

1 Q. Please provide copies of Hydro's forecasted availability measures and the actual availability
2 measures for 2016-2018 for both hydraulic and thermal production assets.

3

4

5 A. For Newfoundland and Labrador Hydro's ("Hydro") forecast availability measures and
6 actual measures for the last three years please refer to:

7

8 • PUB-NLH-015, Attachment 1 for Hydro's "Quarterly Report on Performance of
9 Generating Units for the Quarter Ended March 31, 2016;"

10

11 • PUB-NLH-015, Attachment 2 for Hydro's "Quarterly Report on Performance of
12 Generating Units for the Quarter Ended June 30, 2016;"

13

14 • PUB-NLH-015, Attachment 3 for Hydro's "Quarterly Report on Performance of
15 Generating Units for the Quarter Ended September 30, 2016;"

16

17 • PUB-NLH-015, Attachment 4 for Hydro's "Quarterly Report on Performance of
18 Generating Units for the Quarter Ended December 31, 2016;"

19

20 • PUB-NLH-015, Attachment 5 for Hydro's "Quarterly Report on Performance of
21 Generating Units for the Quarter Ended March 31, 2017;"

22

23 • PUB-NLH-015, Attachment 6 for Hydro's "Quarterly Report on Performance of
24 Generating Units for the Quarter Ended June 30, 2017;"

25

26 • PUB-NLH-015, Attachment 7 for Hydro's "Quarterly Report on Performance of
27 Generating Units for the Quarter Ended September 30, 2017;"

- 1 • PUB-NLH-015, Attachment 8 for Hydro’s “Quarterly Report on Performance of
2 Generating Units for the Quarter Ended December 31, 2017;”
3
- 4 • PUB-NLH-015, Attachment 9 for Hydro’s “Quarterly Report on Performance of
5 Generating Units for the Quarter Ended March 31, 2018;”
6
- 7 • PUB-NLH-015, Attachment 10 for Hydro’s “Quarterly Report on Performance of
8 Generating Units for the Quarter Ended June 30, 2018;”
9
- 10 • PUB-NLH-015, Attachment 11 for Hydro’s “Quarterly Report on Performance of
11 Generating Units for the Quarter Ended September 30, 2018;” and
12
- 13 • PUB-NLH-015, Attachment 12 for Hydro’s “Quarterly Report on Performance of
14 Generating Units for the Quarter Ended December 31, 2018.”



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April 14, 2016

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 the original plus 12 copies of the quarterly report *Rolling 12 Month Performance of Hydro's Generating Units*.

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

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

A handwritten signature in blue ink that reads "Tracey Pennell".

Tracey L. Pennell
Legal Counsel

TLP/bs

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Sheryl Nisenbaum – Praxair Canada Inc.
ecc: Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Thomas Johnson – Consumer Advocate
Thomas O' Reilly – Cox & Palmer
Danny Dumaresque

A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

QUARTERLY REPORT
ON
PERFORMANCE OF GENERATING UNITS
FOR THE QUARTER ENDED MARCH 31, 2016
NEWFOUNDLAND AND LABRADOR HYDRO
APRIL 14, 2016

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1 **1.0 Introduction**

2 In this report, Newfoundland and Labrador Hydro (Hydro) provides data on forced outage
3 rates of its generating facilities. This data is provided in relation to historical forced outage
4 rates and as well as in relation to assumptions used in Loss of Load Hours (LOLH) calculations
5 for system planning purposes.

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8 the three units at the Holyrood Thermal Generating Station (HTGS) and Hydro's gas turbines
9 for the current 12-month reporting period of April 1, 2015 to March 31, 2016. The report
10 also provides, for comparison purposes, the individual generating unit data on forced outage
11 rates for the previous period April 1, 2014 to March 31, 2015. Further, total asset class data
12 is presented on an annual basis for years the 2005-2014. This report provides data on
13 outage rates for forced outages, not planned outages.

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15 The forced outage rates of Hydro's generating units are presented using two measures:
16 Derated Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units and
17 Utilization Forced Outage Probability (UFOP) for the gas turbines.

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19 Derated Adjusted Forced Outage Rate (DAFOR) is a metric that measures the percentage of
20 the time that a unit or group of units is unable to generate at its maximum continuous rating
21 (MCR) due to forced outages. The DAFOR for each unit is weighted to reflect differences in
22 generating unit sizes in order to provide a company total and reflect the relative impact a
23 unit's performance has on overall generating performance. This measure is applied to
24 hydraulic and thermal units. However, this measure is not applicable to gas turbines
25 because of their nature as a standby unit and relatively low operating hours.

26 Utilization Forced Outage Probability (UFOP) is a metric that measures the percentage of
27 time that a unit or group of units will encounter a forced outage and not be available when
28 required. This metric is used for the gas turbines.

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2 Included in the forced outage rates are outages that remove the unit from service
3 completely, as well as instances when units are de-rated. If a unit's output is reduced by
4 more than 2%, the unit is considered de-rated by Canadian Electricity Association (CEA)
5 guidelines. Per CEA guidelines, to take into account the de-rated levels of a generating unit,
6 the operating time at the de-rated level is converted into an equivalent outage time.
7
8 In addition to forced outage rates, this report provides outage details for those outages that
9 contributed materially to forced outage rates exceeding those used in Hydro's generation
10 planning analysis.

1 **2.0 Period Ending March 31, 2016 Overview**

Class of Units	April 1, 2014 to March 31, 2015 (%)	April 1, 2015 to March 31, 2016 (%)	Base Planning Assumption (%)
Hydraulic (DAFOR)	4.45	2.76	0.90
Thermal (DAFOR)	10.99	13.54	9.64
Gas Turbine (Combined) (UFOP)	18.36	8.29	10.62
Gas Turbine (Holyrood) (UFOP)	0.70 ¹	2.81	5.00

2

3 The hydraulic DAFOR and the combined² gas turbine UFOP performance (in table above) all
 4 show improvement for the current period, the 12-month period ending March 2016
 5 compared to the previous period, the 12-month period ending March 2015. There was a
 6 decline in Thermal DAFOR performance for the current period compared to the previous
 7 period.

8

9 In the 10 year period prior to 2014, the hydraulic units show a somewhat consistent DAFOR.
 10 The DAFOR of the current 12-month period compared to the previous 10 years is higher,
 11 primarily due to vibration problems experienced at Unit 1 at Bay d’Espoir.

12

13 The thermal units, in the 10 year period prior to 2014, exhibit more variability in DAFOR than
 14 the hydraulic units, but in many years were close to a consistent rate of approximately 10%.
 15 The forced outage rate of the current period ending March 2016 is 13.54% which is above
 16 the base planning assumption of 9.64%, and the sensitivity of 11.64%. This is primarily
 17 caused by an airflow derating on Unit 1 and boiler tube failures on Units 1 and 2.

18

19 Hydro’s combined gas turbines’ UFOP in the 10 year period prior to 2014 was generally
 20 consistent at approximately 10% until the year 2012 when the rate exceeded 50%. Since

¹ Only includes data from March 1, 2015 to March 31, 2015

² Combined Gas Turbines include the Hardwoods, Happy Valley, and Stephenville units. The performance of the Holyrood CT was not included in the combined base planning or sensitivity numbers as these numbers were set prior to the Holyrood CT’s in service date.

1 2012, the UFOP has been improving each year. For the current 12-month period ending
2 March 31, 2016, performance was mainly affected by the forced outages to both the
3 Stephenville and Happy Valley units. The decline in performance for the Holyrood CT is
4 related to the data collection period. Performance data for the Holyrood CT for the 12-
5 month period ending March 2015 includes one month of data where the 12-month period
6 ending March 2016 includes a full year of data.

7

8 Note that the data in the charts for 2004 to 2014 are annual numbers (January 1 to
9 December 31), while the data for March 2015 and March 2016 are 12-month rolling (April 1
10 to March 31 for each period).

1 **3.0 Generation Planning Assumptions**

2 The DAFOR and UFOP indicators used in Hydro’s generation planning model is
3 representative of a historic average of the actual performance of these units. These
4 numbers are noted in the table below under the column “Base Planning Assumption”³.

5

6 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation
7 planning analysis. This number takes into account a higher level of unavailability, should it
8 occur, to assess the impact of higher unavailability of these units on overall generation
9 requirements. During the 12-month period ending March 31, 2016, the gas turbine units
10 performed within this sensitivity range for UFOP, while both the hydraulic and thermal
11 classes performed outside of the for DAFOR. Hydro notes that as part of the ongoing risk
12 review considering energy supply up to Lower Churchill interconnection, Hydro is
13 considering several years of data of DAFOR and UFOP and the resulting implication for
14 meeting reliability criteria.

15

16 The new gas turbine (Holyrood CT) has a lower expected rate of unavailability than the
17 original gas turbines, of 5% compared to 10.62% respectively, due to the fact that the unit is
18 new and can be expected to have better availability than the older units.⁴

³ Hydro is currently completing a risk assessment on thermal generation supply for the period up to interconnection with Labrador and Nova Scotia. As part of this risk assessment, Hydro is reviewing the recent availability results. The outcome of this review may reflect a new base planning assumption for various generation sources.

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

- 1 Hydro's current generation planning assumptions for DAFOR and UFOP are:
- 2

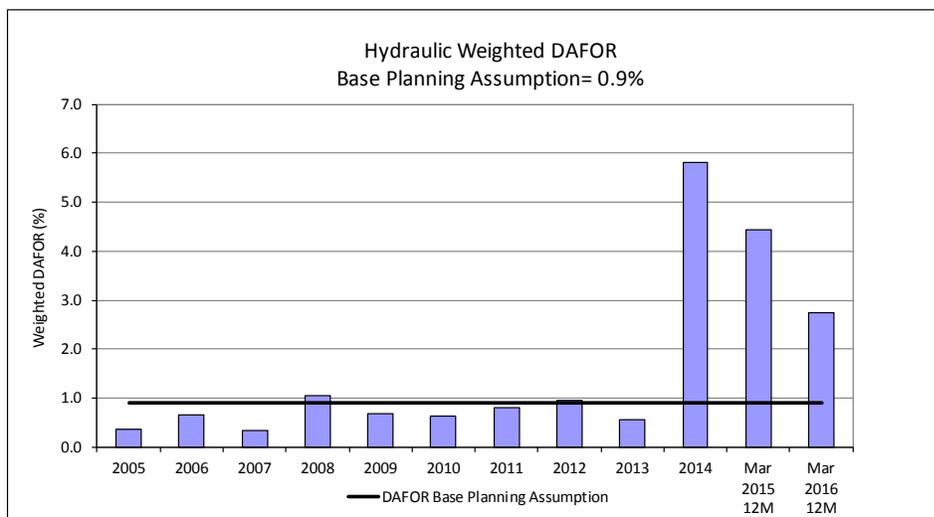
	DAFOR (%)		UFOP (%)	
	Base Planning Assumption	Sensitivity	Base Planning Assumption	Sensitivity
Hydraulic Units	0.90	0.90		
Thermal Units	9.64	11.64		
Gas Turbines - Existing			10.62	20.62
Gas Turbines - New			5.0	10.0 ⁵

⁵ In previous reports this sensitivity value was reported as 5.0%. The generation planning sensitivity for the Holyrood CT was updated to 10 % since the last report for system planning purposes.

1 **4.0 Hydraulic Unit Forced Outage Rate Performance**

2 The hydraulic unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 3 results for the 12-month period ending March 31, 2016 are presented as well as the data for
 4 the 12-month period ending March 31, 2015. These are compared to Hydro’s generation
 5 planning assumption for the forced outage rate.

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending March 2015 (%)	12 months ending March 2016 (%)	Hydro Generation Base Planning Assumption (%)
All Hydraulic Units - weighted	954.4	4.45	2.76	0.90
Hydraulic Units				
Bay D'Espoir 1	76.5	0.03	26.91	0.90
Bay D'Espoir 2	76.5	0.01	0.07	0.90
Bay D'Espoir 3	76.5	0.00	0.00	0.90
Bay D'Espoir 4	76.5	0.64	0.42	0.90
Bay D'Espoir 5	76.5	0.18	3.09	0.90
Bay D'Espoir 6	76.5	45.48	0.00	0.90
Bay D'Espoir 7	154.4	2.10	0.00	0.90
Hinds Lake	75	0.21	0.16	0.90
Upper Salmon	84	2.22	0.00	0.90
Granite Canal	40	0.32	2.07	0.90
Cat Arm 1	67	0.62	0.01	0.90
Cat Arm 2	67	1.34	1.39	0.90
Paradise River	8	0.00	0.24	0.90



1 The weighted “All Hydraulic Units” DAFOR was 2.76% for the current 12 month period ending March
2 31, 2016. The forced outage and derating of Unit 1 at Bay d’Espoir was the primary contributor to
3 the DAFOR of 2.76% as compared to a base planning assumption of 0.9%.

4 Considering the individual units performance, the assumed Hydro generation base planning DAFOR
5 was materially exceeded for Bay d’Espoir Unit 1. Also, there were exceedances compared to base
6 planning assumption for Bay d’Espoir Unit 5, Granite Canal and Cat Arm Unit 2, for the current
7 period.

8

9 The Bay d’Espoir Unit 1 DAFOR of 26.91% compared to the base planning assumption of 0.9% was
10 the result of a forced extension of a planned outage. The planned annual maintenance was
11 scheduled from April 26, 2015 to May 15, 2015. The extension is the unanticipated result of having
12 to replace the turbine bearing. It was identified in the annual work plan to check the turbine bearing
13 clearances due to an increase in bearing temperatures. The bearing clearances were checked and
14 damage was found to the turbine bearing. Therefore it was replaced with a new bearing. Vibration
15 issues continued to be experienced at the unit after the bearing was replaced, which extended the
16 planned outage. Two vibration experts, Hydro’s Project Execution and Technical Services personnel,
17 as well as the Original Equipment Manufacturer were retained to troubleshooting the issue, with the
18 unit eventually being returned to service at a reduced capacity. The original turbine bearing was
19 reinstalled after being refurbished (with reduced clearances) and, while the vibration issue remained,
20 a further dismantling of the unit revealed other issues including a damaged thrust bearing. Additional
21 repairs were made and a new thrust bearing installed, which resolved the vibration issue, and the
22 unit was returned to service at full capability on September 30, 2015.

23

24 The Bay d’Espoir Unit 5 DAFOR of 3.09% compared to the base planning assumption of 0.9% was the
25 result of a forced outage after the completion of planned annual maintenance. The planned annual
26 maintenance was completed from May 27, 2015 to August 7, 2015. Upon starting the unit, a stator
27 ground fault occurred, which required five days to repair before the unit was placed into service on
28 August 12, 2015.

29

30 The Granite Canal unit DAFOR of 2.07% compared to the base planning assumption of 0.9% was the
31 result of a forced outage after a lightning strike to transmission line TL263 which connects the unit to
32 the grid. A bearing issue (low water flow on the shaft seal) was experienced on the restart of the unit.

1 From August 10, 2015 to August 14, 2015, the unit incurred forced unavailability while repairs were
2 completed to resolve this issue. From December 16, 2015 to December 17, 2015, the unit
3 experienced forced unavailability due to debris on the intake trash rack.

4

5 The DAFOR for Cat Arm Unit 2 was 1.39% compared to the base planning assumption of 0.9%. On
6 May 12, 2015, the unit experienced a nine hour forced outage due to a faulty unit shutdown relay.
7 On May 21, 2015, the unit experienced a 14 hour forced outage due to a problem with a governor
8 timer on the pump controls. Due a problem with the spherical valve and a governor pressure issue
9 the unit also experienced a forced outage from June 13, 2015 to June 16, 2015.

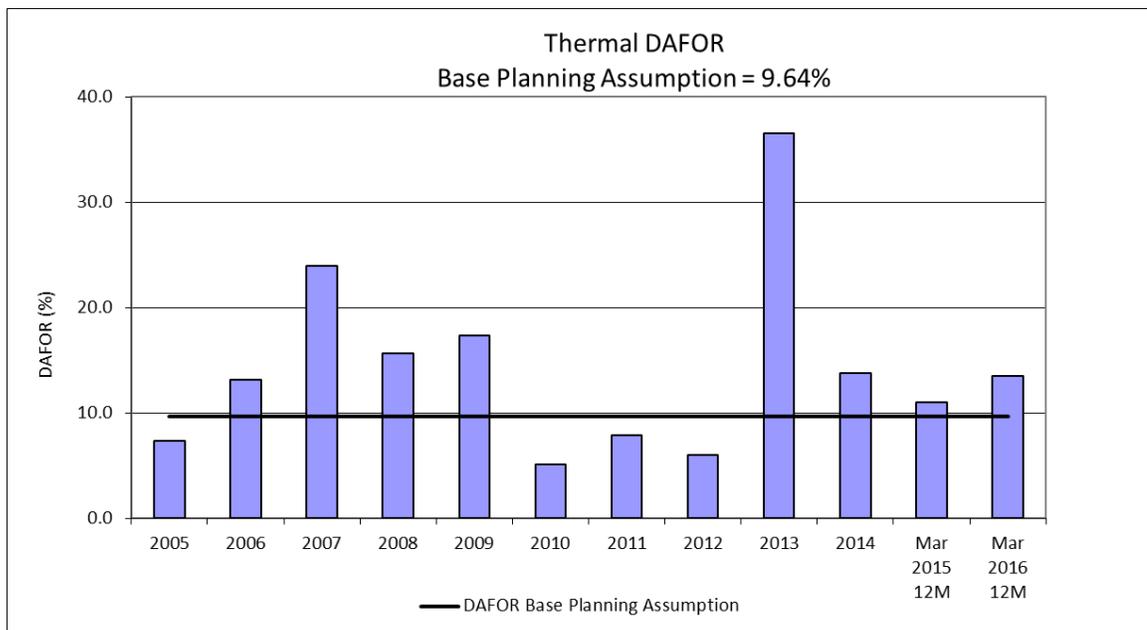
1 **5.0 Thermal Unit Forced Outage Rate Performance**

2 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 3 results for the 12-month period ending March 31, 2016 are presented as well as the data for
 4 the 12-month period ending March 31, 2015. These are compared to Hydro’s generation
 5 base planning assumption for the forced outage rate.

6
 7

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending March 2015 (%)	12 months ending March 2016 (%)	Hydro Generation Base Planning Assumption (%)
<i>All Thermal Units - weighted</i>	490	10.99	13.54	9.64
Thermal Units				
Holyrood 1	170	15.45	12.28	9.64
Holyrood 2	170	11.94	18.33	9.64
Holyrood 3	150	5.55	8.98	9.64

8



9

10 For the 12-month period ending March 31, 2016, the weighted DAFOR for, all thermal units, of
 11 13.54% is above the assumed Hydro generation base planning DAFOR value of 9.64%, and also
 12 exceeded the previous 12-month period rate of 10.99%. Unit 1 DAFOR was 12.28% and Unit 2

1 DAFOR was 18.33%, and the performance for both units was above the base planning assumption of
2 9.64%. Unit 3 DAFOR was 8.98%, which is better than the base planning assumption of 9.64%.

3
4 The DAFOR performance for Holyrood Unit 1 (170 MW) was affected by several events in the current
5 12 MTD period.

6
7 From May 14, 2015 to August 1, 2015, a derating to 155 MW occurred due to airflow limitations.
8 During the 2015 planned maintenance outage from August to October, the air heaters were
9 found to be heavily fouled. They were cleaned during the outage. It was expected that the air
10 flow problem that led to the load restriction has been resolved as a result of this clearing. Testing
11 of the air flow controls during the maintenance outage did not reveal any problems

12
13 From November 27, 2015 to February 3, 2016 the unit was derated to 155 MW due to airflow
14 limitations, suspected to be related to the new variable frequency drives on the forced draft (FD)
15 fans. This was a continuation of the problems experienced prior to the annual maintenance
16 outage. The air heater fouling that was discovered and corrected during the outage did not solve
17 the problem with air flow. Boiler tuning may be effective in resolving this issue. This is not
18 possible to complete until after the reheater tubes are replaced (see below).

19
20 On February 3, 2016 the east FD fan variable frequency drive failed and caused the unit to trip.
21 Investigation by Siemens (the manufacturer of the drives) and plant engineering was conducted.
22 Under a Siemens recommendation, a control card on the drive unit was replaced and the unit
23 was returned to service on February 5, 2016. Siemens is completing a root cause failure analysis
24 on the control card. When the unit was returned to service the load was limited to 140 MW to
25 make the unit more reliable in consideration of the boiler reheater tube failures experienced in
26 Unit 2.

27
28 On February 8, 2016 the unit experienced a tube failure in the reheater section of the boiler. The
29 unit was operated with a deration to 50 MW until an opportune time to shut it down for repairs
30 on February 16, 2016. Hydro considered the risk of additional tube failures and the favorable
31 weather forecast at the time and proceeded with the replacement of the lowest wall thickness
32 tubes during this outage. Sixteen lower reheater tubes were replaced at that time. The unit was

1 returned to service on February 26, 2016 with a derating to 120 MW to improve the reliability of
2 the reheater until the remaining lower reheater tubes can be replaced during the upcoming
3 scheduled annual maintenance outage.

4

5 The DAFOR performance for Holyrood Unit 2 (170 MW) was primarily affected by several events.

6

7 On January 6, 2016 the unit experienced a tube failure in the reheater section of the boiler. Upon
8 discovery of the failure the unit was taken offline in a controlled shutdown and allowed to cool
9 for internal inspection. Four failed tubes in the lower section of the reheater were identified and
10 replaced. The unit was returned to service after the repairs on January 15, 2016. As is common
11 practice when returning the unit to service, a stepped approach to loading the unit was
12 employed. Between January 15 and January 19, the unit was gradually loaded in steps between
13 70 MW and 140 MW. On January 19, 2016, when operating at 140 MW, the unit experienced
14 another failure in the lower reheater section of the boiler. Again the unit was taken offline in a
15 controlled shutdown. Hydro considered the risk of additional tube failures and the favorable
16 weather forecast at the time and proceeded with the replacement of the lowest wall thickness
17 tubes during this outage. Over the period since the unit first went out of service January 6, 2016,
18 27 lower and three upper reheat tubes were replaced prior to the unit going back in service
19 February 3, 2016. The unit was returned to service with a derating to 120 MW to improve the
20 reliability of the reheater until the remaining lower reheater tubes can be replaced during the
21 upcoming scheduled annual maintenance outage.

1 **6.0 Gas Turbine UFOP Performance**

2 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was
 3 8.29% for the 12-month period ending March 31, 2016. This is better than the base planning
 4 assumption of 10.62%. The current period UFOP improved from the previous period UFOP of
 5 18.36%. The Hardwoods UFOP for the current period is 3.05%, which is better than the base
 6 planning assumption of 10.62%. The Stephenville unit's current period UFOP is 15.08%
 7 compared to that of the previous period of 9.50%. Happy Valley's UFOP is 14.22% for the
 8 current period compared to 1.04% in the previous period.

9

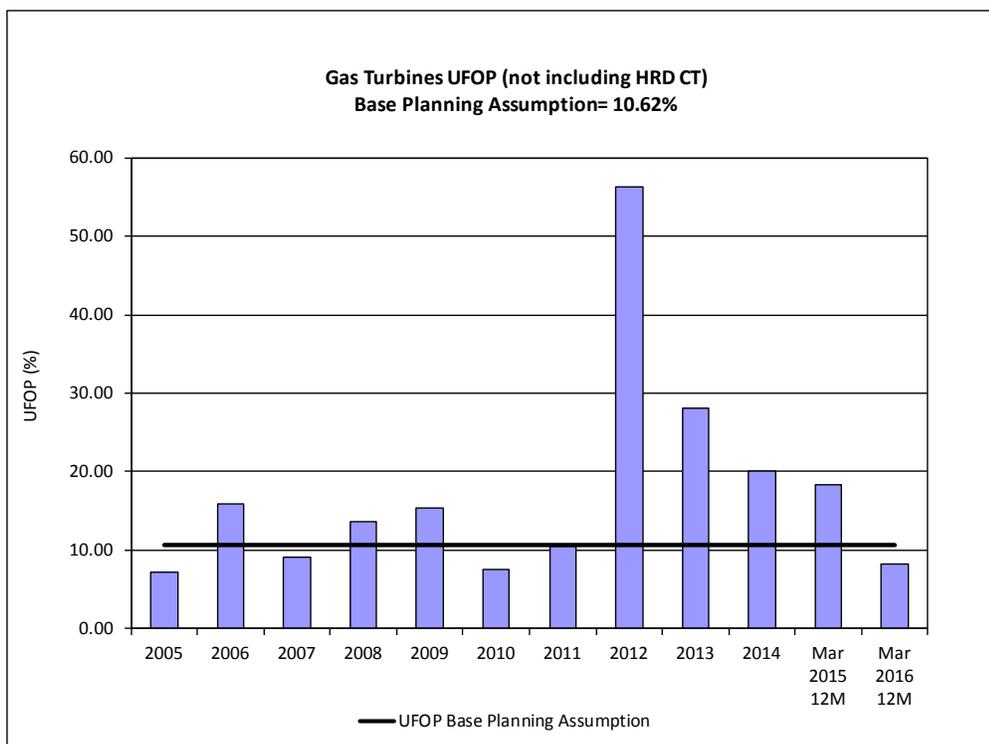
10

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2015 (%)	12 months ending March 2016 (%)	Hydro Generation Base Planning Assumption (%)
Combined Gas Turbines	125	18.36	8.29	10.62
Stephenville	50	9.50	15.08	10.62
Hardwoods	50	33.82	3.05	10.62
Happy Valley	25	1.04	14.22	10.62

13

14 The Holyrood (HRD) CT UFOP of 2.81% for the current period is better than the base
 15 planning assumption of 5.00%.

Combustion Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2015 (%)	12 months ending March 2016 (%)	Hydro Generation Base Planning Assumption (%)
Holyrood CT	123.5	0.70	2.81	5.00



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The Stephenville unit UFOP was affected by three notable events in the reporting period.

The UFOP for Stephenville gas turbine was primarily impacted in 2015 by a forced outage from May 1, to May 27, due to an alternator bearing problem. The bearing was inspected, repaired, and all operating parameters checked and confirmed prior to returning the unit to service.

From February 10, 2016 to February 12, 2016, End B was unavailable due to a stuck solenoid on the fuel shut off valve. Minor maintenance was performed on the valve and the unit was returned to service.

As of March 26, 2016, there is a derating of the unit to 25 MW (from 50 MW). End A tripped and has been unavailable. A report on the unit is expected shortly.

1 The Happy Valley unit UFOP was primarily affected by the following event in the reporting
2 period.

3

4 In 2015, the UFOP for the Happy Valley gas turbine was primarily impacted by a forced
5 outage from September 9 to September 21, due to a vibration issue. The vibration issue
6 was determined to be a result of a broken air pipe which was repaired and the unit was
7 then tested and returned to service.



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July 15, 2016

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

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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

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Senior Counsel, Regulatory

TLP/bs

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A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

QUARTERLY REPORT
ON
PERFORMANCE OF GENERATING UNITS
FOR THE QUARTER ENDED JUNE 30, 2016

NEWFOUNDLAND AND LABRADOR HYDRO

JULY 15, 2016

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9 for the current 12-month reporting period of July 1, 2015 to June 30, 2016. The report also
10 provides, for comparison purposes, the individual generating unit data on forced outage
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12 presented on an annual basis for the years 2005-2014. This report provides data on outage
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25 of their nature as a standby unit and relatively low operating hours.

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28 time that a unit or group of units will encounter a forced outage and not be available when
29 required. This metric is used for the gas turbines.

1 Included in the forced outage rates are outages that remove the unit from service
2 completely, as well as instances when units are de-rated. If a unit's output is reduced by
3 more than 2%, the unit is considered de-rated by Canadian Electricity Association (CEA)
4 guidelines. Per CEA guidelines, to take into account the de-rated levels of a generating unit,
5 the operating time at the de-rated level is converted into an equivalent outage time.

6

7 In addition to forced outage rates, this report provides outage details for those outages that
8 contributed materially to forced outage rates exceeding those used in Hydro's generation
9 planning analysis.

1 **2.0 Period Ending June 30, 2016 Overview**

Class of Units	July 1, 2014 to June 30, 2015 (%)	July 1, 2015 to June 30, 2016 (%)	Base Planning Assumption (%)
Hydraulic (DAFOR)	2.85	2.15	0.90
Thermal (DAFOR)	10.06	19.45	9.64
Gas Turbine (Combined) (UFOP)	21.19	5.54	10.62
Gas Turbine (Holyrood) (UFOP)	1.56 ¹	2.53	5.00

2

3 The hydraulic DAFOR and the combined² gas turbine UFOP performance (in table above) all
4 show improvement for the current period, the 12-month period ending June 2016 compared
5 to the previous period, the 12-month period ending June 2015. There was a decline in
6 Thermal DAFOR performance for the current period compared to the previous period.

7

8 In the 10 year period prior to 2014, the hydraulic units show a somewhat consistent DAFOR.
9 The DAFOR of the current 12-month period compared to the previous 10 years is higher,
10 primarily due to vibration problems experienced at Unit 1 at Bay d’Espoir.

11

12 The thermal units, in the 10 year period prior to 2014, exhibit more variability in DAFOR than
13 the hydraulic units, but in many years were close to a consistent rate of approximately 10%.
14 The forced outage rate of the current period ending June 2016 is 19.45% which is above the
15 base planning assumption of 9.64%, and the sensitivity of 11.64%. This is primarily caused by
16 an airflow derating on Unit 1 and boiler tube failures on Units 1 and 2.

17

18 Hydro’s combined gas turbines’ UFOP in the 10 year period prior to 2014 was generally
19 consistent at approximately 10% until the year 2012 when the rate exceeded 50%. Since

¹ Only includes data from March 1, 2015 to June 30, 2015

² Combined Gas Turbines include the Hardwoods, Happy Valley, and Stephenville units. The performance of the Holyrood CT was not included in the combined base planning or sensitivity numbers as these numbers were set prior to the Holyrood CT’s in service date.

1 2012, the UFOP has been improving each year. For the current 12-month period ending June
2 30, 2016, performance was mainly affected by the forced outages to the Happy Valley unit.
3 The decline in performance for the Holyrood CT is related to the data collection period.
4 Performance data for the Holyrood CT for the 12-month period ending June 2015 includes
5 four months of data where the 12-month period ending June 2016 includes a full year of
6 data.
7
8 Note that the data in the charts for 2004 to 2014 are annual numbers (January 1 to
9 December 31), while the data for June 2015 and June 2016 are 12-month rolling (July 1 to
10 June 30 for each period).

1 **3.0 Generation Planning Assumptions**

2 The DAFOR and UFOP indicators used in Hydro’s generation planning model are
3 representative of a historic average of the actual performance of these units. These numbers
4 are noted in the table below under the column “Base Planning Assumption”³.

5
6 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation
7 planning analysis. This number takes into account a higher level of unavailability, should it
8 occur, to assess the impact of higher unavailability of these units on overall generation
9 requirements. During the 12-month period ending June 30, 2016, the gas turbine units
10 performed well within this sensitivity range for UFOP. Both the hydraulic and thermal classes
11 performed well outside of the sensitivity range for DAFOR. As part of the ongoing risk review
12 considering energy supply up to Lower Churchill interconnection, Hydro is considering
13 several years of data of DAFOR and UFOP and the resulting implication for meeting reliability
14 criteria.

15
16 The new gas turbine (Holyrood CT) has a lower expected rate of unavailability than the
17 original gas turbines, of 5% compared to 10.62% respectively, due to the fact that the unit is
18 new and can be expected to have better availability than the older units.⁴

³ Hydro is currently completing a risk assessment on thermal generation supply for the period up to interconnection with Labrador and Nova Scotia. As part of this risk assessment, Hydro is reviewing the recent availability results. The outcome of this review may reflect a new base planning assumption for various generation sources.

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

1 Hydro's current generation planning assumptions for DAFOR and UFOP are:

2

	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 ⁵

⁵ In previous reports this sensitivity value was reported as 5.0%. The generation planning sensitivity for the Holyrood CT was updated to 10 % since the last report for system planning purposes.

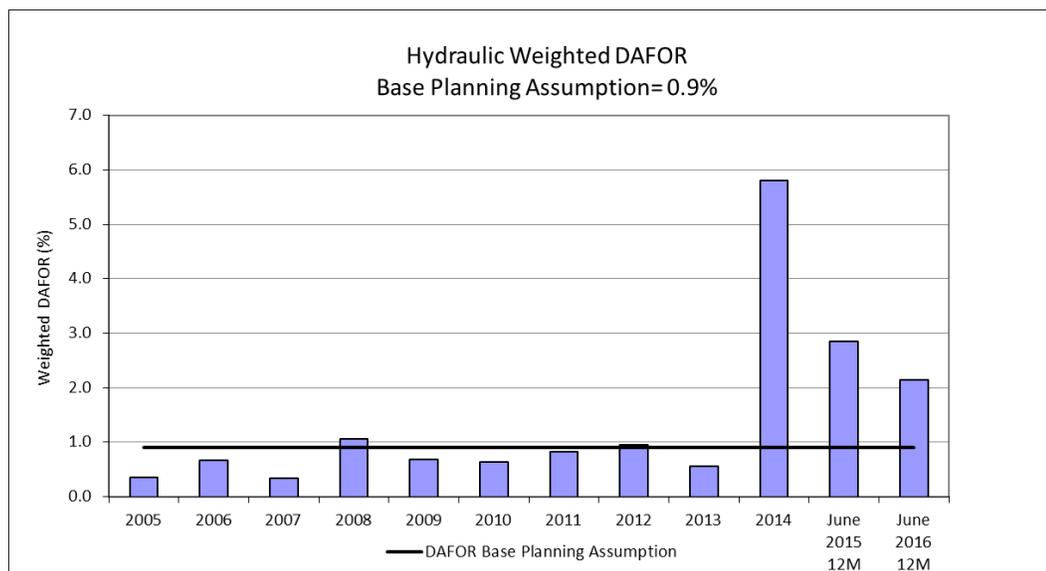
1 **4.0 Hydraulic Unit Forced Outage Rate Performance**

2

3 The hydraulic unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 4 results for the 12-month period ending June 30, 2016 are presented as well as the data for
 5 the 12-month period ending June 30, 2015. These are compared to Hydro’s generation
 6 planning assumption for the forced outage rate.

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending June 2015 (%)	12 months ending June 2016 (%)	Hydro Generation Base Planning Assumption (%)
All Hydraulic Units - weighted	954.4	2.85	2.15	0.90
Hydraulic Units				
Bay D'Espoir 1	76.5	13.75	17.69	0.90
Bay D'Espoir 2	76.5	0.00	7.44	0.90
Bay D'Espoir 3	76.5	0.00	0.00	0.90
Bay D'Espoir 4	76.5	0.23	0.11	0.90
Bay D'Espoir 5	76.5	0.00	3.36	0.90
Bay D'Espoir 6	76.5	15.39	0.00	0.90
Bay D'Espoir 7	154.4	0.84	0.00	0.90
Hinds Lake	75	0.30	0.05	0.90
Upper Salmon	84	1.17	0.00	0.90
Granite Canal	40	0.37	1.83	0.90
Cat Arm 1	67	0.60	0.01	0.90
Cat Arm 2	67	1.91	0.21	0.90
Paradise River	8	0.00	0.31	0.90

7



1 Considering the individual units performance, the assumed Hydro generation base planning
2 DAFOR was materially exceeded for Bay d’Espoir Unit 1. Also, there were exceedances
3 compared to base planning assumption for Bay d’Espoir Unit 2, Bay d’Espoir Unit 5, and
4 Granite Canal for the current period.

5

6 The Bay d’Espoir Unit 1 DAFOR of 17.69% compared to the base planning assumption of
7 0.9% was the result of a forced extension of a planned outage. This one forced outage,
8 contributed 52% of the total DAFOR in this asset class. The planned annual maintenance was
9 scheduled from April 26, 2015 to May 15, 2015. The extension is the unanticipated result of
10 having to replace the turbine bearing. It was identified in the annual work plan to check the
11 turbine bearing clearances due to an increase in bearing temperatures. The bearing
12 clearances were checked and damage was found to the turbine bearing. Therefore it was
13 replaced with a new bearing. Vibration issues continued to be experienced at the unit after
14 the bearing was replaced, which extended the planned outage. Two vibration experts,
15 Hydro’s Project Execution and Technical Services personnel, as well as the Original
16 Equipment Manufacturer were retained to troubleshoot the issue, with the unit eventually
17 being returned to service at a reduced capacity. The original turbine bearing was reinstalled
18 after being refurbished (with reduced clearances) and, while the vibration issue remained, a
19 further dismantling of the unit revealed other issues including a damaged thrust bearing.
20 Additional repairs were made and a new thrust bearing installed, which resolved the
21 vibration issue, and the unit was returned to service at full capability on September 30,
22 2015. The Unit 1 DAFOR was also impacted (5.02%) by the Unit being removed from service
23 on May 21, 2016, as a result of a leak in Penstock 1, which provides water to both Units 1
24 and 2. The following detail relating to the Unit 2 DAFOR applies to Unit 1 as well.

25

26 The Bay d’Espoir Unit 2 DAFOR of 7.44% compared to the base planning assumption of 0.9%
27 was the result of a forced outage, caused by a leak in Penstock 1, which supplies both Units 1

1 and 2. The forced outage started on May 21, 2016 after a leak was reported in the Penstock.
2 A consultant was engaged to conduct an investigation into the issue, and a repair procedure
3 was provided on June 2. The damaged section of penstock was repaired and Unit 1 was
4 returned to service on June 3, 2016 at 1938 hours and Unit 2 was returned to service on
5 June 3, 2016 at 2014 hours.

6

7 The Bay d’Espoir Unit 5 DAFOR of 3.36% compared to the base planning assumption of 0.9%
8 was the result of a forced outage after the completion of planned annual maintenance. The
9 planned annual maintenance was completed from May 27, 2015 to August 7, 2015. Upon
10 starting the unit, a stator ground fault occurred, which required five days to repair before
11 the unit was placed into service on August 12, 2015.

12

13 The Granite Canal unit DAFOR of 1.83% compared to the base planning assumption of 0.9%
14 was the result of a forced outage after a lightning strike to transmission line TL263 which
15 connects the unit to the grid. A bearing issue (low water flow on the shaft seal) was
16 experienced on the restart of the unit. From August 10, 2015 to August 14, 2015, the unit
17 incurred forced unavailability while repairs were completed to resolve this issue. From
18 December 16, 2015 to December 17, 2015, the unit experienced forced unavailability due to
19 debris on the intake trash rack.

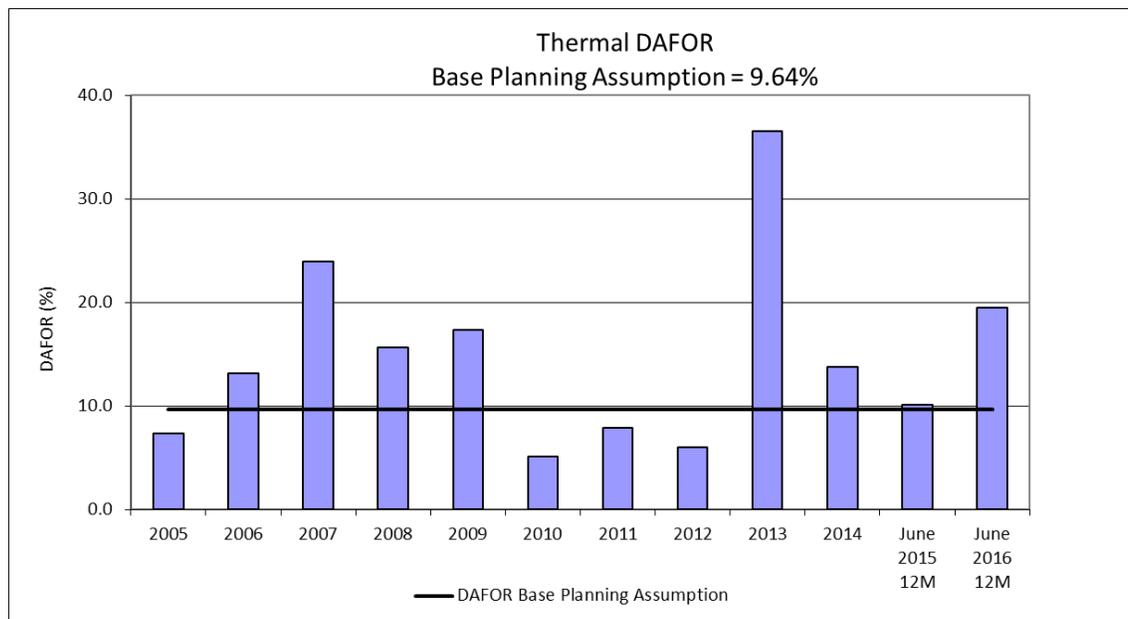
1 **5.0 Thermal Unit Forced Outage Rate Performance**

2

3 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 4 results for the 12-month period ending June 30, 2016 are presented as well as the data for
 5 the 12-month period ending June 30, 2015. These are compared to Hydro’s generation base
 6 planning assumption for the forced outage rate.

7

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending June 2015 (%)	12 months ending June 2016 (%)	Hydro Generation Base Planning Assumption (%)
<i>All Thermal Units - weighted</i>	490	10.06	19.45	9.64
Thermal Units				
Holyrood 1	170	13.20	20.66	9.64
Holyrood 2	170	11.06	26.46	9.64
Holyrood 3	150	5.67	8.91	9.64



8

9 For the 12-month period ending June 30, 2016 the weighted DAFOR for all thermal units of
 10 19.45% is above the assumed Hydro generation base planning DAFOR value of 9.64%, and
 11 also exceeded the previous 12-month period rate of 10.06%. Unit 1 DAFOR was 20.66% and

1 Unit 2 DAFOR was 26.46%, and the performance for both units was above the base planning
2 assumption of 9.64%. Unit 3 DAFOR was 8.91%, which is better than the base planning
3 assumption of 9.64%.

4
5 The DAFOR performance for Holyrood Unit 1 (170 MW) was affected by several events in the
6 current 12 MTD period.

7
8 From May 14, 2015 to August 1, 2015, a derating to 155 MW occurred due to airflow
9 limitations. During the 2015 planned maintenance outage from August to October, the
10 air heaters were found to be heavily fouled. They were cleaned during the outage. It was
11 expected that the air flow problem that led to the load restriction has been resolved as a
12 result of this clearing. Testing of the air flow controls during the maintenance outage did
13 not reveal any problems.

14
15 From November 27, 2015 to February 3, 2016 the unit was derated to 155 MW due to
16 airflow limitations, suspected to be related to the new variable frequency drives on the
17 forced draft (FD) fans. This was a continuation of the problems experienced prior to the
18 annual maintenance outage. The air heater fouling that was discovered and corrected
19 during the outage did not solve the problem with air flow. Boiler tuning may be effective
20 in resolving this issue. This is not possible to complete until after the reheater tubes are
21 replaced (see below).

22
23 On February 3, 2016 the east FD fan variable frequency drive failed and caused the unit
24 to trip. Investigation by Siemens (the manufacturer of the drives) and plant engineering
25 was conducted. Under a Siemens recommendation, a control card on the drive unit was
26 replaced and the unit was returned to service on February 5, 2016. When the unit was
27 returned to service the load was limited to 140 MW to make the unit more reliable in
28 consideration of the boiler reheater tube failures experienced in Unit 2. Siemens has

1 been actioned to complete a holistic investigation of all VFD issues that have occurred at
2 Holyrood. This was completed and presented to Hydro on July 7, 2016.

3
4 On February 8, 2016 the unit experienced a tube failure in the reheater section of the
5 boiler. The unit was operated with a deration to 50 MW until an opportune time to shut
6 it down for repairs was presented on February 16, 2016. Hydro considered the risk of
7 additional tube failures and the favorable weather forecast at the time and proceeded
8 with the replacement of the lowest wall thickness tubes during this outage. Sixteen
9 lower reheater tubes were replaced at that time. The unit was returned to service on
10 February 26, 2016 with a derating to 120 MW to improve the reliability of the reheater
11 until the remaining lower reheater tubes can be replaced during the upcoming scheduled
12 annual maintenance outage.

13
14 The DAFOR performance for Holyrood Unit 2 (170 MW) was primarily affected by several
15 events.

16
17 On January 6, 2016 the unit experienced a tube failure in the reheater section of the
18 boiler. Upon discovery of the failure the unit was taken offline in a controlled shutdown
19 and allowed to cool for internal inspection. Four failed tubes in the lower section of the
20 reheater were identified and replaced. The unit was returned to service after the repairs
21 on January 15, 2016. As is common practice when returning the unit to service, a
22 stepped approach to loading the unit was employed. Between January 15 and January
23 19, the unit was gradually loaded in steps between 70 MW and 140 MW. On January 19,
24 2016, when operating at 140 MW, the unit experienced another failure in the lower
25 reheater section of the boiler. Again the unit was taken offline in a controlled shutdown.
26 Hydro considered the risk of additional tube failures and the favorable weather forecast
27 at the time and proceeded with the replacement of the lowest wall thickness tubes
28 during this outage. Over the period since the unit first went out of service January 6,
29 2016, 27 lower and three upper reheat tubes were replaced prior to the unit going back

1 in service February 3, 2016. The unit was returned to service with a derating to 120 MW
2 to improve the reliability of the reheater until the remaining lower reheater tubes can be
3 replaced during the upcoming scheduled annual maintenance outage.

4
5 On May 26, 2016 the west FD fan variable frequency drive failed and caused the unit to
6 trip. Siemens (the manufacturer of the drives) was contacted immediately and a
7 technician was dispatched to travel to site. He did not arrive until late in the day on May
8 27, 2016. In parallel, the plant Electrical Engineer (in consultation with Siemens),
9 Electricians, and Operations conducted an internal investigation and determined that
10 there were no current faults with the fan and it could be safely started. It was decided to
11 put the unit back on line later in the day on May 26, 2016 while waiting for the Siemens
12 technician. Because the reason for the trip had not been determined, the unit load was
13 restricted to 50 MW (below UFLS).

14
15 The Siemens technician performed some on-line diagnostics on May 27, 2016 and May
16 28, 2016. Overnight on May 28, 2016 the unit was taken offline for a full internal
17 inspection of the drive under direction of the Siemens technician. A control card on the
18 drive unit was replaced and the unit was returned to service the next morning on May
19 29, 2016. Siemens has been actioned to complete a holistic investigation of all VFD issues
20 that have occurred at Holyrood since the drives were installed. This was completed and
21 presented to Hydro on July 7, 2016.

22
23 On June 20, 2016 the annual maintenance outage began on this unit. Included in the
24 scheduled work is the replacement of the lower reheater tubes.

1 **6.0 Gas Turbine UFOP Performance**

2

3 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was
 4 5.54% for the 12-month period ending June 30, 2016. This is better than the base planning
 5 assumption of 10.62%. The current period UFOP improved from the previous period UFOP of
 6 21.19%. The Hardwoods UFOP for the current period is 1.84%, which is better than the base
 7 planning assumption of 10.62%. The Stephenville unit’s current period UFOP is 3.59%
 8 compared to that of the previous period of 16.40%. Happy Valley’s UFOP is 14.04% for the
 9 current period compared to 1.03% in the previous period.

