12-month period, the combined gas turbines DAUFOP (Hardwoods and Stephenville units only) performance is primarily impacted by a lengthy forced outage to the Stephenville

[7] While the near- term planning assumption for thermal was materially exceeded in the preceding 12 month period, there were no supply issues experienced. Improved performance at the other assets contributed to this outcome. Further, the near term planning assumption is a probabilistic view of system performance under various criteria.

[8] The unit has normally been considered capable of sustained running at 170 MW. Under the right conditions and with the boiler in very clean condition, it is able to go to 175 MW. However, at this maximum limit, the unit is unable to respond to load increases and as normal fouling from operation progresses, it might not be available. Therefore, this 5 MW is not part of the continuous rating and is not used for planning purposes, but would be used if available and required by the system.

unit. The Happy Valley gas turbine DAUFOP performance is impacted by a single forced outage that occurred in October 2017.

3.0 Generation Planning Assumptions

Hydro's generation long term planning assumptions for 2018 DAFOR and UFOP are noted in Table 2. The DAFOR and UFOP indicators used in the generation planning model represent an historic average of the actual performance of these units. These numbers are noted in Table 2 under the column "Base Planning Assumption". This is a long term outlook. The Base Planning Assumptions are under review as part of the ongoing 2018 Reliability Review. Hydro will report the review results in the Supply Adequacy report in November 2018.

Hydro also currently provides a sensitivity number for long term planning DAFOR and UFOP as part of its generation planning analysis. This number assumes a higher level of unavailability to assess the impact of higher unavailability of these units on overall generation requirements. During the 12-month period ending September 30, 2018, the gas turbine units performed well within this sensitivity range for UFOP, while both the hydraulic and thermal classes were above the sensitivity range for long term planning DAFOR.

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.[9]

Table 2: 2017 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	20.62
Gas Turbines - New			5.0	10.0

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

Hydro produces reports based on comprehensive reviews of energy supply for the Island Interconnected System ("IIS"). This is part of Hydro's analysis of energy supply up to the Muskrat Falls interconnection. The most recent 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 around 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. This analysis will be updated accordingly if asset assumptions change materially.

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

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	15.0	
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 September 30, 2018, are presented in Table 4, as well as the data for the 12-month period ending September 30, 2017. These are compared to Hydro's short term generation adequacy assumptions, as used in the 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 September 2017 (%)	12 months ending September 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
All Hydraulic Units - weighted	954.4	4.17	1.79	0.90	2.60
Hydraulic Units					
Bay D'Espoir 1	76.5	19.88	8.24	0.90	3.90
Bay D'Espoir 2	76.5	25.77	11.66	0.90	3.90
Bay D'Espoir 3	76.5	0.03	0.00	0.90	3.90
Bay D'Espoir 4	76.5	0.23	0.14	0.90	3.90
Bay D'Espoir 5	76.5	0.00	0.00	0.90	3.90
Bay D'Espoir 6	76.5	1.35	0.43	0.90	3.90
Bay D'Espoir 7	154.4	1.80	0.00	0.90	3.90
Cat Arm 1	67	1.06	0.98	0.90	0.70
Cat Arm 2	67	0.08	0.00	0.90	0.70
Hinds Lake	75	1.09	0.03	0.90	0.70
Upper Salmon	84	0.87	0.14	0.90	0.70
Granite Canal	40	0.00	0.49	0.90	0.70
Paradise River	8	4.05	0.00	0.90	0.70