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending June 2015 (%)	12 months ending June 2016 (%)	Hydro Generation Base Planning Assumption (%)
Combined Gas Turbines	125	21.19	5.54	10.62
Stephenville	50	16.40	3.59	10.62
Hardwoods	50	32.44	1.84	10.62
Happy Valley	25	1.03	14.04	10.62

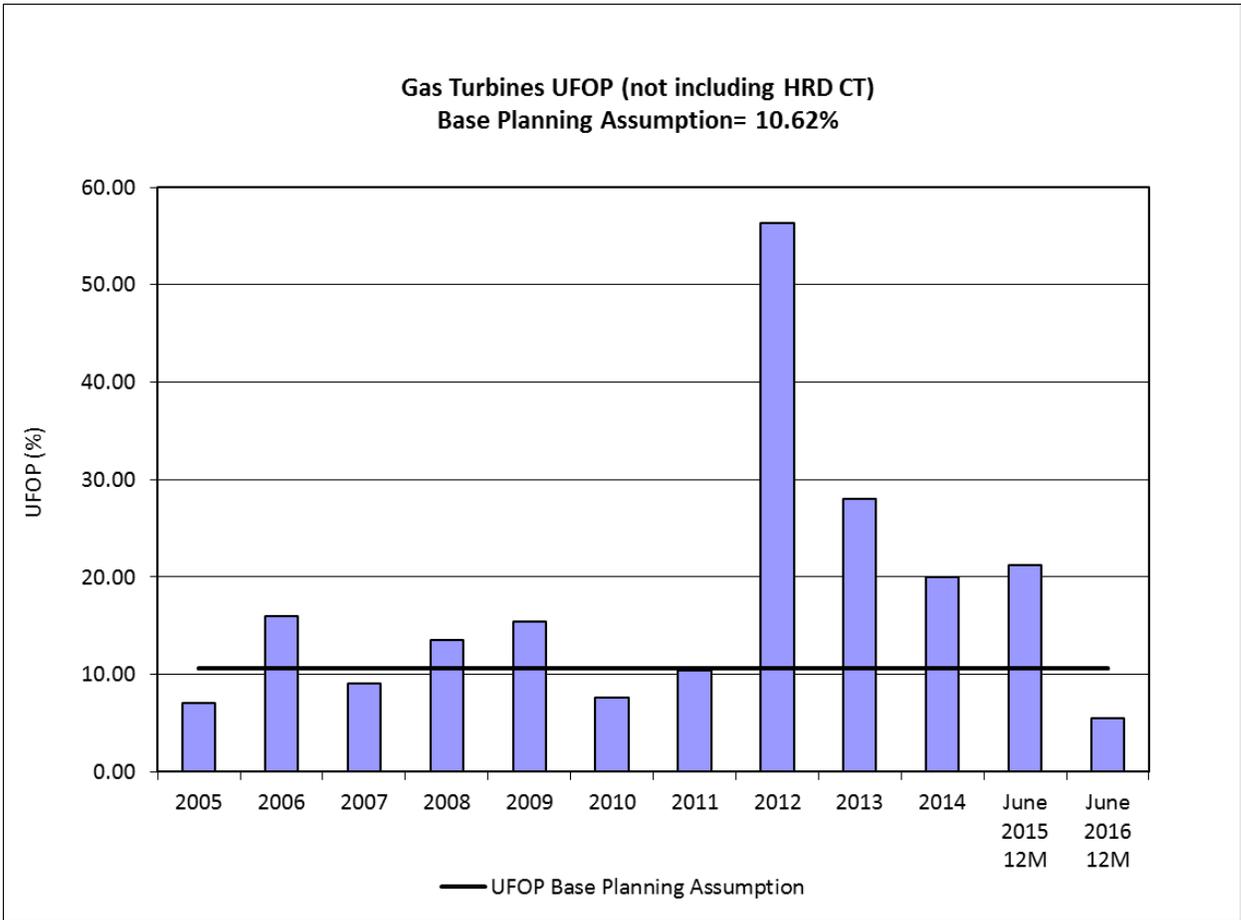
10

11 The Holyrood (HRD) CT UFOP of 2.53% for the current period is better than the base
 12 planning assumption of 5.00%.

13

14

Combustion Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending June 2015 (%)	12 months ending June 2016 (%)	Hydro Generation Base Planning Assumption (%)
Holyrood CT	123.5	1.56	2.53	5.00



- 1
- 2 The UFOP for the Happy Valley gas turbine was impacted by a forced outage from
- 3 September 9 to September 21, 2015 due to a vibration issue. The vibration issue was
- 4 determined to be a result of a broken air pipe which was repaired and the unit was then
- 5 tested and returned to service.



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October 14, 2016

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 the original plus 12 copies of the quarterly report *Rolling 12 Month Performance of Hydro's Generating Units*.

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

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

A handwritten signature in blue ink that reads 'Tracey Pennell'.

Tracey L. Pennell
Senior Counsel, Regulatory

TLP/bs

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Sheryl Nisenbaum – Praxair Canada Inc.
ecc: Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Thomas Johnson – Consumer Advocate
Thomas O' Reilly – Cox & Palmer
Danny Dumaresque

A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

QUARTERLY REPORT
ON
PERFORMANCE OF GENERATING UNITS
FOR THE QUARTER ENDED SEPTEMBER 30, 2016

NEWFOUNDLAND AND LABRADOR HYDRO

OCTOBER 14, 2016

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1 **1.0 Introduction**

2 In this report, Newfoundland and Labrador Hydro (Hydro) provides data on forced outage
3 rates of its generating facilities. This data is provided in relation to historical forced outage
4 rates and as well as in relation to assumptions used in Loss of Load Hours (LOLH) calculations
5 for system planning purposes.

6

7 The forced outage rates are provided for individual generating units at hydraulic facilities;
8 the three units at the Holyrood Thermal Generating Station (HTGS) and Hydro's gas turbines
9 for the current 12-month reporting period of October 1, 2015 to September 30, 2016. The
10 report also provides, for comparison purposes, the individual generating unit data on forced
11 outage rates for the previous period October 1, 2014 to September 30, 2015. Further, total
12 asset class data is presented on an annual basis for years the 2005-2014. This report
13 provides data on outage rates for forced outages, not planned outages.

14

15 The forced outage rates of Hydro's generating units are presented using two measures:
16 Derated Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units and
17 Utilization Forced Outage Probability (UFOP) for the gas turbines.

18

19 Derated Adjusted Forced Outage Rate (DAFOR) is a metric that measures the percentage of
20 the time that a unit or group of units is unable to generate at its maximum continuous rating
21 (MCR) due to forced outages. The DAFOR for each unit is weighted to reflect differences in
22 generating unit sizes in order to provide a company total and reflect the relative impact a
23 unit's performance has on overall generating performance. This measure is applied to
24 hydraulic and thermal units. However, this measure is not applicable to gas turbines because
25 of their nature as a standby unit and relatively low operating hours.

26

27 Utilization Forced Outage Probability (UFOP) is a metric that measures the percentage of
28 time that a unit or group of units will encounter a forced outage and not be available when
29 required. This metric is used for the gas turbines.

1 Included in the forced outage rates are outages that remove the unit from service
 2 completely, as well as instances when units are de-rated. If a unit’s output is reduced by
 3 more than 2%, the unit is considered de-rated by Canadian Electricity Association (CEA)
 4 guidelines. Per CEA guidelines, to take into account the de-rated levels of a generating unit,
 5 the operating time at the de-rated level is converted into an equivalent outage time.

6

7 In addition to forced outage rates, this report provides outage details for those outages that
 8 contributed materially to forced outage rates exceeding those used in Hydro’s generation
 9 planning analysis.

10

11 **2.0 Period Ending September 30, 2016 Overview**

12

Class of Units	October 1, 2014 to September 30, 2015 (%)	October 1, 2015 to September 30, 2016 (%)	Base Planning Assumption (%)
Hydraulic (DAFOR)	2.82	2.02	0.90
Thermal (DAFOR)	9.86	19.72	9.64
Gas Turbine (Combined) (UFOP)	15.89	5.54	10.62
Gas Turbine (Holyrood) (UFOP)	5.01 ¹	1.33	5.00

13

14 The hydraulic DAFOR and the combined² gas turbine UFOP performance (in table above)
 15 show improvement for the current period, the 12-month period ending September 2016
 16 compared to the previous period, the 12-month period ending September 2015. There was a
 17 decline in Thermal DAFOR performance for the current period compared to the previous
 18 period.

¹ Only includes data from March 1, 2015 to September 30, 2015

² Combined Gas Turbines include the Hardwoods, Happy Valley, and Stephenville units. The performance of the Holyrood CT was not included in the combined base planning or sensitivity numbers as these numbers were set prior to the Holyrood CT’s in service date.

1 In the 10 year period prior to 2014, the hydraulic units show a somewhat consistent DAFOR.
2 The DAFOR of the current 12-month period compared to the previous 10 years is higher,
3 primarily due to penstock issues experienced on Units 1 and 2 at Bay d’Espoir.

4
5 The thermal units, in the 10 year period prior to 2014, exhibit more variability in DAFOR than
6 the hydraulic units, but in many years were close to a consistent rate of approximately 10%.
7 The forced outage rate of the current period ending September 2016 is 19.72% which is
8 above the base planning assumption of 9.64%, and the sensitivity of 11.64%. This is primarily
9 caused by an airflow derating on Unit 1 and boiler tube failures on Units 1 and 2.

10

11 Hydro’s combined gas turbines’ UFOP in the 10 year period prior to 2014 was generally
12 consistent at approximately 10% until the year 2012 when the rate exceeded 50%. Since
13 2012, the UFOP has been improving each year. For the current 12-month period ending
14 September 30, 2016, performance was mainly affected by forced outages to the Stephenville
15 unit. Performance data for the Holyrood CT for the 12-month period ending September 2015
16 includes seven months of data where the 12-month period ending September 2016 includes
17 a full year of data.

18

19 Note that the data in the charts for 2005 to 2014 are annual numbers (January 1 to
20 December 31), while the data for September 2015 and September 2016 are 12-month rolling
21 (October 1 to September 30 for each period).

22

23 **3.0 Generation Planning Assumptions**

24 The DAFOR and UFOP indicators used in Hydro’s generation planning model is
25 representative of a historic average of the actual performance of these units. These numbers
26 are noted in the table below under the column “Base Planning Assumption”³.

³ Hydro is currently completing a risk assessment on thermal generation supply for the period up to interconnection with Labrador and Nova Scotia. As part of this risk assessment, Hydro is reviewing the recent availability results. The outcome of this review may reflect a new base planning assumption for various generation sources.

1 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation
 2 planning analysis. This number takes into account a higher level of unavailability, should it
 3 occur, to assess the impact of higher unavailability of these units on overall generation
 4 requirements. During the 12-month period ending September 30, 2016, the gas turbine units
 5 performed well within this sensitivity range for UFOP, while both the hydraulic and thermal
 6 classes performed outside of the sensitivity range for DAFOR. As part of the ongoing risk
 7 review considering energy supply up to Lower Churchill interconnection, Hydro is
 8 considering several years of data of DAFOR and UFOP and the resulting implication for
 9 meeting reliability criteria.

10

11 The new gas turbine (Holyrood CT) has a lower expected rate of unavailability than the
 12 original gas turbines, of 5% compared to 10.62% respectively, due to the fact that the unit is
 13 new and can be expected to have better availability than the older units.⁴

14

15 Hydro's generation planning assumptions for DAFOR and UFOP for the year 2016 are:

16

	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 ⁵

17

18 **4.0 Hydraulic Unit Forced Outage Rate Performance**

19 The hydraulic unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 20 results for the 12-month period ending September 30, 2016 are presented as well as the

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

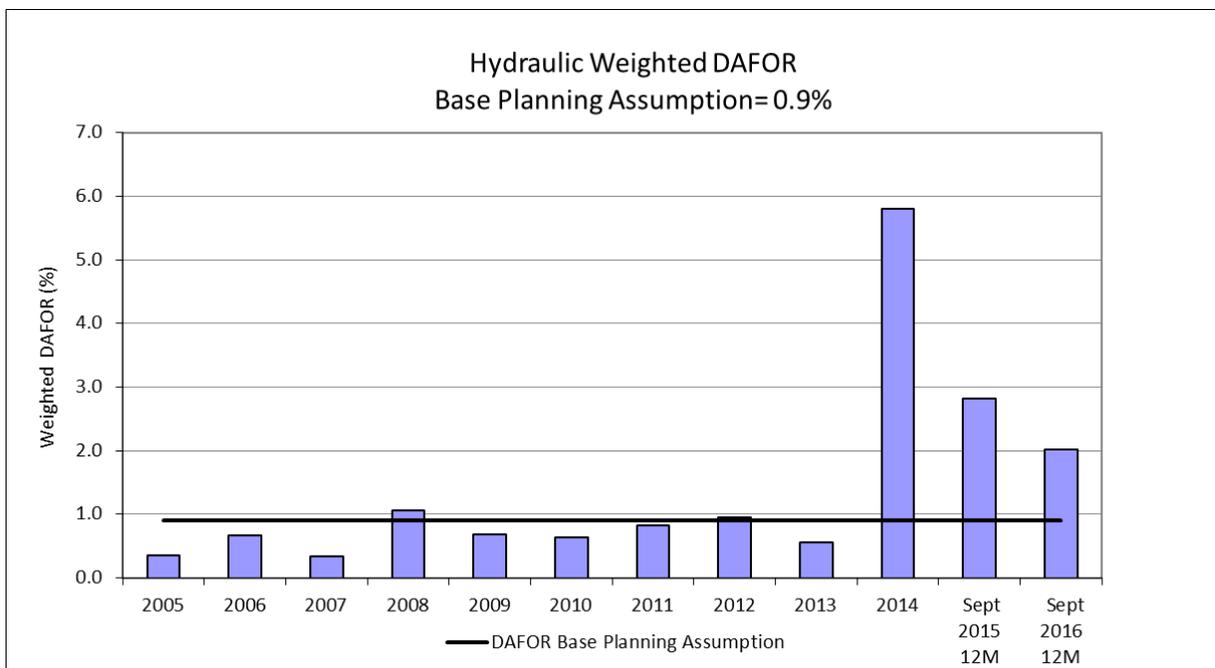
⁵ In previous reports this sensitivity value was reported as 5.0%. The generation planning sensitivity for the Holyrood CT was updated to 10% in the September 2015 Q3 report for system planning purposes.

Performance of Generating Units

1 data for the 12-month period ending September 30, 2015. These are compared to Hydro's
2 generation planning assumption for the forced outage rate.

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending September 2015 (%)	12 months ending September 2016 (%)	Hydro Generation Base Planning Assumption (%)
All Hydraulic Units - weighted	954.4	2.82	2.02	0.90
Hydraulic Units				
Bay D'Espoir 1	76.5	25.64	10.57	0.90
Bay D'Espoir 2	76.5	0.00	13.52	0.90
Bay D'Espoir 3	76.5	0.00	0.00	0.90
Bay D'Espoir 4	76.5	0.23	1.33	0.90
Bay D'Espoir 5	76.5	2.46	0.63	0.90
Bay D'Espoir 6	76.5	0.00	0.18	0.90
Bay D'Espoir 7	154.4	0.00	0.00	0.90
Hinds Lake	75	0.32	0.06	0.90
Upper Salmon	84	0.98	0.00	0.90
Granite Canal	40	1.51	1.72	0.90
Cat Arm 1	67	0.63	0.13	0.90
Cat Arm 2	67	1.42	0.00	0.90
Paradise River	8	0.19	5.16	0.90

20
21



22
23
24

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. Also, there

1 were exceedances compared to base planning assumption for Bay d'Espoir Unit 4, Granite
2 Canal, and Paradise River for the current period.

3

4 The Bay d'Espoir Unit 1 DAFOR of 10.57% and Unit 2 DAFOR of 13.53%, compared to the
5 base planning assumption of 0.9% were impacted by the units being removed from service
6 on two separate occasions as a result of a leak in Penstock 1, which provides water to both
7 Units 1 and 2. The first event occurred on May 21, 2016. A consultant was engaged to
8 conduct an investigation into the issue, which contributed the leak to a localized issue
9 caused by an improper weld. A repair procedure was provided on June 2, 2016, with repairs
10 carried out and completed on June 3, 2016. Unit 1 was returned to service on June 3, 2016,
11 at 1938 hours and Unit 2 returned to service a short time later at 2014 hours.

12

13 The second leak in Penstock 1 occurred on September 14, 2016. Considering this leak was
14 similar to the first and located in the same area, a consultant was engaged to conduct a
15 thorough investigation of the welds throughout the penstock, which included cutting a
16 sample coupon, from the penstock wall, for testing. This investigation is ongoing, but actions
17 are now underway to refurbish the welds along the upper section of the penstock between
18 the Intake and Surge Tank. All efforts are being put in place to complete this work in advance
19 of December 1, 2016 and at this time, Hydro has no indication this timeline is at risk. Hydro
20 is committed to keeping the Board informed on the status of this effort.

21

22 The Bay d'Espoir Unit 4 DAFOR of 1.33% compared to the base planning assumption of 0.9%
23 was the result of two forced outages. The unit experienced a starting failure on September
24 20 from 0545 hrs to 1316 hrs, which was related to generator power transformer. A new
25 protection system had been installed on this transformer as part of the capital program,
26 which required that the time settings be increased. A forced outage from September 22 at
27 0949 hrs to September 23 at 0843 hours, related to an issue with the Governor Permanent
28 Magnetic Generator (PMG). One of the drive pins was broken and another was bent, which

1 caused erratic speed signals to the governor. The drive pins were replaced and the PMG was
2 function tested, before being reinstalled and the unit returned to service.

3
4 The Granite Canal Unit DAFOR of 1.72% compared to the base planning assumption of 0.9%
5 was the result of the unit being unavailable from December 16, 2015 to December 17, 2015,
6 due to frazil ice accumulation on the intake trash rack.

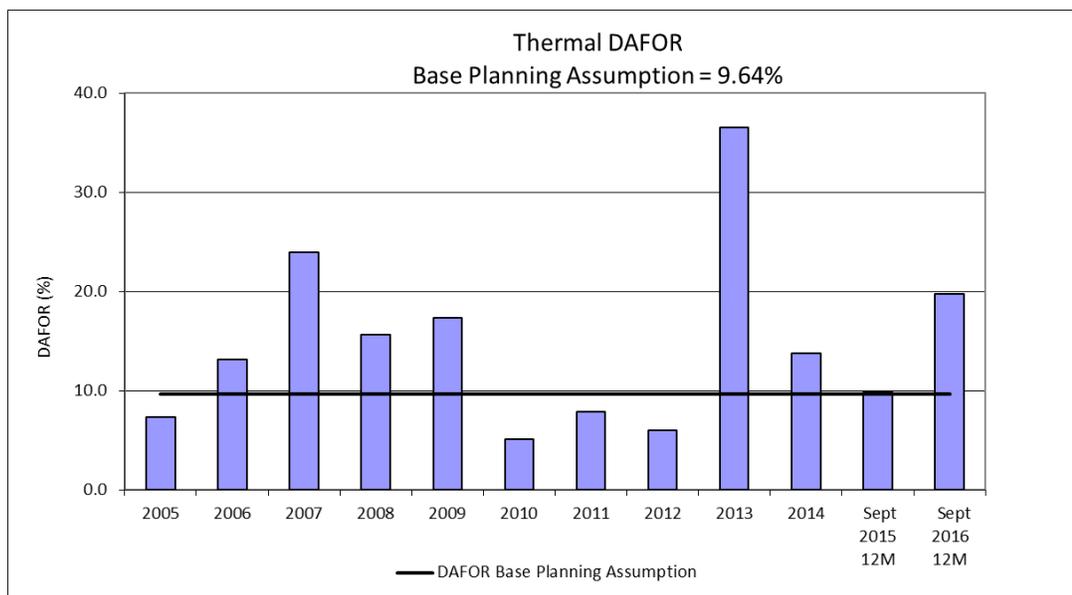
7
8 The Paradise River unit DAFOR of 5.16% compared to the base planning assumption of 0.9%
9 was the result of a forced outage. A forced outage was experienced on September 23 from
10 0031 hrs to September 30 at 1805 hrs, which related to a governor low oil level alarm. This
11 alarm was caused when a seal broke on one of the Governor servos, releasing oil from the
12 governor oil sump into the powerhouse sump system. A new seal was installed and oil added
13 to the governor system. There have been repeated trips of this plant over the past number
14 of months. Hydro has investigated these trips and has determined that a number of trips
15 that cannot be found to be associated with a plant issue, and may be connected to a
16 distribution system issue. The plant is connected into the local distribution system, which is
17 the original design and is not typical for a generating facility. This structural set up exposes
18 the plant to disturbances on the distribution system potentially causing plant trips. To better
19 understand if the distribution system is causing plant trips, a recloser in the nearby
20 substation is being replaced with a modern recloser that will better capture system
21 information. This information will assist in troubleshooting distribution issues and hopefully,
22 reduce plant trips.

23 24 **5.0 Thermal Unit Forced Outage Rate Performance**

25 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
26 results for the 12-month period ending September 30, 2016 are presented as well as the
27 data for the 12-month period ending September 30, 2015. These are compared to Hydro's
28 generation base planning assumption for the forced outage rate.

Performance of Generating Units

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending September 2015 (%)	12 months ending September 2016 (%)	Hydro Generation Base Planning Assumption (%)
All Thermal Units - weighted	490	9.86	19.72	9.64
Thermal Units				
Holyrood 1	170	12.22	25.46	9.64
Holyrood 2	170	7.15	25.64	9.64
Holyrood 3	150	10.08	2.86	9.64



1

2 For the 12-month period ending September 30, 2016, the weighted DAFOR for all thermal
3 units, of 19.72% is above the assumed Hydro generation base planning DAFOR value of
4 9.64%, and also exceeded the previous 12-month period rate of 9.86%. Unit 1 DAFOR was
5 25.46% and Unit 2 DAFOR was 25.64%, and the performance for both units was above the
6 base planning assumption of 9.64%. Unit 3 DAFOR was 2.86%, which is significantly better
7 than the base planning assumption of 9.64%.

8

9 The DAFOR performance for Holyrood Unit 1 (170 MW) was affected by several events in the
10 current 12 MTD period.

1 From November 27, 2015 to February 3, 2016 the unit was derated to 155 MW due to
2 airflow limitations. This was a continuation of the problems experienced prior to the
3 2015 annual maintenance outage. During the 2015 annual outage the boiler components
4 were internally inspected in an attempt to diagnose and resolve the airflow limitations.
5 Significant air heater fouling was discovered and corrected during that outage. It was
6 thought that the problem had been resolved, however airflow limitations continued
7 once the unit was put back on line after the annual outage. Boiler tuning would have
8 been the next step in resolving this issue. Tuning requires the unit to be operated
9 through a range of high and low loads while control parameters are manipulated. The
10 reheater tube failures in February 2013 and subsequent unit derating (see below)
11 occurred before the tuning could be completed, removing the opportunity. Tuning is
12 currently planned for November 2016, after the annual maintenance outage is
13 completed and when higher unit loads can be reached without significantly increasing
14 risk to electrical system stability in the event of a unit trip.

15
16 On February 3, 2016 the east FD fan variable frequency drive failed and caused the unit
17 to trip. Investigation by Siemens (the manufacturer of the drives) and plant engineering
18 was conducted. Under a Siemens recommendation, a control card on the drive unit was
19 replaced and the unit was returned to service on February 5, 2016. When the unit was
20 returned to service the load was limited to 140 MW to make the unit more reliable in
21 consideration of the boiler reheater tube failures experienced in Unit 2. Hydro engaged
22 Siemens to review the VFD reliability. Siemens completed a review and provided a set of
23 recommendations which have been implemented by Hydro.

24
25 On February 8, 2016 the unit experienced a tube failure in the reheater section of the
26 boiler. The unit was operated with a deration to 50 MW until an opportune time to shut
27 it down for repairs on February 16, 2016. Hydro considered the risk of additional tube
28 failures and the favorable weather forecast at the time and proceeded with the
29 replacement of the lowest wall thickness tubes during this outage. Sixteen lower

1 reheater tubes were replaced at that time. The unit was returned to service on February
2 26, 2016 with a derating to 120 MW to improve the reliability of the reheater until the
3 remaining lower reheater tubes can be replaced during the upcoming scheduled annual
4 maintenance outage.

5

6 On July 15, the unit was removed from service to repair a feedwater isolator gland
7 failure, and to perform a wash of the air heaters and to repair cracks in the FD fan
8 ductwork. The unit was returned to service after approximately 35 hours of outage time.

9

10 On August 27, 2016 the unit was taken off line in preparation for the annual
11 maintenance outage. The work scope includes replacement of the lower reheater tubes.
12 The boiler gas path work scope includes internal visual inspection and repairs,
13 replacement of degraded steam coil air heaters, and ash removal from the economizer,
14 air heaters, and stack breaching, as well as verifying proper function of the forced draft
15 fans and their variable frequency drives. The unit is scheduled back in service by
16 November 1, 2016. Boiler tuning is planned for November when electrical system
17 conditions permit.

18

19 The DAFOR performance for Holyrood Unit 2 (170 MW) was primarily affected by several
20 events.

21

22 On January 6, 2016 the unit experienced a tube failure in the reheater section of the
23 boiler. Upon discovery of the failure the unit was taken offline in a controlled
24 shutdown and allowed to cool for internal inspection. Four failed tubes in the lower
25 section of the reheater were identified and replaced. The unit was returned to
26 service on January 15, 2016. As is common practice when returning the unit to
27 service, a stepped approach to loading the unit was employed. Between January 15
28 and January 19, the unit was gradually loaded in steps between 70 MW and 140 MW.

29

30 On January 19, 2016, when operating at 140 MW, the unit experienced another
failure in the lower reheater section of the boiler. Again the unit was taken offline in

1 a controlled shutdown. Hydro considered the risk of additional tube failures and the
2 favorable weather forecast at the time and proceeded with the replacement of the
3 lowest wall thickness tubes during this outage. Over the period since the unit first
4 went out of service January 6, 2016, 27 lower and three upper reheat tubes were
5 replaced prior to the unit going back in service February 3, 2016. The unit was
6 returned to service with a derating to 120 MW to improve the reliability of the
7 reheater until the remaining lower reheater tubes were replaced during the
8 scheduled annual maintenance outage.

9
10 On May 26, 2016 the west FD fan variable frequency drive failed and caused the unit
11 to trip. Siemens (the manufacturer of the drives) was contacted immediately and a
12 technician was dispatched to travel to site. In parallel, the plant Electrical Engineer (in
13 consultation with Siemens), Electricians, and Operations conducted an internal
14 investigation and determined that there were no current faults with the fan and it
15 could be safely started. It was decided to put the unit back on line later in the day on
16 May 26, 2016 while waiting for the Siemens technician. Because the reason for the
17 trip had not been determined, the unit load was restricted to 50 MW (below UFLS).

18
19 The Siemens technician performed on-line diagnostics on May 27, 2016 and May 28,
20 2016. Overnight on May 28, 2016 the unit was taken offline for a full internal
21 inspection of the drive under direction of the Siemens technician. A control card on
22 the drive unit was replaced and the unit was returned to service the next morning on
23 May 29, 2016. Hydro engaged Siemens to review the VFD reliability. Siemens
24 completed a review and provided a set of recommendations which have been
25 implemented by Hydro.

26
27 On June 20, 2016 the annual maintenance outage began on this unit. Included in the
28 scheduled work was the replacement of the lower reheater tubes. The unit was
29 returned to service on September 15, 2016. The unit was derated to 130 MW until

1 September 20 and to 150 MW until September 29 until on-line testing of the safety
2 valves could be completed.

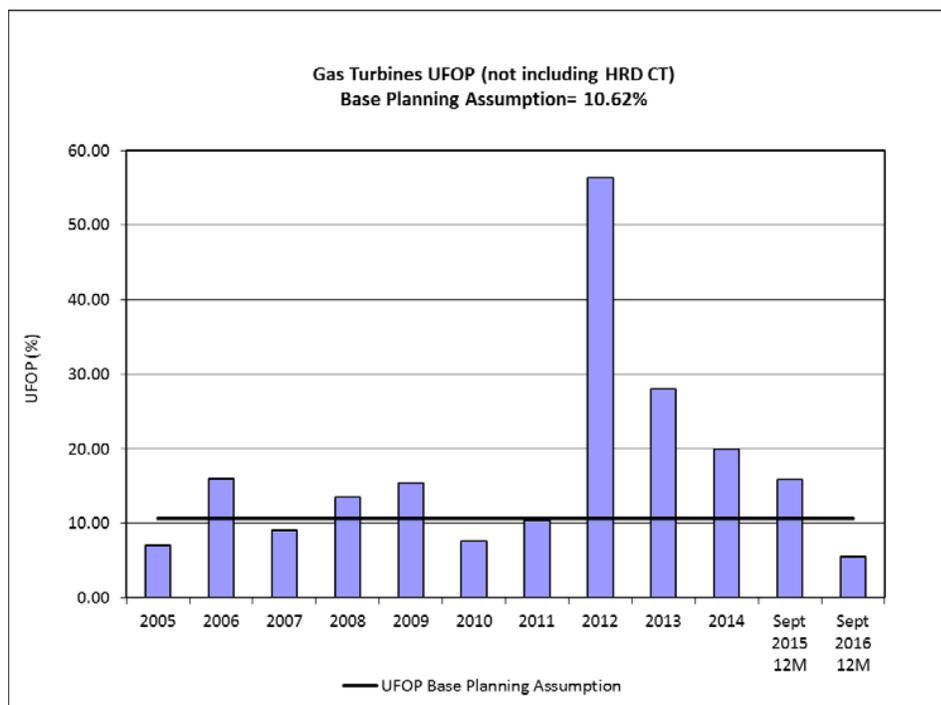
3
4 **6.0 Gas Turbine UFOP Performance**

5
6 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was
7 5.54% for the 12-month period ending September 30, 2016. This is better than the base
8 planning assumption of 10.62%. The current period UFOP improved from the previous
9 period UFOP of 15.89%. The Hardwoods UFOP for the current period is 2.16%, which is
10 better than the base planning assumption of 10.62%. The Stephenville unit’s current period
11 UFOP is 12.03% compared to that of the previous period of 17.75%. Happy Valley’s UFOP is
12 5.59% for the current period compared to 13.77% in the previous period.

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2015 (%)	12 months ending September 2016 (%)	Hydro Generation Base Planning Assumption (%)
<i>Combined Gas Turbines</i>	125	15.89	5.54	10.62
Stephenville	50	17.75	12.03	10.62
Hardwoods	50	16.14	2.16	10.62
Happy Valley	25	13.77	5.59	10.62

13
14
15 The Holyrood (HRD) CT UFOP of 1.33% for the current period is better than the base
16 planning assumption of 5.00%.

Combustion Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2015 (%)	12 months ending September 2016 (%)	Hydro Generation Base Planning Assumption (%)
Holyrood CT	123.5	5.01	1.33	5.00



1 The Stephenville unit UFOP was primarily affected by the following events in the reporting
 2 period.

3

4 The UFOP for the Stephenville gas turbine was impacted by a forced outage from
 5 August 2 to August 5, 2016 due to a lube oil leak in the alternator module. The source
 6 of the leak was determined and the repair completed. The area was cleaned of oil
 7 and the unit returned to service.

8

9 There was another forced outage in August, from August 9 to August 19, 2016. This
 10 outage was due to the presence of debris on the metallic chip detectors during a
 11 routine inspection. A review of unit operation was completed in consultation with
 12 the overhaul facility, and the unit was returned to service with continued monitoring.
 13 No further issues have been found to date. The debris was analyzed and found to be
 14 minor very fine particles and not a cause of concern. The lubricating oil was analyzed
 15 and found to be in satisfactory condition for continued operation.

A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

QUARTERLY REPORT
ON
PERFORMANCE OF GENERATING UNITS
FOR THE QUARTER ENDED DECEMBER 31, 2016

NEWFOUNDLAND AND LABRADOR HYDRO

January 16, 2017



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1 **1.0 INTRODUCTION**

2 In this report, Newfoundland and Labrador Hydro (Hydro) provides data on forced outage rates of its
3 generating facilities. This data is provided in relation to historical forced outage rates and as well as
4 in relation to assumptions used in Loss of Load Hours (LOLH) calculations for system planning
5 purposes.

6

7 The forced outage rates are provided for individual generating units at hydraulic facilities; the three
8 units at the Holyrood Thermal Generating Station (HTGS) and Hydro's gas turbines for the current 12-
9 month reporting period of January 1, 2016 to December 31, 2016. The report also provides, for
10 comparison purposes, the individual generating unit data on forced outage rates for the previous
11 period January 1, 2015 to December 31, 2015. Further, total asset class data is presented on an
12 annual basis for years the 2005-2014. This report provides data on outage rates for forced outages,
13 not planned outages.

14

15 The forced outage rates of Hydro's generating units are presented using two measures: Derated
16 Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units and Utilization Forced
17 Outage Probability (UFOP) for the gas turbines.

18

19 Derated Adjusted Forced Outage Rate (DAFOR) is a metric that measures the percentage of the time
20 that a unit or group of units is unable to generate at its maximum continuous rating (MCR) due to
21 forced outages. The DAFOR for each unit is weighted to reflect differences in generating unit sizes in
22 order to provide a company total and reflect the relative impact a unit's performance has on overall
23 generating performance. This measure is applied to hydraulic and thermal units. However, this
24 measure is not applicable to gas turbines because of their nature as a standby unit and relatively low
25 operating hours.

26

27 Utilization Forced Outage Probability (UFOP) is a metric that measures the percentage of time that a
28 unit or group of units will encounter a forced outage and not be available when required. This metric
29 is used for the gas turbines.

1 Included in the forced outage rates are outages that remove the unit from service completely, as well
2 as instances when units are de-rated. If a unit's output is reduced by more than 2%, the unit is
3 considered de-rated by Canadian Electricity Association (CEA) guidelines. Per CEA guidelines, to take
4 into account the de-rated levels of a generating unit, the operating time at the de-rated level is
5 converted into an equivalent outage time.

6

7 In addition to forced outage rates, this report provides outage details for those outages that
8 contributed materially to forced outage rates exceeding those used in Hydro's generation planning
9 analysis.

1 **2.0 PERIOD ENDING DECEMBER 31, 2016 OVERVIEW**

Class of Units	January 1, 2015 to December 31, 2015 (%)	January 1, 2016 to December 31, 2016 (%)	Base Planning Assumption (%)
Hydraulic (DAFOR)	2.66	5.51	0.90
Thermal (DAFOR)	5.04	19.42	9.64
Gas Turbine (Combined) (UFOP)	12.94	9.35	10.62
Gas Turbine (Holyrood) (UFOP)	3.06 ¹	1.65	5.00

2

3 The combined² gas turbine UFOP performance (in table above) shows improvement for the current
4 period, the 12-month period ending December 2016 compared to the previous period, the 12-month
5 period ending December 2015. There was a decline in Hydraulic and Thermal DAFOR performance
6 for the current period compared to the previous period.

7

8 In the 10 year period prior to 2014, the hydraulic units show a somewhat consistent DAFOR. The
9 DAFOR of the current 12-month period compared to the previous 10 years is higher, primarily due to
10 penstock issues experienced on Units 1 and 2 at Bay d’Espoir.

11

12 The thermal units, in the 10 year period prior to 2014, exhibit more variability in DAFOR than the
13 hydraulic units, but in many years were close to a consistent rate of approximately 10%. The forced
14 outage rate of the current period ending December 2016 is 19.42% which is above the base planning
15 assumption of 9.64%, and the sensitivity of 11.64%. This is primarily caused by an airflow derating on
16 Unit 1 and boiler tube failures on Units 1 and 2.

¹ Only includes data from March 1, 2015 to December 31, 2015

² Combined Gas Turbines include the Hardwoods, Happy Valley, and Stephenville units. The performance of the Holyrood CT was not included in the combined base planning or sensitivity numbers as these numbers were set prior to the Holyrood CT’s in service date.

1 Hydro's combined gas turbines' UFOP in the 10 year period prior to 2014 was generally consistent at
2 approximately 10% until the year 2012 when the rate exceeded 50%. Since 2012, the UFOP has been
3 improving each year. For the current 12-month period ending December 31, 2016, performance was
4 mainly affected by forced outages to the Stephenville unit. Performance data for the Holyrood CT for
5 the 12-month period ending December 2015 includes nine months of data where the 12-month
6 period ending December 2016 includes a full year of data.

7

8 Note that the data in the charts for 2005 to 2014 are annual numbers (January 1 to December 31),
9 and the data for December 2015 and December 2016 are 12-month rolling (January 1 to December
10 31 for this period).

1 **3.0 GENERATION PLANNING ASSUMPTIONS**

2 The DAFOR and UFOP indicators used in Hydro’s generation planning model is representative of a
 3 historic average of the actual performance of these units. These numbers are noted in the table
 4 below under the column “Base Planning Assumption”³.

5
 6 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation planning
 7 analysis. This number takes into account a higher level of unavailability, should it occur, to assess the
 8 impact of higher unavailability of these units on overall generation requirements. During the 12-
 9 month period ending December 31, 2016, the gas turbine units performed well within this sensitivity
 10 range for UFOP, while both the hydraulic and thermal classes performed outside of the sensitivity
 11 range for DAFOR. As part of the ongoing risk review considering energy supply up to Lower Churchill
 12 interconnection, Hydro is considering several years of data of DAFOR and UFOP and the resulting
 13 implication for meeting reliability criteria.

14
 15 The new gas turbine (Holyrood CT) has a lower expected rate of unavailability than the original gas
 16 turbines, of 5% compared to 10.62% respectively, due to the fact that the unit is new and can be
 17 expected to have better availability than the older units.⁴

18
 19 Hydro’s generation planning assumptions for DAFOR and UFOP for the year 2016 are:

	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 ⁵

³ Hydro has completed a risk assessment on thermal generation supply for the period up to interconnection with Labrador and Nova Scotia. As part of this risk assessment, Hydro reviewed the recent availability results, no final decision has been made on new base planning assumption for various generation sources.

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

⁵ In previous reports this sensitivity value was reported as 5.0%. The generation planning sensitivity for the Holyrood CT was updated to 10 % in the September 2015 Q3 report for system planning purposes.

1 **4.0 HYDRAULIC UNIT FORCED OUTAGE RATE PERFORMANCE**

2 The hydraulic unit forced outage rates are measured using the CEA metric, DAFOR. Detailed results
 3 for the 12-month period ending December 31, 2016 are presented as well as the data for the 12-
 4 month period ending December 31, 2015. These are compared to Hydro's generation planning
 5 assumption for the forced outage rate.

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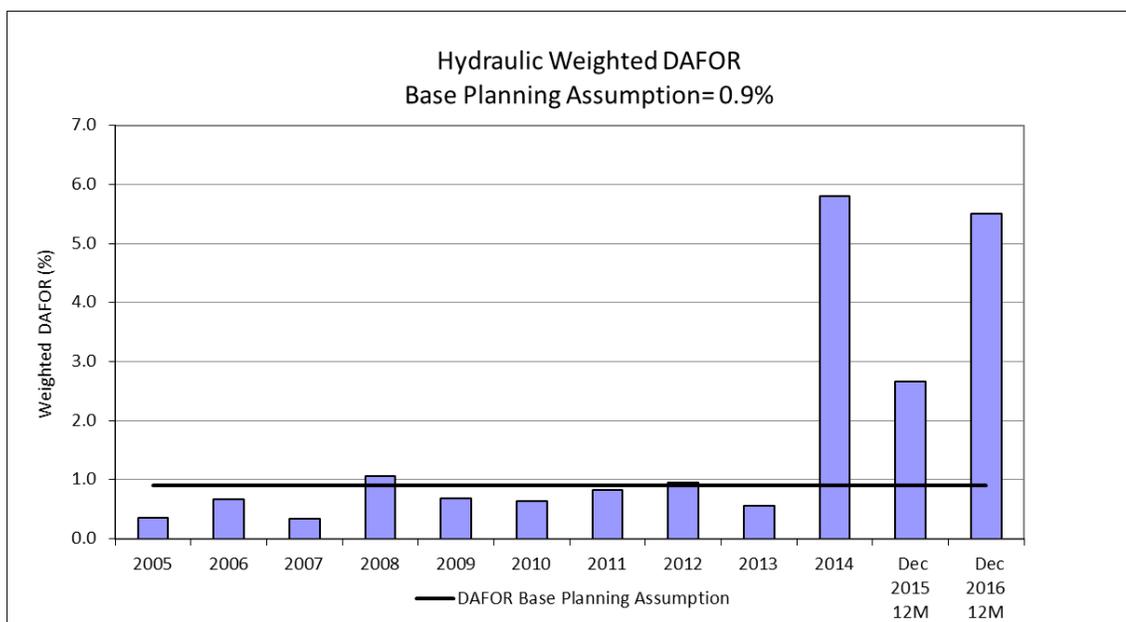
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16

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending December 2015 (%)	12 months ending December 2016 (%)	Hydro Generation Base Planning Assumption (%)
<i>All Hydraulic Units - weighted</i>	954.4	2.66	5.51	0.90
Hydraulic Units				
Bay D'Espoir 1	76.5	25.35	30.87	0.90
Bay D'Espoir 2	76.5	0.06	33.90	0.90
Bay D'Espoir 3	76.5	0.00	0.00	0.90
Bay D'Espoir 4	76.5	0.28	0.93	0.90
Bay D'Espoir 5	76.5	2.54	0.56	0.90
Bay D'Espoir 6	76.5	0.00	0.18	0.90
Bay D'Espoir 7	154.4	0.00	0.00	0.90
Hinds Lake	75	0.16	0.24	0.90
Upper Salmon	84	0.00	0.06	0.90
Granite Canal	40	1.88	1.36	0.90
Cat Arm 1	67	0.01	1.02	0.90
Cat Arm 2	67	1.41	0.00	0.90
Paradise River	8	0.24	7.08	0.90



1

2 Considering the individual units performance, the assumed Hydro generation base planning DAFOR
3 was materially exceeded for Bay d’Espoir Unit 1 and Bay d’Espoir Unit 2. Also, there were
4 exceedances compared to base planning assumption for Granite Canal, Cat Arm Unit 1 and Paradise
5 River for the current period.

6

7 The Bay d’Espoir Unit 1 DAFOR of 30.87% and Unit 2 DAFOR of 33.90%, compared to the base
8 planning assumption of 0.9% were impacted by the units being removed from service on two
9 separate occasions as a result of a leak in Penstock 1, which provides water to both Units 1 and 2.
10 The first event occurred on May 21, 2016. A consultant was engaged to conduct an investigation into
11 the issue, which contributed the leak to a localized issue caused by, what was suspected to be, a
12 defect at the weld. A repair procedure was provided on June 2, 2016, with repairs carried out and
13 completed on June 3, 2016. Unit 1 was returned to service on June 3, 2016, at 1938 hours and Unit 2
14 returned to service a short time later at 2014 hours.

15

16 The second leak in Penstock 1 occurred on September 14, 2016. Considering this leak was similar to
17 the first and located in the same area, a consultant was engaged to conduct a thorough investigation
18 of the welds throughout the penstock, which included cutting sample sections from the penstock
19 wall, for testing. This investigation is ongoing, but action was taken to refurbish the welds along the

1 upper section of the penstock between the Intake and Surge Tank. Both units were returned to
2 service on November 30, 2016.

3

4 The Granite Canal Unit DAFOR of 1.36% compared to the base planning assumption of 0.9% was the
5 result of the unit being unavailable from July 19, 2016 to July 22, 2016, due to water in the generator
6 bearing oil. An investigation revealed that the generator bearing oil cooler experienced a leak, which
7 resulted in water getting into the bearing oil. The damaged cooler was replaced with a new cooler
8 and the unit returned to service.

9

10 The Cat Arm Unit 1 DAFOR of 1.02% compared to the base planning assumption of 0.9% was the
11 result of the unit being unavailable from November 23, 2016 to November 25, 2016, due to a
12 governor oil pump trip. An investigation into the issue revealed that the internal seals in the pump
13 had failed, preventing the pump from maintaining the governor oil pressure. The oil system was
14 completely cleaned, flushed and replaced with new oil. A new oil pump was installed and the unit
15 returned to service.

16

17 The Paradise River unit DAFOR of 7.08% compared to the base planning assumption of 0.9% was the
18 result of a forced outage. A forced outage was experienced on September 23 from 0031 hrs to
19 September 30 at 1805 hrs, which related to a governor low oil level alarm. This alarm was caused
20 when a seal broke on one of the Governor servos, releasing oil from the governor oil sump into the
21 powerhouse sump system. A new seal was installed and oil added to the governor system. There
22 was another trip due to governor low pressure on October 23, 2016 to October 27, 2016. There have
23 been repeated trips of this plant over the past number of months that had no obvious cause. Hydro
24 investigated these trips and determined that it was most likely not a plant related issue, and likely
25 due to distribution system disturbances. In consultation with Newfoundland Power regarding their
26 equipment at the nearby Monkstown Substation, they agreed to replace the recloser with one having
27 the capability to capture system information and assist in troubleshooting distribution issues. Since
28 the recloser has been replaced there have been no associated cause-undetermined trips.

1 **5.0 THERMAL UNIT FORCED OUTAGE RATE PERFORMANCE**

2

3 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed results
 4 for the 12-month period ending December 31, 2016 are presented as well as the data for the 12-
 5 month period ending December 31, 2015. These are compared to Hydro’s generation base planning
 6 assumption for the forced outage rate.

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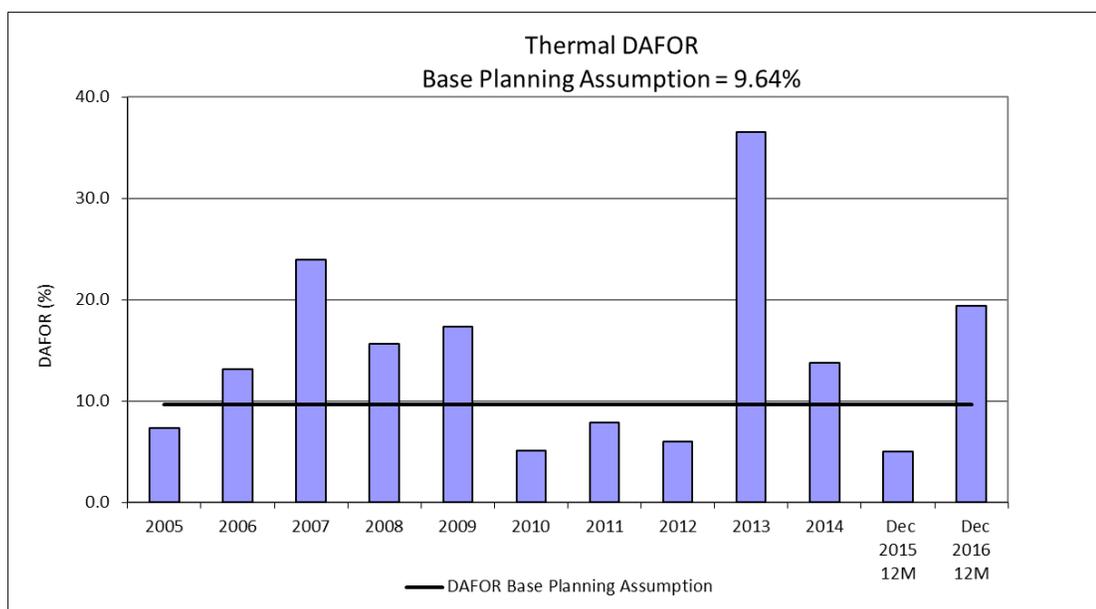
<u>Generating Unit</u>	<u>Maximum Continuous Unit Rating (MW)</u>	<u>12 months ending December 2015 (%)</u>	<u>12 months ending December 2016 (%)</u>	<u>Hydro Generation Base Planning Assumption (%)</u>
<i>All Thermal Units - weighted</i>	490	5.04	19.42	9.64
Thermal Units				
Holyrood 1	170	4.94	24.55	9.64
Holyrood 2	170	1.89	26.69	9.64
Holyrood 3	150	9.37	2.41	9.64

10

11

12

13



1 For the 12-month period ending December 31, 2016, the weighted DAFOR for all thermal units, of
2 19.42% is above the assumed Hydro generation base planning DAFOR value of 9.64%, and also
3 exceeded the previous 12-month period rate of 5.04%. Unit 1 DAFOR was 24.55% and Unit 2 DAFOR
4 was 26.69%, and the performance for both units was above the base planning assumption of 9.64%.
5 Unit 3 DAFOR was 2.41%, which is better than the base planning assumption of 9.64%. It is
6 estimated that approximately half of the 19.42% DAFOR for the plant in 2016 is due to deratings and
7 complications from the boiler tubes.