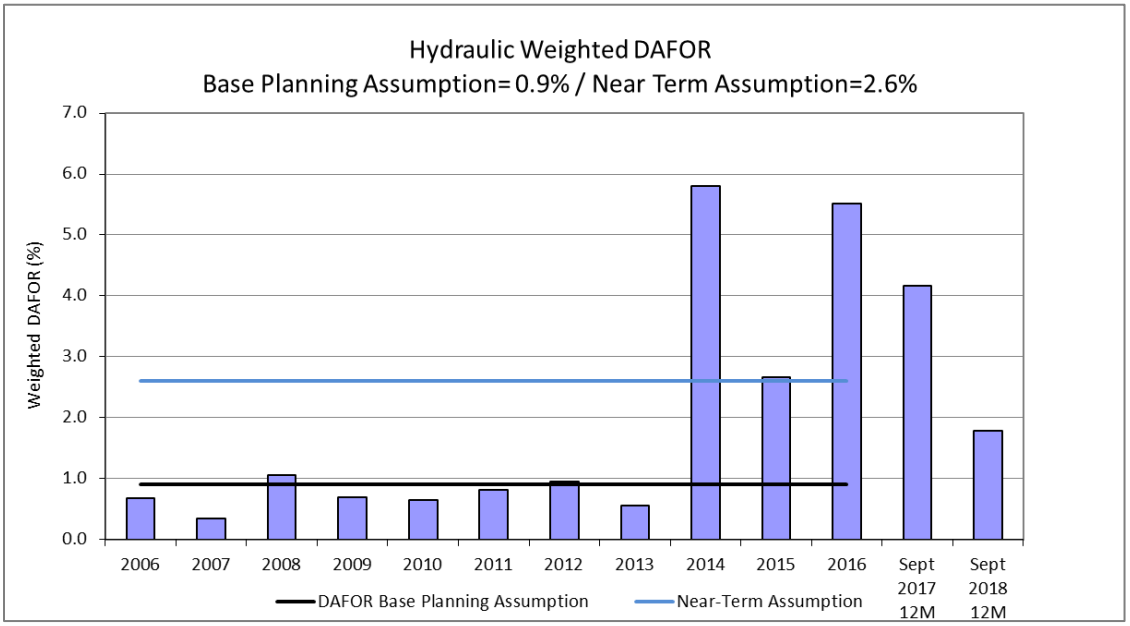

Figure 1: Hydraulic Weighted DAFOR

Considering the individual units' performance, the assumed Hydro generation base planning DAFOR was materially exceeded for Bay d'Espoir Unit 1 and Bay d'Espoir Unit 2.[10] Also, Cat Arm Unit 1 exceeded the base planning assumption for the current period.

The Bay d'Espoir Unit 1 DAFOR of 8.24%[11] and Unit 2 DAFOR of 11.66%[12] exceeded the base planning assumption of 0.9% and the near-term assumption of 3.9% for an individual Bay d'Espoir unit. This was due to Units 1 and 2 being removed from service on November 4, 2017 as a result of a leak in Penstock 1, which provides water to both units. A consultant and contractor were engaged in the process to provide recommendations for refurbishment, and to return the penstock to reliable service. The penstock was returned to service on December 8, 2017. Hydro received the final root cause report and is implementing the findings, including the execution of condition assessment work approved by the Board in P.U. 23(2018). The 2018 condition assessment, field inspection component, of the three Bay d'Espoir penstocks is now complete. Hydro is working with its consultant on a detailed report that will interpret the results of the three penstocks Level 2 condition assessments and provide recommendations for reliable operation of each penstock. Based on the findings of the inspection, Hydro expects the penstocks to perform reliably this winter given that there were no identified issues with the penstocks.

The Cat Arm Unit 1 DAFOR of 0.98% 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 to August 6, 2018 as a result of a malfunction 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.

[10] Penstock 1 supplies Bay d'Espoir Unit 1 and Bay d'Espoir Unit 2. The penstock went back into service December 8, 2017 and therefore is still affecting the 12 month rolling generation performance. Performance will continue to be affected for the next quarterly rolling generation performance report but will no longer affect performance in the subsequent reports. The overall Hydraulic DAFOR would be 0.20% with the Penstock issues removed for this period.

[11] Bay d'Espoir Unit 1 DAFOR with the Penstock issues removed was 0.01% for this period.

[12] Bay d'Espoir Unit 2 DAFOR with the Penstock issues removed was 0.84% for this period.

5.0 Thermal Unit DAFOR Performance

Detailed results for the 12-month period ending September 30, 2018, are presented in Table 5, as well as the data for the 12-month period ending September 30, 2017. These are compared to Hydro's short term generation adequacy assumptions, as used in the 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 September 2017 (%)	12 months ending September 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
All Thermal Units - weighted	490	13.77	29.77	9.64	14.00
Thermal Units					
Holyrood 1	170	18.23	35.49	9.64	15.00
Holyrood 2	170	18.27	30.64	9.64	10.00
Holyrood 3	150	4.44	18.17	9.64	18.00

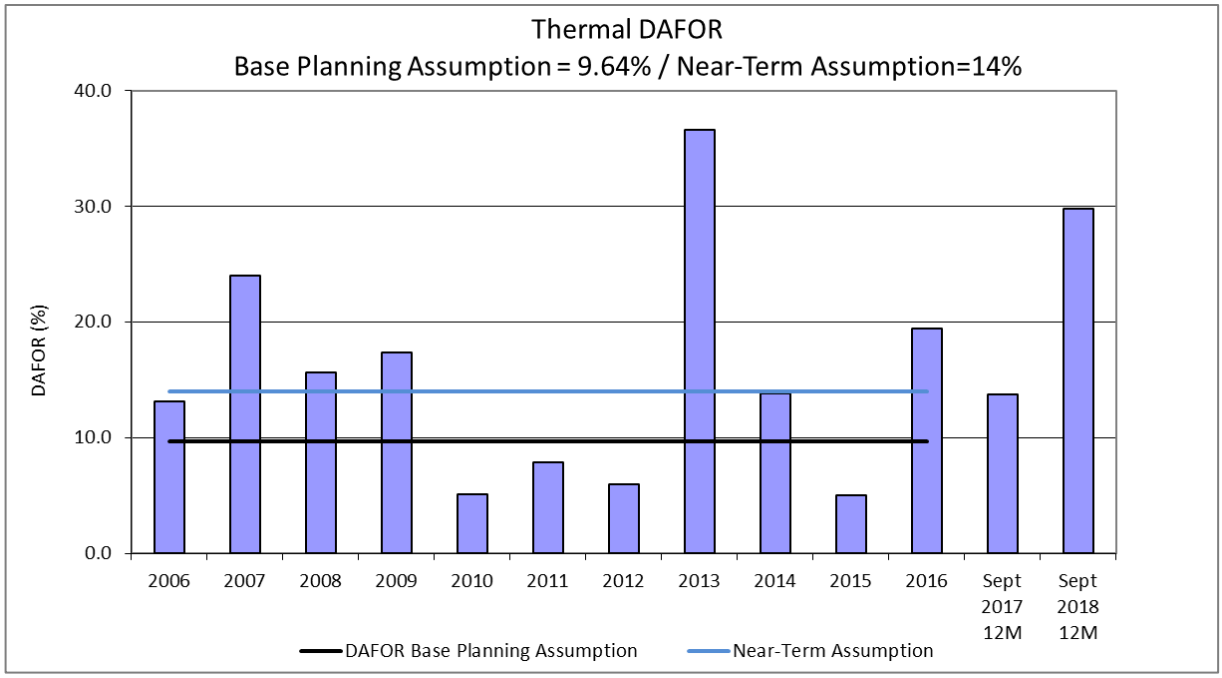

Figure 2: Thermal DAFOR

For the 12-month period ending September 31, 2018, the weighted DAFOR for all thermal units of 29.77%[13] is above the assumed Hydro generation base planning DAFOR value of 9.64%, and the near-term assumption of 14.00%. Unit 1 DAFOR was 35.49% and Unit 2 DAFOR was 30.64%. 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 18.17%, which is above the base planning assumption of 9.64% and the near-term assumption of 18.0%.

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

- Unit 1 tripped on October 5, 2017 and was de-rated to a precautionary load of 35 MW, while the reason for the trip was being investigated and corrected. It was determined that the trip was caused by frayed wires in one of the forced drive ("FD") fan motors and, following repairs, the unit was returned to full capability on October 10, 2017.
- From October 17, 2017 to October 22, 2017, the unit was de-rated to 154 MW due to low steam pressure while waiting for safety valve testing to be completed. The safety valve testing was completed on October 24, 2017, but the unit was further de-rated to 145 MW from October 22, 2017 to October 24, 2017, and to 135 MW until the end of the month due to overheating motor windings in the west FD fan. The unit was monitored while waiting for an opportunity to replace the motor. The spare motor was installed and the unit was returned to service on November 12, 2017 but remained de-rated to 145 MW due to high furnace pressure.
- On November 14, 2017 the unit was taken off line to repair a piping leak at the condenser flash tank. This was repaired and the unit returned to service on November 15, 2017. However another leak developed in the area and the unit was removed from service on November 15, 2017 for 12 hours for repair.
- Unit 1 remained limited to 145 MW until it was taken off line on November 30, 2017 to perform an air heater wash and additional maintenance. The unit was returned to

[13] The Thermal DAFOR is 13.53% with the Airflow derating removed.

service on December 4, 2017. A load test completed on December 5, 2017, confirmed a capacity of 150 MW[14] with the unit load limited by high furnace pressure.

- On January 3, 2018 the unit capability was reduced from 150 to 135 MW as a result of oscillations in the turbine control valve hydraulic ram. An outage was taken from January 5 to address the issue. After this work, the load was restored to 145 MW, limited by high furnace pressure, and it was noted that the control valve oscillations had not been eliminated. On January 18 the oscillations had increased and the load was reduced to 140 MW as a result. On January 20 the unit was taken off line to replace another control cable as recommended by GE to resolve the oscillation issue. While the unit was off line for this work, the boiler stop valve failed, which resulted in an extension to the outage. The unit remained off line until February 2 while stop valve refurbishment was ongoing. During this time, the hydraulic ram was removed from the turbine and sent off site for refurbishment to ensure that the oscillation problem had been resolved. Also a high pressure wash (12,500 psi) was completed on the air heater baskets.
- The outage due to the boiler stop valve failure extended from January 20, 2018 until February 21, 2018, following several solutions which attempted to address the leak. On February 21, 2018 the stop valve work was complete and the unit was returned to service.
- On February 22 the unit had to be taken off line due to a turbine bearing issue. Lube oil had leaked, undetected, from the bearing during the stop valve outage. This led to a smoldering underneath the bearing when the components heated up. The contaminated insulation was replaced and close inspection of the bearing confirmed no active leak. The unit was returned to service on February 25, 2018.