8

9 The DAFOR performance for Holyrood Unit 1 (170 MW) was affected by several events in the current
10 12 MTD period.

11

12 From November 27, 2015 to February 3, 2016, the unit was derated to 155 MW due to
13 airflow limitations. This was a continuation of the problems experienced prior to the 2015
14 annual maintenance outage. During the 2015 annual outage the boiler components were
15 internally inspected in an attempt to diagnose and resolve the airflow limitations. Significant
16 air heater fouling was discovered and corrected during that outage. It was thought that the
17 problem had been resolved, however airflow limitations continued once the unit was put
18 back on line after the annual outage. Boiler tuning would have been the next step in
19 resolving this issue. Tuning requires the unit to be operated through a range of high and low
20 loads while control parameters are manipulated. The reheater tube failures in February 2013
21 and subsequent unit derating (see below) occurred before the tuning could be completed,
22 removing the opportunity.

23

24 On February 3, 2016, the east forced draft fan variable frequency drive failed and caused the
25 unit to trip. Investigation by Siemens (the manufacturer of the drives) and plant engineering
26 was conducted. Under a Siemens recommendation, a control card on the drive unit was
27 replaced and the unit was returned to service on February 5, 2016. When the unit was
28 returned to service the load was limited to 140 MW to make the unit more reliable in
29 consideration of the boiler reheater tube failures experienced in Unit 2. Hydro engaged
30 Siemens to review the VFD reliability. Siemens completed a review and provided a set of
31 recommendations which have been implemented by Hydro.

1 On February 8, 2016, the unit experienced a tube failure in the reheater section of the boiler.
2 The unit was operated with a deration to 50 MW until an opportune time to shut it down for
3 planned tube replacements on February 16, 2016. Hydro considered the risk of additional
4 tube failures and the favorable weather forecast at the time and proceeded with the
5 replacement of the lowest wall thickness tubes only during this maintenance outage. Sixteen
6 lower reheater tubes were replaced at that time. The unit was returned to service on
7 February 26, 2016 with a derating to 120 MW to maintain the reliability of the reheater until
8 the remaining lower reheater tubes can be replaced during the upcoming scheduled annual
9 maintenance outage.

10

11 On July 15, 2016, the unit was removed from service to repair a feedwater isolator gland
12 failure, and to perform a wash of the air heaters and to repair cracks in the FD fan ductwork.
13 The unit was returned to service after approximately 35 hours of outage time.

14

15 On August 27, 2016, the unit was taken off line in preparation for the annual maintenance
16 outage. The work scope included replacement of the lower reheater tubes. The boiler gas
17 path work scope included internal visual inspection and repairs, replacement of degraded
18 steam coil air heaters, and ash removal from the economizer, air heaters, and stack
19 breaching, as well as verifying proper function of the forced draft fans and their variable
20 frequency drives.

21

22 During return to service from annual maintenance on October 29, 2016, a Mark V governor
23 control card failed, causing a forced outage. The failed card was replaced and the unit was
24 synchronized on November 2, 2016.

25

26 When the unit was first returned to service it remained derated due to air flow issues. As
27 planned, combustion tuning was completed during the week of November 14, 2016 to
28 diagnose the air flow issues on this unit. Tuning was completed by an expert from Foxboro
29 (supplier of the distributed control system) with assistance from a boiler field expert from
30 B&W. They determined that the air flow issues that Hydro is experiencing are due to fouling
31 through various stages of the boiler, and air heater leakage. After an air heater wash, 160
32 MW was achieved. Further improvements require an outage to fully correct and this is being

1 planned for TH 2017 annual maintenance outage. Work will include boiler cleaning and air
2 heater upgrades. Full load capability is expected upon completion of this work.

3

4 The DAFOR performance for Holyrood Unit 2 (170 MW) was primarily affected by several events.

5

6 On January 6, 2016, the unit experienced a tube failure in the reheater section of the boiler.
7 Upon discovery of the failure the unit was taken offline in a controlled shutdown and allowed
8 to cool for internal inspection. Four failed tubes in the lower section of the reheater were
9 identified and replaced. The unit was returned to service on January 15, 2016. As is common
10 practice when returning the unit to service, a stepped approach to loading the unit was
11 employed. Between January 15, 2016 and January 19, 2016 the unit was gradually loaded in
12 steps between 70 MW and 140 MW. On January 19, 2016, when operating at 140 MW, the
13 unit experienced another failure in the lower reheater section of the boiler. Again the unit
14 was taken offline in a controlled shutdown. Hydro considered the risk of additional tube
15 failures and the favorable weather forecast at the time and proceeded with the replacement
16 of the lowest wall thickness tubes during this outage. Over the period since the unit first
17 went out of service January 6, 2016, 27 lower and three upper reheat tubes were replaced
18 prior to the unit going back in service February 3, 2016. The unit was returned to service with
19 a derating to 120 MW to improve the reliability of the reheater until the remaining lower
20 reheater tubes were replaced during the scheduled annual maintenance outage.

21

22 On May 26, 2016, the west FD fan variable frequency drive failed and caused the unit to trip.
23 Siemens (the manufacturer of the drives) was contacted immediately and a technician was
24 dispatched to travel to site. In parallel, the plant Electrical Engineer (in consultation with
25 Siemens), Electricians, and Operations conducted an internal investigation and determined
26 that there were no current faults with the fan and it could be safely started. It was decided to
27 put the unit back on line later in the day on May 26, 2016 while waiting for the Siemens
28 technician. Because the reason for the trip had not been determined, the unit load was
29 restricted to 50 MW (below UFLS).

30

31 The Siemens technician performed on-line diagnostics on May 27, 2016 and May 28, 2016.

1 Overnight on May 28, 2016, the unit was taken offline for a full internal inspection of the
2 drive under direction of the Siemens technician. A control card on the drive unit was
3 replaced and the unit was returned to service the next morning on May 29, 2016. Hydro
4 engaged Siemens to review the VFD reliability. Siemens completed a review and provided a
5 set of recommendations which have been implemented by Hydro.

6
7 The unit was returned to service on September 15, 2016, after its annual maintenance. The
8 unit was derated to 130 MW until September 20, 2016 and to 150 MW until September 29,
9 2016 until on-line testing of the safety valves could be completed.

10
11 On November 6, 2016, the main steam inlet flange to the upper control valves was found
12 leaking and the unit was derated to 70 MW until it was removed from service for gasket
13 replacement on November 8, 2016. The unit was returned to service on November 10, 2016
14 but had to be taken off-line for another failure of the same gasket on November 16, 2016.
15 This time the gasket was changed and a contractor was hired to provide a supplementary
16 seal of the gasket. The unit was returned to service on November 21, 2016. This problematic
17 joint is expected to be reliable for the remainder of the season and will be replaced during
18 the planned outage in 2017.

19
20 On November 18, 2016, when attempting to go back on line after repair of the November 16
21 inlet flange leak, there was an issue discovered with turbine speed indication. After trouble
22 shooting, it was determined that the speed probes had to be repositioned. The unit was
23 returned to service on November 21, 2016.

1 **6.0 GAS TURBINE UFOP PERFORMANCE**

2 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was 9.35% for
3 the 12-month period ending December 31, 2016. This is better than the base planning assumption of
4 10.62%. The current period UFOP improved from the previous period UFOP of 12.94%. The
5 Hardwoods UFOP for the current period is 7.83%, which is better than the base planning assumption
6 of 10.62%. The Stephenville unit's current period UFOP is 15.40% compared to that of the previous
7 period of 15.71%. Happy Valley's UFOP is 5.03% for the current period compared to 14.45% in the
8 previous period.

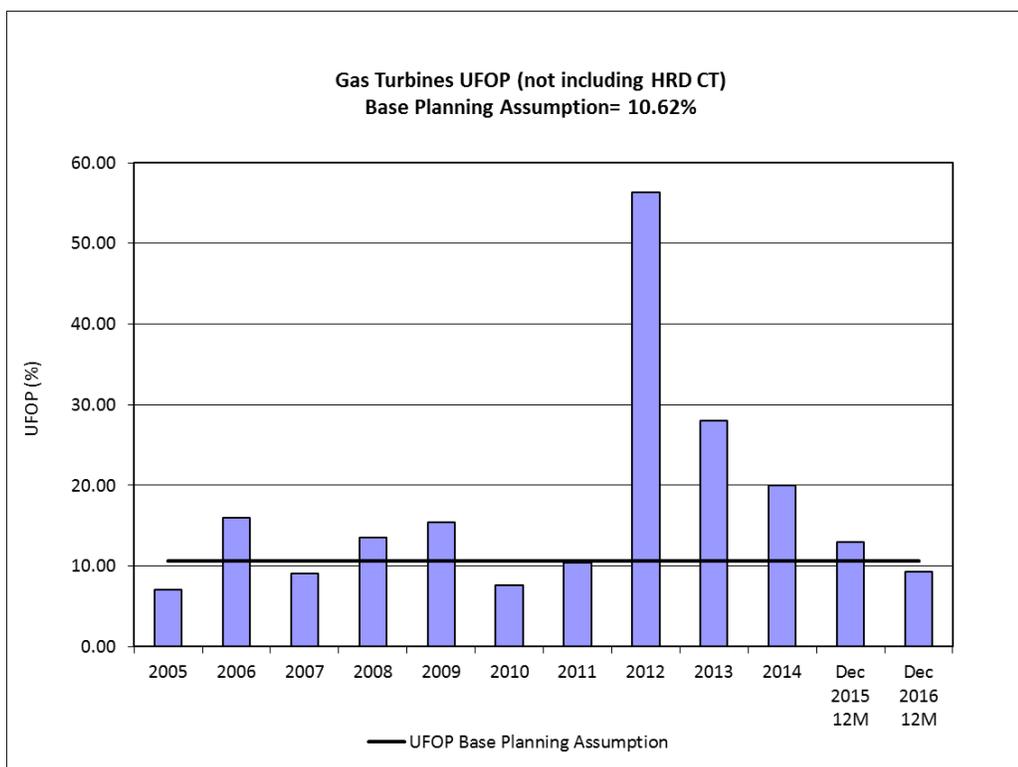
9

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending December 2015 (%)	12 months ending December 2016 (%)	Hydro Generation Base Planning Assumption (%)
<i>Combined Gas Turbines</i>	125	12.94	9.35	10.62
Stephenville	50	15.71	15.40	10.62
Hardwoods	50	6.39	7.83	10.62
Happy Valley	25	14.45	5.03	10.62

10 The Holyrood (HRD) CT UFOP of 1.65% for the current period is better than the base planning
11 assumption of 5.00%.

12

Combustion Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending December 2015 (%)	12 months ending December 2016 (%)	Hydro Generation Base Planning Assumption (%)
Holyrood CT	123.5	3.06	1.65	5.00



1

2 The Stephenville unit UFOP was primarily affected by the following events in the reporting period.

3

4 The UFOP for the Stephenville gas turbine was impacted by a forced outage from August 2,
 5 2016 to August 5, 2016 due to a lube oil leak in the alternator module. The source of the
 6 leak was determined and the repair completed. The area was cleaned of oil and the unit
 7 returned to service.

8

9 There was another forced outage in August, from August 9 to August 19, 2016. This outage
 10 was due to the presence of debris on the metallic chip detectors during a routine inspection.
 11 A review of unit operation was completed in consultation with the overhaul facility, and the
 12 unit was returned to service with continued monitoring. No further issues have been found
 13 to date. The debris was analyzed and found to be minor in nature as very fine particles and
 14 not a cause of concern. The lubricating oil was analyzed and found to be in satisfactory
 15 condition for continued operation.



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April 28, 2017

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 the original plus 12 copies of the quarterly report *Rolling 12 Month Performance of Hydro's Generating Units*.

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

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

A handwritten signature in blue ink, appearing to read 'Michael Ladha', written over a horizontal line.

Michael Ladha
Legal Counsel & Assistant Corporate Secretary
TLP/bs

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Sheryl Nisenbaum – Praxair Canada Inc.
ecc: Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Dennis Browne, Q.C. – Consumer Advocate
Thomas O' Reilly, Q.C. – Cox & Palmer
Danny Dumaresque

Quarterly Report on Performance of Generating Units
For the Quarter ended March 31, 2017

April 28, 2017

A Report to the Board of Commissioners of Public Utilities

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1 **1.0 Introduction**

2 In this report, Newfoundland and Labrador Hydro (Hydro) provides data on forced outage rates
3 of its generating facilities. This data is provided in relation to historical forced outage rates and
4 as well as in relation to assumptions used in Loss of Load Hours (LOLH) calculations for system
5 planning purposes.

6

7 The forced outage rates are provided for individual generating units at hydraulic facilities, the
8 three units at the Holyrood Thermal Generating Station, and Hydro's gas turbines, for the
9 current 12-month reporting period of April 1, 2016 to March 31, 2017. The report also provides,
10 for comparison purposes, the individual generating unit data on forced outage rates for the
11 previous period April 1, 2015 to March 31, 2016. Further, total asset class data is presented on
12 an annual basis for the years 2006-2015. This report provides data on outage rates for forced
13 outages, not planned outages.

14

15 The forced outage rates of Hydro's generating units are presented using two measures: Derated
16 Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units and Utilization
17 Forced Outage Probability (UFOP) for the gas turbines.

18

19 Derated Adjusted Forced Outage Rate (DAFOR) is a metric that measures the percentage of the
20 time that a unit or group of units is unable to generate at its maximum continuous rating due to
21 forced outages. The DAFOR for each unit is weighted to reflect differences in generating unit
22 sizes in order to provide a company total and reflect the relative impact a unit's performance
23 has on overall generating performance. This measure is applied to hydraulic and thermal units.
24 However, this measure is not applicable to gas turbines because of their nature as standby
25 units, and relatively low operating hours.

26

27 Utilization Forced Outage Probability (UFOP) is a metric that measures the percentage of time
28 that a unit or group of units will encounter a forced outage and not be available when required.
29 This metric is used for the gas turbines.

1 The forced outage rates include outages that remove a unit from service completely, as well as
 2 instances when units are derated. If a unit’s output is reduced by more than 2%, the unit is
 3 considered derated by Canadian Electricity Association (CEA) guidelines. Per CEA guidelines, to
 4 take into account the derated levels of a generating unit, the operating time at the derated
 5 level is converted into an equivalent outage time.

6
 7 In addition to forced outage rates, this report provides outage details for those outages that
 8 contributed materially to forced outage rates exceeding those used in Hydro’s generation
 9 planning analysis for both the short and long term.

10

11 **2.0 Period Ending March 31, 2017 Overview**

Table 1: DAFOR and UFOP Overview

Class of Units	April 1, 2015 to March 31, 2016 (%)	April 1, 2016 to March 31, 2017 (%)	Base Planning Assumption (%)	ESRA Assumption ¹ (%)
Hydraulic (DAFOR)	2.71	5.53	0.90	2.60
Thermal (DAFOR)	11.51	14.56	9.64	14.00
Gas Turbine (Combined) (UFOP)	11.68	12.49	10.62	20.00
Gas Turbine (Holyrood) (UFOP)	1.70	3.71	5.00	5.00

12 There was a decline in both hydraulic and thermal DAFOR performance for the current 12-
 13 month period ending March 2017, compared to the previous 12-month period ending March
 14 2016 (see Table 1). The combined² gas turbine UFOP performance shows a decline in
 15 performance for the current period compared to the previous period.

¹ Energy Supply Risk Assessment, November 30, 2016, see section 5.0 for further details.

² Combined Gas Turbines include the Hardwoods, Happy Valley, and Stephenville units. The performance of the Holyrood CT was not included in the combined base planning or sensitivity numbers as these numbers were set prior to the Holyrood CT’s in service date.

1 In the 10-year period prior to 2015, the hydraulic units showed a somewhat consistent DAFOR.
2 The DAFOR of the current 12-month period compared to the previous 10 years is higher,
3 primarily due to penstock issues experienced on Units 1 and 2 at Bay d’Espoir in 2016. The
4 effect on the 12 month DAFOR results is still in the current period, and will be in the current 12
5 month period until after November 2017.

6
7 The Holyrood thermal units, in the 10-year period prior to 2015, exhibited more variability in
8 DAFOR than the hydraulic units, but in many years were close to a consistent rate of
9 approximately 10%. The forced outage rate of the current period ending March 2017 is 14.56%,
10 which is above the base planning assumption of 9.64%, the sensitivity of 11.64%, and slightly
11 above the ESRA assumption of 14.00%. This is primarily caused by an airflow derating on Unit 1
12 that started in the fall of 2016 and will continue until this unit is taken down for maintenance in
13 2017, as well as derating after the repairs of boiler tube failures on Units 1 and 2 during 2016.

14
15 Hydro’s combined gas turbines’ UFOP in the 10-year period prior to 2015 was generally
16 consistent at approximately 10% until the year 2012 when the rate exceeded 50%. Since 2012,
17 the UFOP has been improving each year. For the current 12-month period ending March 31,
18 2017, performance was affected by forced outages to the Hardwoods and Stephenville units.

19
20 Note that the data for 2006 to 2015 in Figures 1, 2 and 3 are annual numbers (January 1 to
21 December 31), while the data for 2016 and 2017 are 12-month rolling numbers (April 1 to
22 March 31 for each year).

23

24 **3.0 Generation Planning Assumptions**

25 The DAFOR and UFOP indicators used in Hydro’s generation planning model are representative
26 of a historic average of the actual performance of these units. These numbers are noted in the
27 following table under the column “Base Planning Assumption”. This is a long term outlook.

1 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation planning
 2 analysis. This number takes into account a higher level of unavailability, should it occur, to
 3 assess the impact of higher unavailability of these units on overall generation requirements.
 4 During the 12-month period ending March 31, 2017, the gas turbine units performed well
 5 within this sensitivity range for UFOP, while both the hydraulic and thermal classes performed
 6 outside of the sensitivity range for DAFOR.

7

8 The new gas turbine (Holyrood CT) has a lower expected rate of unavailability than the original
 9 gas turbines, (5% compared to 10.62%), due to the fact that the unit is new and can be
 10 expected to have better availability than the older units.³

11

12 Hydro’s generation long term planning assumptions for DAFOR and UFOP for the year 2017 are
 13 noted in Table 2:

Table 2: 2017 DAFOR and UFOP 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 ⁴

14 As part of Hydro’s analysis of energy supply up to Muskrat Falls interconnection, Hydro
 15 completes comprehensive reviews of, and produces reports on, energy supply for the Island
 16 Interconnected System. The most recent report was filed on November 30, 2016. The report,

³ Hydro selected a 5% UFOP for the new Holyrood CT following commentary on forced outage rates contained in the *Independent Supply Decision Review – Navigant (September 14, 2011)*.

⁴ In previous reports this sensitivity value was reported as 5.0%. The generation planning sensitivity for the Holyrood CT was updated to 10% in the September 2015 Q3 report for system planning purposes.

1 “Energy Supply Risk Assessment”, (ESRA) outlines the shorter term DAFOR and UFOP and the
 2 resulting implication for meeting reliability criteria until the interconnection with the North
 3 American grid. This report is currently being updated for submission to the Board of
 4 Commissioners of Public Utilities (the Board) in May 2017.
 5
 6 Hydro’s generation ESRA short term planning assumptions for DAFOR and UFOP are noted in
 7 Table 3:

Table 3: DAFOR and UFOP ESRA Analysis Assumptions

	DAFOR (%)	UFOP (%)
	ESRA Assumption	ESRA Assumption
All Hydraulic Units	2.6	
Bay d’Espoir Hydraulic Units	3.9	
Other Hydraulic Units	0.7	
Holyrood Plant	14.0	
Holyrood Unit 1	15.0	
Holyrood Unit 2	10.0	
Holyrood Unit 3	18.0	
Hardwoods & Stephenville Gas Turbines		20.0
Holyrood Gas Turbine		5.0

1 **4.0 Hydraulic Unit Forced Outage Rate Performance**

2

3 The hydraulic unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 4 results for the 12-month period ending March 31, 2017, are presented in Table 4, as well as the
 5 data for the 12-month period ending March 31, 2016. These are compared to Hydro's
 6 generation planning and ESRA assumptions for the forced outage rate.

Table 4: Hydraulic Weighted DAFOR

Generating Unit	Maximum	12 months ending	12 months ending	Hydro Generation	ESRA Planning
	Continuous Unit Rating (MW)	March 2016 (%)	March 2017 (%)	Base Planning Assumption (%)	Assumption (%)
All Hydraulic Units - weighted	954.4	2.76	5.55	0.90	2.60
Hydraulic Units					
Bay D'Espoir 1	76.5	26.91	30.54	0.90	3.90
Bay D'Espoir 2	76.5	0.07	31.30	0.90	3.90
Bay D'Espoir 3	76.5	0.00	0.02	0.90	3.90
Bay D'Espoir 4	76.5	0.42	0.69	0.90	3.90
Bay D'Espoir 5	76.5	3.09	0.48	0.90	3.90
Bay D'Espoir 6	76.5	0.00	1.31	0.90	3.90
Bay D'Espoir 7	154.4	0.00	0.00	0.90	3.90
Cat Arm 1	67	0.01	1.02	0.90	0.70
Cat Arm 2	67	1.39	0.00	0.90	0.70
Hinds Lake	75	0.16	0.25	0.90	0.70
Upper Salmon	84	0.00	0.91	0.90	0.70
Granite Canal	40	2.07	1.16	0.90	0.70
Paradise River	8	0.24	6.94	0.90	0.70

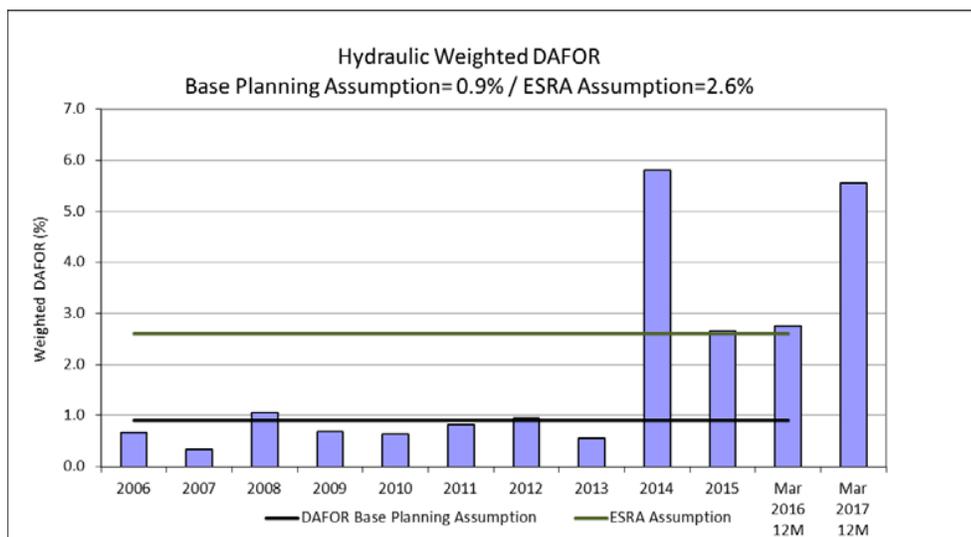


Figure 1: Hydraulic Weighted DAFOR

1 Considering the individual units' performance, the assumed Hydro generation base planning
2 DAFOR was materially exceeded for Bay d'Espoir Unit 1 and Bay d'Espoir Unit 2. Also, there
3 were exceedances compared to base planning assumption for Bay d'Espoir Unit 6, Granite
4 Canal, Cat Arm Unit 1 and Paradise River for the current period.

5

6 The Bay d'Espoir Unit 1 DAFOR of 30.54% and Unit 2 DAFOR of 31.30%, exceeded the base
7 planning assumption of 0.9% and the ESRA assumption of 3.9%, due to the units being removed
8 from service on two separate occasions as a result of a leak in Penstock 1, which provides water
9 to both Units 1 and 2. These penstock issues contributed 99.9% of the DAFOR for this period.
10 After the first event occurred on May 21, 2016, a consultant was engaged to conduct an
11 investigation into the issue, with the conclusion that the leak was a localized issue caused by,
12 what was suspected to be, a defect at the weld. A repair procedure was proposed on June 2,
13 2016, with repairs carried out and completed on June 3, 2016. Unit 1 was returned to service
14 on June 3, 2016, at 1938 hours and Unit 2 returned to service a short time later at 2014 hours.

15

16 The second leak in Penstock 1 occurred on September 14, 2016. Considering this leak was
17 similar to the first and located in the same area, a new consultant was engaged to conduct a
18 thorough investigation of the welds throughout the penstock, which included cutting sample
19 sections from the penstock wall, for testing. An investigation was completed, and action was
20 taken to refurbish a significant proportion of the welds along the upper section of the penstock
21 between the Intake and Surge Tank. Both units were then returned to service on November 30,
22 2016.

23

24 The completed weld refurbishment provided a long term solution for the penstock. The
25 investigation into this outage identified two additional long term recommendations to extend
26 the reliable life of Penstock 1. The first recommendation is to add structural backfill to the
27 upper portion of the penstock, planned for 2018. The second is to replace the internal
28 protective coating, planned to start in 2021.

1 The Bay d'Espoir Unit 6 DAFOR of 1.31% exceeded the base planning assumption of 0.9% and
2 the ESRA assumption of 3.9%, as a result of the unit being unavailable from February 22, 2017,
3 to February 25, 2017, due to a high turbine bearing alarm, which caused the unit trip protection
4 to operate and shut the unit down in a controlled fashion. An investigation was completed, and
5 it was determined that the Babbitt bearing was damaged. The bearing was repaired and the
6 unit was returned to service. The results of the investigation found no issues for long term
7 bearing reliability.

8

9 The Granite Canal Unit DAFOR of 1.16% exceeded the base planning assumption of 0.9% and
10 the ESRA assumption of 0.7%, as a result of the unit being unavailable from July 19, 2016, to
11 July 22, 2016, due to water in the generator bearing oil. An investigation revealed that the
12 generator bearing oil cooler experienced a leak, which resulted in water getting into the
13 bearing oil. The leaking cooler was replaced with a new cooler and the unit was returned to
14 service.

15

16 The Cat Arm Unit 1 DAFOR of 1.02% exceeded the base planning assumption of 0.9% and the
17 ESRA assumption of 0.7%, as a result of the unit being unavailable from November 23, 2016, to
18 November 25, 2016, due to a governor oil pump trip. An investigation into the issue revealed
19 that the internal seals in the pump had failed, preventing the pump from maintaining the
20 governor oil pressure. The oil system was completely cleaned, flushed and replaced with new
21 oil. A new oil pump was installed and the unit returned to service. This issue has been resolved,
22 and further improvements are under review from a long term reliability perspective.

23

24 The Paradise River unit DAFOR of 6.94% exceeded the base planning assumption of 0.9% and
25 the ESRA assumption of 0.7%, primarily as a result of a forced outage from September 23, 2016,
26 to September 30, 2016, which was related to a governor low oil level alarm. This alarm was
27 caused when a seal broke on one of the governor servo motors, releasing oil from the governor
28 oil sump into the powerhouse sump system. A new seal was installed and oil was added to the

1 governor system. The results of the investigation found no issues regarding long term governor
 2 reliability.

3

4 There were also repeated trips of the Paradise River unit in 2016 that had no obvious cause.
 5 Hydro investigated these trips and determined that it was most likely not a unit related issue,
 6 and was likely due to distribution system disturbances. In consultation with Newfoundland
 7 Power regarding their equipment at the nearby Monkstown Substation Newfoundland Power
 8 agreed to replace their recloser with one having the capability to capture system information,
 9 and assist in troubleshooting distribution issues. Since Newfoundland Power replaced the
 10 recloser, there have been no associated trips without identifiable cause. Newfoundland
 11 Power’s recloser is the interconnection point of the Paradise River Unit to the grid.

12

13 **5.0 Thermal Unit Forced Outage Rate Performance**

14 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 15 results for the 12-month period ending March 31, 2017, are presented in Table 5, as well as the
 16 data for the 12-month period ending March 31, 2016. These are compared to Hydro’s
 17 generation base planning assumption for the forced outage rate.

Table 5: Thermal DAFOR

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending March 2016 (%)	12 months ending March 2017 (%)	Hydro Generation Base Planning Assumption (%)	ESRA Planning Assumption (%)
<i>All Thermal Units - weighted</i>	490	13.54	13.96	9.64	14.00
Thermal Units					
Holyrood 1	170	12.28	20.49	9.64	15.00
Holyrood 2	170	18.33	14.92	9.64	10.00
Holyrood 3	150	8.98	3.06	9.64	18.00

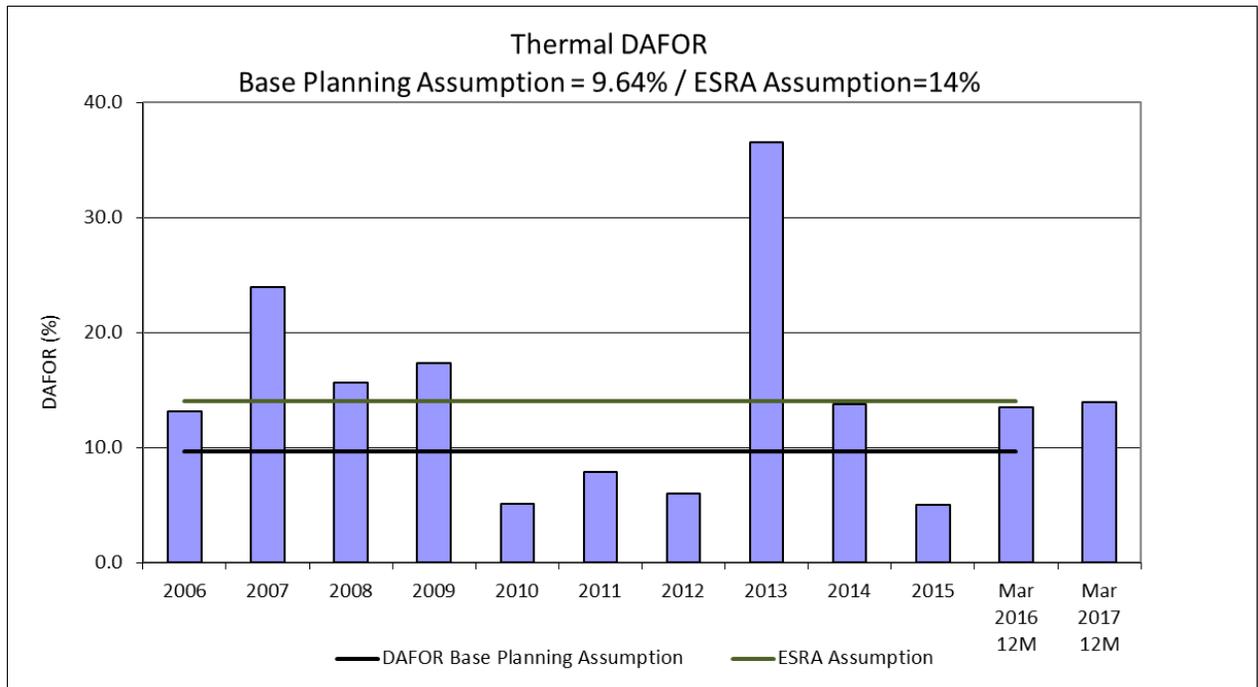


Figure 2: Thermal DAFOR

1 For the 12-month period ending March 31, 2017, the weighted DAFOR for all thermal units, of
 2 14.56% is above the assumed Hydro generation base planning DAFOR value of 9.64%, and
 3 comparable to the ESRA assumption of 14.00%. Unit 1 DAFOR was 20.49% and Unit 2 DAFOR
 4 was 14.92%. The performance for both Units 1 and 2 was above the base planning assumption
 5 of 9.64% and the ESRA assumption of 15% (Unit 1) and 10% (Unit 2). Unit 3 DAFOR was 3.06%,
 6 which is better than the base planning assumption of 9.64% and ESRA assumption of 18.0%.

7 The majority of the 13.96% DAFOR for the plant is due to deratings from airflow issues in the
 8 2016/2017 winter season and deration after the replacement of failed boiler tubes in 2016.

9

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

12

13 Following a forced outage to replace failed lower reheater tubes, the unit was returned to
 14 service on February 26, 2016, with a derating to 120 MW until its annual planned outage,
 15 which started on August 27, 2016. This derating was imposed to ensure the reliability of the

1 reheater until the remaining lower reheater tubes could be replaced during the 2016 annual
2 maintenance outage. Prior to the tube failures, the unit had been derated to 155 MW due
3 to air flow issues.

4
5 On July 15, 2016, the unit was removed from service to repair a feedwater isolator gland
6 failure, to perform a wash of the air heaters, and to repair cracks in the forced draft fan
7 ductwork. The unit was returned to service after approximately 35 hours of outage time.

8
9 On August 27, 2016, the unit was taken off line to commence the annual maintenance
10 outage. The work scope included complete replacement of the lower reheater tubes,
11 intended to eliminate the derating due to risk of boiler tube failure, and other work to
12 address the air flow issues that resulted in the derating prior to the boiler tube concerns.

13
14 During return to service from annual maintenance on October 29, 2016, a turbine control
15 system (Mark V) governor control card failed, causing a forced outage. The failed card was
16 replaced and the unit was synchronized on November 2, 2016.

17
18 When Unit 1 was first returned to service, it remained derated due to air flow issues,
19 although there was an improvement to 160 MW from 155 MW before the outage. As
20 planned, combustion tuning was completed during the week of November 14, 2016, to
21 diagnose the air flow issues on this unit. Tuning was completed by an expert from Foxboro
22 (supplier of the distributed control system) with assistance from a boiler field expert from
23 Babcock & Wilcox (B&W.) They determined that the air flow issues that Hydro was
24 experiencing are due to fouling through various stages of the boiler and air heater leakage.
25 Further improvements require an outage to fully correct this, which is planned for
26 completion during the 2017 annual planned maintenance outage. Work will include boiler
27 cleaning and air heater upgrades. Full load capability is expected upon completion of this
28 work. Hydro recently completed work to address similar air flow restrictions on Unit 2

1 during two weeks in April 2017. Prior to this work, Unit 2 had been derated to 135MW, and
2 is now rated at 165 MW.

3
4 Unit 1 load capability was reduced to 145 MW on January 20, 2017, due to increased
5 fouling, particularly in the air heater. An air heater wash was completed on a maintenance
6 outage from January 26 to 27, 2017, which restored the load capability to the pre-wash
7 condition of 160 MW. However, the capability was further reduced due to continued fouling
8 in the economizer, and at the end of February the unit was derated to 150 MW. On March
9 4, 2017, the unit capability was rated at 140 MW, and by the end of March this had further
10 reduced to 135 MW. Correction of this problem requires an extended outage and the work
11 has been planned for the 2017 annual outage. Full load capability is expected after the unit
12 is returned to service after the outage.

13
14 On March 8, 2017, it was necessary to take a short forced outage to repair two air heater
15 bearing cooling water leaks. The unit was taken off-line in a controlled manner and was
16 returned to service approximately 23 hours later after completion of the repairs.

17
18 The DAFOR performance for Holyrood Unit 2 (170 MW) was primarily affected by the following
19 events:

20
21 At the beginning of the current reporting period, Unit 2 was operating with a forced
22 derating of 120 MW. The derating had been applied to ensure reliable operation until the
23 complete lower reheater tube section could be replaced during the 2016 annual outage.

24
25 On May 26, 2016, the west forced draft fan variable frequency drive failed and caused the
26 unit to trip. Siemens (the manufacturer of the drives) was contacted immediately and a
27 technician was dispatched to travel to site. In parallel, the plant Electrical Engineer (in
28 consultation with Siemens), Electricians, and Operations conducted an internal investigation
29 and determined that there were no current faults with the fan and it could be safely

1 started. It was decided to put the unit back on line later in the day on May 26, 2016 while
2 waiting for the Siemens technician. Because the reason for the trip had not been
3 determined at that point, the unit load was restricted to 50 MW (below under-frequency
4 load shedding limits in the event of a subsequent unit trip).

5
6 The Siemens technician performed on-line diagnostics on May 27, 2016, and May 28, 2016.
7 Overnight on May 28, 2016, the unit was taken offline for a full internal inspection of the
8 drive under direction of the Siemens technician. A control card on the drive unit was
9 replaced and the unit was returned to service the next morning on May 29, 2016. Hydro
10 engaged Siemens to review the variable frequency drive reliability. Siemens completed a
11 review and provided a set of recommendations which have been implemented by Hydro.

12
13 Unit 2's annual planned maintenance outage started on June 20, 2016, and the unit was
14 returned to service on September 15, 2016. During the outage all remaining lower reheater
15 tubes were replaced, thus eliminating the 120 MW derating that had been previously
16 applied. Upon start-up, the unit was derated to 130 MW until September 20, 2016, and to
17 150 MW until September 29, 2016 until on-line testing of the boiler safety valves could be
18 completed. The unit was then capable of generating full load.

19
20 On November 6, 2016, the main steam inlet flange to the upper control valves was found
21 leaking and the unit was derated to 70 MW until it was removed from service for gasket
22 replacement on November 8. The unit was returned to service on November 10, 2016, but
23 had to be taken off-line for another failure of the same gasket on November 16, 2016. This
24 time the gasket was changed and a contractor was hired to provide a supplementary seal of
25 the gasket, further encapsulating the replaced gasket. The unit was returned to service on
26 November 21, 2016. This problematic joint is scheduled for replacement during the planned
27 outage in 2017.

1 On November 18, 2016, when attempting to go back on line after repair of the November
2 16, 2016, inlet flange leak, there was an issue discovered with turbine speed indication.
3 After trouble shooting, it was determined that the speed probes had to be repositioned.
4 The unit was returned to service at full capacity on November 21, 2016.

5
6 On January 20, 2017, the unit load capacity was reduced to 150 MW due to boiler fouling,
7 particularly in the air heater and economizer. An air heater wash was completed on
8 February 18, 2017, but due to economizer fouling, the unit remained derated to 150 MW at
9 the end of February. Continued fouling during operation further reduced the load capability
10 of the unit. On March 6, 2017, the capability was rated at 140 MW. On March 21, 2017, this
11 was further reduced to approximately 135 MW. Hydro completed an early two week
12 duration outage on Unit 2 on April 23, 2017. The outage addressed the fouling related air
13 flow issues that were considered a significant effort and could not be completed during an
14 air heater wash, or during peak winter season demand. Activities included, but were not
15 limited to, cleaning and removal of hardened ash in the economizer section of the gas path.
16 Issues affecting air flow restrictions were addressed and Unit 2 is now rated at 165 MW
17 following this work, as tested on April 26, 2017. Additional work is scheduled during the
18 2017 planned annual outage to address air flow issues.

20 **6.0 Gas Turbine UFOP Performance**

21 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was
22 12.32% for the 12-month period ending March 31, 2017 (see Table 6). This is above the base
23 planning assumption of 10.62%, but better than the ESRA assumption of 20.00%. The current
24 period UFOP declined from the previous period UFOP of 8.29%. The Hardwoods UFOP for the
25 current period is 15.97%, which is above than the base planning assumption of 10.62%, but
26 better than the ESRA assumption of 20.00%. The Stephenville unit's current period UFOP is
27 15.96% compared to that of the previous period of 15.08%. Happy Valley's UFOP is 2.61% for
28 the current period compared to 14.22% in the previous period. Hydro has determined an
29 additional or replacement measure is appropriate for analyzing gas turbine performance with

- 1 respect to reliability. This measure will be discussed more in the next Energy Supply Risk
- 2 Assessment planned for submittal to the Board in May 2017.

Table 6: Gas Turbine UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2016 (%)	12 months ending March 2017 (%)	Hydro Generation Base Planning Assumption (%)	ESRA Planning Assumption (%)
<i>Combined Gas Turbines</i>	125	8.29	12.32	10.62	20.00
Stephenville	50	15.08	15.96	10.62	20.00
Hardwoods	50	3.05	15.97	10.62	20.00
Happy Valley	25	14.22	2.61	10.62	20.00

- 3 The Holyrood (HRD) CT UFOP of 2.24% for the current period is better than the base planning
- 4 and ESRA assumptions of 5.00% (see Table 7).

Table 7: Holyrood CT UFOP

Combustion Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2016 (%)	12 months ending March 2017 (%)	Hydro Generation Base Planning Assumption (%)	ESRA Planning Assumption (%)
Holyrood CT	123.5	2.81	2.24	5.00	5.00

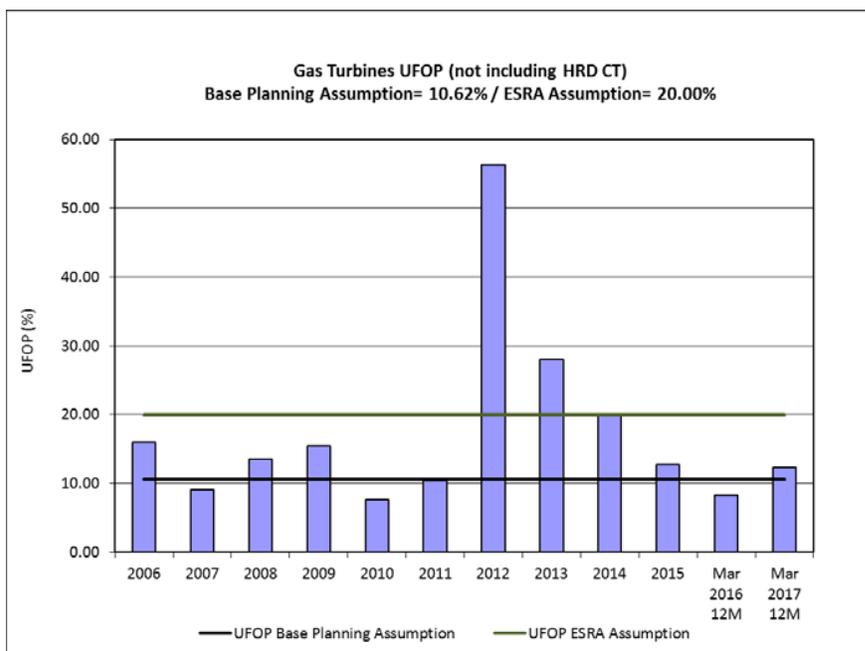


Figure 3: Gas Turbine UFOP

1 The Hardwoods unit UFOP was primarily affected by the following events in the reporting
 2 period:

3
 4 On October 3, 2016, the Hardwoods gas turbine tripped due to a loss of fuel pressure when
 5 starting End B. It was determined that the main fuel valve was periodically closing during
 6 start up, resulting in intermittent failed starts. The unit remained available for service while
 7 the fuel valve issue was diagnosed. The fuel valve was replaced on February 10, 2017. No
 8 further issues have been experienced with this system since replacing the valve.

9
 10 Also in October 2016, the Hardwoods gas turbine experienced four trips due to mounting
 11 and wiring issues with the vibration accelerometers installed on the alternator. The
 12 accelerometers were remounted and the wiring replaced. The repairs were completed and
 13 the unit was released for service on October 26, 2016. No further issues have been
 14 experienced with this system.

15
 16 On November 24, 2016, Hardwoods experienced an extended outage following a lightning
 17 storm resulting in the trip of the unit while operating in synchronous condense mode. Post

1 trip, the unit was not able to synchronize to the electrical system. Hydro's investigation
2 found blown fuses in the alternator's voltage sensing circuit and a fault on the automatic
3 voltage regulator (AVR). The fuses were replaced and the AVR fault was diagnosed and
4 corrected with technical support from the AVR manufacturer. The unit was tested and
5 released for service on December 2, 2016.

6
7 The Stephenville unit UFOP was primarily affected by the following events in the reporting
8 period:

9
10 A forced outage occurred from August 2 to August 5, 2016, due to a lube oil leak in the
11 alternator module. The source of the leak was determined and the repair completed. The
12 unit was then returned to service. No further issues have been experienced with this
13 system.

14
15 A second forced outage occurred from August 9 to August 19, 2016. This outage was due to
16 the presence of debris on the metallic chip detectors during a routine inspection. A review
17 of unit operation was completed in consultation with the overhaul facility, and the unit was
18 returned to service with continued monitoring. The debris was analyzed and found to be
19 minor very fine particles and not a cause of concern. The lubricating oil was analyzed and
20 found to be in satisfactory condition for continued operation. No further issues have been
21 experienced to date.



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July 31, 2017

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 the original plus 12 copies of the quarterly report *Rolling 12 Month Performance of Hydro's Generating Units*.

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

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

A handwritten signature in blue ink, appearing to read "Michael Ladha", written over a horizontal line.

Michael Ladha
Legal Counsel & Assistant Corporate Secretary
ML/bs

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Sheryl Nisenbaum – Praxair Canada Inc.
ecc: Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Dennis Browne, Q.C. – Consumer Advocate
Thomas O' Reilly, Q.C. – Cox & Palmer
Danny Dumaresque

Quarterly Report on Performance of Generating Units
For the Quarter ended June 30, 2017

July 31, 2017

A Report to the Board of Commissioners of Public Utilities

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1 **1.0 Introduction**

2 In this report, Newfoundland and Labrador Hydro (Hydro) provides data on forced outage rates
3 of its generating facilities. This data is provided in relation to historical forced outage rates and
4 in relation to assumptions used for system planning purposes.

5

6 The forced outage rates are provided for individual generating units at hydraulic facilities, the
7 three units at the Holyrood Thermal Generating Station, and Hydro's gas turbines, for the
8 current 12-month reporting period of July 1, 2016, to June 30, 2017. The report also provides,
9 for comparison purposes, the individual generating unit data on forced outage rates for the
10 previous period July 1, 2015, to June 30, 2016. Further, total asset class data is presented on an
11 annual basis for the years 2006 to 2015. This report provides data on outage rates for forced
12 outages, not planned outages.

13

14 The forced outage rates of Hydro's generating units are presented using two measures, Derated
15 Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units and Utilization
16 Forced Outage Probability (UFOP) for the gas turbines.

17

18 DAFOR is a metric that measures the percentage of the time that a unit or group of units is
19 unable to generate at its maximum continuous rating due to forced outages. The DAFOR for
20 each unit is weighted to reflect differences in generating unit sizes in order to provide a
21 company total and reflect the relative impact a unit's performance has on overall generating
22 performance. This measure is applied to hydraulic and thermal units. However, this measure is
23 not applicable to gas turbines because of their nature as standby units, and relatively low
24 operating hours.

25

26 UFOP is a metric that measures the percentage of time that a unit or group of units will
27 encounter a forced outage and not be available when required. This metric is used for the gas
28 turbines.

1 The forced outage rates include outages that remove a unit from service completely, as well as
 2 instances when units are derated. If a unit’s output is reduced by more than 2%, the unit is
 3 considered derated by Canadian Electricity Association (CEA) guidelines. Per CEA guidelines, to
 4 take into account the derated levels of a generating unit, the operating time at the derated
 5 level is converted into an equivalent outage time.

6

7 In addition to forced outage rates, this report provides outage details for those outages that
 8 contributed materially to forced outage rates exceeding those used in Hydro’s generation
 9 planning analysis for both the short and long term.

10

11 **2.0 Overview of Period Ending June 30, 2017**

Table 1: DAFOR and UFOP Overview

Class of Units	July 1, 2015 to June 30, 2016 (%)	July 1, 2016 to June 30, 2017 (%)	Base Planning Assumption (%)	Near Term Planning Assumption ¹ (%)
Hydraulic (DAFOR)	2.15	4.85	0.90	2.60
Thermal (DAFOR)	19.45	15.45	9.64	14.00
Gas Turbine (Combined) (UFOP)	4.19	8.68	10.62	20.00
Gas Turbine (Holyrood) (UFOP)	2.53	2.46	5.00	5.00

12 There was a decline in hydraulic DAFOR performance for the current 12-month period ending
 13 June 2017, compared to the previous 12-month period ending June 2016 (see Table 1). The

¹ Near-term Generation Adequacy Report, May 15, 2017, see section 5.0 for further details.

1 combined² gas turbine UFOP performance shows a decline in performance for the current
2 period compared to the previous period.

3

4 In the 10-year period prior to 2015, the hydraulic units showed a somewhat consistent DAFOR.
5 The DAFOR of the current 12-month period compared to the previous 10 years is higher,
6 primarily due to penstock issues experienced on Units 1 and 2 at Bay d’Espoir in 2016. The
7 effect on the 12 month DAFOR result is still in the current period, and will be in this 12 month
8 period until after November 2017.