[14] Hydro has completed work to eliminate the furnace pressure issues on Unit 1 and Unit 2, including changing hot end air heater baskets and chemically washing the economizers. A two week outage on Unit 3 will be completed in October to replace the hot end baskets and correct an air heater air leakage problem. Hydro has also reinstated the fuel additive system on all three units to prevent continued fouling. Unit 2 has since returned to service and load testing confirmed the capability of the unit at 175 MW. Similar results are expected for Unit 1 and Unit 3 when they return to service later in the fall.

- On February 28 a load test was completed to 148 MW, with load limited by high furnace pressure due to boiler and air heater fouling. By the end of March 2018 the unit's capability had reduced to 137 MW as a result of continued fouling in the boiler and air heaters.
- There were two unit trips related to FD fan variable frequency drive ("VFD") trips. These occurred on March 19, 2018 and March 26, 2018. In both instances the unit was returned to service using replacement parts from inventory. During the outage related to the March 19, 2018 trip, a problem with the Mark V turbine governor system was also resolved. Hydro is continuing to work towards resolving the problems with VFD reliability.
- 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 the unit tripped at 70 MW on high boiler drum level. The cause was suspected to be a trip of the east boiler feed pump, which caused unstable water level in the drum and led to the trip. The unit was returned to service later that same day with only the west boiler feed pump in service and the load restricted temporarily to 70 MW until the health of the east pump was verified. The unit was returned to 116 MW later on May 21, 2018 once the east pump was ruled out as the cause of the trip. The cause was determined to be a failure of a turbine control valve stem. Once this was confirmed 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. This had to be cleaned up 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. Based on an engineering study completed prior to the outage season, and the results of the work completed, Hydro expects that Unit 1 will be capable of full load or near full load operation when it is returned to service later in the fall of 2018.

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

- Unit 2 returned from the 2017 annual planned outage on October 28, 2017. During the outage work was completed to address air flow issues, which included additional boiler cleaning and air heater upgrades. The unit was placed on line for commissioning of new exciter controls on October 28, 2017 with a scheduled de-rating of 35 MW. Exciter commissioning was interrupted by two forced outages. From October 28, 2017 to October 30, 2017 the unit was taken offline due to a combustion upset in the boiler. The unit was returned to service with load restricted to 50 MW. It was determined that the upset was due incomplete set-up of a new fuel flow transmitter. Setup of this transmitter was completed on November 2, 2017. Also, from October 30, 2017 to November 1, 2017 the unit was removed from service to replace some oil-soaked turbine insulation that resulted from an oil leak at a turbine bearing. The source of the leak was also corrected.
- From November 3, 2017, until November 4, 2017 the unit was de-rated to 70 MW and then to 110 MW while completing commissioning of the new exciter controls. From November 4, 2017 to November 8, 2017 the unit was de-rated to 150 MW while waiting

for safety valve testing to be completed. From November 8, 2017 to November 20, 2017, the unit was de-rated to 165 MW due to a leaking safety valve. Corrective work required an outage to complete. The unit was taken off line on November 20, 2017, and returned to service on November 24, 2017. An air heater wash was also completed during this outage. A load test on November 28, 2017 revealed that the unit was capable of 160 MW, limited by high furnace pressure.

- On December 19, 2017, the unit experienced a 14-hour deration to 70 MW as a result of a trip of one forced draft fan on the unit. The cause of the fan trip was corrected and the fan returned to service later that day in time for the evening peak, with the unit again capable of 160 MW.
- The capability of the unit continued to decline due to ongoing fouling during operation. On January 4, 2018 the capability had reduced to 154 MW. On January 25, 2018 the capability had reduced to 135 MW due to high furnace pressure as a result of boiler and air heater fouling. On February 14, 2018 the capability had reduced to 117 MW. At the end of February 2018 the capability had reduced to 100 MW. System requirements, given the issues with Unit 1, had precluded an air heater wash on this unit during the month of February 2018. An air heater wash was completed from March 5, 2018 to March 6, 2018; however this was not successful in restoring any capacity. By the end of March 2018, the unit capability had reduced to 90 MW as a result of continued boiler and air heater fouling during operation.
- On February 7, 2018 the unit was taken off for a short, planned outage to replace generator brushes. There was a forced extension to this outage when a unit board breaker tripped during re-start of the unit. Electricians were called in to reset the breaker.
- The unit was further de-rated to 70 MW from March 1, 2018 to March 2, 2018 due to an issue with the west boiler feed pump. A water leak from a reference line nearby caused contamination of the pump lube oil and the pump was taken off line until the repairs were completed.

- On March 22, 2018, one of the turbine reheat intercept valves became stuck during regular on-line testing and the unit had to be taken off line for approximately eight hours to replace the servos on these valves. To address this problem, the hydraulic fluid was replaced and the system flushed during the 2018 annual outage.
- 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. TRO replaced the B2T2 breaker during the 2018 annual outage, which should resolve 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 offline to address a suspected stress failure, not a thinning failure, of a tube in the lower waterwall (not in the area of previous boiler tube issues). At the time of the failure, it was determined that the unit was no longer required for system reliability reasons prior to the schedule 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 greatly improved. Equipment issues related to start up caused a number of short forced outages and de-rates during the first few days of operation. On September 21, 2018, the unit was load tested to 140 MW, limited because the on-line 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 when the unit was tested to 171 MW and was capable of more.
- On September 26, 2018 there was a boiler trip related to starting a boiler feed pump. It was demonstrated that this would not occur in VFD air flow control and the fans were switched to VFD. Investigation into the reason for this trip is ongoing.

Unit 2 has now been returned to service following annual maintenance and upgrades. Load test has confirmed 175 MW capability. The work completed during the 2018 outage is expected to address the previous air flow issues which were the prime contributor to 12 month DAFOR performance. Similar outcomes are expected on Units 1 and 3 when they return from their annual outage.

The DAFOR performance for Holyrood Unit 3 (150 MW) was primarily affected by the following events:

- On December 13, 2017, Unit 3 was de-rated to 135 MW as a result of air flow issues. The unit capability declined steadily to 105 MW until an air heater wash could be completed

on December 31, 2017. The wash was successful in restoring the load to 131 MW. The available load continued to decline due to ongoing air heater fouling. On January 18, 2108 the available load was determined to be 120 MW, and on February 10, 2018, this had further reduced to 100 MW. An air heater wash outage was completed from February 10, 2018 to February 11, 2018. System requirements, with Unit 1 already off line, had precluded an air heater wash on this unit until that time. When the unit was returned to service there was a de-rating to 70 MW for approximately 10 hours when the west boiler feed pump failed to start. This was resolved and the available load was determined to be 110 MW, still limited by air heater fouling. The unit was capable of 100 MW at the beginning of March 2018. This capability further reduced to 75 MW on March 20, 2018. An air heater wash outage was completed on March 28, 2018 and the predicted load after this wash was 110 MW. This unit was not required for the system, and was left on standby until the planned unit outage started on April 2, 2018.

- On January 11, 2018, a ¾" diameter domestic water pipe located above the Unit 3 exciter ruptured at a cap and the resulting water leak contacted the exciter causing a unit trip. There was no significant equipment damage resulting from this incident and once the exciter was safely dried, the unit was returned to service on January 12, 2018. This event was investigated and the leak repaired. A shut off valve was relocated for improved access in the event of a further trip, regular inspections of the area were implemented, and a plan was formulated to replace this piping during the annual outages. On February 14, 2018 the unit load was reduced to 50 MW for approximately eight hours as a precautionary measure because of another leak in a domestic water line in close proximity to the exciter. After this event, the piping was relocated so that further leaks would not impact the exciter.
- The annual outage was from April 2, 2018 until June 1, 2018. Air flow issues could not be corrected during the annual outage because of the long lead times for replacement air heater materials. The remainder of the planned work was completed, and a two week outage is planned for October 2018 to complete the air heater work required to restore load capability.

- The Unit 3 generator was put in service in synchronous condenser mode on June 1, 2018 and ran until September 24, 2018, when it was taken off line for a maintenance outage to replace some generator brushes. There was a problem with the drive controller that prevented re-start of the synchronous condenser. On September 28, 2018 the unit was placed on a maintenance outage to prepare for conversion to generation mode.

6.0 Gas Turbine UFOP Performance

The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was 7.03% for the 12-month period ending September 30, 2018 (see Table 6 and Figure 3). This is below the base planning assumption of 10.62%, and the near-term assumption of 20.00%. The current period UFOP was essentially the same as the previous period UFOP of 7.06%. The Hardwoods UFOP for the current period is 3.19%, which is better than the base planning assumption of 10.62%. The Stephenville UFOP for the current period is 4.95%, which is better than the base planning assumption of 10.62%. Happy Valley's UFOP is 15.39% for the current period, which is above the base planning assumption of 10.62%.

The UFOP for the Happy Valley, Stephenville and Hardwoods gas turbines for the period was impacted by a number of forced outages and deratings. These outages and deratings are detailed in the following section, Gas Turbine DAUFOP Performance.

Table 6: Gas Turbine UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2017 (%)	12 months ending September 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Combined Gas Turbines	125	7.06	7.03	10.62	20.00
Stephenville	50	8.02	4.95	10.62	20.00
Hardwoods	50	6.47	3.19	10.62	20.00
Happy Valley	25	6.81	15.39	10.62	20.00