9

10 The Holyrood thermal units, in the 10-year period prior to 2015, exhibited more variability in
11 DAFOR than the hydraulic units, but in many years were close to a consistent rate of
12 approximately 10%. The forced outage rate of the current period ending June 2017 is 15.27%,
13 which is above the base planning assumption of 9.64%, the sensitivity of 11.64%, and slightly
14 above the near-term planning assumption of 14.00%. This is primarily caused by an airflow
15 derating on Unit 1 that started in the fall of 2016 and will continue until this unit is taken down
16 for maintenance in 2017, as well as derating after the repairs of boiler tube failures on Units 1
17 and 2 during 2016.

18

19 Hydro’s combined gas turbines’ UFOP in the 10-year period prior to 2015 was generally
20 consistent at approximately 10% until the year 2012 when the rate exceeded 50%. Since 2012,
21 the UFOP has been improving each year. For the current 12-month period ending June 30,
22 2017, performance was affected by forced outages to the Hardwoods and Stephenville units.

23

24 Note that the data for 2006 to 2015 in Figures 1, 2 and 3 are annual numbers (January 1 to
25 December 31), while the data for 2016 and 2017 are 12-month rolling numbers (July 1 to June
26 30 for each year).

² 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.

1 **3.0 Generation Planning Assumptions**

2 The DAFOR and UFOP indicators used in Hydro’s generation planning model are representative
3 of a historic average of the actual performance of these units. These numbers are noted in the
4 Table 2 under the column “Base Planning Assumption”, which is a long term outlook.

5

6 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation planning
7 analysis. These numbers take into account a higher level of unavailability, should it occur, to
8 assess the impact of higher unavailability of these units on overall generation requirements.

9 During the 12-month period ending June 30, 2017, the gas turbine units performed well within
10 this sensitivity range for UFOP, while both the hydraulic and thermal classes performed outside
11 of the sensitivity range for DAFOR.

12

13 The Holyrood gas turbine (Holyrood GT) had a lower expected rate of unavailability than the
14 original gas turbines, (5% compared to 10.62%), due to the fact that the unit is new and can be
15 expected to have better availability than the older units.³

16

17 As noted in Hydro’s “Near-term Generation Adequacy” report, dated May 15, 2017, Hydro
18 continues to evaluate the appropriateness of the DAUFOP metric as an alternate or additional
19 measure of gas turbine unit reliability. Hydro will present its findings and make a
20 recommendation on this metric in its next “Near-term Generation Adequacy” report, to be filed
21 with the Board on November 15, 2017.

22

23 Hydro’s generation long term planning assumptions for DAFOR and UFOP for the year 2017 are
24 noted in Table 2.

³ 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)*.

Table 2: 2017 DAFOR and UFOP 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 ⁴

1 As part of Hydro’s analysis of energy supply prior to Muskrat Falls Interconnection, Hydro
 2 completes comprehensive reviews of, and produces reports on, energy supply for the Island
 3 Interconnected System. The “Near-term Generation Adequacy” report, filed on May 15, 2017,
 4 contained analysis based on the near-term DAFOR and UFOP and the resulting implication for
 5 meeting reliability criteria until the interconnection with the North American grid. As stated in
 6 the May 15 report submission, Hydro intends on filing its “Near-term Generation Adequacy”
 7 report semi-annually, on May 15 and November 15 of each year through interconnection.

8

9 The DAFOR and UFOP assumptions used in developing Hydro’s Near-term Generation Adequacy
 10 report are noted in Table 3.

⁴ In previous reports this sensitivity value was reported as 5.0%. The generation planning sensitivity for the Holyrood GT was updated to 10% in the September 2015 Q3 report for system planning purposes.

Table 3: DAFOR and UFOP Near-term Generation Adequacy Analysis Assumptions

	DAFOR (%)	UFOP (%)
	Near-term Generation Adequacy Assumption	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	
Holyrood Unit 1	15.0	
Holyrood Unit 2	10.0	
Holyrood Unit 3	18.0	
Hardwoods & Stephenville Gas Turbines		20.0
Holyrood Gas Turbine		5.0

1 4.0 Hydraulic Unit Forced Outage Rate Performance

2 The hydraulic unit forced outage rates are measured using the CEA Metric, DAFOR. Detailed
 3 results for the 12-month period ending June 30, 2017, are presented in Table 4, as well as the
 4 data for the 12-month period ending June 30, 2016. These are compared to Hydro’s short-term
 5 generation adequacy assumptions, as used in the “Near-term Generation Adequacy” report and
 6 Hydro’s long-term generation planning assumptions for the forced outage rate.

Table 4: Hydraulic Weighted DAFOR

Generating Unit	Maximum	12 months	12 months ending	Hydro Generation	
	Continuous Unit Rating (MW)	ending June 2016 (%)	June 2017 (%)	Base Planning Assumption (%)	Near-Term Planning Assumption (%)
All Hydraulic Units - weighted	954.4	2.15	4.85	0.90	2.60
Hydraulic Units					
Bay D’Espoir 1	76.5	17.69	23.04	0.90	3.90
Bay D’Espoir 2	76.5	7.44	26.75	0.90	3.90
Bay D’Espoir 3	76.5	0.00	0.02	0.90	3.90
Bay D’Espoir 4	76.5	0.11	0.97	0.90	3.90
Bay D’Espoir 5	76.5	3.36	0.00	0.90	3.90
Bay D’Espoir 6	76.5	0.00	1.30	0.90	3.90
Bay D’Espoir 7	154.4	0.00	0.00	0.90	3.90
Cat Arm 1	67	0.01	1.02	0.90	0.70
Cat Arm 2	67	0.21	0.00	0.90	0.70
Hinds Lake	75	0.05	1.14	0.90	0.70
Upper Salmon	84	0.00	0.86	0.90	0.70
Granite Canal	40	1.83	1.15	0.90	0.70
Paradise River	8	0.31	7.58	0.90	0.70

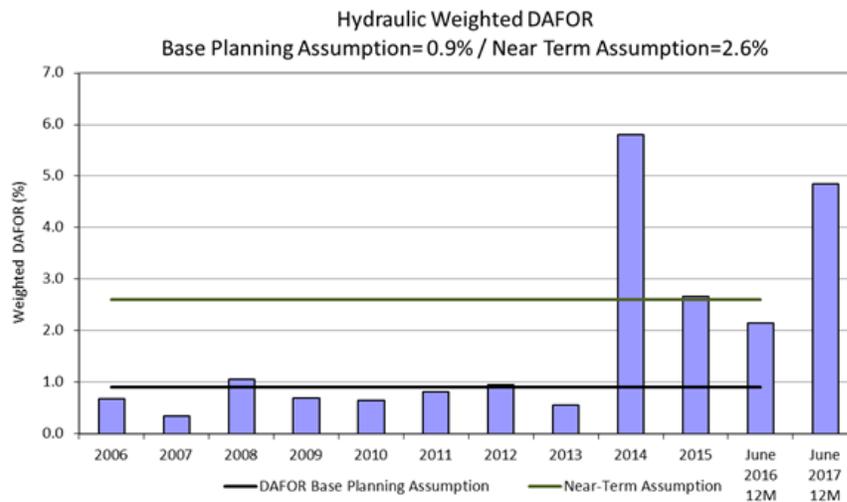


Figure 1: Hydraulic Weighted DAFOR

1 Considering the individual units’ performance, the assumed Hydro generation base planning
 2 DAFOR was materially exceeded for Bay d’Espoir Unit 1 and Bay d’Espoir Unit 2. Also, there
 3 were exceedances compared to base planning assumption for Bay d’Espoir Unit 6, Granite
 4 Canal, Cat Arm Unit 1, Hinds Lake and Paradise River for the current period.

5

6 The Bay d’Espoir Unit 1 DAFOR of 23.04% and Unit 2 DAFOR of 26.75%, exceeded the base
 7 planning assumption of 0.9% and the near-term assumption of 3.9%, due to the units being
 8 removed from service on two separate occasions as a result of a leak in Penstock 1, which
 9 provides water to both Units 1 and 2. These penstock issues contributed 99.9% of the DAFOR
 10 for this period. After the first event, that occurred on May 21, 2016, a consultant was engaged
 11 to conduct an investigation into the issue, with the conclusion that the leak was a localized
 12 issue caused by, what was suspected to be, a defect at the weld. A repair procedure was
 13 proposed on June 2, 2016, with repairs completed on June 3, 2016. Unit 1 was returned to
 14 service on June 3, 2016, at 1938 hours and Unit 2 returned to service at 2014 hours.

15

16 The second leak in Penstock 1 occurred on September 14, 2016. Considering this leak was
 17 similar to the first and located in the same area, a new consultant was engaged to conduct a
 18 thorough investigation of the welds throughout the penstock, which included cutting sample

1 sections from the penstock wall for testing. An investigation was completed and action taken to
2 refurbish a significant proportion of the welds along the upper section of Penstock 1 between
3 the Intake and Surge Tank. Both units were then returned to service on November 30, 2016.

4

5 The completed weld refurbishment provided a long term solution for the penstock. The
6 investigation into this outage identified two additional long term recommendations to extend
7 the reliable life of Penstock 1. The first recommendation is to add structural backfill to the
8 upper portion of the penstock, planned for 2018. The second is to replace the internal
9 protective coating, which is currently being planned as part of the capital refurbishment
10 program to coincide with the generation outage schedules.

11

12 The Bay d’Espoir Unit 6 DAFOR of 1.30% exceeded the base planning assumption of 0.9% and
13 the near-term assumption of 3.9%, as a result of the unit being unavailable from February 22,
14 2017, to February 25, 2017, due to a high turbine bearing alarm, which caused the unit trip
15 protection to operate and shut the unit down in a controlled fashion. An investigation was
16 completed and it was determined that the Babbitt bearing was damaged. The bearing was
17 repaired and the unit was returned to service. The results of the investigation found no issues
18 for long term bearing reliability.

19

20 The Granite Canal Unit DAFOR of 1.15% exceeded the base planning assumption of 0.9% and
21 the near-term assumption of 0.7%, as a result of the unit being unavailable from July 19, 2016,
22 to July 22, 2016, due to water in the generator bearing oil. An investigation revealed that the
23 generator bearing oil cooler experienced a leak, which resulted in water getting into the
24 bearing oil. The leaking cooler was replaced with a new cooler and the unit was returned to
25 service. All future cooler replacements have now been scheduled as part of a cooler
26 replacement program and the preventative maintenance (PM) program has been revised to
27 reflect these changes.

1 The Cat Arm Unit 1 DAFOR of 1.02% exceeded the base planning assumption of 0.9% and the
2 near-term assumption of 0.7%, as a result of the unit being unavailable from November 23,
3 2016, to November 25, 2016, due to a governor oil pump trip. An investigation into the issue
4 revealed that the internal seals in the pump had failed, preventing the pump from maintaining
5 the governor oil pressure. The oil system was completely cleaned, flushed, and replaced with
6 new oil. A new oil pump was installed and the unit returned to service. This issue has been
7 resolved and the preventative maintenance (PM) program is being revised to reflect changes to
8 scope and frequency. Research is also ongoing to identify direct replacement pumps that are
9 more robust with a longer service life.

10

11 The Hinds Lake Unit DAFOR of 1.14% exceeded the base planning assumption of 0.9% and the
12 near-term assumption of 0.7%, as a result of the unit being unavailable from April 19, 2017, to
13 April 22, 2017, due to water in the generator bearing oil. An investigation revealed that the
14 generator bearing oil cooler experienced a leak, which resulted in water getting into the
15 bearing oil. Testing revealed that three of the six coolers were leaking. The damaged coolers
16 were isolated from the system, with tests conducted to confirm adequacy of reduced cooling
17 capacity. These tests confirmed that cooling with the three remaining coolers were adequate at
18 ambient air and water temperatures. A planned maintenance outage was arranged from May
19 24-30, 2017, to repair the damaged coolers, as well as to conduct extensive testing of the three
20 in-service coolers. All work was completed, with no further issues being identified, and the unit
21 was returned to service with 100% cooling capacity. Further testing is planned during the
22 November 2017 maintenance outage. Presently, a complete set of spare coolers (6) are also
23 being purchased as part of the critical spares program.

24

25 The Paradise River unit DAFOR of 7.58% exceeded the base planning assumption of 0.9% and
26 the near-term assumption of 0.7%, primarily as a result of a forced outage from September 23-
27 30, 2016, which was related to a governor low oil level alarm. This alarm was caused when a
28 seal broke on one of the governor servo motors, releasing oil from the governor oil sump into

1 the powerhouse sump system. A new seal was installed and oil was added to the governor
2 system. The results of the investigation found no issues regarding long term governor reliability.

3

4 There were repeated trips of the Paradise River unit in 2016. Hydro investigated these trips and
5 determined that it was most likely not a unit related issue and was likely due to distribution
6 system disturbances. In consultation with Newfoundland Power regarding their equipment at
7 the nearby Monkstown Substation, Newfoundland Power agreed to replace their recloser with
8 one having the capability to capture system information and assist in troubleshooting
9 distribution issues. Since replacement of the recloser, there have been no associated trips
10 without identifiable cause. Newfoundland Power’s recloser is the interconnection point of the
11 Paradise River Unit to the grid.

12

13 **5.0 Thermal Unit Forced Outage Rate Performance**

14 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
15 results for the 12-month period ending June 30, 2017, are presented in Table 5, as well as the
16 data for the 12-month period ending June 30, 2016. These are compared to Hydro’s short term
17 generation adequacy assumptions, as used in the Near-term Generation Adequacy report, and
18 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 June 2016 (%)	12 months ending June 2017 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
<i>All Thermal Units - weighted</i>	490	19.45	15.27	9.64	14.00
Thermal Units					
Holyrood 1	170	20.66	21.33	9.64	15.00
Holyrood 2	170	26.46	19.57	9.64	10.00
Holyrood 3	150	8.91	3.29	9.64	18.00

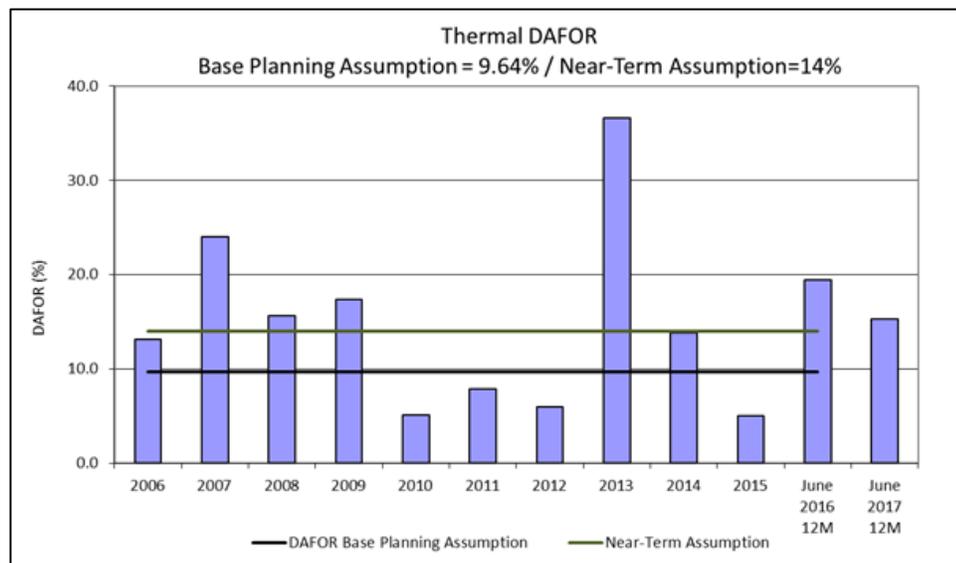


Figure 2: Thermal DAFOR

1 For the 12-month period ending June 30, 2017, the weighted DAFOR for all thermal units, of
2 15.27% is above the assumed Hydro generation base planning DAFOR value of 9.64%, and
3 comparable to the near-term assumption of 14.00%. Unit 1 DAFOR was 21.33% and Unit 2
4 DAFOR was 26.46%. The performance for both Units 1 and 2 was above the base planning
5 assumption of 9.64% and the near-term assumption of 15% (Unit 1) and 10% (Unit 2). Unit 3
6 DAFOR was 3.29%, which is better than the base planning assumption of 9.64% and near-term
7 assumption of 18.0%. The majority of the 15.27% DAFOR for the plant is due to deratings from
8 airflow issues in the 2016/2017 winter season and deration after the replacement of failed
9 boiler tubes in 2016.

10

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

- 13 • Following a forced outage to replace failed lower reheater tubes, the unit was returned
14 to service on February 26, 2016, with a derating to 120 MW until its annual planned
15 outage, which started on August 27, 2016. This derating was imposed to ensure the
16 reliability of the reheater until the remaining lower reheater tubes could be replaced

- 1 during the 2016 annual maintenance outage. Prior to the tube failures, the unit had
2 been derated to 155 MW due to air flow issues.
- 3 • On July 15, 2016, the unit was removed from service to repair a feedwater isolator gland
4 failure, to perform a wash of the air heaters, and to repair cracks in the forced draft fan
5 ductwork. The unit was returned to service after approximately 35 hours of outage time.
 - 6 • On August 27, 2016, the unit was taken off line to commence the annual maintenance
7 outage. The work scope included complete replacement of the lower reheater tubes,
8 intended to eliminate the derating due to risk of boiler tube failure, and other work to
9 address the air flow issues that resulted in the derating prior to the boiler tube
10 concerns.
 - 11 • During return to service from annual maintenance on October 29, 2016, a turbine
12 control system (Mark V) governor control card failed, causing a forced outage. The failed
13 card was replaced and the unit was synchronized on November 2, 2016.
 - 14 • When Unit 1 was first returned to service, it remained derated due to air flow issues,
15 although there was an improvement from 155 MW, before the outage, to 160 MW. As
16 planned, combustion tuning was completed during the week of November 14, 2016, to
17 diagnose the air flow issues on this unit. Tuning was completed by an expert from
18 Foxboro (supplier of the distributed control system) with assistance from a boiler field
19 expert from Babcock & Wilcox (B&W.) They determined that the air flow issues that
20 Hydro was experiencing were due to fouling through various stages of the boiler and air
21 heater leakage. Further improvements require an outage to fully correct this, which is
22 planned for completion during the 2017 annual planned maintenance outage. Work will
23 include boiler cleaning and air heater upgrades. Full load capability is expected upon
24 completion of this work. Hydro recently completed work to address similar air flow
25 restrictions on Unit 2 during two weeks in April 2017. Prior to this work, Unit 2 had been
26 derated to 135MW and is now rated at 165 MW.
 - 27 • Unit 1 load capability was reduced to 145 MW on January 20, 2017, due to increased
28 fouling, particularly in the air heater. An air heater wash was completed on a
29 maintenance outage from January 26-27, 2017, which restored the load capability to the

1 pre-wash condition of 160 MW. However, the capability was further reduced due to
2 continued fouling in the economizer, and at the end of February the unit was derated to
3 150 MW. On March 4, 2017, the unit capability was rated at 140 MW and by the end of
4 March this had further reduced to 135 MW. As previously stated, correction of this
5 problem requires an extended outage and the work has been planned for the 2017
6 annual outage. Full load capability is expected after the unit is returned to service after
7 the outage.

- 8 • On March 8, 2017, it was necessary to take a short forced outage to repair two air
9 heater bearing cooling water leaks. The unit was taken off-line in a controlled manner
10 and was returned to service approximately 23 hours later after completion of the
11 repairs.

12 For the remainder of the operating season, the available load continued to reduce as the boiler
13 fouling condition continued to deteriorate. On June 6 an air heater wash was completed, which
14 restored the load to 120 MW, up from 94 MW prior to the wash. The unit was shut down for
15 the annual maintenance outage at the end of June with a capability of 120 MW.

16

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

- 19 • Unit 2's annual planned maintenance outage for 2016 started on June 20, 2016, and the
20 unit was returned to service on September 15, 2016. During the outage all remaining
21 lower reheater tubes were replaced, thus eliminating the 120 MW derating that had
22 been previously applied. Upon start-up, the unit was derated to 130 MW until
23 September 20, 2016, and to 150 MW until September 29, 2016, until on-line testing of
24 the boiler safety valves could be completed. The unit was then capable of generating at
25 full load.
- 26 • On November 6, 2016, the main steam inlet flange to the upper control valves was
27 found leaking and the unit was derated to 70 MW until it was removed from service for
28 gasket replacement on November 8, 2016. The unit was returned to service on
29 November 10, 2016, but had to be taken off-line for another failure of the same gasket

1 on November 16, 2016. This time the gasket was changed and a contractor was hired to
2 provide a supplementary seal of the gasket, further encapsulating the replaced gasket.
3 The unit was returned to service on November 21, 2016. This problematic joint is
4 scheduled for replacement during the planned maintenance outage in 2017.

- 5 • On November 18, 2016, when attempting to place back online after repair of the
6 November 16, 2016 inlet flange leak, there was an issue discovered with turbine speed
7 indication. After trouble shooting, it was determined that the speed probes had to be
8 repositioned. The unit was returned to service at full capacity on November 21, 2016.
- 9 • On January 20, 2017, the unit load capacity was reduced to 150 MW due to boiler
10 fouling, particularly in the air heater and economizer. An air heater wash was completed
11 on February 18, 2017, but due to economizer fouling the unit remained derated to 150
12 MW. Continued fouling during operation further reduced the load capability of the unit.
13 On March 6, 2017, the capability was rated at 140 MW. On March 21, 2017, this was
14 further reduced to approximately 135 MW. Hydro completed an early two week
15 duration outage on Unit 2 starting on April 23, 2017. The outage addressed the fouling
16 related air flow issues that were considered a significant effort and could not be
17 completed during an air heater wash, or during peak winter season demand. Activities
18 included, but were not limited to, cleaning and removal of hardened ash in the
19 economizer section of the gas path. Issues affecting air flow restrictions were addressed
20 and Unit 2 was then rated at 165 MW following this work, as tested on April 26, 2017.
21 Additional work is scheduled during the 2017 planned annual outage to address air flow
22 issues.
- 23 • On April 22 there was a brief outage required to repair a section of flexible ductwork on
24 the ignitor air system that had come apart during start-up after the boiler cleaning
25 outage.
- 26 • On May 1, 2017, the unit experienced a forced outage when a section of flexible
27 ductwork adjacent to the location that had failed on April 22 also failed and allowed hot
28 gas to escape from the boiler. This hot gas caused a cable tray fire adjacent to the north
29 east corner of the boiler on the second floor. The fire was extinguished very quickly by

1 the Holyrood Emergency Response Team, but cable replacement took until May 28,
2 2017, to complete. This work included asbestos abatement, as loose asbestos fibres
3 were found in the cable tray. While the unit was off line, work protection permits were
4 issued to allow other work that was planned for the annual outage to proceed in
5 parallel. Unit 3 was re-called from its planned outage to provide generation to satisfy
6 system requirements.

- 7 • In parallel to the cable tray restoration work, the cause of the failure of the ignitor flex
8 hoses was investigated. This was the first such incident on record at the plant. All of the
9 Unit 2 flexible hoses on the ignitor system were upgraded as required. This included
10 extending the rigid pipe in the corner that failed such that the gap could be spanned by
11 one flexible hose length. A splice was in the area of the failure, which was concluded to
12 be part of the reason for the failure. Additional clamps were installed on Unit 1, which
13 was in operation at the time, to verify that the hoses were secure. During the annual
14 2017 maintenance outages, all hoses on Unit 2 and Unit 1 will be positively secured to
15 ensure this failure cannot re-occur.
- 16 • Unit 2 tripped on June 03, 2017. The unit was returned to service a few hours later on
17 the same day, but was limited to 50 MW until the reason for the trip could be confirmed
18 and mitigated. A General Electric (GE) representative was brought to the site to
19 diagnose the problem. The representative determined that during the trip, the control
20 valves closed while the governor was calling for them to remain open. This pointed to
21 three possibilities, including: loose wire, control card failure, or servo failure. A card
22 failure was ruled out since all other functions of the card were working normally. The
23 wires were tested with the unit at 25 MW and no issues were found. An outage was
24 then completed from June 8-11, 2017, to replace the servo and change out the hydraulic
25 fluid and filters. During this same outage, the turbine speed probe cables were replaced
26 and probe clearance gaps were adjusted. This corrected a reliability issue that previously
27 occurred on November 18, 2016, and was planned to be completed during the annual
28 outage.

- 1 • On June 16, 2017, there was an issue with one of the two boiler feed pumps. The west
2 pump had recently completed a rebuild and it appeared that there was some debris that
3 went through one of the bearings and caused a spike in temperature and vibration. The
4 temperature and vibration returned to normal, but the pump was taken out of service
5 to change the oil and clean out the lube oil tank. The unit was derated to 70 MW while
6 the pump was out of service. It was successfully tested and returned to service on June
7 17, 2017.
- 8 • On June 29, 2017, Unit 2 experienced vibration and temperature excursions on the
9 motor inboard bearing, with failure of the bearing being suspected. The pump was again
10 taken out of service causing another derate to 70MW. Failure of the bearing was
11 confirmed by opening the bearing. The capital spare boiler feed pump motor was
12 brought to site and installed in place of the motor with the failed bearing, as this was
13 the most expedient option to get the pump back in service. This work was completed on
14 July 2, 2017, and the unit returned to 165 MW. Work instructions for boiler feed pump
15 rebuilt have been updated to ensure that a lube oil flush is completed before returning
16 the pumps back to service.

18 **6.0 Gas Turbine UFOP Performance**

19 The combined UFOP for the Hardwoods, Happy Valley, and Stephenville gas turbines was 8.68%
20 for the 12-month period ending June 30, 2017 (see Table 6). This is better than both the base
21 planning assumption of 10.62% and the near-term assumption of 20.00%. The current period
22 UFOP declined from the previous period UFOP of 4.19%. The Hardwoods UFOP for the current
23 period is 10.14%, which is better than the base planning assumption of 10.62%. The
24 Stephenville UFOP for the current period is 13.10%, which is higher than the base planning
25 assumption of 10.62%. Happy Valley's UFOP is 0.00% for the current period compared to
26 13.31% in the previous period.

27
28 As noted in Hydro's Near-term Generation Adequacy report, dated May 15, 2017, Hydro
29 continues to evaluate the appropriateness of the Derating Adjusted Utilization Forced Outage

- 1 Probability (DAUFOP)⁵ metric as an alternate or additional measure of gas turbine unit
- 2 reliability. Hydro will present its findings and make a recommendation on this metric in its next
- 3 Near-term Generation Adequacy report, to be filed with the Board on November 15, 2017.

Table 6: Gas Turbine UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending June 2016 (%)	12 months ending June 2017 (%)	Hydro Generation	
				Base Planning Assumption (%)	Near-Term Planning Assumption (%)
<i>Combined Gas Turbines</i>	125	4.19	8.68	10.62	20.00
Stephenville	50	2.88	13.10	10.62	20.00
Hardwoods	50	1.42	10.14	10.62	20.00
Happy Valley	25	13.31	0.00	10.62	20.00

- 4 The Holyrood (HRD) GT UFOP of 2.46% for the current period is better than the base planning
- 5 and near-term assumptions of 5.00% (see Table 7).

Table 7: Holyrood GT UFOP

Combustion Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending June 2016 (%)	12 months ending June 2017 (%)	Hydro Generation	
				Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Holyrood CT	123.5	2.53	2.46	5.00	5.00

⁵ DAUFOP is the probability that a generating unit will not be available due to forced outages or forced deratings when there is demand on the unit to generate.

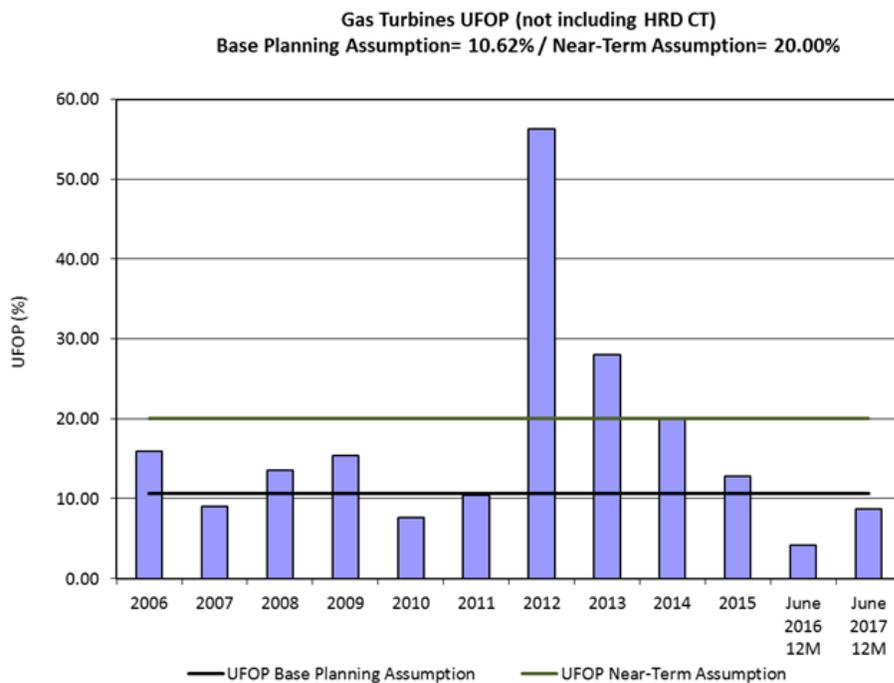


Figure 3: Gas Turbine UFOP

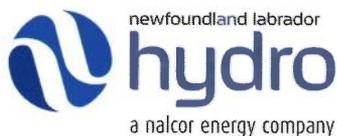
- 1 The Hardwoods unit UFOP was primarily affected by the following events in the reporting
- 2 period:
 - 3 • On October 3, 2016, the Hardwoods gas turbine tripped due to a loss of fuel pressure
 - 4 when starting End B. It was determined that the main fuel valve was periodically closing
 - 5 during start up, resulting in intermittent failed starts. The unit remained available for
 - 6 service while the fuel valve issue was diagnosed. The fuel valve was replaced on
 - 7 February 10, 2017. No further issues have been experienced with this system since
 - 8 replacing the valve.
 - 9 • In October 2016, the Hardwoods gas turbine experienced four trips due to mounting
 - 10 and wiring issues with the vibration accelerometers installed on the alternator. The
 - 11 accelerometers were remounted and the wiring replaced. The repairs were completed
 - 12 and the unit was released for service on October 26, 2016. No further issues have been
 - 13 experienced with this system.

- 1 • On November 24, 2016, Hardwoods experienced an extended outage following a
2 lightning storm resulting in the trip of the unit while operating in synchronous condense
3 mode. Post trip, the unit was not able to synchronize to the electrical system. Hydro's
4 investigation found blown fuses in the alternator's voltage sensing circuit and a fault on
5 the automatic voltage regulator (AVR). The fuses were replaced and the AVR fault was
6 diagnosed and corrected with technical support from the AVR manufacturer. The unit
7 was tested and released for service on December 2, 2016.

8

9 The Stephenville unit UFOP was primarily affected by the following events in the reporting
10 period:

- 11 • A forced outage occurred from August 2-5, 2016, due to a lube oil leak in the alternator
12 module. The source of the leak was determined and the repair completed. The unit was
13 then returned to service. No further issues have been experienced with this system.
- 14 • A second forced outage occurred from August 9-19, 2016. This outage was due to the
15 presence of debris on the metallic chip detectors during a routine inspection. A review
16 of unit operation was completed in consultation with the overhaul facility, and the unit
17 was returned to service with continued monitoring. The debris was analyzed and found
18 to be minor very fine particles and not a cause of concern. The lubricating oil was
19 analyzed and found to be in satisfactory condition for continued operation. No further
20 issues have been experienced to date.
- 21 • A forced outage occurred from June 21st to June 22nd. This outage was due to the
22 activation of the fire suppression system resulting in a trip of the Unit. The investigation
23 of the trip found that the fire suppression system activated due to a fire in End B. The
24 fire was caused by a loose connection on a fuel hose to one of the gas turbine fuel
25 burners. Engine was inspected and a small number of fuel hoses were found to be
26 damaged in the fire. The damaged hoses were replaced and the Unit was released for
27 service.



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October 30, 2017

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 the original plus 12 copies of the quarterly report *Rolling 12
Month Performance of Hydro's Generating Units*.

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

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

A handwritten signature in blue ink, appearing to read 'Michael Ladha', written over a horizontal line.

Michael Ladha
Legal Counsel & Assistant Corporate Secretary
ML/bs

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Danny Dumaresque
ecc: Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Dennis Browne, Q.C. – Consumer Advocate
Sheryl Nisenbaum – Praxair Canada Inc.
Dennis Fleming – Cox & Palmer

Quarterly Report on Performance of Generating Units
For the Quarter ended September 30, 2017

October 30, 2017

A Report to the Board of Commissioners of Public Utilities

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1 **1.0 Introduction**

2 In this report, Newfoundland and Labrador Hydro (Hydro) provides data on forced outage rates
3 of its generating facilities. This data is provided in relation to historical forced outage rates and
4 as well as in relation to assumptions used for system planning purposes.

5

6 The forced outage rates are provided for individual generating units at hydraulic facilities, the
7 three units at the Holyrood Thermal Generating Station, and Hydro's gas turbines, for the
8 current 12-month reporting period of October 1, 2016 to September 30, 2017. The report also
9 provides, for comparison purposes, the individual generating unit data on forced outage rates
10 for the previous period October 1, 2015 to September 30, 2016. Further, total asset class data is
11 presented on an annual basis for the years 2006-2015. This report provides data on outage
12 rates for forced outages, not planned outages.

13

14 The forced outage rates of Hydro's generating units are presented using two measures: Derated
15 Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units and Utilization
16 Forced Outage Probability (UFOP) for the gas turbines.

17

18 Derated Adjusted Forced Outage Rate (DAFOR) is a metric that measures the percentage of the
19 time that a unit or group of units is unable to generate at its maximum continuous rating due to
20 forced outages. The DAFOR for each unit is weighted to reflect differences in generating unit
21 sizes in order to provide a company total and reflect the relative impact a unit's performance
22 has on overall generating performance. This measure is applied to hydraulic and thermal units.
23 However, this measure is not applicable to gas turbines because of their nature as standby
24 units, and relatively low operating hours.

25

26 Utilization Forced Outage Probability (UFOP) is a metric that measures the percentage of time
27 that a unit or group of units will encounter a forced outage and not be available when required.
28 This metric is used for the gas turbines.

1 The forced outage rates include outages that remove a unit from service completely, as well as
 2 instances when units are derated. If a unit’s output is reduced by more than 2%, the unit is
 3 considered derated by Canadian Electricity Association (CEA) guidelines. Per CEA guidelines, to
 4 take into account the derated levels of a generating unit, the operating time at the derated
 5 level is converted into an equivalent outage time.

6

7 In addition to forced outage rates, this report provides outage details for those outages that
 8 contributed materially to forced outage rates exceeding those used in Hydro’s generation
 9 planning analysis for both the short and long term.

10

11 **2.0 Period Ending September 30, 2017 Overview**

Table 1: DAFOR and UFOP Overview

Class of Units	October 1, 2015 to September 30, 2016 (%)	October 1, 2016 to September 30, 2017 (%)	Base Planning Assumption (%)	Near-term Planning Assumption ¹ (%)
Hydraulic (DAFOR)	2.02	4.17	0.90	2.60
Thermal (DAFOR)	19.72	13.77	9.64	14.00
Gas Turbine (Combined) (UFOP)	5.54	7.06	10.62	20.00
Gas Turbine (Holyrood) (UFOP)	1.33	2.10	5.00	5.00

12 There was a decline in hydraulic DAFOR performance for the current 12-month period ending
 13 September 30, 2017, compared to the previous 12-month period ending September 30, 2016

¹ Near-term Generation Adequacy Report, May 15, 2017, see section 5.0 for further details.

1 (see Table 1). The combined² gas turbine UFOP performance shows a decline in performance
2 for the current period compared to the previous period.

3

4 In the 10-year period prior to 2015, the hydraulic units showed a somewhat consistent DAFOR.
5 The DAFOR of the current 12-month period compared to the previous 10 years is higher,
6 primarily due to penstock issues experienced on Units 1 and 2 at Bay d’Espoir in 2016. The
7 effect on the 12 month DAFOR results is still in the current period, and will be in the current 12
8 month period until after November 2017.

9

10 The Holyrood thermal units, in the 10-year period prior to 2015, exhibited more variability in
11 DAFOR than the hydraulic units, but in many years were close to a consistent rate of
12 approximately 10%. The forced outage rate of the current period ending September 2017 is
13 13.77%, which was above the base planning assumption of 9.64%, the sensitivity of 11.64%, but
14 below the near-term planning assumption of 14.00%. This is primarily caused by an airflow
15 derating on Unit 1 and Unit 2 that started in the fall of 2016 and continued until the units were
16 taken down for maintenance in 2017.

17

18 Hydro’s combined gas turbines’ UFOP in the 10-year period prior to 2015 was generally
19 consistent at approximately 10% until the year 2012 when the rate exceeded 50%. Since 2012,
20 the UFOP has been improving each year. For the current 12-month period ending September
21 30, 2017, performance was affected by forced outages to the Hardwoods and Stephenville
22 units.

23

24 Note that the data for 2006 to 2015 in Figures 1, 2 and 3 are annual numbers (January 1 to
25 December 31), while the data for 2016 and 2017 are 12-month rolling numbers (for this report
26 they are October 1 to September 30 for each year).

² 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.

1 **3.0 Generation Planning Assumptions**

2 The DAFOR and UFOP indicators used in Hydro’s generation planning model are representative
3 of a historic average of the actual performance of these units. These numbers are noted in
4 Table 2 under the column “Base Planning Assumption”. This is a long term outlook.

5
6 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation planning
7 analysis. This number takes into account a higher level of unavailability, should it occur, to
8 assess the impact of higher unavailability of these units on overall generation requirements.
9 During the 12-month period ending September 30, 2017, the gas turbine units performed well
10 within this sensitivity range for UFOP, while both the hydraulic and thermal classes performed
11 outside of the sensitivity range for DAFOR.

12
13 The new gas turbine (Holyrood GT) has a lower expected rate of unavailability than the original
14 gas turbines, (5% compared to 10.62%), due to the fact that the unit is new and can be
15 expected to have better availability than the older units.³

16
17 As noted in Hydro’s Near-term Generation Adequacy report, dated May 15, 2017, Hydro
18 evaluated the appropriateness of the DAUFOP metric as an alternate or additional measure of
19 gas turbine unit reliability. Hydro will present its findings and make a recommendation on this
20 metric in its next Near-term Generation Adequacy report, to be filed with the Board on
21 November 15, 2017.

22
23 Hydro’s generation long term planning assumptions for DAFOR and UFOP for the year 2017 are
24 noted in Table 2.

³ 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)*.

Table 2: 2017 DAFOR and UFOP 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 ⁴

- 1 As part of Hydro’s analysis of energy supply up to Muskrat Falls interconnection, Hydro
- 2 completes comprehensive reviews of, and produces reports on, energy supply for the Island
- 3 Interconnected System. The Near-Term Generation Adequacy report, filed on May 15, 2017,
- 4 contains analysis based on the near-term DAFOR and UFOP and the resulting implication for
- 5 meeting reliability criteria until the interconnection with the North American grid.
- 6
- 7 The DAFOR and UFOP assumptions used in developing Hydro’s Near-term Generation Adequacy
- 8 report are noted in Table 3.

⁴ In previous reports this sensitivity value was reported as 5.0%. The generation planning sensitivity for the Holyrood GT was updated to 10% in the September 2015 Q3 report for system planning purposes.

Table 3: DAFOR and UFOP Near-term Generation Adequacy Analysis Assumptions

	DAFOR (%)	UFOP (%)
	Near-term Generation Adequacy Assumption	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	
Holyrood Unit 1	15.0	
Holyrood Unit 2	10.0	
Holyrood Unit 3	18.0	
Hardwoods & Stephenville Gas Turbines		20.0
Holyrood Gas Turbine		5.0

1 4.0 Hydraulic Unit Forced Outage Rate Performance

2 The hydraulic unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 3 results for the 12-month period ending September 30, 2017, are presented in Table 4, as well as
 4 the data for the 12-month period ending September 30, 2016. These are compared to Hydro’s
 5 short term generation adequacy assumptions, as used in the Near-term Generation Adequacy
 6 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 2016 (%)	12 months ending September 2017 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
<i>All Hydraulic Units - weighted</i>	954.4	2.02	4.17	0.90	2.60
Hydraulic Units					
Bay D'Espoir 1	76.5	10.57	19.88	0.90	3.90
Bay D'Espoir 2	76.5	13.52	25.77	0.90	3.90
Bay D'Espoir 3	76.5	0.00	0.03	0.90	3.90
Bay D'Espoir 4	76.5	1.33	0.23	0.90	3.90
Bay D'Espoir 5	76.5	0.63	0.00	0.90	3.90
Bay D'Espoir 6	76.5	0.18	1.35	0.90	3.90
Bay D'Espoir 7	154.4	0.00	1.80	0.90	3.90
Cat Arm 1	67	0.13	1.06	0.90	0.70
Cat Arm 2	67	0.00	0.08	0.90	0.70
Hinds Lake	75	0.06	1.09	0.90	0.70
Upper Salmon	84	0.00	0.87	0.90	0.70
Granite Canal	40	1.72	0.00	0.90	0.70
Paradise River	8	5.16	4.05	0.90	0.70

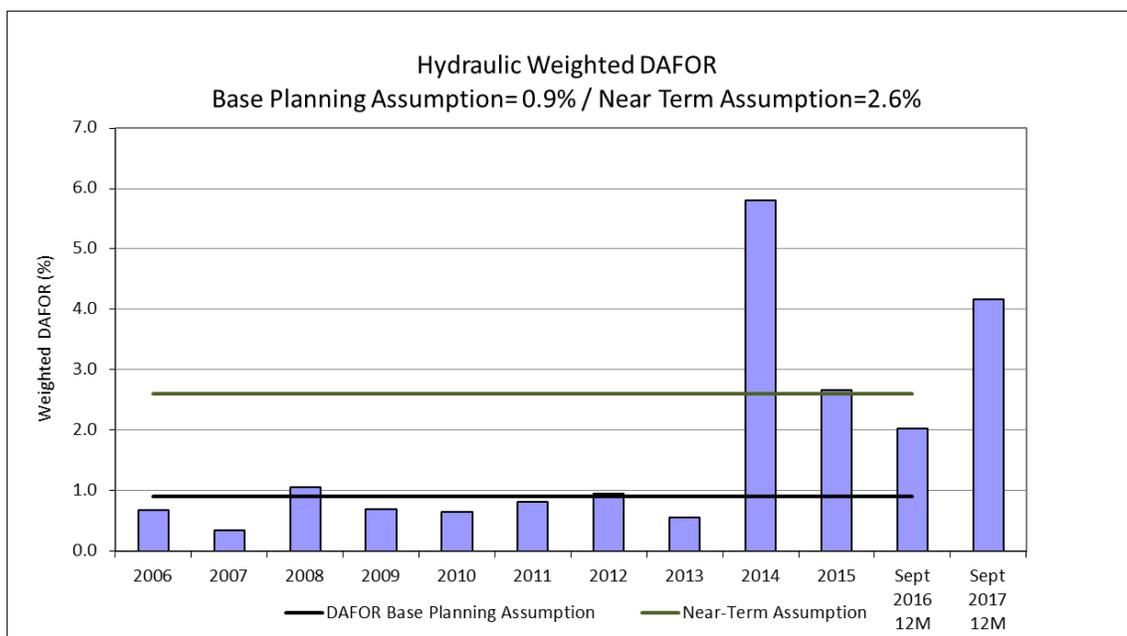


Figure 1: Hydraulic Weighted DAFOR

- 1 Considering the individual units' performance, the assumed Hydro generation base planning
- 2 DAFOR was materially exceeded for Bay d'Espoir Unit 1 and Bay d'Espoir Unit 2. Also, there
- 3 were exceedances compared to base planning assumption for Bay d'Espoir Unit 6, Bay d'Espoir
- 4 Unit 7, Cat Arm Unit 1, Hinds Lake and Paradise River for the current period.

1

2 The Bay d'Espoir Unit 1 DAFOR of 19.88% and Unit 2 DAFOR of 25.77%, exceeded the base
3 planning assumption of 0.9% and the near-term assumption of 3.9%, due to the units being
4 removed from service on two separate occasions as a result of a leak in Penstock 1, which
5 provides water to both Unit 1 and Unit 2. These penstock issues contributed 99.9% of the
6 DAFOR for this period.

7

8 The investigation identified a major weld refurbishment of the penstock, which was completed
9 to provide a long term solution. The investigation into this outage identified two additional long
10 term recommendations to extend the reliable life of Penstock 1. The first recommendation is to
11 add structural backfill to the upper portion of the penstock, planned for 2018. The second is to
12 replace the internal protective coating, which is currently being planned as part of the capital
13 refurbishment program to coincide with the generation outage schedules.

14

15 The Bay d'Espoir Unit 6 DAFOR of 1.35% exceeded the base planning assumption of 0.9% and is
16 less than the near-term assumption of 3.9%. This is a result of the unit being unavailable from
17 February 22, 2017, to February 25, 2017, due to a high turbine bearing alarm, which caused the
18 unit trip protection to operate and shut the unit down in a controlled fashion. An investigation
19 was completed, and it was determined that the Babbitt bearing was damaged. The bearing was
20 repaired and the unit was returned to service. The results of the investigation found no issues
21 for long term bearing reliability.

22

23 The Bay d'Espoir Unit 7 DAFOR of 1.80% exceeded the base planning assumption of 0.9% and is
24 less than the near-term assumption of 3.9%, as a result of the unit being unavailable from July
25 3, 2017, to July 9, 2017, due to a failure in the collector assembly, which caused the unit
26 protection to operate and isolate the unit from the system. An investigation was completed,
27 and it was determined that there was a flash over between the positive and negative slip
28 rings which was caused by excessive brush wear. The investigation resulted in improvements to
29 the preventive maintenance (PM) program for brush gear inspections across the hydraulic

1 generation fleet of assets. As a short term measure, all brush gear assemblies have been
2 scheduled for an additional inspection prior to December 1, 2017. The PM Program for the
3 brush gear assemblies will also be reviewed during the 2017/2018 winter season with a revised
4 program in place prior to the start of the 2018 maintenance season.

5

6 The Cat Arm Unit 1 DAFOR of 1.06% exceeded the base planning assumption of 0.9% and the
7 near-term assumption of 0.7%, as a result of the unit being unavailable from November 23,
8 2016, to November 25, 2016, due to a governor oil pump trip. An investigation into the issue
9 revealed that the internal seals in the pump had failed, preventing the pump from maintaining
10 the governor oil pressure. The oil system was completely cleaned, flushed and replaced with
11 new oil. A new oil pump was installed and the unit returned to service, and the issue has been
12 resolved. An additional consideration to improving the system is with respect to changing how
13 the plant alarms are grouped. This will permit minor anomalies to be initiated as such, and not
14 as major anomalies, which have the potential to take the unit off line. Recommendations will
15 be finalized by end of Q4.

16

17 The Hinds Lake Unit DAFOR of 1.09% exceeded the base planning assumption of 0.9% and the
18 near-term assumption of 0.7%, as a result of the unit being unavailable from April 19, 2017, to
19 April 22, 2017, due to water in the generator bearing oil. An investigation revealed that the
20 generator bearing oil cooler experienced a leak, which resulted in water getting into the
21 bearing oil. Testing revealed that three of the six coolers were leaking. The damaged coolers
22 were isolated from the system, with tests conducted to confirm adequacy of reduced cooling
23 capacity. These tests confirmed that cooling with the three remaining coolers were adequate at
24 ambient air and water temperatures. A planned maintenance outage was arranged from May
25 24, 2017 to May 30, 2017, to repair the damaged coolers, as well as to conduct extensive
26 testing of the three in-service coolers. All work was completed, with no further issues being
27 identified, and the unit was returned to service with 100% cooling capacity. Further testing is
28 planned during the November maintenance outage. A complete set of spare coolers (6) are also

1 presently being purchased as part of the critical spares program. Hydro is planning to replace
 2 these coolers in 2018.

3

4 The Paradise River unit DAFOR of 4.05% exceeded the base planning assumption of 0.9% and
 5 the near-term assumption of 0.7%, primarily as a result of a forced outage from September 23,
 6 2016, to September 30, 2016, which was related to a governor low oil level alarm. This alarm
 7 was caused when a seal broke on one of the governor servo motors, releasing oil from the
 8 governor oil sump into the powerhouse sump system. A new seal was installed and oil was
 9 added to the governor system. The results of the investigation found no issues regarding long
 10 term governor reliability.

11

12 **5.0 Thermal Unit Forced Outage Rate Performance**

13 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 14 results for the 12-month period ending September 30, 2017, are presented in Table 5, as well as
 15 the data for the 12-month period ending September 30, 2016. These are compared to Hydro’s
 16 short term generation adequacy assumptions, as used in the Near-Term Generation Adequacy
 17 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 2016 (%)	12 months ending September 2017 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
<i>All Thermal Units - weighted</i>	490	19.72	13.77	9.64	14.00
Thermal Units					
Holyrood 1	170	25.46	18.23	9.64	15.00
Holyrood 2	170	25.64	18.27	9.64	10.00
Holyrood 3	150	2.86	4.44	9.64	18.00

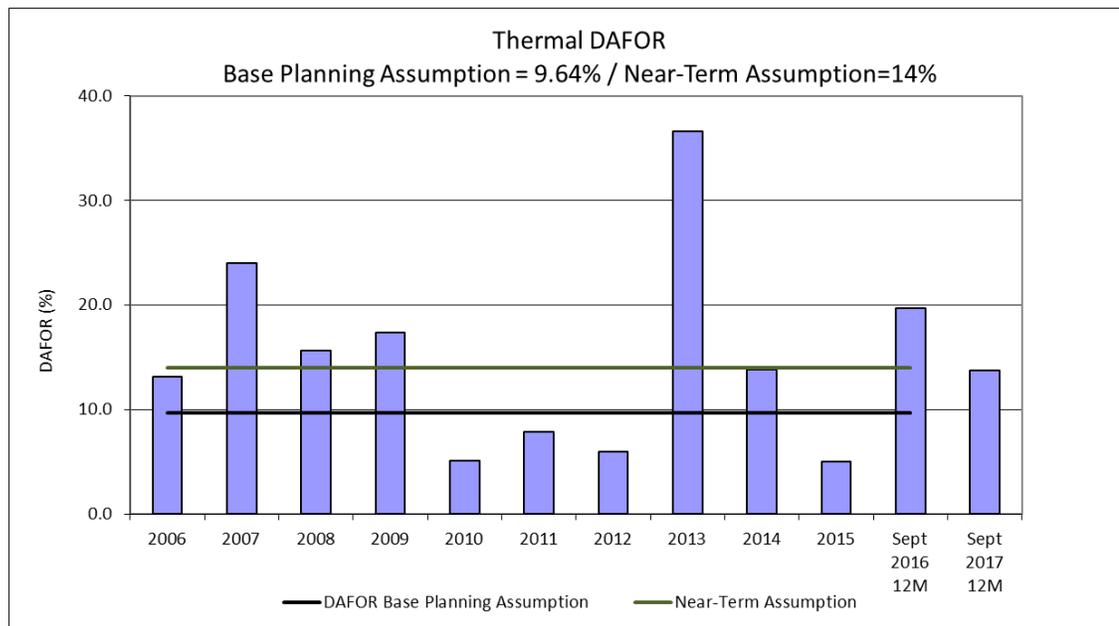


Figure 2: Thermal DAFOR

1 For the 12-month period ending September 30, 2017, the weighted DAFOR for all thermal units,
 2 13.77%, was above the assumed Hydro generation base planning DAFOR value of 9.64%;
 3 however, below the near-term assumption of 14.00%. Unit 1 DAFOR was 18.23% and Unit 2
 4 DAFOR was 18.27%. The performance for both Units 1 and 2 was above the base planning
 5 assumption of 9.64% and the near-term assumption of 15% (Unit 1) and 10% (Unit 2). Unit 3
 6 DAFOR was 4.44%, which is better than the base planning assumption of 9.64% and near-term
 7 assumption of 18.0%. The majority of the 13.77% DAFOR for the plant is due to deratings from
 8 airflow issues in the 2016/2017 winter season on Unit 1 and Unit 2.

9

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

12 During return to service from annual maintenance on October 29, 2016, a turbine control
 13 system (Mark V) governor control card failed, causing a forced outage. The failed card was
 14 replaced and the unit was synchronized on November 2, 2016.

1 When Unit 1 was first returned to service after the 2016 annual outage, it remained derated
2 due to air flow issues, although there was an improvement to 160 MW from 155 MW
3 before the outage. As planned, combustion tuning was completed during the week of
4 November 14, 2016, to diagnose the air flow issues on this unit. Tuning was completed by
5 an expert from Foxboro (supplier of the distributed control system) with assistance from a
6 boiler field expert from Babcock & Wilcox (B&W.) They determined that the air flow issues
7 that Hydro was experiencing are due to fouling through various stages of the boiler and air
8 heater leakage. Further improvements required an outage to fully correct this, which was
9 completed during the 2017 annual planned maintenance outage. Work included boiler
10 cleaning and air heater upgrades. Full load capability is expected after completion of this
11 work and at the end of the reporting period the unit had returned to service with
12 encouraging results. The furnace pressure was much lower than seen at comparable loads
13 during the previous operating season, which indicated a significant reduction in fouling
14 through the boiler and air heaters. The unit has not been load tested due to system
15 constraints.

16
17 After the tuning, and prior to the planned 2017 outage, the Unit 1 load capability continued
18 to deteriorate as a result of fouling. Load capability was reduced to 145 MW on January 20,
19 2017, due to increased fouling, particularly in the air heater. An air heater wash was
20 completed on a maintenance outage from January 26, 2017 to January 27, 2017, which
21 restored the load capability to the pre-wash condition of 160 MW. However, the capability
22 was further reduced due to continued fouling in the economizer, and at the end of February
23 the unit was derated to 150 MW. On March 4, 2017, the unit capability was rated at 140
24 MW, and by the end of March this had further reduced to 135 MW. When the unit was
25 taken off-line for the 2017 maintenance outage at the end of June, it was capable of 120
26 MW. For the coming 2017/2018 winter season, the 2017 annual maintenance outage is
27 expected to materially reduce the effects of fouling discussed here.

1 On March 8, 2017, it was necessary to take a short forced outage to repair two air heater
2 bearing cooling water leaks. The unit was taken off-line in a controlled manner and was
3 returned to service approximately 23 hours later after completion of the repairs.

4
5 The 2017 maintenance outage on Unit 1 was from July 5, 2017 until September 11, 2017.
6 The unit was put on-line on September 17, 2017 to allow for on-line commissioning of the
7 new exciter controls system by the Original Equipment Manufacturer, ABB.

8
9 The Unit tripped at 70 MW on September 18, 2017, during commissioning of the new
10 exciter controls on that unit. The unit was de-rated to 50 MW (below Under Frequency Load
11 Shed limits) until September 21, 2017, when the cause of the trip was determined. This was
12 to ensure that any further trips would not impact customers. Investigation determined that
13 this trip, which happened when starting a boiler feed pump, was due to low unit board
14 voltages. Starting the pump caused the already low voltage to drop below acceptable levels
15 and this engaged under voltage protection and a unit trip. Voltages had been reduced
16 intentionally as part of the exciter commissioning and were not returned to normal levels
17 prior to starting the pump. This issue has been addressed with commissioning activities to
18 ensure that it will not reoccur.

19
20 The DAFOR performance for Holyrood Unit 2 (170 MW) was primarily affected by the following
21 events:

22 On November 6, 2016, the main steam inlet flange to the upper control valves was found
23 leaking and the unit was derated to 70 MW until it was removed from service for gasket
24 replacement on November 8, 2016. The unit was returned to service on November 10,
25 2016, but had to be taken off-line for another failure of the same gasket on November 16,
26 2016. This time the gasket was changed and a contractor was hired to provide a
27 supplementary seal of the gasket, further encapsulating the replaced gasket. The unit was
28 returned to service on November 21, 2016. This problematic joint was removed and
29 replaced with a section of pipe during the planned outage in 2017.

1 On November 18, 2016, when attempting to go back on line after repair of the November
2 16, 2016, inlet flange leak, there was an issue discovered with turbine speed indication.
3 After trouble shooting, it was determined that the speed probes had to be repositioned.
4 The unit was returned to service at full capacity on November 21, 2016. During an outage
5 on June 3, 2017 (see below) a GE expert ensured the proper adjustment of these probes.
6

7 On January 20, 2017, the unit load capacity was reduced to 150 MW due to boiler fouling,
8 particularly in the air heater and economizer. An air heater wash was completed on
9 February 18, 2017, but due to economizer fouling, the unit remained derated to 150 MW at
10 the end of February. Continued fouling during operation further reduced the load capability
11 of the unit. On March 6, 2017, the capability was rated at 140 MW. On March 21, 2017, this
12 was further reduced to approximately 135 MW. Hydro completed an early two week
13 duration outage on Unit 2 on April 23, 2017. The outage addressed the fouling related air
14 flow issues that were considered to be a significant effort and could not be completed
15 during an air heater wash, or during peak winter season demand. Activities included, but
16 were not limited to, cleaning and removal of hardened ash in the economizer section of the
17 gas path. Issues affecting air flow restrictions were addressed and Unit 2 was then rated at
18 165 MW following this work, as tested on April 26, 2017. Additional work was scheduled for
19 the 2017 planned annual outage to further address air flow issues.
20

21 On April 22, 2017 there was a brief outage required to repair a section of flexible ductwork
22 on the ignitor air system that had come apart during start-up after the boiler cleaning
23 outage.
24

25 On May 1, 2017 the unit experienced a forced outage when a section of flexible ductwork
26 adjacent to the location that failed on April 22, 2017, also failed and allowed hot gas to
27 escape from the boiler. This hot gas caused a cable tray fire adjacent to the north east
28 corner of the boiler on the second floor. Refurbishment work was completed by May 28,
29 2017 and included asbestos abatement, as loose asbestos fibres were found in the cable

1 tray. While the unit was off line for repairs, work protection permits were issued to allow
2 other work, which was planned for the annual outage, to proceed in parallel. Also Unit 3
3 was re-called from its planned outage to provide generation to satisfy system requirements.
4

5 In parallel to the refurbishment work noted above, the cause of the failure of the ignitor flex
6 hoses was investigated. This was the first such incident on record at the plant. All of the
7 Unit 2 flexible hoses on the ignitor system were upgraded as required. This included
8 extending the rigid pipe in the corner that failed such that the gap could be spanned by one
9 flexible hose length. Two had been spliced together in the area of the failure and this was
10 concluded to be part of the reason for the failure. On Unit 1, which was in operation at the
11 time, additional clamps were installed to verify the hoses were secure. During the annual
12 2017 outages all hoses on Unit 2 and Unit 1 were positively secured to ensure this failure
13 can not re-occur. Unit 3 is not of the same design, does not have flexible ignitor air ducting,
14 and is not susceptible to a similar failure.
15

16 On June 3, 2017 the Unit 2 tripped. The unit was returned to service a few hours later on
17 June 3, 2017 but was limited to 50 MW until the reason for the trip could be confirmed and
18 mitigated. A GE representative was brought to site to diagnose the problem and
19 determined that during the trip, the control valves closed while the governor was calling for
20 them to remain open. This pointed to three possibilities; loose wire, control card failure, or
21 servo failure. A card failure was ruled out since all other functions of the card were working
22 normally. The wires were tested with the unit at 25 MW and no issues were found. An
23 outage was then completed on June 8, 2017, to June 11, 2017, to replace the servo and
24 change out the hydraulic fluid and filters. During this same outage, the turbine speed probe
25 cables were replaced and probe clearance gaps were adjusted. This corrected a reliability
26 issue that previously occurred on November 18, 2016 and was planned to be done during
27 the annual outage.

1 On June 16 there was an incident on one of the two approximately 50% duty boiler feed
2 pumps. It appeared that some debris went through one of the bearings of the west pump
3 and caused a spike in temperature and vibration. The temperature and vibration returned
4 to normal, but the pump was taken out of service to change the oil and clean out the lube
5 oil tank. The unit was derated to 70 MW while the pump was out of service. It was
6 successfully tested and returned to service on June 17.

7
8 On June 29, 2017 vibration and temperature excursions occurred on the same motor
9 inboard bearing. At this point failure of the bearing was suspected. The pump was again
10 taken out of service causing another de-rate to 70MW. Failure of the bearing was
11 confirmed, and the spare boiler feed pump motor was brought to site and installed in place
12 of the motor with the failed bearing. This was the most expedient option to get the pump
13 back in service. This work was completed on July 2, 2017 and the unit returned to 165 MW
14 capability. Additional checks have been added to pump rebuilds to check for issues
15 witnessed on this pump.

16
17 Unit 2 was removed from service at the end of July, 2017 to accommodate the planned
18 total plant outage and the unit annual maintenance outage. During the unit outage
19 additional work was completed to address air flow issues. This included additional boiler
20 cleaning and air heater upgrades. At the time of writing of this report, Unit 2 was in the
21 process of coming back online following its annual maintenance, which included several
22 upgrades.

23 24 **6.0 Gas Turbine UFOP Performance**

25 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was 7.06%
26 for the 12-month period ending September 30, 2017 (see Table 6). This is below the base
27 planning assumption of 10.62%, and the near-term assumption of 20.00%. The current period
28 UFOP declined from the previous period UFOP of 5.54%. The Hardwoods UFOP for the current
29 period is 6.47%, which is better than the base planning assumption of 10.62%. Happy Valley's

1 UFOP is 6.81% for the current period compared to 5.59% in the previous period. Hydro will
 2 begin using DAUFOP as a reliability measure in addition to UFOP going forward. Beginning in
 3 January, 2018 Hydro will report on the gas turbines using DAUFOP. Targets for this measure will
 4 be set based on historical data as well as planned improvements. This will be discussed further in
 5 Hydro’s next Near-Term Generation Adequacy Report, to be filed with the Board on November
 6 15, 2017.

Table 6: Gas Turbine UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2016 (%)	12 months ending September 2017 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
<i>Combined Gas Turbines</i>	125	5.54	7.06	10.62	20.00
Stephenville	50	12.03	8.02	10.62	20.00
Hardwoods	50	2.16	6.47	10.62	20.00
Happy Valley	25	5.59	6.81	10.62	20.00

7 The Holyrood gas turbine UFOP of 2.10% for the current period is better than the base planning
 8 and near-term assumptions of 5.00% (see Table 7).

Table 7: Holyrood GT UFOP

Combustion Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2016 (%)	12 months ending September 2017 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Holyrood CT	123.5	1.33	2.10	5.00	5.00

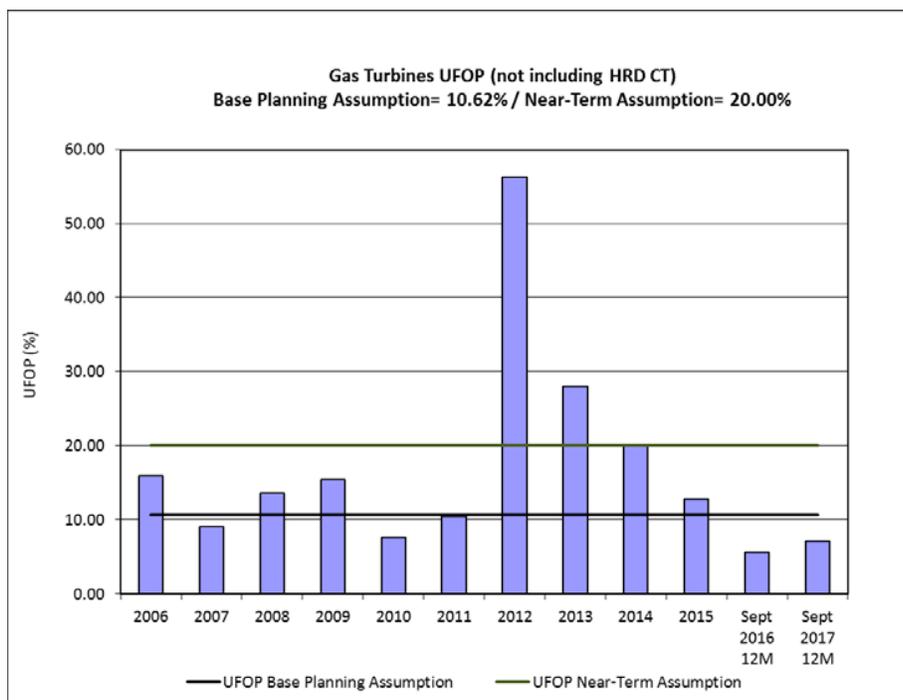


Figure 3: Gas Turbine UFOP – Hardwoods/Happy Valley/Stephenville Units

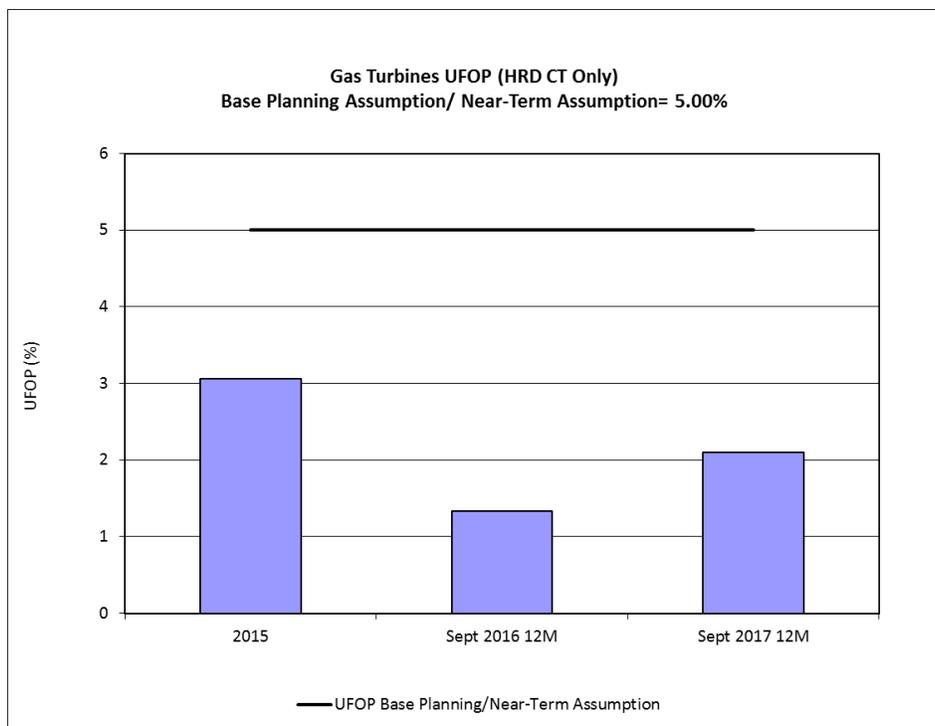


Figure 4: Gas Turbine UFOP – Holyrood Gat Turbine Only

- 1 Hydro continues to mitigate extended outages to the Hardwoods and Stephenville gas turbines
- 2 by utilizing spare engines to allow for timely replacement of failed engines to return the units to
- 3 full or near-full capacity. During the winter 2017/2018, Hydro will have two spare engines
- 4 available for this purpose.



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February 1, 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").

During final quality verification, a discrepancy was identified and the Report was held until correct data was confirmed. The data included in this report has been verified as accurate and matches the Generation Equipment Status database.

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

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

A handwritten signature in blue ink, appearing to read "Michael Ladha", written over a horizontal line.

Michael Ladha
Legal Counsel & Assistant Corporate Secretary
ML/skc

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Danny Dumaresque
ecc: Dennis Fleming – Cox & Palmer
Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Dennis Browne, Q.C. – Browne, Fitzgerald, Morgan & Avis
Dean Porter – Poole Althouse

Larry Bartlett – Teck Resources Limited

Quarterly Report on Performance of Generating Units
For the Quarter ended December 31, 2017

February 1, 2018

A Report to the Board of Commissioners of Public Utilities

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1 **1. Introduction**

2 In this report, Newfoundland and Labrador Hydro (Hydro) provides data on forced outage rates
3 of its generating facilities. This data is provided in relation to historical forced outage rates and
4 as well as in relation to assumptions used for system planning purposes.

5

6 The forced outage rates are provided for individual generating units at hydraulic facilities, the
7 three units at the Holyrood Thermal Generating Station, and Hydro's gas turbines for the
8 current 12-month reporting period of January 1, 2017 to December 31, 2017. This report also
9 provides, for comparison purposes, the individual generating unit data on forced outage rates
10 for the previous period January 1, 2016 to December 31, 2016. Further, total asset class data is
11 presented on an annual basis for the years 2006-2016. This report provides data on outage
12 rates for forced outages, not planned outages.

13

14 The forced outage rates of Hydro's generating units are presented using two measures: Derated
15 Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units and Utilization
16 Forced Outage Probability (UFOP) for the gas turbines.

17

18 Derated Adjusted Forced Outage Rate (DAFOR) is a metric that measures the percentage of the
19 time that a unit or group of units is unable to generate at its maximum continuous rating due to
20 forced outages. The DAFOR for each unit is weighted to reflect differences in generating unit
21 sizes in order to provide a company total and reflect the relative impact a unit's performance
22 has on overall generating performance. This measure is applied to hydraulic and thermal units.
23 However, this measure is not applicable to gas turbines because of their nature as standby
24 units, and relatively low operating hours.

25

26 Utilization Forced Outage Probability (UFOP) is a metric that measures the percentage of time
27 that a unit or group of units will encounter a forced outage and not be available when required.
28 This metric is used for the gas turbines.

1 The forced outage rates include outages that remove a unit from service completely, as well as
 2 instances when units are derated. If a unit’s output is reduced by more than 2%, the unit is
 3 considered derated by Canadian Electricity Association (CEA) guidelines. Per CEA guidelines, to
 4 take into account the derated levels of a generating unit, the operating time at the derated
 5 level is converted into an equivalent outage time.

6

7 In addition to forced outage rates, this report provides outage details for those outages that
 8 contributed materially to forced outage rates exceeding those used in Hydro’s generation
 9 planning analysis for both the short and long term.

10

11 **2. Period Ending December 31, 2017 Overview**

Table 1 DAFOR and UFOP Overview

Class of Units	January 1, 2016 to December 31, 2016 (%)	January 1, 2017 to December 31, 2017 (%)	Base Planning Assumption (%)	Near-Term Planning Assumption ¹ (%)
Hydraulic (DAFOR)	5.51	2.29	0.90	2.60
Thermal (DAFOR)	19.42	14.91	9.64	14.00
Gas Turbine (Combined) (UFOP)	9.35	6.93	10.62	20.00
Gas Turbine (Holyrood) (UFOP)	1.65	2.02	5.00	5.00

12 There was an improvement in hydraulic and thermal DAFOR performance for the current 12-
 13 month period ending December 2017, compared to the previous 12-month period ending
 14 December 2016 (see Table 1). The combined² gas turbine UFOP performance shows an
 15 improvement in performance for the current period compared to the previous period.

¹ *Near-Term Generation Adequacy Report*, May 15, 2017, see Section 5.0 for further details.

² Combined Gas Turbines (GT) 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.

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

4

5 For the Holyrood thermal units, the forced outage rate of the current period ending December
6 2017 is 14.91%, which is above the base planning assumption of 9.64%, the sensitivity of
7 11.64%, and the near-term planning assumption of 14.00%³. This is primarily caused by an
8 airflow derating on Unit 1 and Unit 2 that started in the fall of 2016 and continued throughout
9 2017.

10

11 Hydro’s combined gas turbines’ UFOP in the 10-year period prior to 2015 was generally
12 consistent at approximately 10% until the year 2012 when the rate exceeded 50%. Since 2012,
13 the UFOP has been improving each year. For the current 12-month period ending December 31,
14 2017, performance was affected by forced outages to the Hardwoods, Happy Valley, and
15 Stephenville units.

16

17 Note that the data for 2006 to 2015 in Figures 1, 2, and 3 are annual numbers (January 1 to
18 December 31), while the data for 2016 and 2017 are 12-month rolling numbers (January 1 to
19 December 31 for each year).

20

21 **3. Generation Planning Assumptions**

22 The DAFOR and UFOP indicators used in Hydro’s generation planning model are representative
23 of a historic average of the actual performance of these units. These numbers are noted in
24 Table 2 under the column “Base Planning Assumption”. This is a long-term outlook.

³ Section 7.0 of Hydro's *Near-Term Generation Adequacy Report*, November 15, 2017, presented results for Holyrood plant DAFOR = 15%. A Holyrood Plant DAFOR of 15% does not result in violations of any criteria for the expected case. The 15% plant DAFOR results in no violations of Expected Unserved Energy (EUE) but does result in some violations of Loss of Load Hours (LOLH) for the fully stressed reference case and demand sensitivity cases considered.

1 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation planning
 2 analysis. This number takes into account a higher level of unavailability, should it occur, to
 3 assess the impact of higher unavailability of these units on overall generation requirements.
 4 During the 12-month period ending December 31, 2017, the gas turbine units performed well
 5 within this sensitivity range for UFOP, while both the hydraulic and thermal classes performed
 6 outside of the sensitivity range for DAFOR.

7

8 The new gas turbine (Holyrood GT) has a lower expected rate of unavailability than the original
 9 gas turbines, (5% compared to 10.62%), due to the fact that the unit is new and can be
 10 expected to have better availability than the older units.⁴

11

12 Hydro’s generation long-term planning assumptions for DAFOR and UFOP for the year 2017 are
 13 noted in Table 2.

Table 2 2017 DAFOR and UFOP 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 ⁵

14 As part of Hydro’s analysis of energy supply up to Muskrat Falls Interconnection, Hydro
 15 completes comprehensive reviews of, and produces reports on, energy supply for the Island
 16 Interconnected System. The *Near-Term Generation Adequacy Report*, filed on November 15,
 17 2017, contains analysis based on outlines the near-term DAFOR and Derated Adjusted

⁴ 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)*.

⁵ In previous reports this sensitivity value was reported as 5.0%. The generation planning sensitivity for the Holyrood GT was updated to 10% in the September 2015 Q3 report for system planning purposes.

1 Utilization Forced Outage Probability (DAUFOP)⁶ and the resulting implication for meeting
 2 reliability criteria until the interconnection with the North American grid. In the *Near-Term*
 3 *Generation Adequacy Report*, Hydro used the DAUFOP metric as the measure of gas turbine
 4 unit reliability into the near term. In 2018, Hydro will be measuring and reporting using
 5 DAUFOP and UFOP for the gas turbines.

6
 7 The DAFOR and DAUFOP assumptions used in developing Hydro’s November 15, 2017 *Near-*
 8 *Term Generation Adequacy Report* are noted in Table 3.

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

	DAFOR (%)	DAUFOP (%)
	Near-Term Generation Adequacy Assumption	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	
Holyrood Unit 1	15.0	
Holyrood Unit 2	10.0	
Holyrood Unit 3	18.0	
Hardwoods & Stephenville Gas Turbines		30.0
Holyrood Gas Turbine		5.0

9 **4. Hydraulic Unit Forced Outage Rate Performance**

10 The hydraulic unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 11 results for the 12-month period ending December 31, 2017, are presented in Table 4, as well as
 12 the data for the 12-month period ending December 31, 2016. These are compared to Hydro’s
 13 short-term generation adequacy assumptions, as used in the *Near-Term Generation Adequacy*
 14 *Report*, and Hydro’s long-term generation planning assumptions for the forced outage rate.

⁶ DAUFOP is the probability that a generating unit will not be available due to forced outages or forced deratings when there is demand on the unit to generate. It is essentially the UFOP calculation adjusted to include the effect of deratings on a unit’s availability.

Table 4 Hydraulic Weighted DAFOR

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending December 2016 (%)	12 months ending December 2017 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
<i>All Hydraulic Units - weighted</i>	954.4	5.51	2.29	0.90	2.60
Hydraulic Units					
Bay D'Espoir 1	76.5	30.87	9.33	0.90	3.90
Bay D'Espoir 2	76.5	33.90	14.11	0.90	3.90
Bay D'Espoir 3	76.5	0.00	0.03	0.90	3.90
Bay D'Espoir 4	76.5	0.93	0.27	0.90	3.90
Bay D'Espoir 5	76.5	0.56	0.00	0.90	3.90
Bay D'Espoir 6	76.5	0.18	1.48	0.90	3.90
Bay D'Espoir 7	154.4	0.00	1.80	0.90	3.90
Cat Arm 1	67	1.02	0.22	0.90	0.70
Cat Arm 2	67	0.00	0.09	0.90	0.70
Hinds Lake	75	0.24	0.89	0.90	0.70
Upper Salmon	84	0.06	0.81	0.90	0.70
Granite Canal	40	1.36	0.11	0.90	0.70
Paradise River	8	7.08	1.70	0.90	0.70

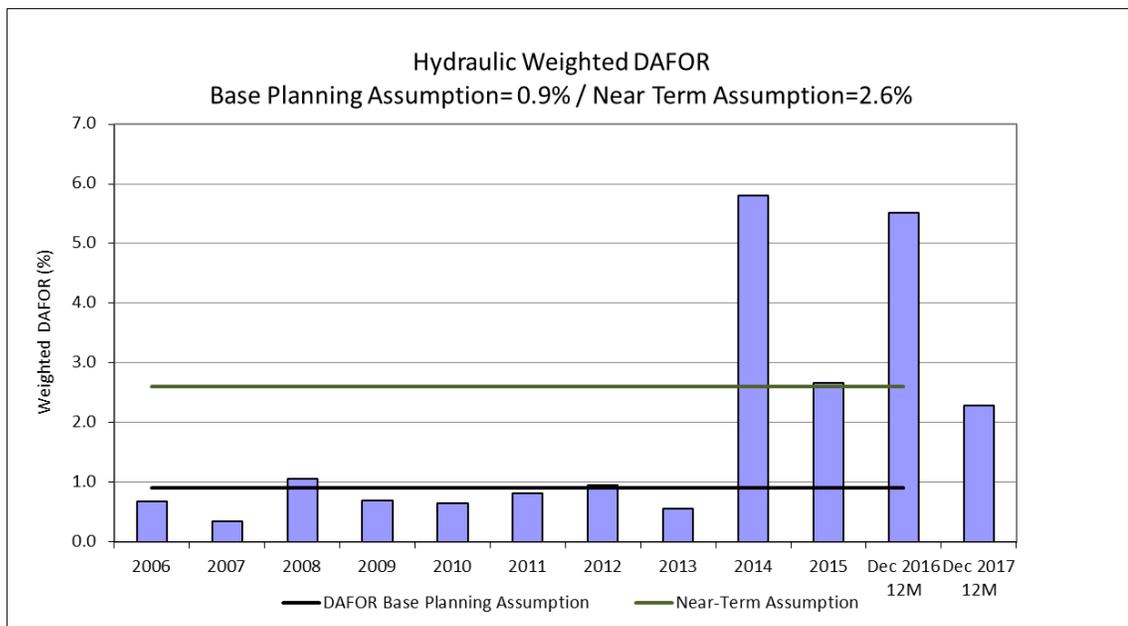


Figure 1 Hydraulic Weighted DAFOR

- 1 Considering the individual units' performance, the assumed Hydro generation base planning
- 2 DAFOR was materially exceeded for Bay d'Espoir Unit 1 and Bay d'Espoir Unit 2. Also, there
- 3 were exceedances compared to base planning assumption for Bay d'Espoir Unit 6, Bay d'Espoir
- 4 Unit 7, and Paradise River for the current period.

1 The Bay d’Espoir Unit 1 DAFOR of 9.33% and Unit 2 DAFOR of 14.11% exceeded the base
2 planning assumption of 0.9% and the near-term assumption of 3.9% for an individual Bay
3 d’Espoir unit. This was due to Units 1 and 2 being removed from service on November 4, 2017
4 as a result of a leak in Penstock 1 which provides water to both units. The leak occurred in the
5 same area where similar leaks had occurred in 2016, which initiated further investigation and
6 subsequent intervention. A consultant (Hatch) was engaged in the process to provide
7 engineering analysis and recommendations to return the penstock to reliable service. Extensive
8 inspection and testing was completed, which resulted in the damaged section being completely
9 removed, and replaced with a new plate that was overlaid with a second plate. All additional
10 suspect areas were also cleaned, re-welded, and overlaid with additional plates. Additional
11 backfill was placed over a section of the repair area, as this had been part of the proposed 2018
12 Capital Budget Application resulting from the 2016 leak. The project to increase the backfill
13 amount on Penstock 1 was subsequently approved in P.U. 43(2017). The final report by Hatch
14 to document their findings and analysis is ongoing and is expected by March 31, 2018. A
15 TapRoot® investigation was also conducted to investigate the root causes of the event. The
16 penstock was watered up and both units were returned to service on December 8, 2017.

17

18 The Bay d’Espoir Unit 6 DAFOR of 1.48% exceeded the base planning assumption of 0.9% and is
19 less than the near-term assumption of 3.9% for an individual Bay d’Espoir unit. This was as a
20 result of the unit being unavailable from February 22, 2017, to February 25, 2017 due to a high
21 turbine bearing alarm which caused the unit trip protection to operate and shut the unit down
22 in a controlled fashion. An investigation was completed and it was determined that the Babbitt
23 bearing was damaged. The bearing was repaired and the unit was returned to service. The
24 results of the investigation found no issues for long-term bearing reliability.

25

26 The Bay d’Espoir Unit 7 DAFOR of 1.80% exceeded the base planning assumption of 0.9% and is
27 less than the near-term assumption of 3.9% for an individual Bay d’Espoir unit. This was as a
28 result of the unit being unavailable from July 3, 2017, to July 9, 2017 due to a failure in the
29 collector assembly which caused the unit protection to operate and isolate the unit from the

1 system. An investigation was completed and it was determined that there was a flash over
2 between the positive and negative slip rings, which was caused by excessive brush wear. The
3 investigation was completed and improvements to the Preventive Maintenance (PM) Program
4 have been implemented across the hydraulic generation fleet of assets. As a short-term
5 measure, all brush gear assemblies had an additional inspection completed prior to December
6 1, 2017, and no issues were found. The PM Program for the brush gear assemblies will also be
7 reviewed during the 2017-2018 winter season with a revised program in place prior to the start
8 of the 2018 maintenance season.

9
10 The Paradise River unit DAFOR of 1.70% exceeded the base planning assumption of 0.9% and
11 the near-term assumption of 0.7%, primarily as a result of a forced outage from May 23, 2017
12 to May 25, 2017. The unit tripped off on May 23, 2017 shortly after being synchronized to the
13 system and loaded to 8 MW. Several attempts to return the unit to service were unsuccessful
14 which resulted in the unit being unavailable until the investigation was completed. The
15 investigation determined the trip was a result of a high generator terminal voltage, attributed
16 to TL 212 being out of service. The condition was rectified by adjusting the generator excitation
17 voltage, and the unit was returned to service on May 25, 2017. There have been no recurrence
18 of events relating to this issue since that time, and this issue is now considered to be resolved.

20 **5. Thermal Unit Forced Outage Rate Performance**

21 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
22 results for the 12-month period ending December 31, 2017 are presented in Table 5, as well as
23 the data for the 12-month period ending December 31, 2016. These are compared to Hydro's
24 short-term generation adequacy assumptions, as used in the *Near-Term Generation Adequacy*
25 *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	12 months ending	Hydro Generation	
		December 2016 (%)	December 2017 (%)	Base Planning Assumption (%)	Near-Term Planning Assumption (%)
All Thermal Units - weighted	490	19.42	14.91	9.64	14.00
Thermal Units					
Holyrood 1	170	24.55	19.35	9.64	15.00
Holyrood 2	170	26.69	19.14	9.64	10.00
Holyrood 3	150	2.41	5.84	9.64	18.00

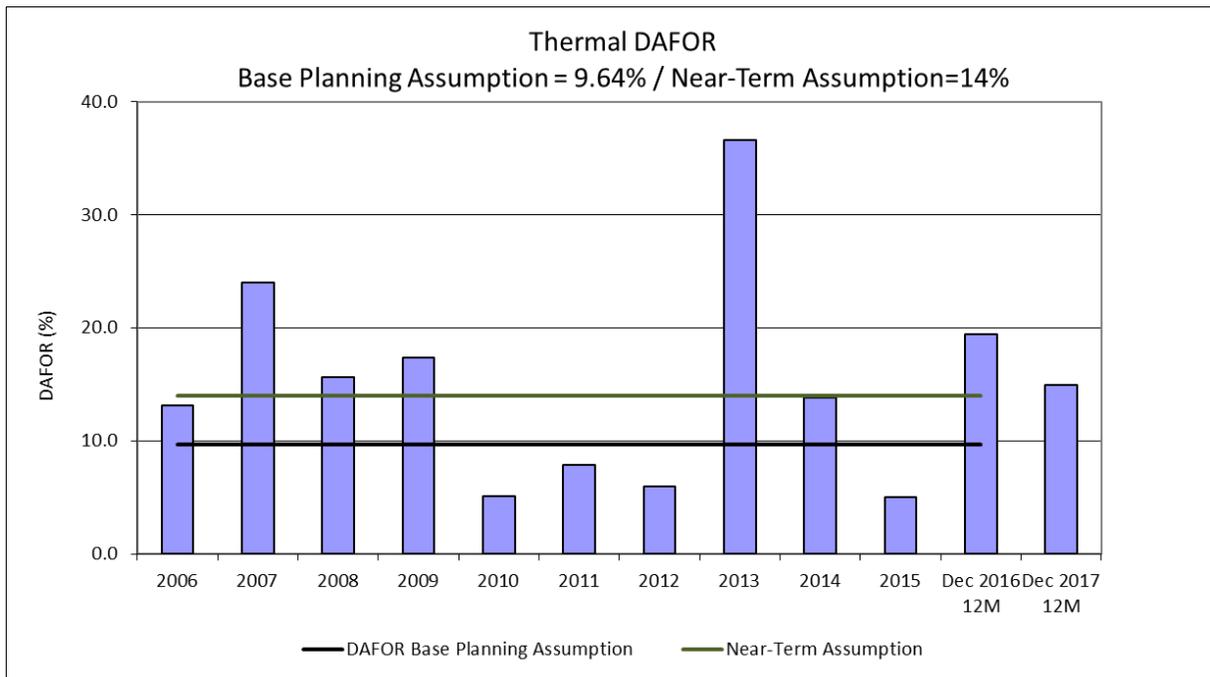


Figure 2 Thermal DAFOR

- 1 For the 12-month period ending December 31, 2017 the weighted DAFOR for all thermal units
- 2 of 14.91% is above the assumed Hydro generation base planning DAFOR value of 9.64% and the
- 3 near-term assumption of 14.00%⁷. Unit 1 DAFOR was 19.35% and Unit 2 DAFOR was
- 4 19.14%.The performance for both Units 1 and 2 was above the base planning assumption of
- 5 9.64% and the near-term assumption of 15% (Unit 1) and 10% (Unit 2). Unit 3 DAFOR was

⁷ Section 7.0 of Hydro's *Near-Term Generation Adequacy Report*, November 15, 2017, presented results for Holyrood plant DAFOR = 15%. A Holyrood Plant DAFOR of 15% does not result in violations of any criteria for the expected case. . The 15% plant DAFOR results in no violations of EUE but does result in some violations of LOLH for the fully stressed reference case and demand sensitivity cases considered.

1 5.84% which is better than the base planning assumption of 9.64% and near-term assumption
2 of 18.0%. The majority of the 14.91% DAFOR for the plant is due to deratings from airflow
3 issues on Unit 1 and Unit 2.

4

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

- 7 • At the start of 2017, Unit 1 was derated to 160 MW due to air flow issues. The load
8 capability continued to deteriorate as a result of fouling. Load capability was reduced to
9 145 MW on January 20, 2017, due to increased fouling, particularly in the air heater. An
10 air heater wash was completed on a maintenance outage from January 26, 2017 to
11 January 27, 2017, which restored the load capability to the pre-wash condition of 160
12 MW. However, the capability was further reduced due to continued fouling in the
13 economizer; and at the end of February, 2017 the unit was derated to 150 MW. On
14 March 4, 2017, the unit capability was rated at 140 MW, and by the end of March 2017
15 this had further reduced to 135 MW. When the unit was taken off-line for the 2017
16 maintenance outage at the end of June, it was capable of 120 MW.
- 17 • On March 8, 2017, it was necessary to take a short forced outage to repair two air
18 heater bearing cooling water leaks. Unit 1 was taken off-line in a controlled manner and
19 was returned to service approximately 23 hours later after completion of the repairs.
- 20 • The 2017 maintenance outage on Unit 1 was from July 5, 2017 until September 11,
21 2017. The unit was put on-line on September 17, 2017 to allow for on-line
22 commissioning of the new exciter controls system by the Original Equipment
23 Manufacturer, ABB.
- 24 • Unit 1 tripped at 70 MW on September 18, 2017 during commissioning of the new
25 exciter controls on that unit. The unit was derated to 50 MW, below Under Frequency
26 Load Shed (UFLS) limits until September 21, 2017, when the cause of the trip was
27 determined. This was to ensure that any further trips would not impact customers.
28 Investigation determined that this trip, which happened when starting a boiler feed
29 pump, was due to low unit board voltages. Starting the pump caused the already low

- 1 voltage to drop below acceptable levels and this engaged under voltage protection and
2 a unit trip. Voltages had been reduced intentionally as part of the exciter commissioning
3 and were not returned to normal levels prior to starting the pump. This issue was
4 addressed with commissioning activities to ensure that it would not reoccur.
- 5 • Unit 1 tripped on October 5, 2017 and was derated to a precautionary load of 35 MW
6 while the reason for the trip was being investigated and corrected. It was determined
7 that the trip was caused by frayed wires in one of the Forced Draft (FD) fan motors and,
8 following repairs, the unit was returned to full capability on October 10, 2017.
 - 9 • From October 17, 2017 to October 22, 2017, Unit 1 was derated to 154 MW due to low
10 steam pressure while waiting for safety valve testing to be completed. The safety valve
11 testing was completed on October 24, 2017, but the unit was further derated to 145
12 MW from October 22, 2017 to October 24, 2017, and to 135 MW until the end of
13 October 2017 due to overheating motor windings in the west FD fan. Plans were
14 established to replace this motor after completion of the Unit 2 exciter commissioning.
15 The spare motor was brought to site and the winding temperature was monitored
16 regularly for changes. The spare motor was installed during an outage from November
17 7, 2017 to November 11, 2017. Unit 1 was returned to service on November 12, 2017
18 but remained derated to 145 MW as a result of high furnace pressure due to fouling.
 - 19 • On November 14, 2017 Unit 1 was taken off-line to repair a piping leak at the condenser
20 flash tank. This was repaired and the unit returned to service on November 15, 2017.
21 However another leak developed in the area and the unit was removed from service on
22 November 15, 2017 for 12 hours for additional repair.
 - 23 • Unit 1 remained limited to 145 MW until it was taken off-line on November 30, 2017 to
24 perform an air heater wash and additional maintenance to restore capacity. This
25 included a pressure wash of the top air heater baskets. The unit was returned to service

1 on December 4, 2017. A load test completed on December 5, 2017 confirmed a capacity
2 of 150 MW⁸ with the unit load limited by high furnace pressure.

3

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

- 6 • Unit 2 started 2017 rated at 165 MW. On January 20, 2017, the unit load capacity was
7 reduced to 150 MW due to boiler fouling, particularly in the air heater and economizer.
8 An air heater wash was completed on February 18, 2017, but as a result of economizer
9 fouling, the unit remained derated to 150 MW at the end of February. Continued fouling
10 during operation further reduced the load capability of the unit and on March 6, 2017,
11 the capability was rated at 140 MW. On March 21, 2017 the load capacity was further
12 reduced to approximately 135 MW. Hydro completed an early two-week duration
13 outage on Unit 2 on April 23, 2017. The outage addressed the fouling-related air flow
14 issues that were considered to be a significant effort and could not be completed during
15 an air heater wash or during peak winter season demand. Activities included, but were
16 not limited to, cleaning and removal of hardened ash in the economizer section of the
17 gas path. Issues affecting air flow restrictions were addressed and, following this work,
18 Unit 2 was then rated at 165 MW, as tested on April 26, 2017. Additional work was
19 scheduled for the 2017 planned annual outage to further address air flow issues.
- 20 • On April 22, 2017 a brief outage was required to repair a section of flexible ductwork on
21 the ignitor air system which had come apart during start-up after the boiler cleaning
22 outage.
- 23 • On May 1, 2017, Unit 2 experienced a forced outage when a section of flexible ductwork
24 adjacent to the location that failed on April 22, 2017, also failed and allowed hot gas to
25 escape from the boiler. This hot gas caused a cable tray fire adjacent to the north east
26 corner of the boiler on the second floor. Refurbishment work was completed by May 28,
27 2017 and included asbestos abatement, as loose asbestos fibres were found in the cable

⁸ Hydro continues to work towards restoring full load on Unit 1 and Unit 2. Further analysis and planning is required. Hydro has set up an engineering team to work with the boiler service provider and other industry experts to identify and, if appropriate, implement the appropriate actions.

1 tray. While the unit was off-line for repairs work protection permits were issued to allow
2 other work, which was planned for the annual outage, to proceed in parallel. At this
3 time, Unit 3 was recalled from its planned outage to provide generation to satisfy
4 system requirements.

5 • In parallel to the refurbishment work noted above, the cause of the failure of the ignitor
6 flex hoses was investigated. This was the first such incident on record at the plant. All of
7 the Unit 2 flexible hoses on the ignitor system were upgraded as required. This included
8 extending the rigid pipe in the corner that failed such that the gap could be spanned by
9 one flexible hose length. Two sections of flexible hose had been spliced together in the
10 area of the failure and this was concluded to be part of the reason for the failure. On
11 Unit 1, which was in operation at the time, additional clamps were installed to verify the
12 hoses were secure. During the annual 2017 outages all hoses on Unit 1 and Unit 2 were
13 positively secured to prevent this failure from reoccurring. Unit 3 is not of the same
14 design, does not have flexible ignitor air ducting, and is not susceptible to a similar
15 failure.

16 • On June 3, 2017 the unit tripped. The unit was returned to service a few hours later on
17 June 3, 2017 but was limited to 50 MW until the reason for the trip could be confirmed
18 and mitigated. A GE representative was brought to site to diagnose the problem and
19 determined that during the trip, the control valves closed while the governor was calling
20 for them to remain open. This pointed to three possibilities; loose wire, control card
21 failure, or servo failure. A card failure was ruled out since all other functions of the card
22 were working normally. The wires were tested with the unit at 25 MW and no issues
23 were found. An outage was then completed on June 8, 2017 to June 11, 2017 to replace
24 the servo and change out the hydraulic fluid and filters. During this same outage, the
25 turbine speed probe cables were replaced and probe clearance gaps were adjusted. This
26 corrected a reliability issue that previously occurred on November 18, 2016 and was
27 planned to be completed during the annual outage.

28 • On June 16, 2017, there was an incident on one of the two approximately 50% duty
29 boiler feed pumps. It appeared that some debris went through one of the bearings of

1 the west pump and caused a spike in temperature and vibration. The temperature and
2 vibration returned to normal, but the pump was taken out of service to change the oil
3 and clean out the lube oil tank. The unit was derated to 70 MW while the pump was out
4 of service. It was successfully tested and returned to service on June 17, 2017.

5 • On June 29, 2017, vibration and temperature excursions occurred on the same motor
6 inboard bearing. At this point failure of the bearing was suspected. The pump was again
7 taken out of service causing another derate to 70MW. Failure of the bearing was
8 confirmed and the spare boiler feed pump motor was brought to site and installed in
9 place of the motor with the failed bearing. This was the most expedient option to get
10 the pump back in service. This work was completed on July 2, 2017 and Unit 2 returned
11 to 165 MW capability. Additional checks have been added to pump rebuilds to check for
12 issues witnessed on this pump.