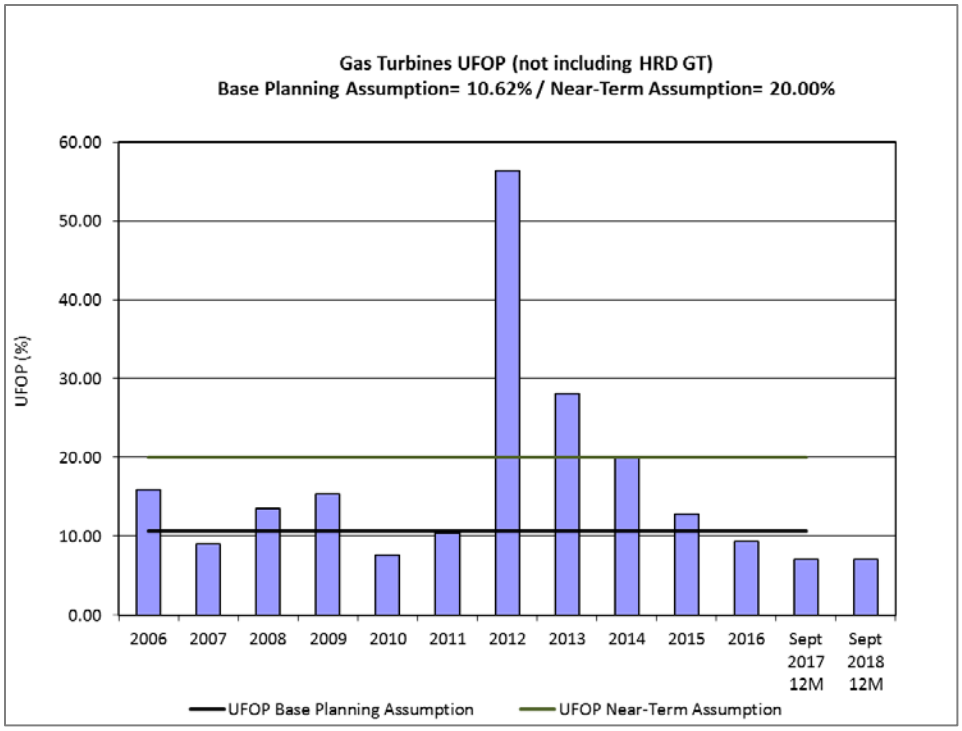

Figure 3: Gas Turbine UFOP – Hardwoods/Happy Valley/Stephenville Units

The Holyrood (HRD) GT UFOP of 0.08% for the current period is better than the base and near-term planning assumptions of 5.00% (see Table 7 and Figure 4).

Table 7: Holyrood GT UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2017 (%)	12 months ending September 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	2.10	0.08	5.00	5.00

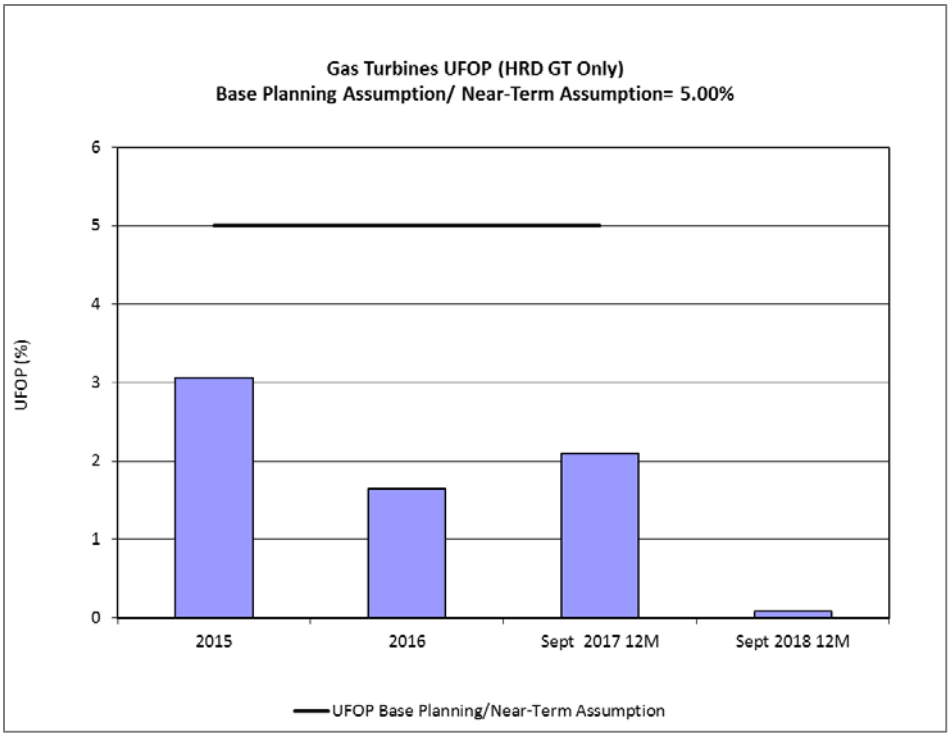

Figure 4: Gas Turbine UFOP – Holyrood Unit

7.0 Gas Turbine DAUFOP Performance

The combined DAUFOP for the Hardwoods and Stephenville gas turbines was 24.83% for the 12-month period ending September 30, 2018 (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 14.47%, which is better than the near-term planning assumption of 30.00%. The Stephenville UFOP for the current period is 51.20%, which is above the near-term planning assumption of 30.00%.

Table 8: Hardwoods/Stephenville Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2017 (%)	12 months ending September 2018 (%)	Near-Term Planning Assumption (%)
Gas Turbines (HWD/SVL)	100	22.30	24.83	30.00
Stephenville	50	88.79	51.20	30.00
Hardwoods	50	18.32	14.47	30.00

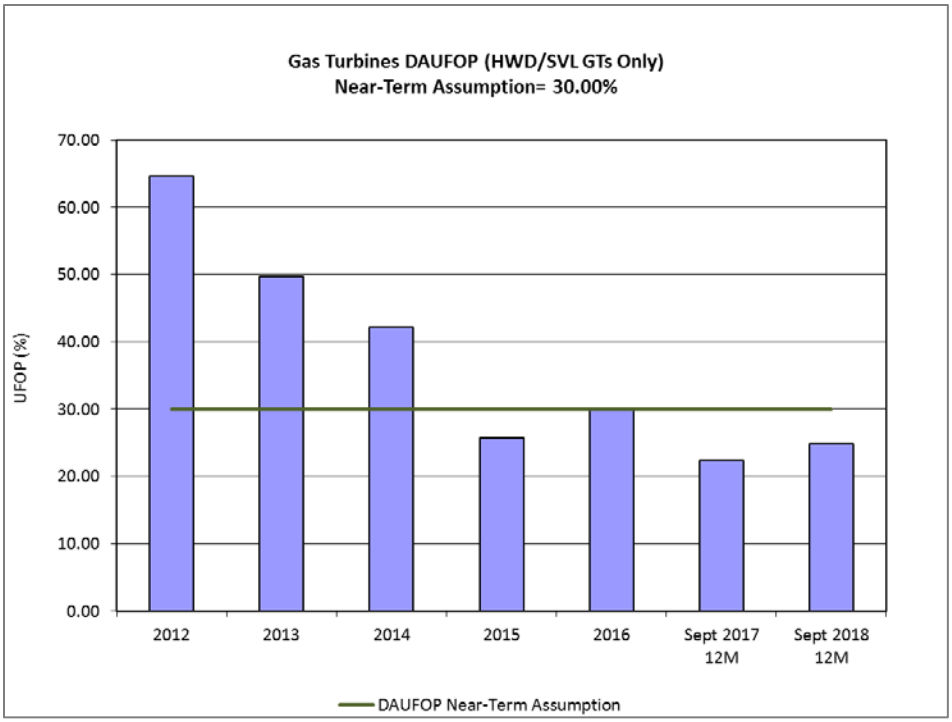

Figure 5: Gas Turbine DAUFOP – Hardwoods/Stephenville Units

The DAUFOP for the Happy Valley gas turbine was 15.39% for the 12-month period ending September 30, 2018 (refer to Table 9 and Figure 6). This is above the near-term planning assumption of 15.00%.

Table 9: Happy Valley Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2017 (%)	12 months ending September 2018 (%)	Near-Term Planning Assumption (%)
Happy Valley	25	12.25	15.39	15.00