13 • Unit 2 was removed from service at the end of July 2017 to accommodate the planned
14 total plant outage and the unit annual maintenance outage. During the unit outage,
15 additional work was completed to address air flow issues. This included additional boiler
16 cleaning and air heater upgrades.

17 • Unit 2 returned from the annual planned outage and was placed on-line for
18 commissioning of new exciter controls on October 28, 2017 with a scheduled derating of
19 35 MW. Exciter commissioning was interrupted by two forced outages. From October
20 28, 2017 to October 30, 2017 the unit was taken off-line due to a combustion upset in
21 the boiler. The unit was returned to service with load restricted to 50 MW. It was
22 determined that the upset was due to incomplete set-up of a new fuel flow transmitter.
23 Set up of this transmitter was completed on November 2, 2017. From October 30, 2017
24 to November 1, 2017 the unit was removed from service to replace some oil-soaked
25 turbine insulation that resulted from a previously corrected oil leak at a turbine bearing.

26 • From November 3, 2017, until November 4, 2017 Unit 2 was derated to 70 and 110 MW
27 while completing commissioning of the new exciter controls. From November 4, 2017 to
28 November 8, 2017 the unit was derated to 150 MW while waiting for safety valve
29 testing to be completed. From November 8, 2017 to November 20, 2017, the unit was

1 rated to 165 MW until a leaking safety valve could be restored. This work required an
2 outage to complete. The unit was taken off-line on November 20, 2017, and returned to
3 service on November 24, 2017. An air heater wash was also completed during this
4 outage. A load test on November 28, 2017 revealed that the unit was capable of 160
5 MW, limited by high furnace pressure.

- 6 • On December 19, 2017, Unit 2 experienced a 14-hour deration to 70 MW as a result of a
7 trip of one forced draft fan on the unit. The cause of the fan trip was corrected and the
8 fan returned to service later that day in time for the evening peak, with the unit again
9 capable of 160 MW.

10

11 **6. Gas Turbine UFOP Performance**

12 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was 6.93%
13 for the 12-month period ending December 31, 2017 (see Table 6 and Figure 3). This is below the
14 base planning assumption of 10.62% and the near-term assumption of 20.00%. The current
15 period UFOP declined from the previous period UFOP of 9.35%. The Hardwoods UFOP for the
16 current period is 2.91%, which is better than the base planning assumption of 10.62%. The
17 Stephenville UFOP for the current period is 5.59%, which is better than the base planning
18 assumption of 10.62%. Happy Valley's UFOP is 19.32% for the current period compared to
19 5.03% in the previous period.

20

21 Hydro will begin using DAUFOP as a reliability measure in addition to UFOP going forward.
22 Beginning in January 2018, Hydro will report on the gas turbines using DAUFOP. Targets for this
23 measure will be set based on historical data as well as planned improvements. This was
24 discussed in Hydro's updated *Near-Term Generation Adequacy Report*, filed with the Board on
25 November 15, 2017.

Table 6 Gas Turbine UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending December 2016 (%)	12 months ending December 2017 (%)	Hydro Generation	
				Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Combined Gas Turbines	125	9.35	6.93	10.62	20.00
Stephenville	50	15.40	5.59	10.62	20.00
Hardwoods	50	7.83	2.91	10.62	20.00
Happy Valley	25	5.03	19.32	10.62	20.00

- 1 The Holyrood (HRD) GT UFOP of 2.02% for the current period is better than the base planning
- 2 and near-term 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 December 2016 (%)	12 months ending December 2017 (%)	Hydro Generation	
				Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	1.65	2.02	5.00	5.00

Quarterly Report on Performance of Generating Units

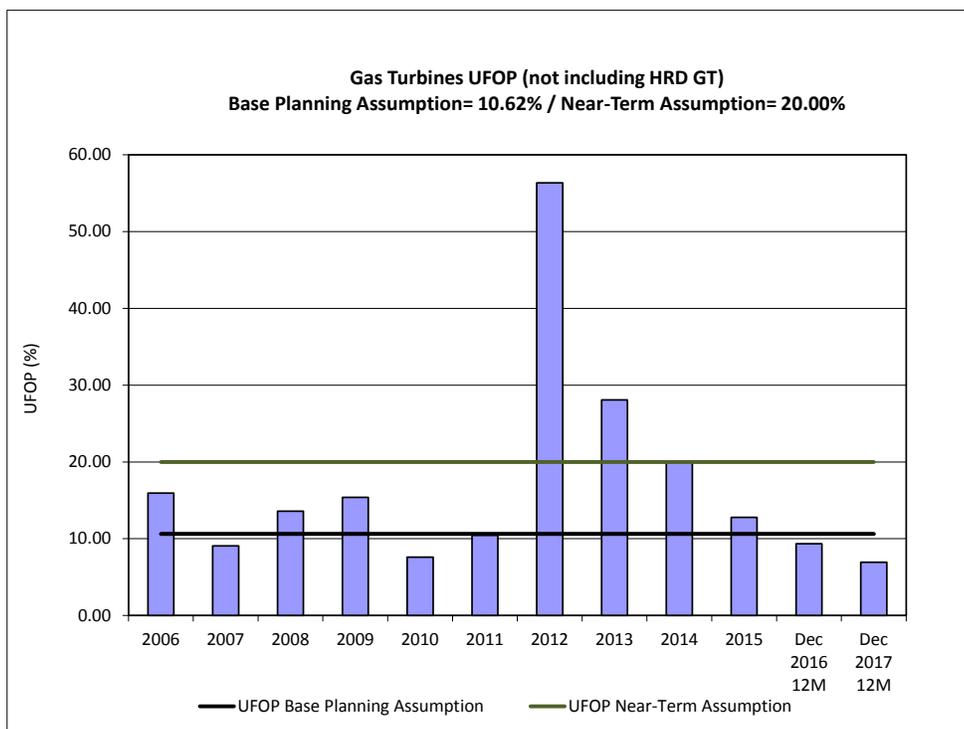


Figure 3 Gas Turbine UFOP – HWD/HVY/SVL Units

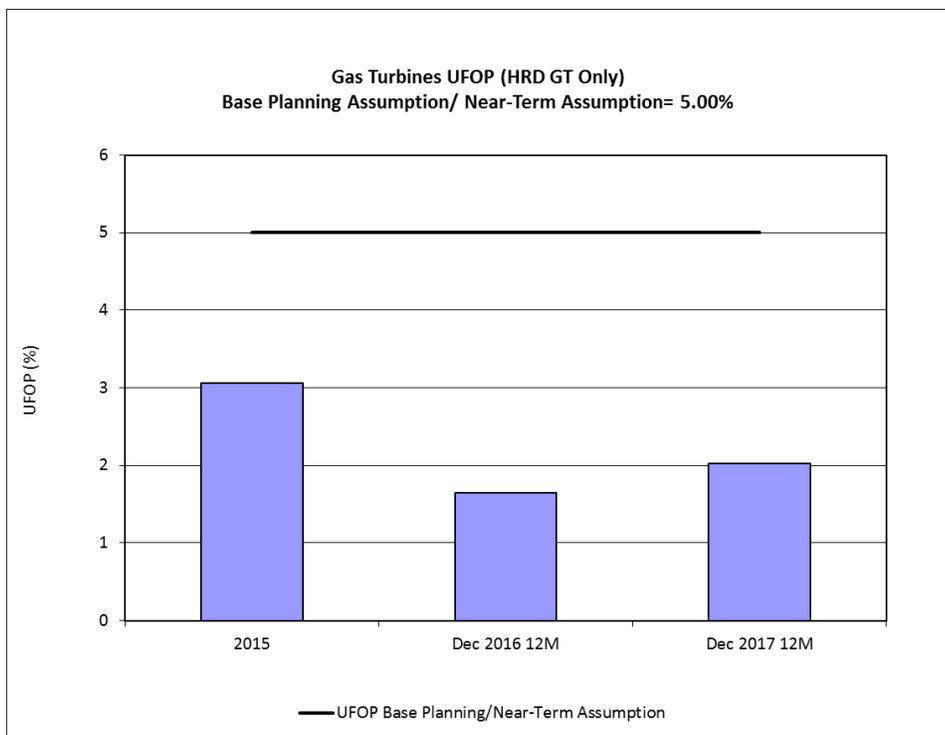


Figure 4 Gas Turbine UFOP – HRD Unit

1 On September 16, 2017, the Happy Valley gas turbine tripped when attempting a black start of
2 the unit to support an unplanned outage in the Happy Valley area. Hydro's investigation found
3 that the cause of the trip was related to the operation of a voltage protection relay in the
4 terminal station. Upon review of the relevant procedures, drawings, and settings it was
5 determined that a setting change was required to the protection relay. The setting was changed
6 and the unit was returned to service on September 21, 2017. During the investigation, it was
7 found, that prior to the trip, the power turbine had developed higher than normal vibration -
8 though it was not the cause of the trip. Further investigation of the higher than normal
9 vibration found the source to be a high temperature exhaust gas leak from the power turbine.
10 Repairs were made to the power turbine and vibration levels returned to normal on October 7,
11 2017.

12
13 On October 15, 2017 the Happy Valley gas turbine experienced a trip while operating at near
14 full load. Hydro's investigation determined that the trip was the result of the failure of an
15 emergency shutoff valve solenoid. The failure of the solenoid caused the 3-way valve to divert
16 some fuel away from the engine as is its design. The reduced fuel flow to the engine caused the
17 engine to be unable to sustain the required load and this resulted in the unit shutting down. A
18 replacement solenoid was sourced, and when received the valve was repaired and the engine
19 was released for service on November 9, 2017.



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April 30, 2018

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

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

A handwritten signature in blue ink, appearing to read 'Michael Ladha', written over a horizontal line.

Michael Ladha
Legal Counsel & Assistant Corporate Secretary
MSL/skc

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey
Danny Dumaresque
ecc: Dennis Fleming – Cox & Palmer
Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Dennis Browne, Q.C. – Browne, Fitzgerald, Morgan & Avis
Dean Porter – Poole Althouse

Larry Bartlett – Teck Resources Limited

Quarterly Report on Performance of Generating Units
For the Quarter ended March 31, 2018

April 30, 2018

A Report to the Board of Commissioners of Public Utilities

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1 **1.0 Introduction**

2 In this report, Newfoundland and Labrador Hydro (Hydro) provides data on forced outage rates
3 of its generating facilities. This data is provided in relation to historical forced outage rates and
4 in relation to assumptions used for system planning purposes.

5

6 The forced outage rates are provided for individual generating units at hydraulic facilities; the
7 three units at the Holyrood Thermal Generating Station; and Hydro's gas turbines for the
8 current 12-month reporting period of April 1, 2017 to March 31, 2018. The report also provides,
9 for comparison purposes, the individual generating unit data on forced outage rates for the
10 previous period April 1, 2016 to March 31, 2017. Further, total asset class data is presented on
11 an annual basis for the years 2006-2016. This report provides data on outage rates for forced
12 outages, not planned outages.

13

14 The forced outage rates of Hydro's generating units are presented using three measures: (i)
15 Derated Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units; (ii)
16 Utilization Forced Outage Probability (UFOP) for the gas turbines; and (iii) Derated Adjusted
17 Utilization Forced Outage Probability (DAUFOP)¹ for the gas turbines.

18

19 Derated Adjusted Forced Outage Rate (DAFOR) is a metric that measures the percentage of the
20 time that a unit or group of units is unable to generate at its maximum continuous rating due to
21 forced outages. The DAFOR for each unit is weighted to reflect differences in generating unit
22 sizes in order to provide a company total and reflect the relative impact a unit's performance
23 has on overall generating performance. This measure is applied to hydraulic and thermal units.
24 However, this measure is not applicable to gas turbines because of their operation as standby
25 units, and relatively low operating hours.

¹ First report in which DAUFOP is reported.

1 Utilization Forced Outage Probability (UFOP) is a metric that measures the percentage of time
2 that a unit or group of units will encounter a forced outage and not be available when required.
3 This metric is used for the gas turbines.

4

5 Derated Adjusted Utilization Forced Outage Probability (DAUFOP) is also a metric that measures
6 the percentage of time that a unit or group of units will encounter a forced outage and not be
7 available when required, but also includes impact of unit deratings. This metric is used for the
8 gas turbines.

9

10 The forced outage rates include outages that remove a unit from service completely, as well as
11 instances when units are derated. If a unit's output is reduced by more than 2%, the unit is
12 considered derated by Canadian Electricity Association (CEA) guidelines. Per CEA guidelines, to
13 take into account the derated levels of a generating unit, the operating time at the derated
14 level is converted into an equivalent outage time.

15

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

1 **2.0 Period Ending March 31, 2018 Overview**

Table 1: DAFOR, UFOP, and DAUFOP Overview

Class of Units	April 1, 2016 to March 31, 2017 (%)	April 1, 2017 to March 31, 2018 (%)	Base Planning Assumption ² (%)	Near-term Planning Assumption ³ (%)
Hydraulic (DAFOR)	5.55	2.13	0.90	2.60
Thermal (DAFOR)	13.96	24.10	9.64	14.00
Gas Turbine (Combined) (UFOP)	12.32	7.26	10.62	20.00
Gas Turbine (Holyrood) (UFOP)	2.24	0.07	5.00	5.00
Gas Turbine (Combined) (DAUFOP)	33.37	20.93	-	30.00
Gas Turbine Holyrood) (DAUFOP)	2.24	0.07	-	5.00

2 There was an improvement in hydraulic DAFOR and a decline in thermal DAFOR performance
3 for the current 12-month period ending March 2018, compared to the previous 12-month
4 period ending March 2017 (see Table 1). The combined⁴ gas turbine UFOP and DAUFOP
5 performance shows an improvement in performance for the current period compared to the
6 previous period.

7

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

11 For the Holyrood thermal units, the forced outage rate of the current period ending March
12 2018 is 24.10%, which is above the base planning assumption of 9.64%, the sensitivity of

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 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.

1 11.64%, and above the near-term planning assumption of 14.00%.⁵ This is primarily caused by
2 an airflow derating on Unit 1 and Unit 2 that continued in 2017 and an extended forced outage
3 on Unit 1 in February 2018.

4

5 Hydro's combined gas turbines' UFOP in the 10-year period prior to 2015 was generally
6 consistent at approximately 10% until the year 2012 when the rate exceeded 50%. Since 2012,
7 the UFOP has been improving each year. For the current 12-month period ending March 31,
8 2018, performance was affected by forced outages to the Hardwoods, Happy Valley, and
9 Stephenville units.

10

11 Note that the data for 2006 to 2016 in Figures 1, 2, and 3 are annual numbers (January 1 to
12 December 31), while the data for 2017 and 2018 are 12-month rolling numbers (April 1 to
13 March 31 for each year).

14

15 **3.0 Generation Planning Assumptions**

16 The DAFOR and UFOP indicators used in Hydro's generation planning model are representative
17 of a historic average of the actual performance of these units. These numbers are noted in
18 Table 2 under the column "Base Planning Assumption." This is a long term outlook.

19

20 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation planning
21 analysis. This number takes into account a higher level of unavailability, should it occur, to
22 assess the impact of higher unavailability of these units on overall generation requirements.
23 During the 12-month period ending March 31, 2018, the gas turbine units performed well
24 within this sensitivity range for UFOP, while both the hydraulic and thermal classes performed
25 outside of the sensitivity range for DAFOR.

⁵ 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.

1 The new gas turbine (Holyrood GT) has a lower expected rate of unavailability than the original
 2 gas turbines (5% compared to 10.62%) due to the fact that the unit is new and can be expected
 3 to have better availability than the older units.⁶

4

5 Hydro’s generation long term planning assumptions for DAFOR and UFOP for the year 2018 are
 6 noted in Table 2.

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

7 As part of Hydro’s analysis of energy supply up to Muskrat Falls interconnection, Hydro
 8 completes comprehensive reviews of, and produces reports on, energy supply for the Island
 9 Interconnected System. The Near-Term Generation Adequacy Report, filed on November 15,
 10 2017, contains analysis based on the near-term DAFOR and DAUFOP and the resulting
 11 implication for meeting reliability criteria until the interconnection with the North American
 12 grid. In the November report, Hydro used the DAUFOP metric as the measure of gas turbine
 13 unit reliability into the near term. In 2018, Hydro will be measuring and reporting using
 14 DAUFOP and UFOP for the gas turbines.

15

16 The DAFOR and DAUFOP assumptions used in developing Hydro’s November 2017 Near-term
 17 Generation Adequacy Report are noted in Table 3.

⁶ 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)*.

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

	DAFOR (%)	DAUFOP (%)
	Near-term Generation Adequacy Assumption	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	
Holyrood Unit 1	15.0	
Holyrood Unit 2	10.0	
Holyrood Unit 3	18.0	
Hardwoods & Stephenville Gas Turbines		30.0
Holyrood Gas Turbine		5.0

1 **4.0 Hydraulic Unit Forced Outage Rate Performance**

2 The hydraulic unit-forced outage rates are measured using the CEA metric, DAFOR. Detailed
 3 results for the 12-month period ending March 31, 2018, are presented in Table 4, as well as the
 4 data for the 12-month period ending March 31, 2017. These are compared to Hydro’s short-
 5 term generation adequacy assumptions, as used in the Near-term Generation Adequacy Report,
 6 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 2017 (%)	12 months ending March 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
All Hydraulic Units - weighted	954.4	5.55	2.13	0.90	2.60
Hydraulic Units					
Bay D'Espoir 1	76.5	30.54	8.86	0.90	3.90
Bay D'Espoir 2	76.5	31.30	13.79	0.90	3.90
Bay D'Espoir 3	76.5	0.02	0.01	0.90	3.90
Bay D'Espoir 4	76.5	0.69	0.29	0.90	3.90
Bay D'Espoir 5	76.5	0.48	0.00	0.90	3.90
Bay D'Espoir 6	76.5	1.31	0.00	0.90	3.90
Bay D'Espoir 7	154.4	0.00	1.80	0.90	3.90
Cat Arm 1	67	1.02	0.22	0.90	0.70
Cat Arm 2	67	0.00	0.09	0.90	0.70
Hinds Lake	75	0.25	0.87	0.90	0.70
Upper Salmon	84	0.91	0.05	0.90	0.70
Granite Canal	40	1.16	0.11	0.90	0.70
Paradise River	8	6.94	1.45	0.90	0.70

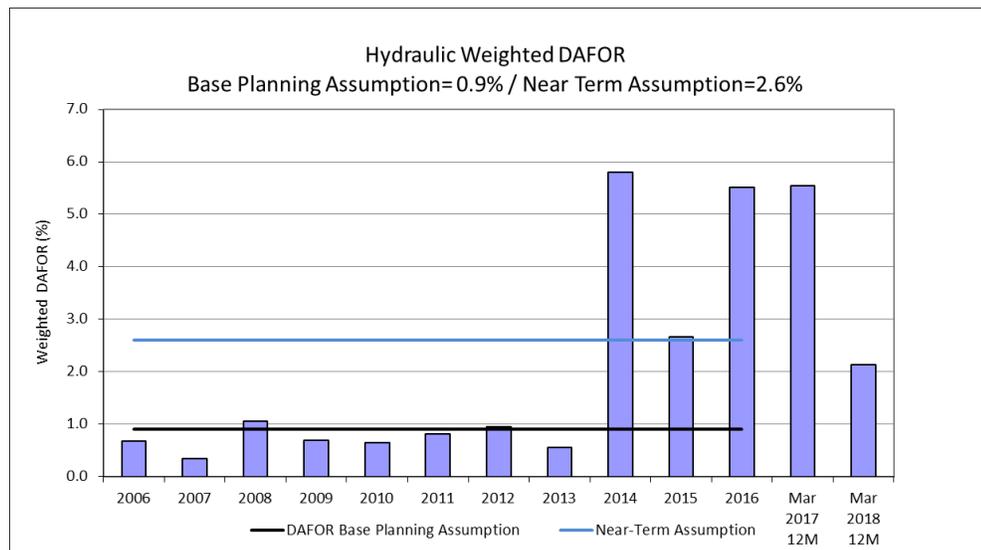


Figure 1: Hydraulic Weighted DAFOR

- 1 Considering the individual units' performance, the assumed Hydro generation base planning
- 2 DAFOR was materially exceeded for Bay d'Espoir Unit 1 and Bay d'Espoir Unit 2. Also, there
- 3 were exceedances compared to base planning assumption for Bay d'Espoir Unit 7, and Paradise
- 4 River for the current period.

1 The Bay d’Espoir Unit 1 DAFOR of 8.86% and Unit 2 DAFOR of 13.79% exceeded the base
2 planning assumption of 0.9% and the near-term assumption of 3.9% for an individual Bay
3 d’Espoir unit. This was due to Units 1 and 2 being removed from service on November 4, 2017
4 as a result of a leak in Penstock 1, which provides water to both units. The leak occurred in the
5 same area where similar leaks had occurred in 2016 which initiated further investigation and
6 subsequent refurbishment. A consultant was engaged in the process to provide engineering
7 analysis and recommendations to return the penstock to reliable service. Extensive inspection
8 and testing was completed, which resulted in the damaged section being completely removed,
9 and replaced with a new plate that was overlaid with a second plate; all additional suspect
10 areas were also cleaned, re-welded, and overlaid with additional plates; and additional backfill
11 was placed over a section of the ruptured area, as this had been part of the approved capital
12 plan resulting from the 2016 leak. The draft report of findings and analysis has been received
13 and is presently being reviewed. The penstock was returned to service on December 8, 2017.

14

15 The Bay d’Espoir Unit 7 DAFOR of 1.80% exceeded the base planning assumption of 0.9% and is
16 less than the near-term assumption of 3.9% for an individual Bay d’Espoir unit, as a result of the
17 unit being unavailable from July 3, 2017 to July 9, 2017 due to a failure in the collector assembly
18 which caused the unit protection to operate and isolate the unit from the system. An
19 investigation was completed, and it was determined that there was a flash-over between
20 the positive and negative slip rings which was caused by excessive brush wear. The
21 investigation was completed and improvements to the preventative maintenance (PM)
22 program have been implemented across the hydraulic generation fleet of assets. As a short-
23 term measure, all brush gear assemblies had an additional inspection completed prior to
24 December 1, 2017 and no issues were found.

25

26 The Paradise River Unit DAFOR of 1.45% exceeded the base planning assumption of 0.9% and
27 the near-term assumption of 0.7%, primarily as a result of outages from May 23, 2017 to May
28 25, 2017. The Unit tripped off on May 23, 2017 shortly after being synchronized to the system
29 and loaded to 8 MW. Several attempts to return the unit to service were unsuccessful, which

1 resulted in the unit being unavailable until the investigation was completed. The investigation
 2 determined the trip was a result of a high generator terminal voltage, attributed to TL 212
 3 being out of service. The condition was rectified by adjusting the generator excitation voltage,
 4 and the Unit was returned to service on May 25, 2017. There have been no recurrence of
 5 events relating to this issue since that time, and this issue is now considered to be resolved.

6
 7 **5.0 Thermal Unit Forced Outage Rate Performance**

8 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 9 results for the 12-month period ending March 31, 2018, are presented in Table 5, as well as the
 10 data for the 12-month period ending March 31, 2017. These are compared to Hydro’s short-
 11 term generation adequacy assumptions, as used in the Near-term Generation Adequacy Report,
 12 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 2017 (%)	12 months ending March 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
<i>All Thermal Units - weighted</i>	490	13.96	24.10	9.64	14.00
Thermal Units					
Holyrood 1	170	20.49	31.66	9.64	15.00
Holyrood 2	170	14.92	25.36	9.64	10.00
Holyrood 3	150	3.06	14.03	9.64	18.00

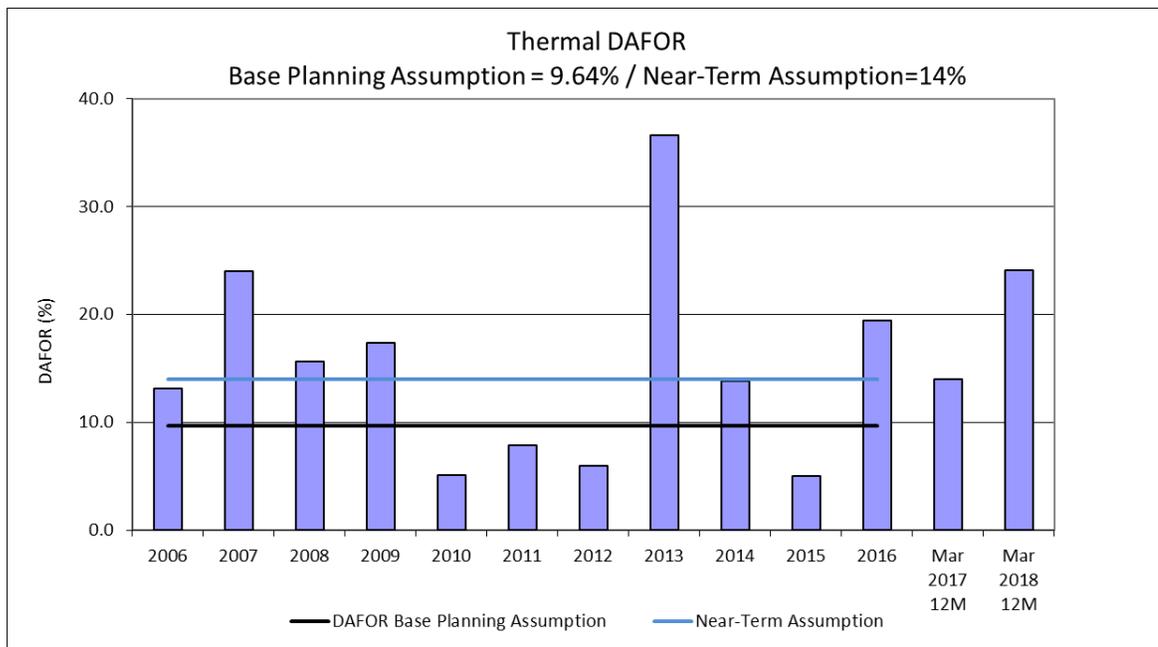


Figure 2: Thermal DAFOR

1 For the 12-month period ending March 31, 2018, the weighted DAFOR for all thermal units of
 2 24.90% is above the assumed Hydro generation base planning DAFOR value of 9.64% and the
 3 near-term assumption of 14.00%⁷. Unit 1 DAFOR was 31.66% and Unit 2 DAFOR was
 4 25.36%. The performance for both Units 1 and 2 was above the base planning assumption of
 5 9.64% and the near-term assumption of 15% (Unit 1) and 10% (Unit 2). Unit 3 DAFOR was
 6 14.03%, which is above the base planning assumption of 9.64% but below the near-term
 7 assumption of 18.0%.

8

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

- 11 • The 2017 maintenance outage on Unit 1 was from July 5, 2017 until September 11,
 12 2017. The Unit was put online on September 17, 2017 to allow for online
 13 commissioning of the new exciter controls system by the original equipment
 14 manufacturer, ABB. The Unit tripped at 70 MW on September 18, 2017 during

⁷ See Hydro's Near-term Generation Adequacy Report, November 15, 2017, section 7.0 for results discussing Holyrood plant DAFOR at 15% compared to 14%. Plant DAFOR of 15% does result in minor differences only, and these differences result only in the extreme sensitivity cases, not the expected system operating cases.

1 commissioning of the new exciter controls on that unit. The Unit was derated to 50
2 MW (below UFLS) until September 21, 2017, when the cause of the trip was
3 determined. This was to ensure that any further trips would not impact customers.
4 Investigation determined that this trip, which happened when starting a boiler feed
5 pump, was due to low unit board voltages. Starting the pump caused the already
6 low voltage to drop below acceptable levels and this appropriately engaged under
7 voltage protection and a unit trip. Voltages had been reduced intentionally as part of
8 the exciter commissioning and were not returned to normal levels prior to starting
9 the pump. This issue has been addressed with commissioning activities to ensure
10 that it will not reoccur.

11 • Unit 1 tripped on October 5, 2017 and was derated to a precautionary load of 35
12 MW, while the reason for the trip was being investigated and corrected. It was
13 determined that the trip was caused by frayed wires in one of the forced draft (FD)
14 fan motors and, following repairs, the Unit was returned to full capability on October
15 10, 2017.

16 • From October 17, 2017 to October 22, 2017, the Unit was derated to 154 MW due
17 to low steam pressure while waiting for safety valve testing to be completed. The
18 safety valve testing was completed on October 24, 2017, but the Unit was further
19 derated to 145 MW from October 22, 2017 to October 24, 2017 and to 135 MW
20 until the end of the month due to overheating motor windings in the west FD fan.
21 Plans were established to replace this motor after completion of Unit 2 exciter
22 commissioning. The spare motor was brought to site and the winding temperature
23 was monitored regularly for changes. The spare motor was installed during an
24 outage from November 7, 2017 to November 11, 2017. The Unit was returned to
25 service on November 12, 2017 but remained derated to 145 MW due to high
26 furnace pressure.

27 • On November 14, 2017 the Unit was taken offline to repair a piping leak at the
28 condenser flash tank. This was repaired and the Unit returned to service on

- 1 November 15, 2017. However another leak developed in the area and the Unit was
2 removed from service on November 15, 2017 for 12 hours for repair.
- 3 • Unit 1 remained limited to 145 MW until it was taken offline on November 30, 2017
4 to perform an air heater wash and additional maintenance. The Unit was returned to
5 service on December 4, 2017, after completion of a maintenance outage to perform
6 an air heater wash and additional maintenance work to restore capacity. This
7 included a pressure wash of the top air heater baskets. A load test completed on
8 December 5, 2017, confirmed a capacity of 150 MW⁸ with the Unit load limited by
9 high furnace pressure.
 - 10 • On January 3, 2018 the Unit capability was reduced from 150 to 135 MW as a result
11 of oscillations in the turbine control valve hydraulic ram. An outage was taken from
12 January 5, 2018 to January 6, 2016 to replace a loose control cable on the hydraulic
13 ram and to complete an air heater wash. After this work, the load was restored to
14 145 MW, limited by high furnace pressure, and it was observed that the control
15 valve oscillations had not been eliminated. On January 18, 2018 the oscillations had
16 increased and the load was reduced to 140 MW as a result. On January 20, 2018 the
17 Unit was taken offline to replace another control cable as recommended by GE to
18 resolve the oscillation issue. While the Unit was offline for this work, the boiler stop
19 valve failed, which resulted in an extension to the outage. The Unit remained offline
20 until February 2, 2018 while stop valve refurbishment was ongoing. During this time,
21 the hydraulic ram was removed from the turbine and sent off site for refurbishment
22 to ensure that the oscillation problem had been resolved. Also a high pressure wash
23 was completed on the air heater baskets to 12,500 psi.
 - 24 • The outage due to the boiler stop valve failure extended from January 20, 2018 until
25 February 21, 2017, following several solutions attempted to address the leak. On

⁸ Hydro continues to work towards restoring full load on all three units. Hydro set up an engineering team to work with the boiler service provider and other industry experts. This team has recommended replacement of air heater baskets on all three units, correction of excessive air heater leakage on Unit 3, cleaning of economizers on Unit 1 and Unit 2, and use of fuel additive on all three units to prevent continued fouling. These recommendations address the issues of high furnace pressure in Unit 1 and Unit 2 and the issues of high air heater fouling and air flow limitations on Unit 3. They are currently being pursued with the intent to complete this work during the 2018 annual overhauls.

- 1 February 21, 2018, the stop valve work was complete and the Unit was returned to
2 service.
- 3 • On February 22, 2018 the Unit had to be taken offline due to a turbine bearing issue.
4 Lube oil had leaked, undetected, from the bearing during the stop valve outage. This
5 led to a smoldering underneath the bearing when the components heated up. The
6 contaminated insulation was replaced and close inspection of the bearing confirmed
7 no active leak. The Unit was returned to service on February 25, 2018.
 - 8 • On February 28, 2018 a load test was completed to 148 MW, with load limited by
9 high furnace pressure due to boiler and air heater fouling. By the end of March this
10 capability had reduced to 137 MW as a result of continued fouling in the boiler and
11 air heaters.
 - 12 • There were two unit trips related to forced draft fan variable frequency drive trips.
13 These occurred on March 19, 2018 and March 26, 2018. In both instances the Unit
14 was returned to service using replacement parts from inventory. During the outage
15 related to the March 19, 2018 trip, a problem with the Mark V turbine governor
16 system was also resolved. Hydro is continuing to work towards resolving the
17 problems with variable frequency drive reliability.

18
19 The DAFOR performance for Holyrood Unit 2 (170 MW) was primarily affected by the following
20 events:

- 21 • On April 22, 2017 there was a brief outage required to repair a section of flexible
22 ductwork on the ignitor air system that had failed during start-up after the boiler
23 cleaning outage.
- 24 • On May 1, 2017, the Unit experienced a forced outage when a section of flexible
25 ductwork adjacent to the location that failed on April 22, 2017, also failed and
26 allowed hot gas to escape from the boiler. This hot gas caused a cable tray fire
27 adjacent to the north east corner of the boiler on the second floor. Refurbishment
28 work was completed by May 28, 2017 and included asbestos abatement, as loose
29 asbestos fibres were found in the cable tray. While the Unit was offline for repairs,

1 work protection permits were issued to allow other work that was planned for the
2 annual outage, to proceed in parallel. Also, Unit 3 was recalled from its planned
3 outage to provide generation to satisfy system requirements.

4 • In parallel to the refurbishment work noted above, the cause of the failure of the
5 ignitor flex hoses was investigated. This was the first such incident on record at the
6 plant. All of the Unit 2 flexible hoses on the ignitor system were upgraded as
7 required. This included extending the rigid pipe in the corner that failed such that
8 the gap could be spanned by one flexible hose length. Two lengths had been spliced
9 together in the area of the failure and this was concluded to be part of the reason
10 for the failure. On Unit 1, which was in operation at the time, additional clamps were
11 installed to ensure the hoses were secure. During the annual 2017 outages, all hoses
12 on Unit 1 and Unit 2 were positively secured to ensure this failure cannot reoccur.
13 Unit 3 is not of the same design, does not have flexible ignitor air ducting, and thus is
14 not susceptible to a similar failure.

15 • On June 3, 2017, Unit 2 tripped. The Unit was returned to service a few hours later
16 but was limited to 50 MW until the reason for the trip could be confirmed and
17 mitigated. A GE representative was brought to site to diagnose the problem and
18 determined that, during the trip, the control valves closed while the governor was
19 calling for them to remain open. This pointed to three possibilities; (i) loose wire; (ii)
20 control card failure; or (iii) servo failure. A card failure was ruled out since all other
21 functions of the card were working normally. The wires were tested with the Unit at
22 25 MW and no issues were found. An outage was then completed on June 8, 2017
23 to June 11, 2017 to replace the servo and change out the hydraulic fluid and filters.
24 During this same outage, the turbine speed probe cables were replaced and probe
25 clearance gaps were adjusted. This corrected a reliability issue that previously
26 occurred on November 18, 2016 and was planned to be done during the annual
27 outage.

28 • On June 16, 2017, there was an issue with one of the two approximately 50% duty
29 boiler feed pumps. It appeared that some debris went through one of the bearings

1 of the west pump and caused a spike in temperature and vibration. The temperature
2 and vibration returned to normal, but the pump was taken out of service to change
3 the oil and clean out the lube oil tank. The Unit was derated to 70 MW while the
4 pump was out of service. It was successfully tested and returned to service on June
5 17, 2017.

6 • On June 29, 2017, vibration and temperature excursions occurred on same the
7 motor inboard bearing. At this point failure of the bearing was suspected. The pump
8 was again taken out of service causing another derate to 70MW. Failure of the
9 bearing was confirmed and the spare boiler feed pump motor was brought to site
10 and installed in place of the motor with the failed bearing. This was the most
11 expedient option to get the pump back in service. This work was completed on July
12 2, 2017 and the Unit returned to 165 MW capability. Additional checks have been
13 added to pump rebuilds to check for the issues experienced on this pump.

14 • Unit 2 was removed from service at the end of July to accommodate the planned
15 total plant outage and the unit annual maintenance outage. During the Unit outage,
16 additional work was completed to address air flow issues. This included additional
17 boiler cleaning and air heater upgrades.

18 • The Unit returned from the annual planned outage and was placed online for
19 commissioning of new exciter controls on October 28, 2017 with a scheduled
20 derating of 35 MW. Exciter commissioning was interrupted by two forced outages.
21 From October 28, 2017 to October 30, 2017 the Unit was taken offline due to a
22 combustion upset in the boiler. The Unit was returned to service with load restricted
23 to 50 MW. It was determined that the upset was due incomplete setup of a new fuel
24 flow transmitter. Setup of this transmitter was completed on November 2, 2017.
25 Also, from October 30, 2017 to November 1, 2017 the Unit was removed from
26 service to replace some oil-soaked turbine insulation that resulted from an oil leak at
27 a turbine bearing.

28 • From November 3, 2017, until November 4, 2017 the Unit was derated to 70 MW
29 and then to 110 MW while completing commissioning of the new exciter controls.

- 1 From November 4, 2017 to November 8, 2017 the Unit was derated to 150 MW
2 while waiting for safety valve testing to be completed. From November 8, 2017 to
3 November 20, 2017, the Unit was derated to 165 MW until a leaking safety valve
4 could be restored. This work required an outage to complete. The Unit was taken
5 offline on November 20, 2017, and returned to service on November 24, 2017. An
6 air heater wash was also completed during this outage. A load test on November 28,
7 2017 revealed that the Unit was capable of 160 MW, limited by high furnace
8 pressure.
- 9 • On December 19, 2017, the Unit experienced a 14 hour deration to 70 MW as a
10 result of a trip of one forced draft fan on the Unit. The cause of the fan trip was
11 corrected and the fan returned to service later that day in time for the evening peak,
12 with the Unit again capable of 160 MW.
 - 13 • The capability of the Unit continued to decline due to ongoing fouling during
14 operation. On January 4, 2018 the capability had reduced to 154 MW. On January
15 25, 2018 the capability had reduced to 135 MW due to high furnace pressure as a
16 result of boiler and air heater fouling. On February 14, 2018 the capability had
17 reduced to 117 MW. At the end of February the capability had reduced to 100 MW.
18 System requirements, given the issues with Unit 1, had precluded an air heater wash
19 on this Unit during the month of February 2018. An air heater wash was completed
20 from March 5, 2018 to March 6, 2018 however this was not successful in restoring
21 any load. By the end of March 2018, the Unit capability had reduced to 90 MW as a
22 result of continued boiler and air heater fouling during operation.
 - 23 • On February 7, 2018 the Unit was taken offline for a short, planned outage to
24 replace generator brushes. There was a forced extension to this outage when a unit
25 board breaker tripped during restart of the Unit. Electricians were called in to reset
26 the breaker.
 - 27 • The Unit was further derated to 70 MW from March 1, 2018 to March 2, 2018 due to
28 an issue with the west boiler feed pump. A water leak from a line nearby caused

1 contamination of the pump lube oil and the pump was taken offline until the repairs
2 were completed.

- 3 • On March 22, 2018, one of the turbine reheat intercept valves became stuck during
4 regular online testing and the Unit had to be taken offline for approximately eight
5 hours to replace the valve servos. Hydraulic fluid contamination will be addressed
6 during the annual outage to prevent recurrence.

7

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

- 10 • On December 13, 2017, Unit 3 was derated to 135 MW as a result of air flow issues.
11 The Unit capability declined steadily to 105 MW until an air heater wash could be
12 completed on December 31, 2017. The wash was successful in restoring the load to
13 131 MW. The available load continued to decline due to ongoing air heater fouling.
14 On January 18, 2018 the available load was determined to be 120 MW and on
15 February 10, 2018 this had further reduced to 100 MW. An air heater wash outage
16 was completed from February 10, 2018 to February 11, 2018. System requirements,
17 with Unit 1 already offline, had precluded an air heater wash on this Unit until that
18 time. When the Unit was returned to service there was a derating to 70 MW for
19 approximately 10 hours when the west boiler feed pump failed to start.
- 20 • This was resolved and the available load was determined to be 110 MW, still limited
21 by air heater fouling. The Unit was capable of 100 MW at the beginning of March
22 2018. This capability had further reduced to 75 MW on March 20, 2018. An air
23 heater wash outage was completed on March 28, 2018 and the predicted load after
24 this wash was 110 MW. This Unit was not required for the system, and was left on
25 standby until the planned unit outage in early April 2018.
- 26 • On January 11, 2018, a ¾" diameter domestic water pipe located above the Unit 3
27 exciter ruptured at a cap and the resulting water leak contacted the exciter causing a
28 unit trip. There was no significant equipment damage resulting from this incident
29 and once the exciter was safely dried, the Unit was returned to service on January

12, 2018. This event was investigated and the leak was 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 due to 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.

6.0 Gas Turbine UFOP Performance

The combined UFOP for the Hardwoods (HWD), Happy Valley (HVY), and Stephenville (SVL) gas turbines was 7.26% for the 12-month period ending March 31, 2018 (see Table 6). This is below the base planning assumption of 10.62%, and the near-term assumption of 20.00%. The current period UFOP declined from the previous period UFOP of 12.32%. The Hardwoods UFOP for the current period is 1.09%, which is better than the base planning assumption of 10.62%. The Stephenville UFOP for the current period is 5.57%, which is better than the base planning assumption of 10.62%. Happy Valley’s UFOP is 20.87% for the current period compared to 2.61% in the previous period.

Table 6: Gas Turbine UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2017 (%)	12 months ending March 2018 (%)	Hydro Generation	
				Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Combined Gas Turbines	125	12.32	7.26	10.62	20.00
Stephenville	50	15.96	5.57	10.62	20.00
Hardwoods	50	15.97	1.09	10.62	20.00
Happy Valley	25	2.61	20.87	10.62	20.00

The Holyrood (HRD) GT UFOP of 0.07% for the current period is better than the base planning and near-term assumptions of 5.00% (see Table 7).

Performance of Generating Units

Table 7: Holyrood GT UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2017 (%)	12 months ending March 2018 (%)	Hydro Generation	
				Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	2.24	0.07	5.00	5.00

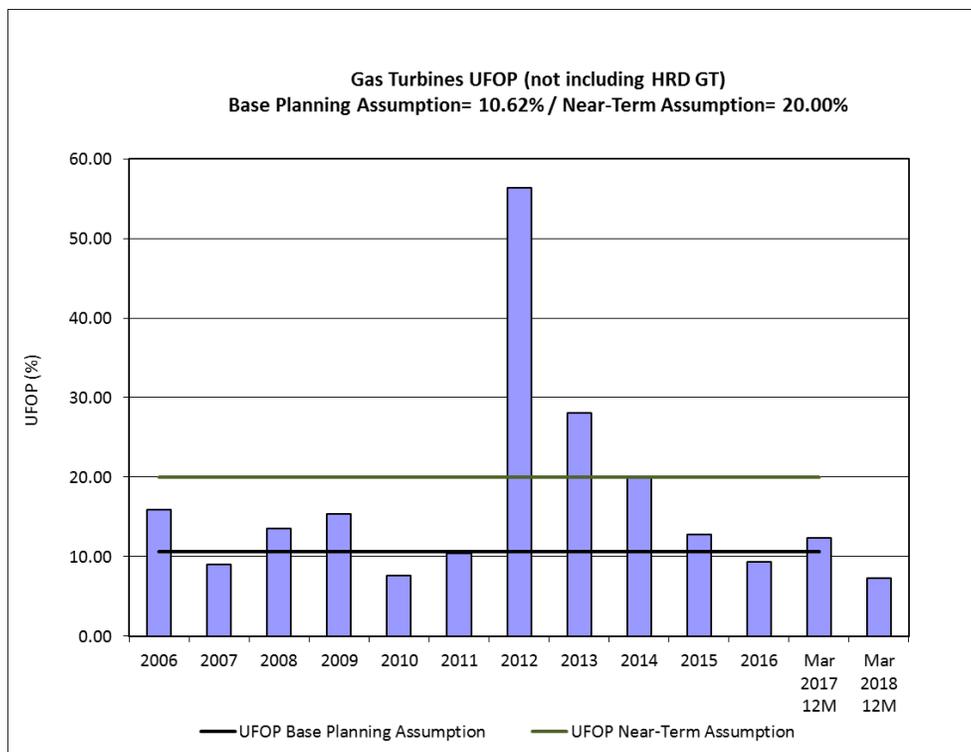


Figure 3: Gas Turbine UFOP – HWD/HVY/SVL Units

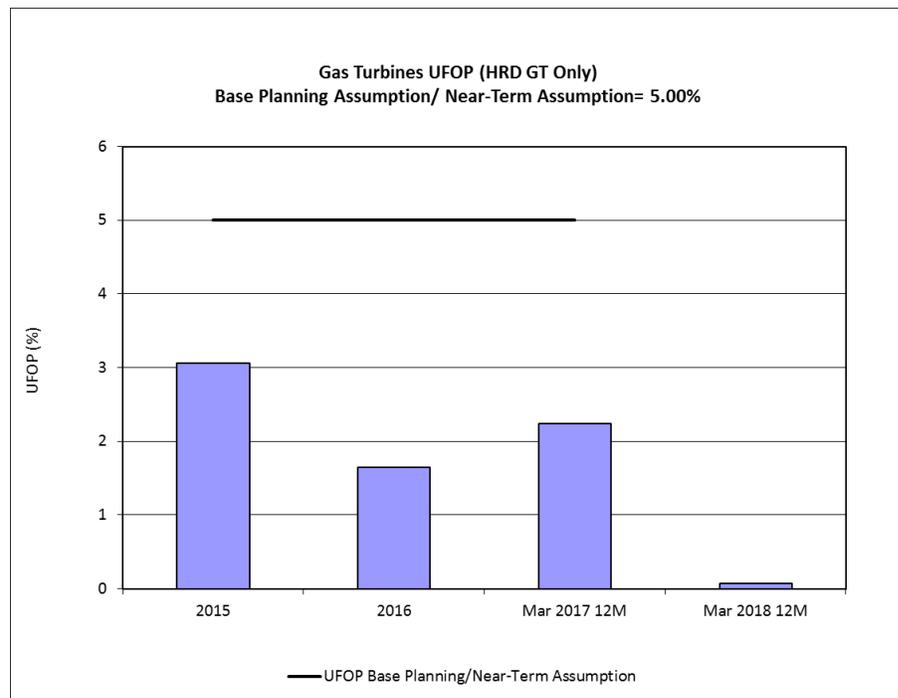


Figure 4: Gas Turbine UFOP – HRD Unit

1 On September 16, 2017 the Happy Valley Gas Turbine tripped when attempting a black start of
2 the unit to support an unplanned outage in the Happy Valley area. Hydro’s investigation found
3 that the cause of the trip was related to the operation of a voltage protection relay in the
4 terminal station. Upon review of the relevant procedures, drawings and settings it was
5 determined that a setting change was required to the protection relay. The setting was changed
6 and the Unit was returned to service on September 21, 2017. During the investigation, it was
7 found that prior to the trip the power turbine had developed higher than normal vibration,
8 though it was not the cause of the trip. Further investigation of the higher than normal
9 vibration found the source to be a high temperature exhaust gas leak from the power turbine.
10 Repairs were made and vibration levels returned to normal on October 7, 2017.

11

12 On October 15, 2017 the Happy Valley Gas Turbine experienced a trip while operating at near-
13 full load. Hydro’s investigation determined that the trip was the result of the failure of an
14 emergency fuel shutoff valve solenoid. The failure of the solenoid caused the three-way valve
15 to divert some fuel away from the engine as is its design. The reduced fuel flow to the engine

1 caused the engine to be unable to sustain the required load and this resulted in the unit
 2 shutting down. A replacement solenoid was sourced, and when received the valve was
 3 repaired and the engine was released for service on November 9, 2017.

4

5 **7.0 Gas Turbine DAUFOP Performance**

6 The combined DAUFOP for the Hardwoods, Happy Valley, and Stephenville gas turbines was
 7 20.93% for the 12-month period ending March 31, 2018 (see Table 8). This is below the near-
 8 term assumption of 30.00%. The Hardwoods DAUFOP for the current period is 5.01%, which is
 9 significantly better than the near-term assumption of 30.00%. The Stephenville UFOP for the
 10 current period is 52.11%, which is above the near-term assumption of 30.00%. Happy Valley’s
 11 DAUFOP is 20.87% which is below the near-term assumption of 30.00%.

Table 8: Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2017 (%)	12 months ending March 2018 (%)	Near-Term Planning Assumption (%)
Combined Gas Turbines	125	33.37	20.93	30.00
Stephenville	50	46.46	52.11	30.00
Hardwoods	50	32.79	5.01	30.00
Happy Valley	25	2.61	20.87	30.00

12 The Holyrood (HRD) GT DAUFOP of 0.07% for the current period is better than the near-term
 13 assumptions of 5.00% (see Table 9).

Table 9: Holyrood GT DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending March 2017 (%)	12 months ending March 2018 (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	2.24	0.07	5.00

Performance of Generating Units

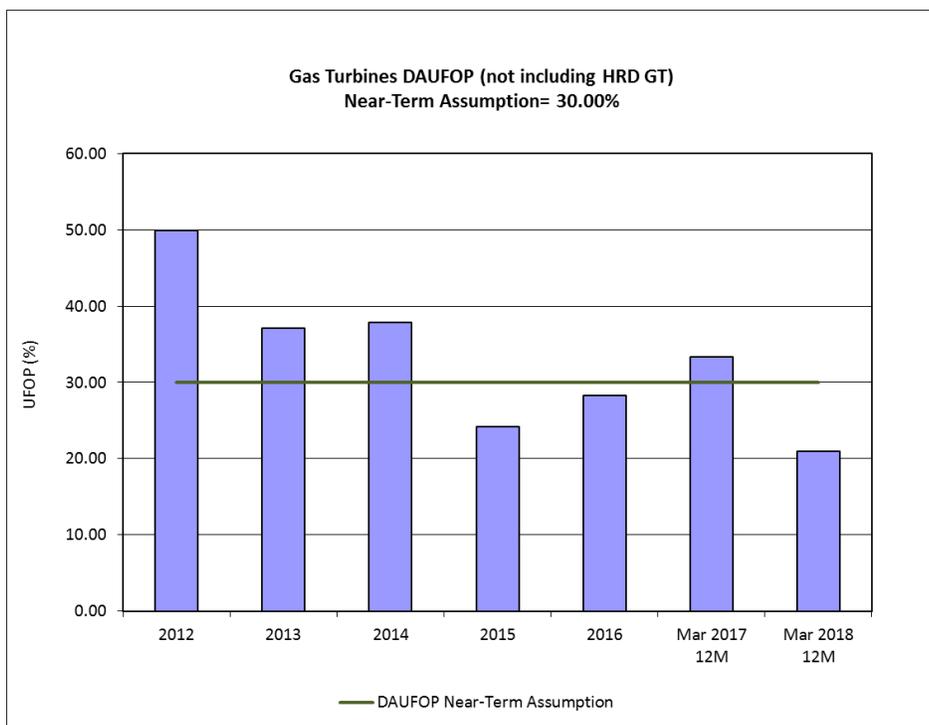


Figure 5: Gas Turbine DAUFOP – HWD/HVY/SVL Units

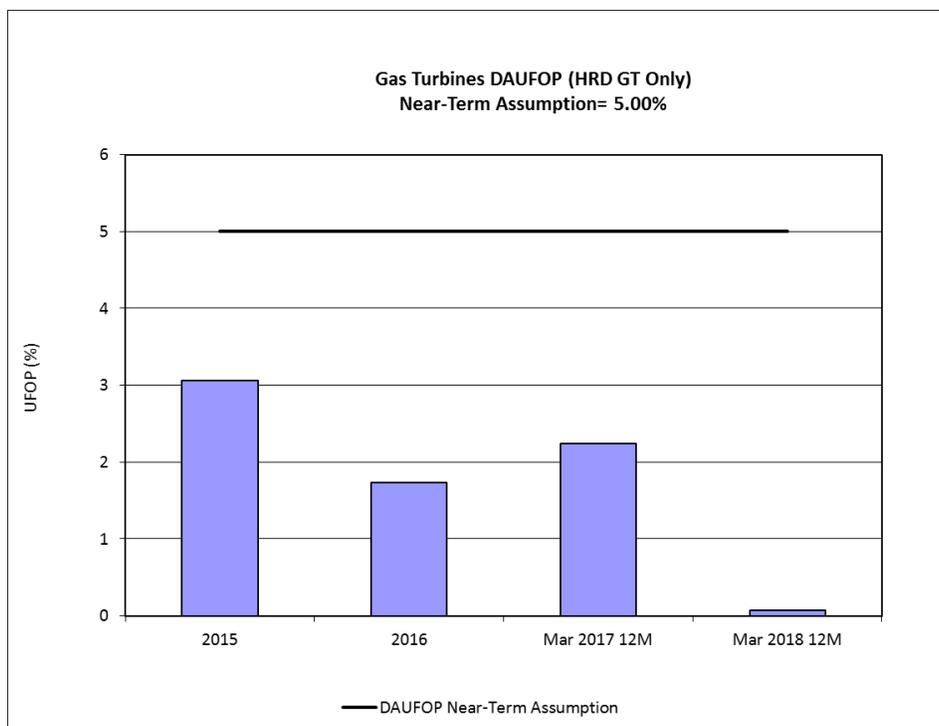


Figure 6: Gas Turbine DAUFOP – HRD Unit

1 The Stephenville Gas Turbine DAUFOP for the period is impacted by the unavailability of End A
2 as a result of an exhaust bellows failure at Hardwoods Gas Turbine End A on December 28,
3 2017. End A was unavailable at this time due to issues with the power turbine rear bearing
4 which requires the bearing to be replaced. Hydro decided to remove the bellows from End A at
5 Stephenville and install it at Hardwoods End A to return that Unit to full capacity. It is currently
6 expected that the Stephenville Gas Turbine will be returned to full capacity at the end of July
7 2018.



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July 30, 2018

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

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

A handwritten signature in blue ink, appearing to read 'Michael Ladha', written over a horizontal line.

Michael Ladha
Legal Counsel & Assistant Corporate Secretary
MSL/sk

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey
Danny Dumaresque
ecc: Dennis Fleming – Cox & Palmer
Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Dennis Browne, Q.C. – Browne, Fitzgerald, Morgan & Avis
Dean Porter – Poole Althouse
Larry Bartlett – Teck Resources Limited

Quarterly Report on Performance of Generating Units
For the Quarter ended June 30, 2018

July 30, 2018

A Report to the Board of Commissioners of Public Utilities

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1 **1.0 Introduction**

2 In this report, Newfoundland and Labrador Hydro (Hydro) provides data on forced outage rates
3 of its generating facilities. This data is provided in relation to historical forced outage rates and
4 assumptions used for system planning purposes.

5

6 The forced outage rates are provided for the 12-month periods of July 1, 2017 to June 30, 2018
7 and July 1, 2016 to June 30, 2017 and reflect the generating units associated with:

- 8 • hydraulic generation facilities;
9 • Holyrood Thermal Generating Station; and
10 • gas turbines.

11

12 Reporting on the prior 12-month period is included for comparison purposes. Additionally,
13 total asset class data is presented on an annual basis for the years 2006-2016. This report
14 provides data on outage rates for forced outages, not planned outages.

15

16 The forced outage rates of Hydro's generating units are presented using three measures:

- 17 1. Derated Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units;
18 2. Utilization Forced Outage Probability (UFOP) for the gas turbines; and
19 3. Derated Adjusted Utilization Forced Outage Probability (DAUFOP) for the gas turbines.

20

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

25 This measure is applied to hydraulic and thermal units. This measure is not applicable to gas
26 turbines due to their operation as standby units and relatively low operating hours.

1 UFOP is a metric that measures the percentage of time that a unit or group of units will
2 encounter a forced outage and not be available when required. This metric is used for the gas
3 turbines.

4

5 DAUFOP is also a metric that measures the percentage of time that a unit or group of units will
6 encounter a forced outage and not be available when required, but also includes impact of unit
7 deratings. This metric is used for the gas turbines.

8

9 The forced outage rates include outages that remove a unit from service completely, as well as
10 instances when units are derated. If a unit's output is reduced by more than 2%, the unit is
11 considered derated by Canadian Electricity Association (CEA) guidelines. Per CEA guidelines, to
12 take into account the derated levels of a generating unit, the operating time at the derated
13 level is converted into an equivalent outage time.

14

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

1 **2.0 Period Ending June 30, 2018 Overview**

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

Class of Units	July 1, 2016 to June 30, 2017	July 1, 2017 to June 30, 2018	Base Planning Assumption ¹	Near-Term Planning Assumption ²
Hydraulic (DAFOR)	4.85	2.04	0.90	2.60
Thermal (DAFOR)	15.27	26.22	9.64	14.00
Gas Turbine (Combined) (UFOP)	8.68	6.78	10.62	20.00
Gas Turbine (Holyrood) (UFOP)	2.46	0.06	5.00	5.00
Gas Turbine (Combined) (DAUFOP)	8.68	24.11	-	30.00
Gas Turbine (Holyrood) (DAUFOP)	2.46	0.06	-	5.00

2 There was an improvement in hydraulic DAFOR and a decline in thermal DAFOR performance
3 for the current 12-month period ending June 2018, compared to the previous 12-month period
4 ending June 2017 (Table 1). The combined³ gas turbine UFOP performance shows an
5 improvement in performance for the current period compared to the previous period, while
6 DAUFOP shows a decline in performance.

¹ 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.

² Near-term Generation Adequacy Report, November 15, 2017, refer to section 5.0 for further details.

³ Combined Gas Turbines include the Hardwoods, Happy Valley, and Stephenville units. The performance of the Holyrood Gas Turbine was not included in the combined base planning or sensitivity numbers as these numbers were set prior to the Holyrood Gas Turbine's in service date.

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

4

5 For the Holyrood thermal units, the forced outage rate of the current period ending June 2018
6 is 26.22%, which is above the base planning assumption of 9.64%, the sensitivity of 11.64%, and
7 above the near-term planning assumption of 14.00%⁴. This is primarily caused by an airflow
8 derating on Unit 1 and Unit 2 that continued in 2017 and 2018 and an extended forced outage
9 on Unit 1 in February 2018.

10

11 The current Holyrood period DAFOR is not an indicator of what to expect for the coming winter
12 season due to the work being completed to improve the unit's performance for airflow
13 limitations. With an interest in shortening Holyrood generating hours (operating time) to avail
14 of more economic purchased electricity, there will be less operating hours in the upcoming fall.
15 The lower operating hours has the effect of negatively impacting the DAFOR calculation as
16 compared to having the units on.

17

18 Hydro's combined gas turbines' UFOP in the 10-year period prior to 2015 was generally
19 consistent at approximately 10% until the year 2012 when the rate exceeded 50%. Since 2012,
20 the UFOP has been improving each year. For the current 12-month period ending June 30,
21 2018, performance was affected by forced outages to the Hardwoods, Happy Valley, and
22 Stephenville units.

23

24 Note that the data for 2006 to 2016 in Figure 1, Figure 2, and Figure 3 are annual numbers
25 (January 1 to December 31), while the data for 2017 and 2018 are 12-month rolling numbers
26 (July 1 to June 30 for each year).

⁴ 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.

1 **3.0 Generation Planning Assumptions**

2 The DAFOR and UFOP indicators used in Hydro’s generation planning model are representative
3 of a historic average of the actual performance of these units. These numbers are noted in
4 Table 2 under the column “Base Planning Assumption”. This is a long-term outlook. The Base
5 Planning Assumptions are under review as part of the 2018 reliability review work ongoing and
6 this review is being reported to the Board as part of Phase 2 of the Outage Inquiry.

7
8 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation planning
9 analysis. This number takes into account a higher level of unavailability, should it occur, to
10 assess the impact of higher unavailability of these units on overall generation requirements.
11 During the 12-month period ending June 30, 2018, the gas turbine units performed well within
12 this sensitivity range for UFOP, while both the hydraulic and thermal classes performed outside
13 of the sensitivity range for DAFOR.

14
15 The Holyrood gas turbine has a lower expected rate of unavailability than the original gas
16 turbines (5% compared to 10.62%) due to the fact that the unit is considered relatively new and
17 can be expected to have better availability than the older units.⁵

18
19 Hydro’s generation long-term planning assumptions for DAFOR and UFOP for the year 2018 are
20 noted in Table 2.

Table 2: 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

⁵ 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)*.

1 As part of Hydro’s analysis of energy supply up to Muskrat Falls interconnection, Hydro
 2 completes comprehensive reviews of, and produces reports on, energy supply for the Island
 3 Interconnected System. The Near-Term Generation Adequacy report, filed on November 15,
 4 2017, contains analysis based on the near-term DAFOR and DAUFOP and the resulting
 5 implication for meeting reliability criteria until the interconnection with the North American
 6 grid. In the November report, Hydro used the DAUFOP metric as the measure of gas turbine
 7 unit reliability into the near term. In 2018, Hydro will be measuring and reporting using
 8 DAUFOP and UFOP for the gas turbines.

9

10 The DAFOR and DAUFOP assumptions used in developing Hydro’s November 2017 Near-term
 11 Generation Adequacy report are noted in Table 3.

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

	DAFOR (%)	DAUFOP (%)
	Near-Term Generation Adequacy Assumption	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	
Holyrood Unit 1	15.0	
Holyrood Unit 2	10.0	
Holyrood Unit 3	18.0	
Hardwoods and Stephenville Gas Turbines		30.0
Holyrood Gas Turbine		5.0

1 **4.0 Hydraulic Unit Forced Outage Rate Performance**

2 The hydraulic unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
3 results for the 12-month period ending June 30, 2018, are presented in Table 4, as well as the
4 data for the 12-month period ending June 30, 2017. These are compared to Hydro’s short term
5 generation adequacy assumptions, as used in the Near-term Generation Adequacy report, and
6 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 June 2017 (%)	12 months ending June 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
<i>All Hydraulic Units - weighted</i>	954.4	4.85	2.04	0.90	2.60
Hydraulic Units					
Bay D'Espoir 1	76.5	23.04	8.67	0.90	3.90
Bay D'Espoir 2	76.5	26.75	12.41	0.90	3.90
Bay D'Espoir 3	76.5	0.02	0.01	0.90	3.90
Bay D'Espoir 4	76.5	0.97	0.15	0.90	3.90
Bay D'Espoir 5	76.5	0.00	0.00	0.90	3.90
Bay D'Espoir 6	76.5	1.30	0.21	0.90	3.90
Bay D'Espoir 7	154.4	0.00	1.80	0.90	3.90
Cat Arm 1	67	1.02	0.22	0.90	0.70
Cat Arm 2	67	0.00	0.09	0.90	0.70
Hinds Lake	75	1.14	0.02	0.90	0.70
Upper Salmon	84	0.86	0.16	0.90	0.70
Granite Canal	40	1.15	0.15	0.90	0.70
Paradise River	8	7.58	0.69	0.90	0.70

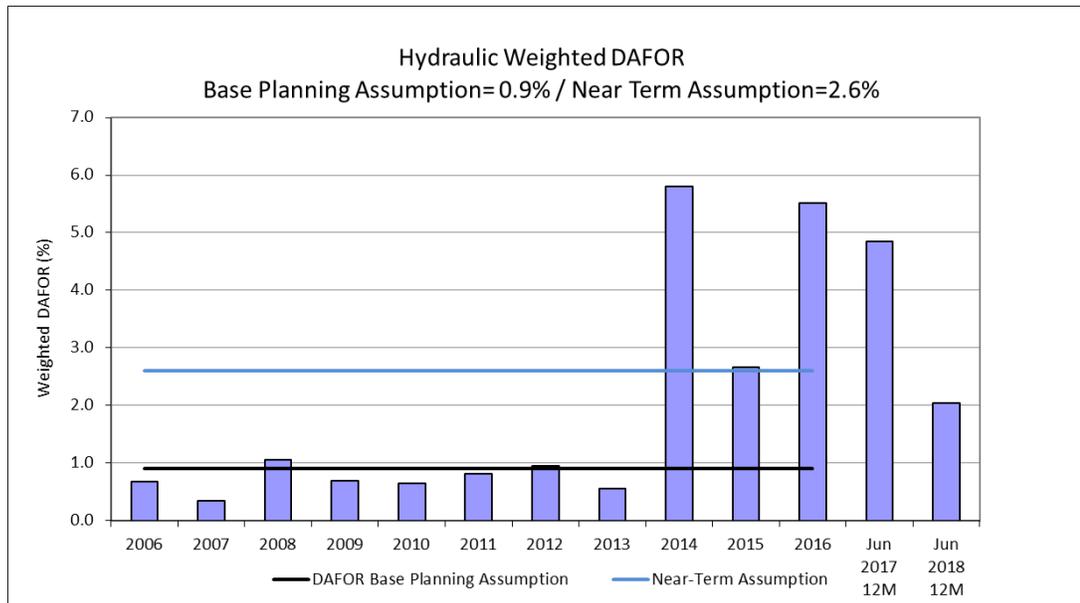


Figure 1: Hydraulic Weighted DAFOR

1 Considering the individual units' performance, the assumed Hydro generation base planning
 2 DAFOR was materially exceeded for Bay d'Espoir Unit 1 and Bay d'Espoir Unit 2. Also, there
 3 were exceedances compared to base planning assumption for Bay d'Espoir Unit 7 for the
 4 current period.

5

6 The Bay d'Espoir Unit 1 DAFOR of 8.67% and Unit 2 DAFOR of 12.41%, exceeded the base
 7 planning assumption of 0.9% and the near-term assumption of 3.9% for an individual Bay
 8 d'Espoir unit. This was due to Units 1 and 2 being removed from service on November 4, 2017
 9 as a result of a leak in Penstock 1, which provides water to both units. A consultant was
 10 engaged in the process to provide engineering analysis and recommendations to return the
 11 penstock to reliable service. Extensive inspection and testing was completed, which resulted in
 12 the damaged section being replaced. All additional suspect areas were also cleaned and
 13 refurbished and additional backfill was placed over a section of the ruptured area as this had
 14 been part of the approved capital plan resulting from the 2016 leak. Findings from the final

1 root cause report are being implemented and the Board approved Condition Assessment work⁶
2 is currently underway. The penstock was returned to service on December 8, 2017.

3

4 The Bay d’Espoir Unit 7 DAFOR of 1.80% exceeded the base planning assumption of 0.9% and is
5 less than the near-term assumption of 3.9% for an individual Bay d’Espoir unit, as a result of the
6 unit being unavailable from July 3, 2017, to July 9, 2017, due to a failure in the collector
7 assembly. An investigation was completed, and it was determined that there was a flash over
8 between the slip rings, which was caused by excessive brush wear. As a result of the
9 investigation, improvements to the preventive maintenance (PM) program have been
10 implemented across the hydraulic generation fleet of assets. As a result of this event, all brush
11 gear assemblies had an additional inspection completed prior to December 1, 2017 and no
12 issues were found.

13

14 **5.0 Thermal Unit Forced Outage Rate Performance**

15 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
16 results for the 12-month period ending June 30, 2018, are presented in Table 5, as well as the
17 data for the 12-month period ending June 30, 2017. These are compared to Hydro’s short-term
18 generation adequacy assumptions, as used in the Near-term Generation Adequacy report, and
19 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 June 2017 (%)	12 months ending June 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
<i>All Thermal Units - weighted</i>	490	15.27	26.22	9.64	14.00
Thermal Units					
Holyrood 1	170	21.33	32.30	9.64	15.00
Holyrood 2	170	19.57	26.62	9.64	10.00
Holyrood 3	150	3.29	16.60	9.64	18.00

⁶ P.U. 23(2018).

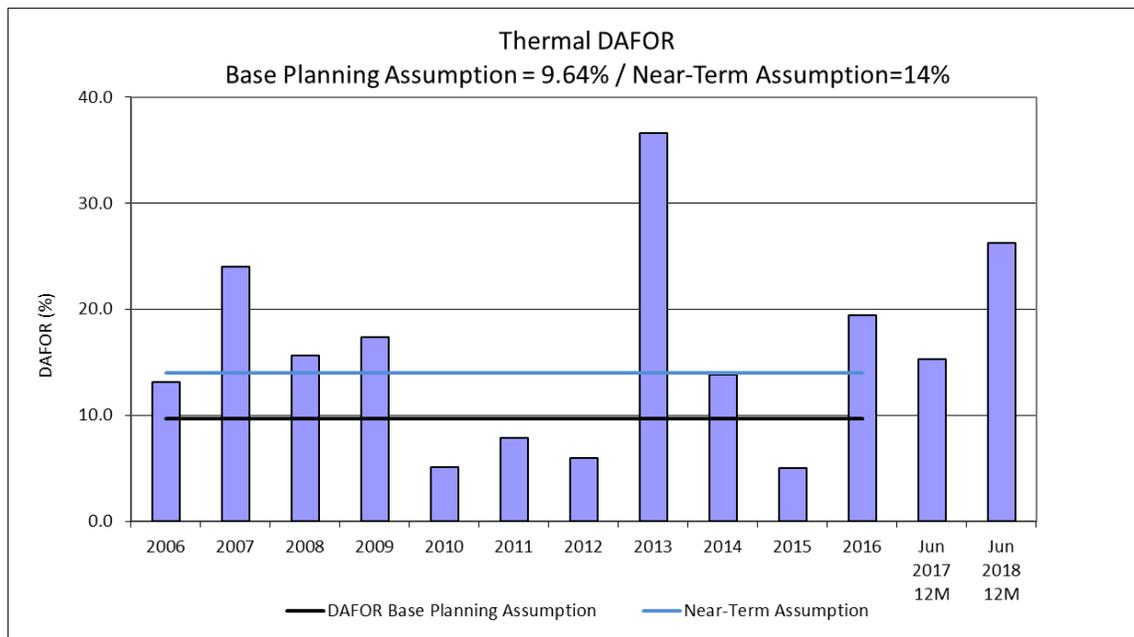


Figure 2: Thermal DAFOR

1 For the 12-month period ending June 31, 2018, the weighted DAFOR of 26.22% for all thermal
 2 units is above the assumed Hydro generation base planning DAFOR value of 9.64%, and the
 3 near-term assumption of 14.00%.⁷ Unit 1 DAFOR was 32.30% and Unit 2 DAFOR was 26.62%.
 4 The performance for both Units 1 and 2 was above the base planning assumption of 9.64% and
 5 the near-term assumption of 15% (Unit 1) and 10% (Unit 2). Unit 3 DAFOR was 16.60%, which
 6 is above the base planning assumption of 9.64% but below the near-term assumption of 18.0%.

7

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

- 10 • The 2017 maintenance outage on Unit 1 was from July 5, 2017 until September 11,
 11 2017. The unit was put on-line on September 17, 2017 to allow for on-line
 12 commissioning of the new exciter controls system by the original equipment
 13 manufacturer, ABB. The unit tripped at 70 MW on September 18, 2017 during
 14 commissioning of the new exciter controls on that unit. The unit was de-rated to 50 MW

⁷ See Hydro's Near-term Generation Adequacy Report, November 15, 2017, section 7.0 for results discussing Holyrood plant DAFOR at 15% compared to 14%. Plant DAFOR of 15% does result in minor differences only, and these differences result only in the extreme sensitivity cases, not the expected system operating cases.

1 (below under frequency load shedding limits) until September 21, 2017, when the cause
2 of the trip was determined. This was to ensure that any further trips would not impact
3 customers. An investigation determined that this trip, which happened when starting a
4 boiler feed pump, was due to low unit board voltages. Starting the pump caused the
5 already low voltage to drop below acceptable levels and this appropriately engaged
6 under voltage protection and a unit trip. Voltages had been reduced intentionally as
7 part of the exciter commissioning and were not returned to normal levels prior to
8 starting the pump. This issue has been addressed with commissioning activities to
9 ensure that it will not reoccur.

- 10 • Unit 1 tripped on October 5, 2017 and was de-rated to a precautionary load of 35 MW,
11 while the reason for the trip was being investigated and corrected. It was determined
12 that the trip was caused by frayed wires in one of the forced draft fan motors and,
13 following repairs, the unit was returned to full capability on October 10, 2017.
- 14 • From October 17, 2017 to October 22, 2017, the Unit was de-rated to 154 MW due to
15 low steam pressure while waiting for safety valve testing to be completed. The safety
16 valve testing was completed on October 24, 2017, but the Unit was further de-rated to
17 145 MW from October 22, 2017 to October 24, 2017 and to 135 MW until the end of the
18 month due to overheating motor windings in the west forced draft fan. Plans were
19 established to replace this motor after completion of Unit 2 exciter commissioning. The
20 spare motor was brought to site and the winding temperature was monitored regularly
21 for changes. The spare motor was installed during an outage from November 7, 2017 to
22 November 11, 2017. The Unit was returned to service on November 12, 2017 but
23 remained de-rated to 145 MW due to high furnace pressure.
- 24 • On November 14, 2017 the Unit was taken off-line to repair a piping leak at the
25 condenser flash tank. This was repaired and the Unit returned to service on November
26 15, 2017. However another leak developed in the area and the Unit was removed from
27 service on November 15, 2017 for 12 hours for repair.
- 28 • Unit 1 remained limited to 145 MW until it was taken off-line on November 30, 2017 to
29 perform an air heater wash and additional maintenance. The Unit was returned to

- 1 service on December 4, 2017, after completion of a maintenance outage to perform an
2 air heater wash and additional maintenance work to restore capacity. This included a
3 pressure wash of the top air heater baskets. A load test completed on December 5, 2017
4 confirmed a capacity of 150 MW⁸ with the unit load limited by high furnace pressure.
- 5 • On January 3, 2018 the Unit capability was reduced from 150 to 135 MW as a result of
6 oscillations in the turbine control valve hydraulic ram. An outage was taken from
7 January 5 to 6 to replace a loose control cable on the hydraulic ram and to complete an air
8 heater wash. After this work the load was restored to 145 MW, limited by high furnace
9 pressure, and it was noted that the control valve oscillations had not been eliminated.
10 On January 18, 2018 the oscillations had increased and the load was reduced to 140
11 MW as a result. On January 20, 2018 the Unit was taken off-line to replace another
12 control cable as recommended by GE to resolve the oscillation issue. While the Unit was
13 off-line for this work the boiler stop valve failed, which resulted in an extension to the
14 outage. The Unit remained off-line until February 2, 2018 while stop valve
15 refurbishment was ongoing. During this time, the hydraulic ram was removed from the
16 turbine and sent off-site for refurbishment to ensure that the oscillation problem had
17 been resolved. Also, a high pressure wash was completed on the air heater baskets to
18 12,500 psi.
 - 19 • The outage due to the boiler stop valve failure extended from January 20, 2018 until
20 February 21, 2018, following several solutions which attempted to address the leak. On
21 February 21, 2018 the stop valve work was complete and the unit was returned to
22 service.
 - 23 • On February 22, 2018 the Unit had to be taken off-line due to a turbine bearing issue.
24 Lube oil had leaked, undetected, from the bearing during the stop valve outage. This led
25 to a smoldering underneath the bearing when the components heated. The

⁸ Hydro continues to work towards restoring full load on all three units. Hydro set up an engineering team to work with the boiler service provider and other industry experts. This team has recommended replacement of air heater baskets on all three units, correction of excessive air heater leakage on Unit 3, cleaning of economizers on Unit 1 and Unit 2, and use of fuel additive on all three units to prevent continued fouling. These recommendations address the issues of high furnace pressure in Unit 1 and Unit 2 and the issues of high air heater fouling and air flow limitations on Unit 3. They are currently being pursued with the intent to complete this work during the 2018 annual overhauls.

- 1 contaminated insulation was replaced and an inspection of the bearing confirmed no
2 active leak. The Unit was returned to service on February 25, 2018.
- 3 • On February 28, 2018 a load test was completed to 148 MW, with load limited by high
4 furnace pressure due to boiler and air heater fouling. By the end of March 2018 the
5 Unit's capability had reduced to 137 MW as a result of continued fouling in the boiler
6 and air heaters.
 - 7 • There were two unit trips related to forced draft fan variable frequency draft trips.
8 These occurred on March 19, 2018 and March 26, 2018. In both instances the Unit was
9 returned to service using replacement parts from inventory. During the outage related
10 to the March 19, 2018 trip, a problem with the Mark V turbine governor system was
11 also resolved. Hydro is continuing to work towards resolving the problems with variable
12 frequency drive reliability.
 - 13 • On April 12, 2018 the load was reduced to 126 MW, limited by high furnace pressure as
14 a result of continued boiler and air heater fouling. The capability of the unit continued
15 to decline for the same reason. On May 6, 2018 the unit capability was 122 MW and on
16 May 15, 2018 it was 116 MW.
 - 17 • On May 21, 2018 the unit tripped at 70 MW on high boiler drum level. The cause was
18 suspected to be a trip of the east boiler feed pump, which caused unstable water level
19 in the drum and led to the trip. The unit was returned to service later that same day
20 with only the west boiler feed pump in service and the load restricted temporarily to 70
21 MW until the health of the east pump was verified. The Unit was returned to 116 MW
22 on May 21, 2018 once the health of the east pump was verified. The pump was ruled
23 out as the cause of the trip, and the cause was determined to be a failure of a turbine
24 control valve stem. There is a scheduled turbine valve outage in 2018 and the contractor
25 will replace the stem as part of this project.
 - 26 • On June 4, 2018 the Unit was further de-rated to 100 MW, limited by high furnace
27 pressure as a result of on-going boiler and air heater fouling. By the end of June this had
28 further reduced to 88 MW.

- 1 • On June 16, 2018, while on a brief planned outage to change worn generator brushes, a
2 pressure gauge failed on the fuel oil system resulting in a spill that had to be cleaned up
3 before the Unit could be safely returned to service. On June 17, 2018 while starting up
4 the unit, a bearing failed on the east forced draft fan and required replacement. The
5 Unit was returned to service on June 18, 2018; however, the same bearing failed after a
6 few hours of operation. The bearing was again replaced and the Unit was successfully
7 returned to service on June 19, 2018. Hydro has made arrangements for a field
8 representative from the fan original equipment manufacturer to assist with the failure
9 analysis once the Unit is removed from service for the annual outage.

10

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

- 13 • Unit 2 was removed from service at the end of July 2017 to accommodate the planned
14 total plant outage and the Unit annual maintenance outage. During the Unit outage,
15 additional work was completed to address air flow issues. This included additional boiler
16 cleaning and air heater upgrades.
- 17 • The Unit returned from the annual planned outage and was placed on-line for
18 commissioning of new exciter controls on October 28, 2017 with a scheduled de-rating
19 of 35 MW. Exciter commissioning was interrupted by two forced outages. From October
20 28, 2017 to October 30, 2017 the Unit was taken off-line due to a combustion upset in
21 the boiler. The Unit was returned to service with load restricted to 50 MW. It was
22 determined that the upset was due to the incomplete set-up of a new fuel flow
23 transmitter. Set-up of the transmitter was completed on November 2, 2017. Also, from
24 October 30, 2017 to November 1, 2017 the Unit was removed from service to replace
25 oil-soaked turbine insulation that resulted from an oil leak at a turbine bearing.
- 26 • From November 3, 2017 until November 4, 2017, the Unit was de-rated to 70 MW and
27 subsequently to 110 MW while completing commissioning of the new exciter controls.
28 From November 4, 2017 to November 8, 2017, the Unit was de-rated to 150 MW while
29 waiting for safety valve testing to be completed. From November 8, 2017 to November

- 1 20, 2017, the Unit was de-rated to 165 MW until a leaking safety valve could be
2 restored. To complete this work an outage was required. The Unit was taken off-line on
3 November 20, 2017 and returned to service on November 24, 2017. An air heater wash
4 was also completed during this outage. A load test on November 28, 2017 revealed that
5 the Unit was capable of 160 MW, limited by high furnace pressure.
- 6 • On December 19, 2017, the Unit experienced a 14-hour deration to 70 MW as a result of
7 a trip of one forced draft fan on the unit. The cause of the fan trip was corrected and the
8 fan returned to service later that day in time for the evening peak, with the unit again
9 capable of 160 MW.
 - 10 • The capability of the Unit continued to decline due to ongoing fouling during operation.
11 On January 4, 2018, the capability had reduced to 154 MW. On January 25, 2018, the
12 capability had reduced to 135 MW due to high furnace pressure as a result of boiler and
13 air heater fouling. On February 14, 2018, the capability had reduced to 117 MW. At the
14 end of February the capability had reduced to 100 MW. System requirements, given the
15 issues with Unit 1, had precluded an air heater wash on this Unit during the month of
16 February 2018. An air heater wash was completed from March 5, 2018 to March 6,
17 2018; however, this was not successful in restoring any load. By the end of March 2018,
18 the Unit capability had reduced to 90 MW as a result of continued boiler and air heater
19 fouling during operation.
 - 20 • On February 7, 2018, the Unit was taken offline for a short, planned outage to replace
21 generator brushes. There was a forced extension to this outage when a unit board
22 breaker tripped during restart of the Unit. Electricians were called in to reset the
23 breaker.
 - 24 • The Unit was further de-rated to 70 MW from March 1, 2018 to March 2, 2018 due to
25 an issue with the west boiler feed pump. A water leak from a reference line nearby
26 caused contamination of the pump lube oil and the pump was taken off-line until the
27 repairs were completed.
 - 28 • On March 22, 2018, one of the turbine reheat intercept valves became stuck during
29 regular on-line testing and the Unit had to be taken off-line for approximately eight

1 hours to replace the valve servos. Hydraulic fluid contamination will be addressed
2 during the annual outage to prevent recurrence.

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

7 • On April 3, 2018 the unit was taken offline on a forced outage to repair a leak in the
8 turbine control valve hydraulic ram. The ram was rebuilt and the unit returned to
9 service on April 4, 2018; however, once installed the seals required additional
10 adjustment. The Unit was returned to service April 5, 2018. Return to service after this
11 outage was delayed by approximately eight hours on April 5, 2018 due to an issue in the
12 switchyard with the B2B11 breaker. TRO is replacing this breaker during the 2018 annual
13 outage.

14 • Unit 2 was available but not operating from April 26, 2018 to May 18, 2018 with the
15 available load de-rated to 70 MW due to high furnace pressure as a result of boiler and
16 air heater fouling. During this time the Unit was kept in hot standby, maintaining an
17 eight hour return to service time if recalled. On May 18, 2018 the Unit was taken offline
18 to address a suspected stress failure of a tube in the lower waterwall (not in the area of
19 previous boiler tube thinning failure issues). The two failed tubes will be sent to an
20 independent lab to determine the failure cause and any recommended mitigation, to be
21 implemented during the annual maintenance outage. At the time of the failure, it was
22 determined that the Unit was no longer required for system reliability requirements and
23 could be placed on planned outage in preparation for the annual outage. The tube leak
24 will be corrected during the annual outage.

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

- 3 • On December 13, 2017, Unit 3 was de-rated to 135 MW as a result of air flow issues. The
4 unit capability declined steadily to 105 MW until an air heater wash could be completed
5 on December 31. The wash was successful in restoring the load to 131 MW. The
6 available load continued to decline due to ongoing air heater fouling. On January 18 the
7 available load was determined to be 120 MW and on February 10, this had further
8 reduced to 100 MW. An air heater wash outage was completed from February 10 - 11,
9 2018. System requirements, with Unit 1 already off-line, had precluded an air heater
10 wash on this unit until that time. When the Unit was returned to service there was a de-
11 rating to 70 MW for approximately 10 hours when the west boiler feed pump failed to
12 start.
- 13 • This was resolved and the available load was determined to be 110 MW, still limited by
14 air heater fouling. The Unit was capable of 100 MW at the beginning of March 2018.
15 This capability had further reduced to 75 MW on March 20, 2018. An air heater wash
16 outage was completed on March 28, 2018 and the predicted load after this wash was
17 110 MW. This Unit was not required for the system and was left on standby until the
18 planned unit outage in early April 2018. On June 1, 2018 the Unit 3 generator was put in
19 service in synchronous condenser mode.
- 20 • On January 11, 2018, a ¾" diameter domestic water pipe located above the Unit 3
21 exciter ruptured at a cap and the resulting water leak contacted the exciter causing a
22 Unit trip. There was no significant equipment damage resulting from this incident and
23 once the exciter was safely dried, the Unit was returned to service on January 12, 2018.
24 This event was investigated and the leak repaired. A shut off valve was relocated for
25 improved access in the event of a further trip, regular inspections of the area were
26 implemented, and a plan was formulated to replace this piping during the annual
27 outages. On February 14, 2018, the Unit load was reduced to 50 MW for approximately
28 eight hours as a precautionary measure due to another leak in a domestic water line in

1 close proximity to the exciter. After this event, the piping was relocated so that further
2 leaks would not impact the exciter.

3

4 **6.0 Gas Turbine UFOP Performance**

5 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was 6.78%
6 for the 12-month period ending June 30, 2018 (refer to Table 6). This is below the base planning
7 assumption of 10.62% and the near-term assumption of 20.00%. The current period UFOP is
8 lower than the previous period UFOP of 12.32%. For the current period, the Hardwoods UFOP is
9 1.35% and the Stephenville UFOP 4.62%, both of which are better than the base planning
10 assumption of 10.62%. Happy Valley’s UFOP is 19.27% for the current period compared to
11 0.00% in the previous period.

Table 6: Gas Turbine UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months		Hydro Generation	
		ending June 2017 (%)	12 months ending June 2018 (%)	Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Combined Gas Turbines	125	8.68	6.78	10.62	20.00
Stephenville	50	13.10	4.62	10.62	20.00
Hardwoods	50	10.14	1.35	10.62	20.00
Happy Valley	25	0.00	19.27	10.62	20.00

12 The Holyrood (HRD) GT UFOP of 0.06% for the current period is better than the base planning
13 and near-term assumptions of 5.00% (refer to Table 7).

Table 7: Holyrood GT UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months		Hydro Generation	
		ending June 2017 (%)	12 months ending June 2018 (%)	Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	2.46	0.06	5.00	5.00

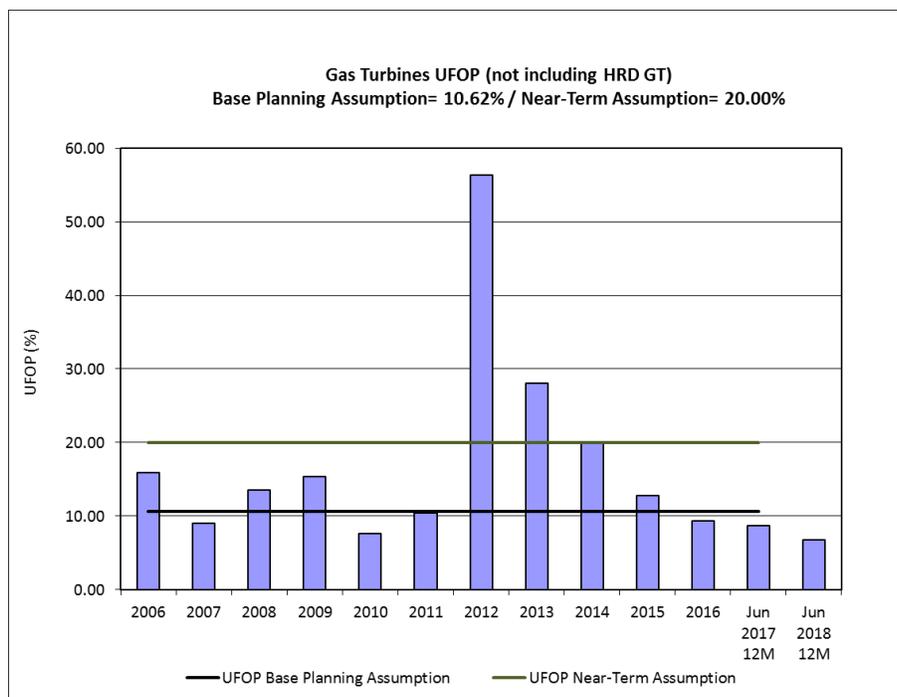


Figure 3: Gas Turbine UFOP – HWD/HVY/SVL Units

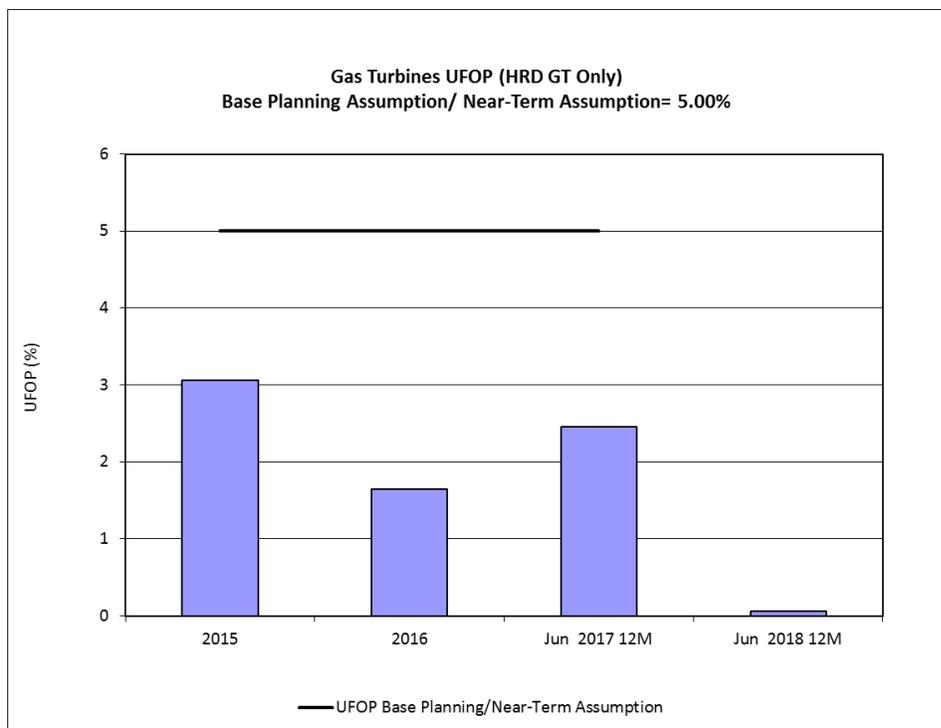


Figure 4: Gas Turbine UFOP – HRD Unit

1 On September 16, 2017, the Happy Valley gas turbine tripped when attempting a black start of
2 the unit to support an unplanned outage in the Happy Valley area. Hydro's investigation found
3 that the cause of the trip was related to the operation of a voltage protection relay in the
4 terminal station. Upon review of the relevant procedures, drawings and settings it was
5 determined that a setting change was required to the protection relay. The setting was
6 changed and the unit was returned to service on September 21, 2017. During the investigation,
7 it was found that prior to the trip the power turbine had developed higher than normal
8 vibration, though it was not the cause of the trip. Further investigation of the higher than
9 normal vibration found the source to be a high temperature exhaust gas leak from the power
10 turbine. Repairs were made and vibration levels returned to normal on October 7, 2017.

11

12 On October 15, 2017 the Happy Valley gas turbine experienced a trip while operating at near
13 full load. Hydro's investigation determined that the trip was the result of the failure of an
14 emergency fuel shut-off valve solenoid. The failure of the solenoid caused the 3-way valve to
15 divert a portion of fuel away from the engine, as is its design. The reduced fuel flow was not
16 able to sustain the required load and resulted in the unit shutting down. A replacement
17 solenoid was sourced and repairs made with the engine released for service on November 9,
18 2017.

19

20 On May 13, 2018 the Hardwoods gas turbine tripped while operating in synchronous condense
21 mode due to a system under voltage and current phase imbalance. The alternator experienced
22 excessive vibration when attempting to restart the Unit on May 14, 2018. Extensive mechanical
23 and electrical testing was conducted on the alternator to determine its condition, with no
24 damage found prior to returning it to service on June 2, 2018.

25

26 On June 13, 2018 the Hardwoods gas turbine tripped due to excessive alternator vibration
27 while being returned to service after a planned maintenance outage. Inspection of the Unit
28 determined that cause of the vibration was a loss of lube oil due to a faulty check valve in the
29 lube oil supply piping to one of the alternator bearings. The bearing which had the faulty check

1 valve was found to be damaged and required replacement with a spare bearing. The Unit was
2 released for service on June 30, 2018.

3
4

5 **7.0 Gas Turbine DAUFOP Performance**

6 The combined DAUFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was
7 24.11% for the 12-month period ending June 30, 2018 (refer to Table 8). This is below the near-
8 term assumption of 30.00%. The Hardwoods DAUFOP for the current period is 6.51%, which
9 significantly exceeds the near-term assumption of 30.00%. The Stephenville UFOP for the
10 current period is 51.35%, which is above the near-term assumption of 30.00%. Happy Valley’s
11 DAUFOP is 19.27% which is below the near-term assumption of 30.00%.

Table 8: Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending June 2017 (%)	12 months ending June 2018 (%)	Near-Term Planning Assumption (%)
Combined Gas Turbines	125	8.68	24.11	30.00
Stephenville	50	13.10	51.35	30.00
Hardwoods	50	10.14	6.51	30.00
Happy Valley	25	0.00	19.27	30.00

12 The Holyrood (HRD) GT DAUFOP of 0.06% for the current period is better than the near-term
13 assumptions of 5.00% (refer to Table 9).