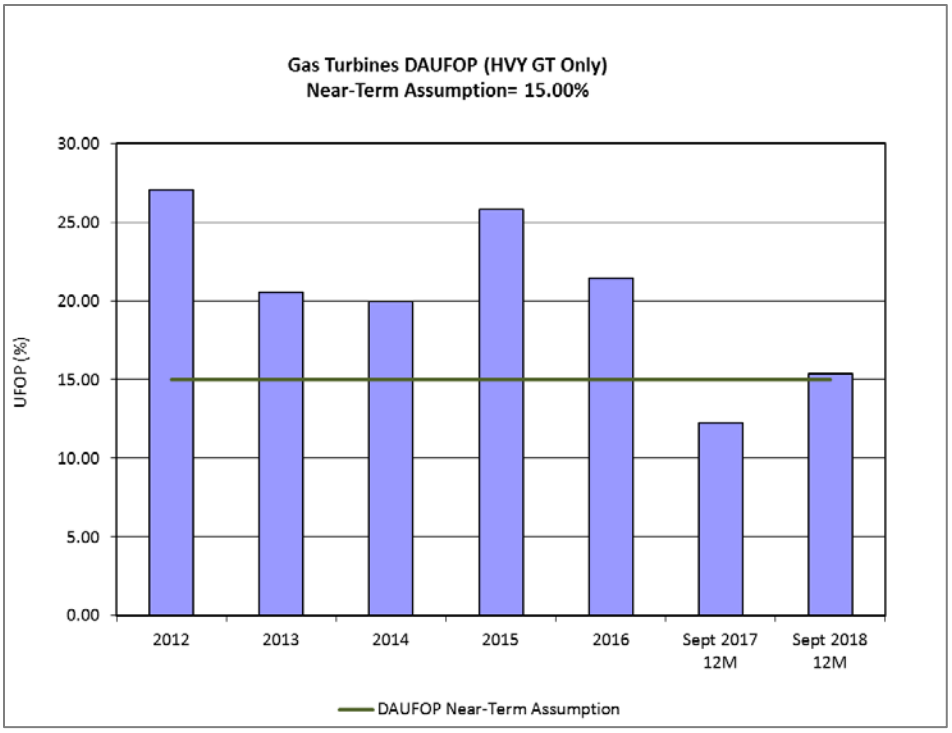

Figure 6: Gas Turbine DAUFOP – Happy Valley Unit

1 The Holyrood gas turbine DAUFOP of 0.08% for the current period is better than the near-term
2 planning assumption of 5.00% (see Table 10 and Figure 7).

Table 10: Holyrood GT DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2017 (%)	12 months ending September 2018 (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	2.10	0.08	5.00

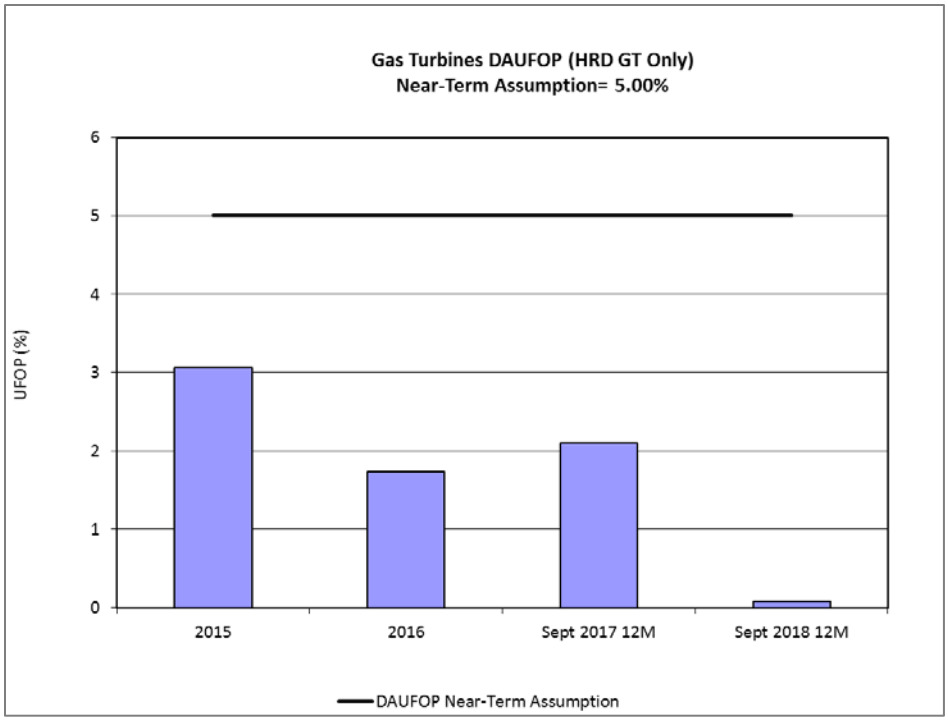

Figure 7: Gas Turbine DAUFOP – Holyrood Unit

The performance for the Stephenville, Hardwoods, and Happy Valley gas turbines was primarily affected by the following events:

- The Stephenville gas turbine DAUFOP for the period is impacted by the unavailability of End A as a result of an exhaust bellows failure at Hardwoods gas turbine End A on December 28, 2017. End A was unavailable at this time due to issues with the power turbine rear bearing, which required the bearing to be replaced. Hydro decided to remove the bellows from End A at Stephenville and install it at Hardwoods End A to return that unit to full capacity.
- The Hardwoods gas turbine DAUFOP for the period is impacted by the unavailability of the unit due to a number of issues. The Hardwoods gas turbine End A became unavailable on May 28, 2018 due to an exhaust bellows failure. The bellows was removed and sent for repair and End A was returned to service on July 25, 2018.
- On June 13, 2018 the Hardwoods gas turbine tripped due to excessive alternator vibration while being returned to service after a planned maintenance outage.

Inspection of the unit determined that the cause of the vibration was a loss of lube oil due to a faulty check valve in the lube oil supply piping to one of the alternator bearings. The bearing, which had the faulty check valve, was found to be damaged and required replacement with a spare bearing. The unit was released for service on June 30, 2018.

- On October 15, 2017 the Happy Valley gas turbine experienced a trip while operating at near full load. Hydro's investigation determined that the trip was the result of the failure of an emergency fuel shutoff valve solenoid. The failure of the solenoid caused the 3-way valve to divert some fuel away from the engine as is its design. The reduced fuel flow to the engine caused the engine to be unable to sustain the required load and this resulted in the unit shutting down. A replacement solenoid was sourced, and when received the valve was repaired and the engine was released for service on November 9, 2017.