Table 9: Holyrood GT DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending June 2017 (%)	12 months ending June 2018 (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	2.46	0.06	5.00

Performance of Generating Units

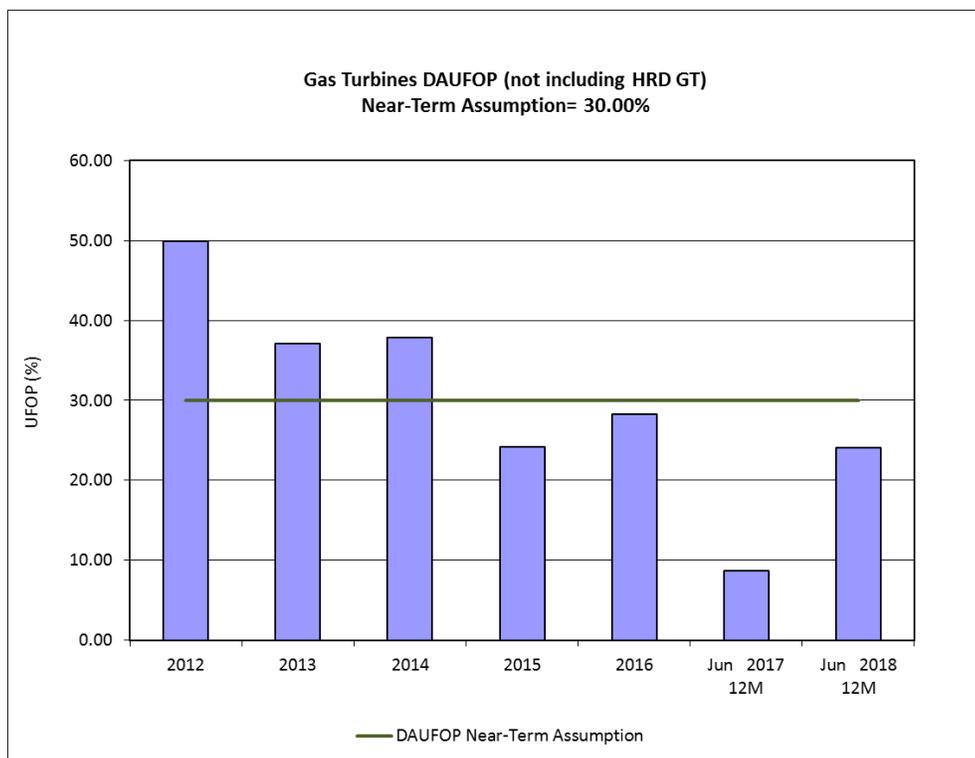


Figure 5: Gas Turbine DAUFOP – HWD/HVY/SVL Units

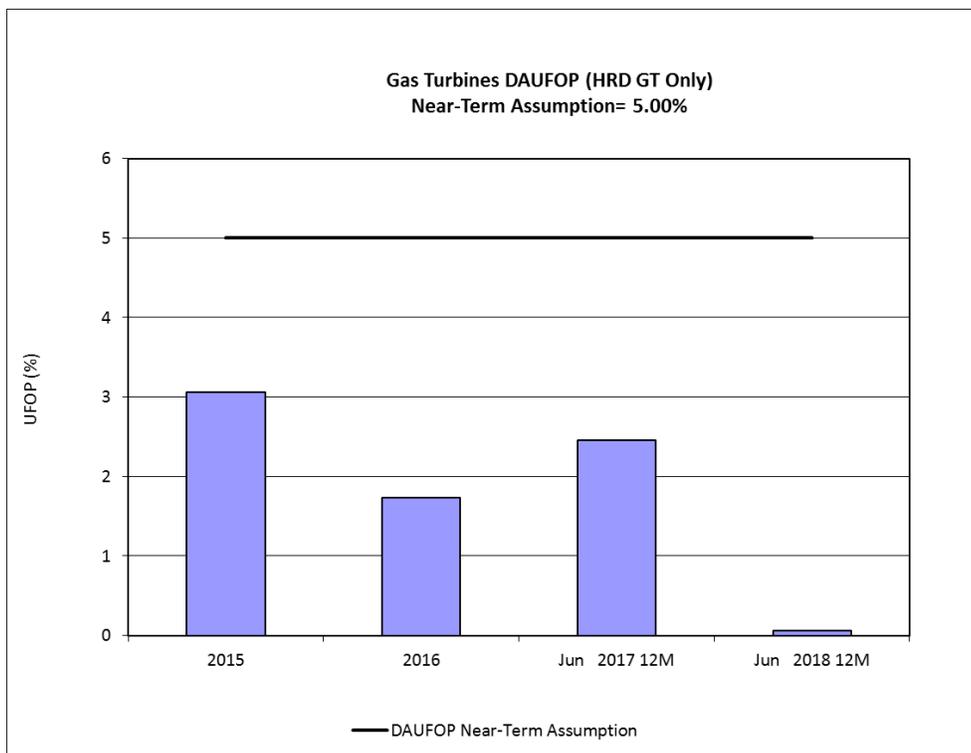


Figure 6: Gas Turbine DAUFOP – HRD Unit

1 The Stephenville gas turbine DAUFOP for the period was impacted by the unavailability of End A
2 as a result of an exhaust bellows failure at Hardwoods gas turbine End A on December 28, 2017.
3 End A was unavailable at this time due to issues with the power turbine rear bearing which
4 requires the bearing to be replaced. Hydro decided to remove the bellows from End A at
5 Stephenville and install it at Hardwoods End A to return that Unit to full capacity. It is currently
6 expected that the Stephenville gas turbine will be returned to full capacity in August 2018.

7

8 The Hardwoods gas turbine DAUFOP for the period is impacted by the unavailability of End A
9 due to an exhaust bellows failure on May 28, 2018. End A remains unavailable with a planned
10 return to service at the end of July 2018.



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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
ecc: Dennis Fleming – Cox & Palmer
Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Dennis Browne, Q.C. – Browne, Fitzgerald, Morgan & Avis
Dean Porter – Poole Althouse
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

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1 **1.0 Introduction**

2 In this report, Newfoundland and Labrador Hydro (“Hydro”) provides data on forced outage
3 rates¹ of its generating facilities. This data provided pertains to historical forced outage rates,
4 and assumptions used for system planning purposes.

5

6 The report contains forced outage rates for the current 12-month reporting period of October
7 1, 2017 to September 30, 2018 for individual generating units at hydraulic facilities, the
8 Holyrood Thermal Generating Station, and Hydro’s gas turbines. The report also provides, for
9 comparison purposes, the individual generating unit data on forced outage rates for the
10 previous period October 1, 2016 to September 30, 2017. Further, total asset class data is
11 presented based on a calendar year for the years 2006-2016.

12

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

17

18 “DAFOR” is a metric that measures the percentage of the time that a unit or group of units is
19 unable to generate at its maximum continuous rating due to forced outages. The DAFOR for
20 each unit is weighted to reflect differences in generating unit sizes in order to provide a
21 company total and reflect the relative impact a unit’s performance has on overall generating
22 performance. This measure is applied to hydraulic and thermal units; however, it is not
23 applicable to gas turbines because of their operation as standby units, and their relatively low
24 operating hours.

25

26 UFOP and DAUFOP are measures used for Gas Turbines. UFOP measures the percentage of time
27 that a unit or group of units will encounter a forced outage and not be available when required.

28 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.

1 encounter a forced outage and not be available when required, but this metric includes impact
2 of unit deratings.

3

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

9

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

13

14 Note that the data for 2006 to 2016 in Figures 1 through 7 are annual numbers (January 1 to
15 December 31), while the data for 2017 and 2018 are 12-month rolling numbers (October 1 to
16 September 30 for each year).

1 **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

2 There was an improvement in hydraulic DAFOR and a decline in thermal DAFOR performance
3 for the current 12-month period ending September 2018, compared to the previous 12-month
4 period ending September 2017 (see Table 1). The combined⁶ gas turbine UFOP performance
5 shows an improvement in performance for the current period compared to the previous
6 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.

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

4

5 For the Holyrood thermal units, the forced outage rate of the current period ending September
6 2018 is 29.77%⁴, which is above the base planning assumption of 9.64%, the sensitivity of
7 11.64% (refer to Section 3), and above the near-term planning assumption of 14.00%.⁷ This is
8 primarily caused by an airflow derating on Unit 1 and Unit 2 that continued in 2017 and 2018
9 and an extended forced outage on Unit 1 in February 2018.

10

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

14

15 Hydro’s combined gas turbines’ UFOP in the 10-year period prior to 2015 was generally
16 consistent at approximately 10%, until the year 2012 when the rate exceeded 50%. Since 2012,
17 the UFOP has been improving each year. For the current 12-month period ending September
18 30, 2018, performance was affected by forced outages to the Hardwoods, Happy Valley, and
19 Stephenville units.

20

21 Hydro began reporting DAUFOP performance beginning in January 2018, but for the purpose of
22 this report, data over the full 12-month period ending September 30, 2018 is included. For the
23 current 12-month period, the combined gas turbines DAUFOP (Hardwoods and Stephenville
24 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.

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

3

4 **3.0 Generation Planning Assumptions**

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

11

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

18

19 The Holyrood gas turbine has a lower expected rate of unavailability than the older gas
20 turbines, (5% compared to 10.62%), due to the fact that the unit is new and can be expected to
21 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)*.

1 Hydro produces reports based on comprehensive reviews of energy supply for the Island
2 Interconnected System (“IIS”). This is part of Hydro’s analysis of energy supply up to the
3 Muskrat Falls interconnection. The most recent Near-Term Generation Adequacy report, filed
4 on May 22, 2018, contains analysis based on the near-term DAFOR and DAUFOP, and the
5 resulting implication for meeting reliability criteria until the interconnection with the North
6 American grid. The near-term analysis has been updated since that time to reflect changes in
7 assumptions around the in-service of the Labrador-Island Link (“LIL”). The results of this analysis
8 were presented to the Board as part of the LIL In-Service Update submitted October 1, 2018.
9 This analysis will be updated accordingly if asset assumptions change materially.
10
11 The DAFOR and DAUFOP assumptions used in developing Hydro’s May 2018 Near-Term
12 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

13 **4.0 Hydraulic Unit DAFOR Performance**

14 Detailed results for the 12-month period ending September 30, 2018, are presented in Table 4,
15 as well as the data for the 12-month period ending September 30, 2017. These are compared to
16 Hydro’s short term generation adequacy assumptions, as used in the Near-Term Generation
17 Adequacy report, and Hydro’s long-term generation planning assumptions for the forced
18 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

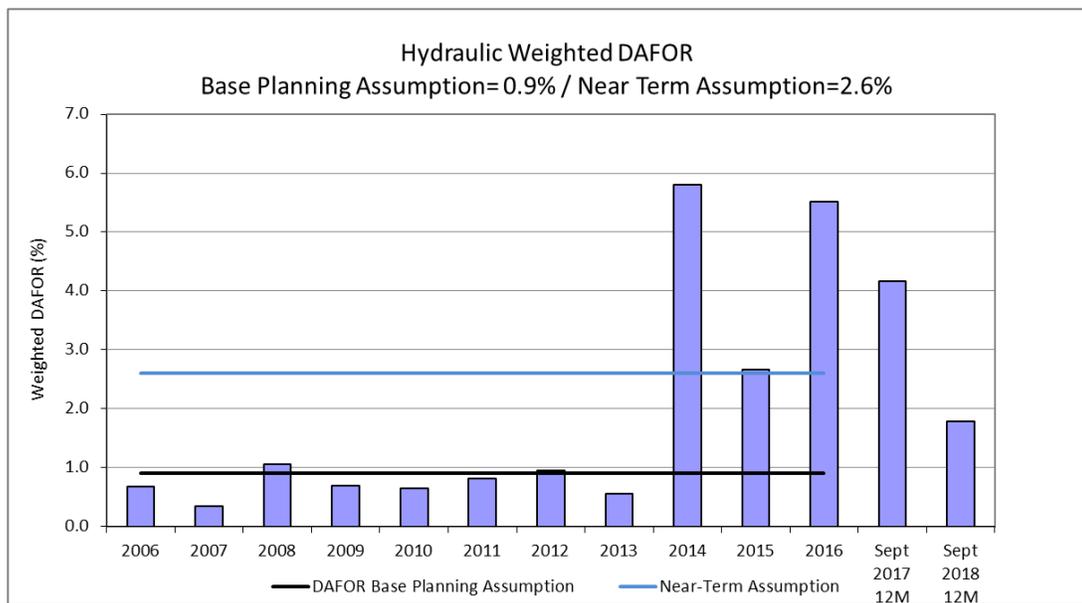


Figure 1: Hydraulic Weighted DAFOR

1 Considering the individual units' performance, the assumed Hydro generation base planning
2 DAFOR was materially exceeded for Bay d'Espoir Unit 1 and Bay d'Espoir Unit 2.¹⁰ Also, Cat Arm
3 Unit 1 exceeded the base planning assumption for the current period.

4

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

19

20 The Cat Arm Unit 1 DAFOR of 0.98% exceeded the base planning assumption of 0.9% and the
21 near-term assumption of 0.7% for an individual Cat Arm unit. This was due to a forced derating
22 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
23 a malfunction with Needle #1 transducer feedback. This issue has since been resolved by
24 replacement of the needle feedback transducer during the annual maintenance outage for the
25 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.

1 **5.0 Thermal Unit DAFOR Performance**

2 Detailed results for the 12-month period ending September 30, 2018, are presented in Table 5,
 3 as well as the data for the 12-month period ending September 30, 2017. These are compared to
 4 Hydro’s short term generation adequacy assumptions, as used in the Near-Term Generation
 5 Adequacy report, and Hydro’s long-term generation planning assumptions for the forced
 6 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 (%)
<i>All Thermal Units - weighted</i>	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

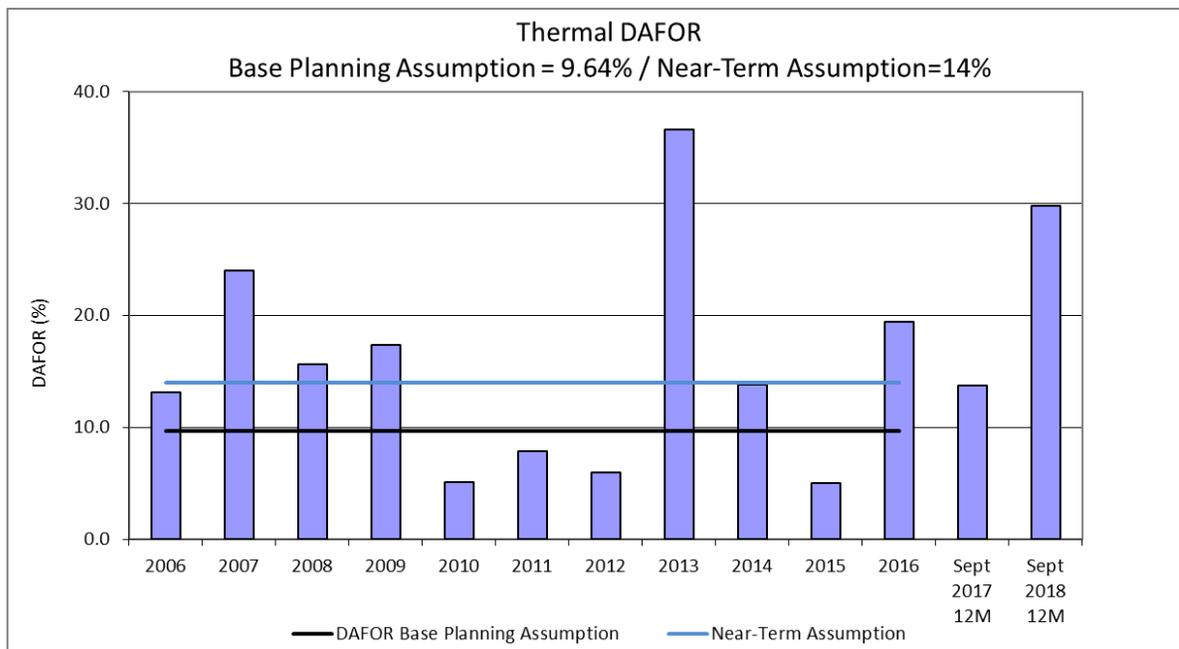


Figure 2: Thermal DAFOR

1 For the 12-month period ending September 31, 2018, the weighted DAFOR for all thermal units
2 of 29.77%¹³ is above the assumed Hydro generation base planning DAFOR value of 9.64%, and
3 the near-term assumption of 14.00%. Unit 1 DAFOR was 35.49% and Unit 2 DAFOR was 30.64%.
4 The performance for both Units 1 and 2 was above the base planning assumption of 9.64% and
5 the near-term assumption of 15% (Unit 1) and 10% (Unit 2). Unit 3 DAFOR was 18.17%, which is
6 above the base planning assumption of 9.64% and the near-term assumption of 18.0%.

7

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

- 10 • Unit 1 tripped on October 5, 2017 and was de-rated to a precautionary load of 35 MW,
11 while the reason for the trip was being investigated and corrected. It was determined
12 that the trip was caused by frayed wires in one of the forced drive (“FD”) fan motors
13 and, following repairs, the unit was returned to full capability on October 10, 2017.
- 14 • From October 17, 2017 to October 22, 2017, the unit was de-rated to 154 MW due to
15 low steam pressure while waiting for safety valve testing to be completed. The safety
16 valve testing was completed on October 24, 2017, but the unit was further de-rated to
17 145 MW from October 22, 2017 to October 24, 2017, and to 135 MW until the end of
18 the month due to overheating motor windings in the west FD fan. The unit was
19 monitored while waiting for an opportunity to replace the motor. The spare motor was
20 installed and the unit was returned to service on November 12, 2017 but remained de-
21 rated to 145 MW due to high furnace pressure.
- 22 • On November 14, 2017 the unit was taken off line to repair a piping leak at the
23 condenser flash tank. This was repaired and the unit returned to service on November
24 15, 2017. However another leak developed in the area and the unit was removed from
25 service on November 15, 2017 for 12 hours for repair.
- 26 • Unit 1 remained limited to 145 MW until it was taken off line on November 30, 2017 to
27 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.

- 1 service on December 4, 2017. A load test completed on December 5, 2017, confirmed a
2 capacity of 150 MW¹⁴ with the unit load limited by high furnace pressure.
- 3 • On January 3, 2018 the unit capability was reduced from 150 to 135 MW as a result of
4 oscillations in the turbine control valve hydraulic ram. An outage was taken from
5 January 5 to address the issue. After this work, the load was restored to 145 MW,
6 limited by high furnace pressure, and it was noted that the control valve oscillations had
7 not been eliminated. On January 18 the oscillations had increased and the load was
8 reduced to 140 MW as a result. On January 20 the unit was taken off line to replace
9 another control cable as recommended by GE to resolve the oscillation issue. While the
10 unit was off line for this work, the boiler stop valve failed, which resulted in an
11 extension to the outage. The unit remained off line until February 2 while stop valve
12 refurbishment was ongoing. During this time, the hydraulic ram was removed from the
13 turbine and sent off site for refurbishment to ensure that the oscillation problem had
14 been resolved. Also a high pressure wash (12,500 psi) was completed on the air heater
15 baskets.
 - 16 • The outage due to the boiler stop valve failure extended from January 20, 2018 until
17 February 21, 2018, following several solutions which attempted to address the leak. On
18 February 21, 2018 the stop valve work was complete and the unit was returned to
19 service.
 - 20 • On February 22 the unit had to be taken off line due to a turbine bearing issue. Lube oil
21 had leaked, undetected, from the bearing during the stop valve outage. This led to a
22 smoldering underneath the bearing when the components heated up. The
23 contaminated insulation was replaced and close inspection of the bearing confirmed no
24 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.

- 1 • On February 28 a load test was completed to 148 MW, with load limited by high furnace
2 pressure due to boiler and air heater fouling. By the end of March 2018 the unit's
3 capability had reduced to 137 MW as a result of continued fouling in the boiler and air
4 heaters.
- 5 • There were two unit trips related to FD fan variable frequency drive ("VFD") trips. These
6 occurred on March 19, 2018 and March 26, 2018. In both instances the unit was
7 returned to service using replacement parts from inventory. During the outage related
8 to the March 19, 2018 trip, a problem with the Mark V turbine governor system was
9 also resolved. Hydro is continuing to work towards resolving the problems with VFD
10 reliability.
- 11 • On April 12, 2018 the load was reduced to 126 MW, limited by high furnace pressure as
12 a result of continued boiler and air heater fouling. The capability of the unit continued
13 to decline for the same reason. On May 6, 2018 the capability was 122 MW and on May
14 15, 2018 it was 116 MW.
- 15 • On May 21 the unit tripped at 70 MW on high boiler drum level. The cause was
16 suspected to be a trip of the east boiler feed pump, which caused unstable water level
17 in the drum and led to the trip. The unit was returned to service later that same day
18 with only the west boiler feed pump in service and the load restricted temporarily to 70
19 MW until the health of the east pump was verified. The unit was returned to 116 MW
20 later on May 21, 2018 once the east pump was ruled out as the cause of the trip. The
21 cause was determined to be a failure of a turbine control valve stem. Once this was
22 confirmed the valve stem was replaced during the planned 2018 turbine valve outage.
- 23 • On June 4, 2018 the unit was further de-rated to 100 MW, limited by high furnace
24 pressure as a result of on-going boiler and air heater fouling. By the end of June 2018
25 this had further reduced to 88 MW.
- 26 • On June 16, 2018, while on a brief planned outage to change worn generator brushes, a
27 pressure gauge failed on the fuel oil system resulting in a spill. This had to be cleaned up
28 before the unit could be safely returned to service. On June 17, 2018 while starting up
29 the unit, a bearing failed on the east forced draft fan and had to be replaced. The unit

1 returned to service on June 18, 2018 but the same bearing failed after only a few hours
2 of operation. The bearing was again replaced and the unit was successfully returned to
3 service on June 19, 2018. A field representative from the fan's original equipment
4 manufacturer travelled to site to assist with the failure analysis of these bearings. It was
5 concluded that the bearing liner babbitted surface failed. Additional checks have been
6 added to the Preventive Maintenance work for these bearings to prevent such a failure.

- 7 • The planned maintenance outage for Unit 1 started on July 27, 2018. Outage work
8 included a chemical wash of the economizer, and replacement of the hot end air heater
9 baskets. Based on an engineering study completed prior to the outage season, and the
10 results of the work completed, Hydro expects that Unit 1 will be capable of full load or
11 near full load operation when it is returned to service later in the fall of 2018.

12

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

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

- 1 for safety valve testing to be completed. From November 8, 2017 to November 20,
2 2017, the unit was de-rated to 165 MW due to a leaking safety valve. Corrective work
3 required an outage to complete. The unit was taken off line on November 20, 2017, and
4 returned to service on November 24, 2017. An air heater wash was also completed
5 during this outage. A load test on November 28, 2017 revealed that the unit was
6 capable of 160 MW, limited by high furnace pressure.
- 7 • On December 19, 2017, the unit experienced a 14-hour deration to 70 MW as a result of
8 a trip of one forced draft fan on the unit. The cause of the fan trip was corrected and the
9 fan returned to service later that day in time for the evening peak, with the unit again
10 capable of 160 MW.
 - 11 • The capability of the unit continued to decline due to ongoing fouling during operation.
12 On January 4, 2018 the capability had reduced to 154 MW. On January 25, 2018 the
13 capability had reduced to 135 MW due to high furnace pressure as a result of boiler and
14 air heater fouling. On February 14, 2018 the capability had reduced to 117 MW. At the
15 end of February 2018 the capability had reduced to 100 MW. System requirements,
16 given the issues with Unit 1, had precluded an air heater wash on this unit during the
17 month of February 2018. An air heater wash was completed from March 5, 2018 to
18 March 6, 2018; however this was not successful in restoring any capacity. By the end of
19 March 2018, the unit capability had reduced to 90 MW as a result of continued boiler
20 and air heater fouling during operation.
 - 21 • On February 7, 2018 the unit was taken off for a short, planned outage to replace
22 generator brushes. There was a forced extension to this outage when a unit board
23 breaker tripped during re-start of the unit. Electricians were called in to reset the
24 breaker.
 - 25 • The unit was further de-rated to 70 MW from March 1, 2018 to March 2, 2018 due to an
26 issue with the west boiler feed pump. A water leak from a reference line nearby caused
27 contamination of the pump lube oil and the pump was taken off line until the repairs
28 were completed.

- 1 • On March 22, 2018, one of the turbine reheat intercept valves became stuck during
2 regular on-line testing and the unit had to be taken off line for approximately eight
3 hours to replace the servos on these valves. To address this problem, the hydraulic fluid
4 was replaced and the system flushed during the 2018 annual outage.
- 5 • At the beginning of April 2018 the unit was rated at 80 MW due to high furnace pressure
6 as a result of boiler and air heater fouling. This capability further reduced to 70 MW on
7 April 24, 2018 and remained at this level until the unit was taken off line for the annual
8 outage.
- 9 • On April 3, 2018 the unit was taken off line on a forced outage to repair a leak in the
10 turbine control valve hydraulic ram. The ram was rebuilt and the unit returned to
11 service on April 4, 2018; however, once installed the seals required additional
12 adjustment. The unit was returned to service April 5, 2018. Return to service after this
13 outage was delayed by approximately eight hours on April 5, 2018 due to an issue in the
14 switchyard. TRO replaced the B2T2 breaker during the 2018 annual outage, which
15 should resolve this issue.
- 16 • Unit 2 was available but not operating from April 26, 2018 to May 18, 2018, with the
17 available load de-rated to 70 MW due to high furnace pressure as a result of boiler and
18 air heater fouling. During this time the unit was kept in hot standby, maintaining an
19 eight hour return to service time if recalled. On May 18, 2018 the unit was taken offline
20 to address a suspected stress failure, not a thinning failure, of a tube in the lower
21 waterwall (not in the area of previous boiler tube issues). At the time of the failure, it
22 was determined that the unit was no longer required for system reliability reasons prior
23 to the schedule planned outage and could be placed on planned outage in preparation
24 for the annual overhaul.
- 25 • The tube leak was corrected during the overhaul. Two adjacent leaking tubes were
26 found in the lower front wall. Through investigation and laboratory failure analysis it
27 was determined that the original failure occurred at a butt welded joint in the tube, and
28 that this weld was part of the original construction, and of relatively poor quality. Other
29 welds in the area were inspected with no damage found. The leak had been present for

1 an unknown period of time underneath the boiler casing and impinged upon the
2 adjacent tube, which also failed as a result. Several other tubes in the immediate area
3 were corroded due to the presence of the leak, but had not failed. A total of seven tube
4 sections were replaced.

5 • Also during the planned overhaul, work was completed to correct the air flow and
6 furnace pressure issues in the boiler. A chemical wash of the economizer was completed
7 and the hot end air heater baskets were replaced. The unit was returned to service on
8 September 15, 2018 with the fuel additive system in service and it was immediately
9 noted that the furnace pressure and air flow conditions had been greatly improved.
10 Equipment issues related to start up caused a number of short forced outages and de-
11 rates during the first few days of operation. On September 21, 2018, the unit was load
12 tested to 140 MW, limited because the on-line safety valve testing had not been
13 completed. However, it was clear from the boiler performance that full load should be
14 achievable. This was later confirmed on October 11 when the unit was tested to 171
15 MW and was capable of more.

16 • On September 26, 2018 there was a boiler trip related to starting a boiler feed pump. It
17 was demonstrated that this would not occur in VFD air flow control and the fans were
18 switched to VFD. Investigation into the reason for this trip is ongoing.

19

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

25

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

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

1 on December 31, 2017. The wash was successful in restoring the load to 131 MW. The
2 available load continued to decline due to ongoing air heater fouling. On January 18,
3 2108 the available load was determined to be 120 MW, and on February 10, 2018, this
4 had further reduced to 100 MW. An air heater wash outage was completed from
5 February 10, 2018 to February 11, 2018. System requirements, with Unit 1 already off
6 line, had precluded an air heater wash on this unit until that time. When the unit was
7 returned to service there was a de-rating to 70 MW for approximately 10 hours when
8 the west boiler feed pump failed to start. This was resolved and the available load was
9 determined to be 110 MW, still limited by air heater fouling. The unit was capable of
10 100 MW at the beginning of March 2018. This capability further reduced to 75 MW on
11 March 20, 2018. An air heater wash outage was completed on March 28, 2018 and the
12 predicted load after this wash was 110 MW. This unit was not required for the system,
13 and was left on standby until the planned unit outage started on April 2, 2018.

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

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

6

7 **6.0 Gas Turbine UFOP Performance**

8 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was 7.03%

9 for the 12-month period ending September 30, 2018 (see Table 6 and Figure 3). This is below

10 the base planning assumption of 10.62%, and the near-term assumption of 20.00%. The current

11 period UFOP was essentially the same as the previous period UFOP of 7.06%. The Hardwoods

12 UFOP for the current period is 3.19%, which is better than the base planning assumption of

13 10.62%. The Stephenville UFOP for the current period is 4.95%, which is better than the base

14 planning assumption of 10.62%. Happy Valley’s UFOP is 15.39% for the current period, which is

15 above the base planning assumption of 10.62%.

16

17 The UFOP for the Happy Valley, Stephenville and Hardwoods gas turbines for the period was

18 impacted by a number of forced outages and deratings. These outages and deratings are

19 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

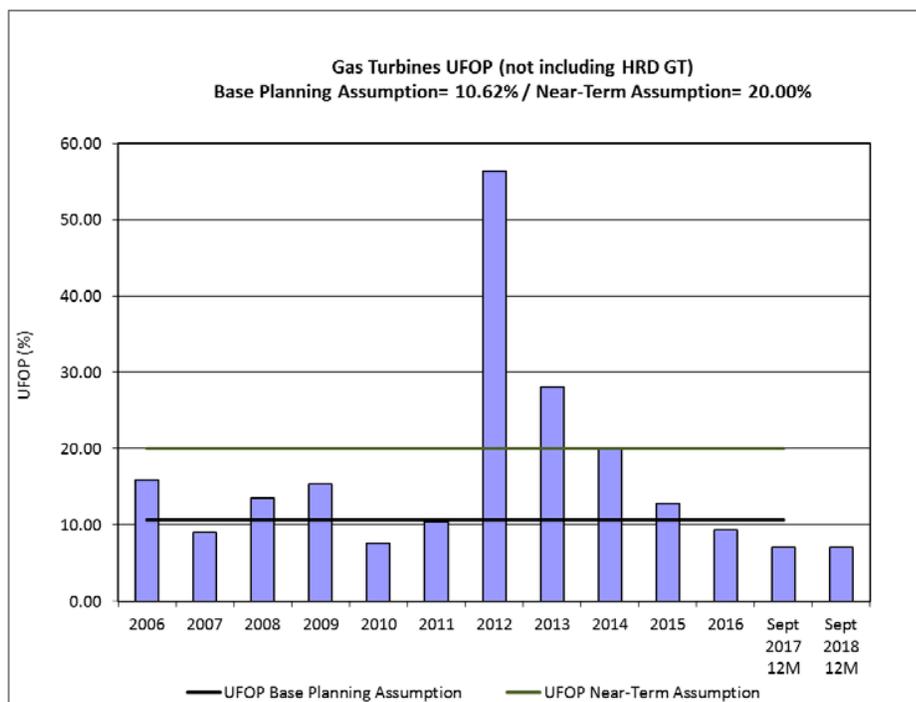


Figure 3: Gas Turbine UFOP – Hardwoods/Happy Valley/Stephenville Units

- 1 The Holyrood (HRD) GT UFOP of 0.08% for the current period is better than the base and near-
- 2 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

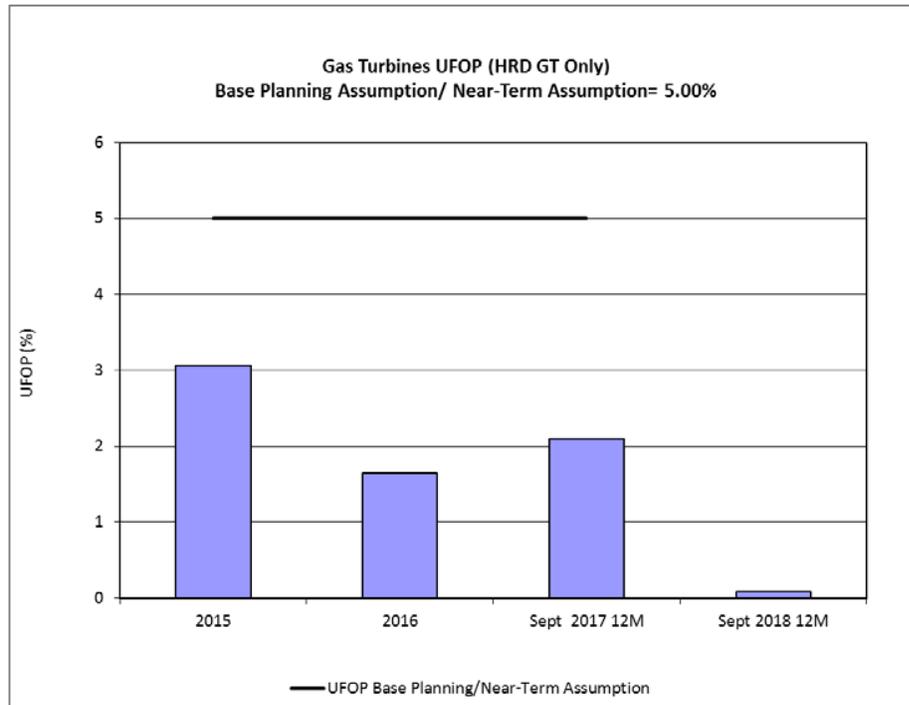


Figure 4: Gas Turbine UFOP – Holyrood Unit

1 **7.0 Gas Turbine DAUFOP Performance**

2 The combined DAUFOP for the Hardwoods and Stephenville gas turbines was 24.83% for the
 3 12-month period ending September 30, 2018 (refer to Table 8 and Figure 5). This is below the
 4 near-term planning assumption of 30.00%. The Hardwoods DAUFOP for the current period is
 5 14.47%, which is better than the near-term planning assumption of 30.00%. The Stephenville
 6 UFOP for the current period is 51.20%, which is above the near-term planning assumption of
 7 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

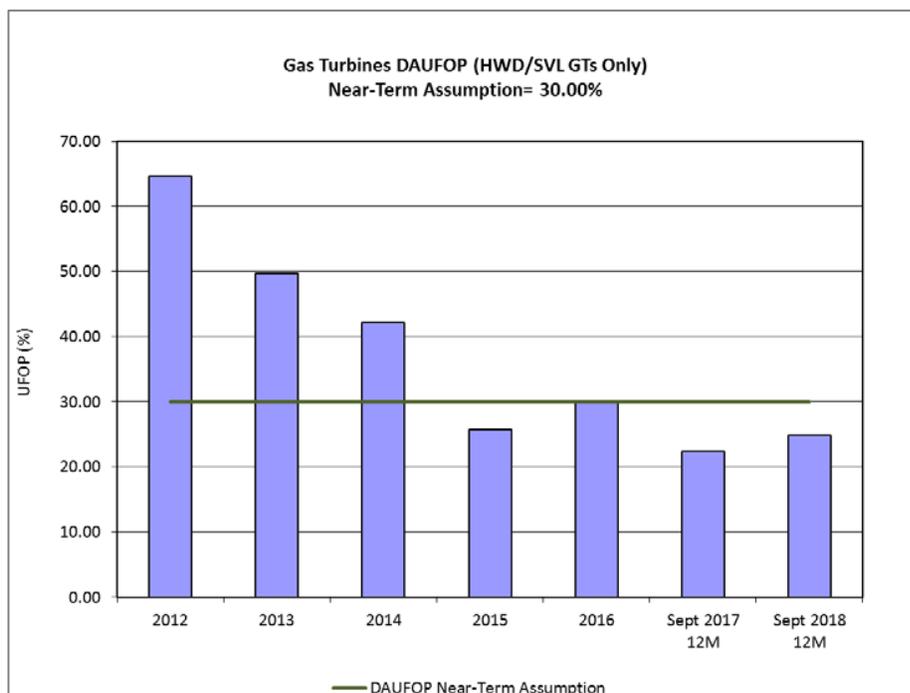


Figure 5: Gas Turbine DAUFOP – Hardwoods/Stephenville Units

- 1 The DAUFOP for the Happy Valley gas turbine was 15.39% for the 12-month period ending
- 2 September 30, 2018 (refer to Table 9 and Figure 6). This is above the near-term planning
- 3 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

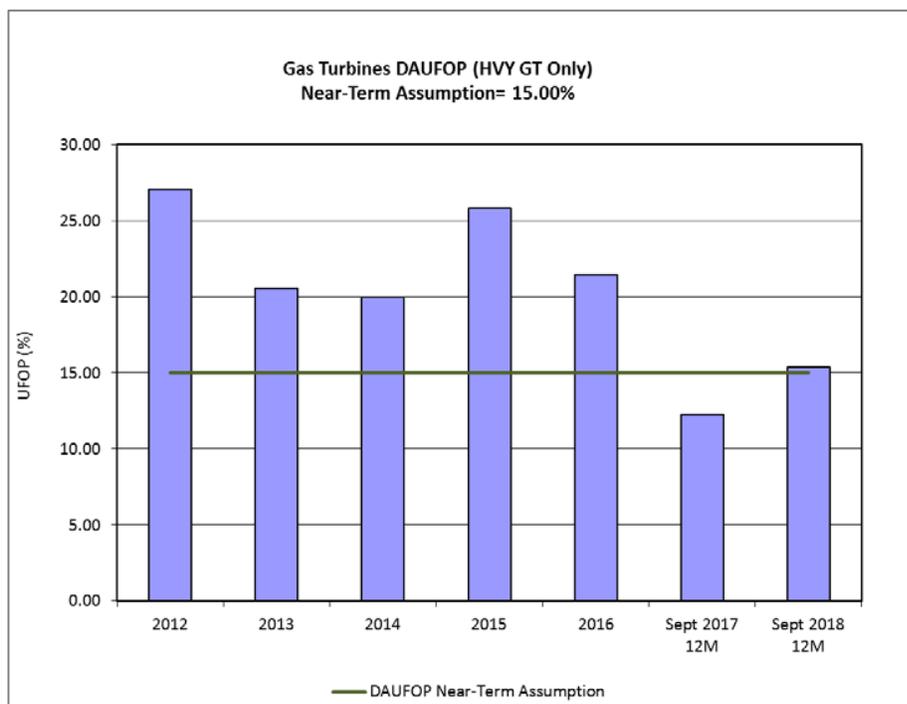


Figure 6: Gas Turbine DAUFOP – Happy Valley Unit

- 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

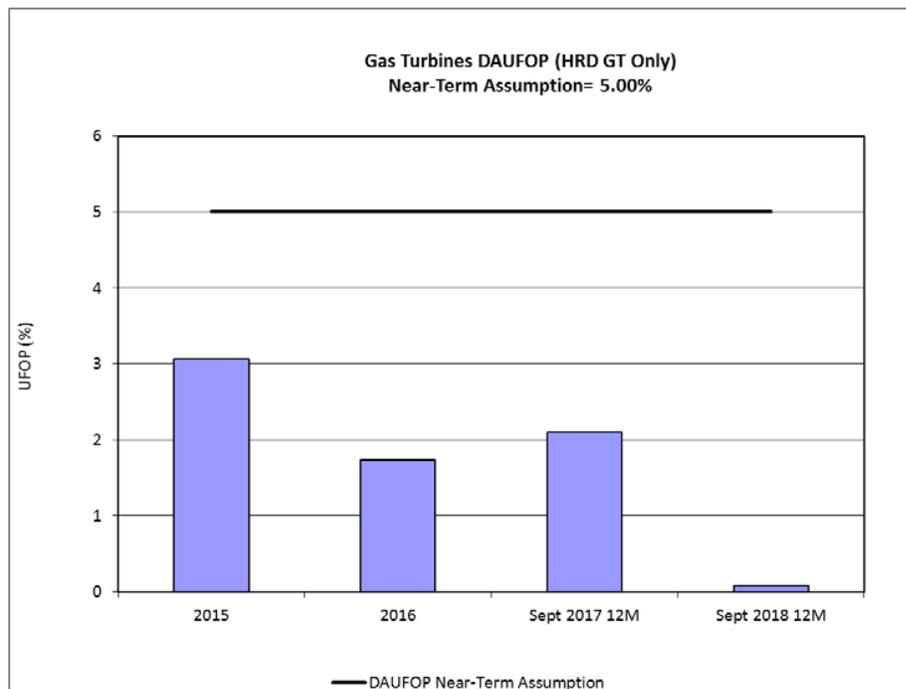


Figure 7: Gas Turbine DAUFOP – Holyrood Unit

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

3

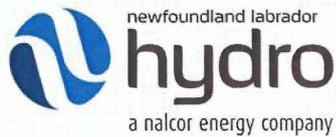
4 • The Stephenville gas turbine DAUFOP for the period is impacted by the unavailability of
5 End A as a result of an exhaust bellows failure at Hardwoods gas turbine End A on
6 December 28, 2017. End A was unavailable at this time due to issues with the power
7 turbine rear bearing, which required the bearing to be replaced. Hydro decided to
8 remove the bellows from End A at Stephenville and install it at Hardwoods End A to
9 return that unit to full capacity.

10 • The Hardwoods gas turbine DAUFOP for the period is impacted by the unavailability of
11 the unit due to a number of issues. The Hardwoods gas turbine End A became
12 unavailable on May 28, 2018 due to an exhaust bellows failure. The bellows was
13 removed and sent for repair and End A was returned to service on July 25, 2018.

14 • On June 13, 2018 the Hardwoods gas turbine tripped due to excessive alternator
15 vibration while being returned to service after a planned maintenance outage.

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

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



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January 31, 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: 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").

On November 16, 2018 Hydro filed the Reliability and Resource Adequacy Study with the Board of Commissioners of Public Utilities ("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 enclosed report, which covers the performance of Hydro's generating units for the quarter ending December 31, 2018, the assumptions that were reported in the previous 2018 quarterly reports have been maintained for clarity prior to the transition to the new assumptions. Future quarterly reports will utilize the planning assumptions included within the Reliability and Resource Adequacy Study.

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

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO



Shirley A. Walsh
Senior Legal Counsel – Regulatory
SAW/kd

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey
Danny Dumaresque
Dennis Browne, Q.C. – Browne, Fitzgerald, Morgan & Avis
Dean Porter – Poole Althouse
Dennis Fleming – Cox & Palmer
Larry Bartlett – Teck Resources Limited
Roberta Frampton Benefiel – Grand Riverkeeper Labrador

Quarterly Report on Performance of Generating Units
For the Quarter ended December 31, 2018

January 31, 2019

A Report to the Board of Commissioners of Public Utilities

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1 **1.0 Introduction**

2 In this report, Newfoundland and Labrador Hydro (“Hydro”) provides data on forced outage
3 rates of its generating facilities. The data provided pertains to historical forced outage rates,
4 and assumptions used by Hydro in its assessments of resource adequacy. On November 16,
5 2018 Hydro filed its Reliability and Resource Adequacy Study with the Board of Commissioners
6 of Public Utilities (“Board”). The Study included Hydro’s proposed planning assumptions for
7 further discussion with the Board and intervenors. This quarterly report covers the
8 performance of Hydro’s generating units for the quarter ending December 31, 2018. The
9 assumptions used throughout are the same as reported in the previous 2018 quarterly reports
10 except where new assumptions are included and identified in Table 12. The continued use of
11 the assumptions and style used in previous reports is to ensure clarity prior to the transition to
12 the new assumptions. Future quarterly reports will utilize the planning assumptions included
13 within the Reliability and Resource Adequacy Study.

14

15 The report contains forced outage rates for the current 12-month reporting period of January 1,
16 2018 to December 31, 2018 for individual generating units at hydraulic facilities, the Holyrood
17 Thermal Generating Station, and Hydro’s gas turbines. The report also provides, for comparison
18 purposes, the individual generating unit data on forced outage rates for the previous period
19 January 1, 2017 to December 31, 2017. Further, total asset class data is presented based on a
20 calendar year for the years 2006-2016.

21

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

26

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

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

4

5 UFOP and DAUFOP are measures used for gas turbines. UFOP measures the percentage of time
6 that a unit or group of units will encounter a forced outage and not be available when required.

7 DAUFOP is a metric that measures the percentage of time that a unit or group of units will
8 encounter a forced outage and not be available when required, but this metric includes the
9 impact of unit deratings.

10

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

16

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

20

21 Note that the data for 2006 to 2016 in Figures 1 through 7 are annual numbers (January 1 to
22 December 31), while the data for 2017 and 2018 are 12-month rolling numbers (January 1 to
23 December 31 for each year).

24

25 As part of its Reliability and Resource Adequacy Study, filed with the Board on November 16,
26 2018, Hydro detailed the process undertaken to determine the forced outage rates most
27 appropriate for use in its near-term reliability assessments and long-term resource adequacy
28 analysis. The revised forced outage rates, which were the outcome of this process, are included
29 in Sections 8 and 9 of this report. The potential impacts of these revised forced outage rates on
30 future performance reporting is also discussed.

2.0 Overview for Period Ending December 31, 2018

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

Class of Units	Jan 1, 2017 to Dec 31, 2017	Jan 1, 2018 to Dec 31, 2018	Base Planning Assumption	Near-term Planning Assumption ¹
Hydraulic (DAFOR)	2.29	0.21	0.90	2.60
Thermal (DAFOR)	14.91	28.97 ²	9.64	14.00
Gas Turbine (Combined) (UFOP)	6.93	3.62	10.62	20.00
Gas Turbine (Holyrood) (UFOP)	2.02	0.00	5.00	5.00
Gas Turbine (Hardwoods/ Stephenville) (DAUFOP)	19.72	21.67	-	30.00
Gas Turbine (Happy Valley) (DAUFOP)	22.18	2.11	-	15.00
Gas Turbine (Holyrood) (DAUFOP)	2.02	0.00	-	5.00

- 1 There was an improvement in hydraulic DAFOR and a decline in thermal DAFOR performance
- 2 for the current 12-month period ending December 2018, compared to the previous 12-month
- 3 period ending December 2017 (see Table 1). The combined³ gas turbine UFOP performance
- 4 shows an improvement in performance for the current period compared to the previous
- 5 period, while DAUFOP shows a slight decline in performance.

¹ Near-term Generation Adequacy Report, November 15, 2017, see section 5.0 for further details.

² The thermal DAFOR is 12.74% 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.

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

4

5 For the Holyrood thermal units, the forced outage rate of the current period ending December
6 2018 is 28.97%⁴, which is above the base planning assumption of 9.64%, the sensitivity of
7 11.64% (refer to Section 3), and above the near-term planning assumption of 14.00%.⁵ This is
8 primarily caused by an air flow derating on Unit 1 and Unit 2 that continued in 2017 and 2018
9 and an extended forced outage on Unit 1 in February 2018.

10

11 The current Holyrood period DAFOR is not an indicator of what to expect for the 2018-2019
12 winter season due to the work that was completed to improve the unit’s performance for air
13 flow limitations. Unit 2 has been successfully tested to 175 MW,⁶ and Unit 3 has been
14 successfully tested to 150 MW. Unit 1 has been load tested to 162 MW. Following the load test
15 in the fall of 2018, further investigation was completed on efforts required to reinstate the 8
16 MW. At this time, Hydro has not approved the project to proceed with reinstating the
17 additional 8 MW. The time, cost, and potential risk to other parts of the generating system
18 associated with suggested work are drivers for the decision not to proceed at this time.

19

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

23

24 Hydro began reporting DAUFOP performance in January 2018, for which the first full 12-month
25 period ending December 31, 2018 is included. For the current 12-month period, the combined

⁴ The thermal DAFOR is 12.74% with the air flow derating removed.

⁵ 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 of the other assets contributed to this outcome. Further, the near-term planning assumption is a probabilistic view of system performance under various criteria.

⁶ 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.

1 gas turbines DAUFOP (Hardwoods and Stephenville units only) performance is primarily
2 impacted by a lengthy forced outage to the Stephenville unit.

3

4 **3.0 Generation Planning Assumptions**

5 The Reliability and Resource Adequacy Study submitted to the Board in November 2018
6 introduced new generation planning assumptions; however, the assumptions used throughout
7 this report are the same as reported in the previous 2018 quarterly reports. The potential
8 impacts of these revised assumptions on reporting of generation unit performance are
9 discussed in Section 9 of this report. The continued use of the assumptions and style used in
10 previous reports is to ensure clarity prior to the transition to the new assumptions.

11

12 Hydro produced reports based on comprehensive reviews of energy supply for the Island
13 Interconnected System (“IIS”). This is part of Hydro’s analysis of energy supply up to the
14 Muskrat Falls interconnection. The most recent Near-Term Generation Adequacy report, filed
15 on May 22, 2018 contains analysis based on the near-term DAFOR and DAUFOP, and the
16 resulting implication for meeting reliability criteria until the interconnection with the North
17 American grid. The near-term analysis has been updated since that time to reflect changes in
18 assumptions around the in-service of the Labrador-Island Link (“LIL”). The results of this analysis
19 were presented to the Board as part of the LIL In-Service Update submitted October 1, 2018.
20 This analysis will be updated accordingly if asset assumptions change materially.

21

22 Hydro’s DAFOR and UFOP planning assumptions are provided in Table 2. The Holyrood gas
23 turbine has a lower expected rate of unavailability than the older gas turbines, (5% compared
24 to 10.62%), due to the fact that the unit is new and can be expected to have better availability
25 than the older units.⁷

⁷ 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)*.

Table 2: 2017⁸ 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

- 1 The DAFOR and DAUFOP assumptions used in developing Hydro’s May 2018 Near-Term
- 2 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	14.0	
Hardwoods & Stephenville Gas Turbines		30.0
Happy Valley Gas Turbine		15.0
Holyrood Gas Turbine		5.0

3 **4.0 Hydraulic Unit DAFOR Performance**

- 4 Detailed results for the 12-month period ending December 31, 2018, are presented in Table 4,
- 5 as well as the data for the 12-month period ending December 31, 2017. These are compared to
- 6 Hydro’s short term generation adequacy assumptions, as used in the May 2018 Near-Term
- 7 Generation Adequacy report, and Hydro’s long-term generation planning assumptions for the
- 8 forced outage rate.

⁸ Near-term Generation Adequacy Report, November 15, 2017, see section 5.0 for further details.

Table 4: Hydraulic Weighted DAFOR

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
All Hydraulic Units - weighted	954.4	2.29	0.21	0.90	2.60
Hydraulic Units					
Bay D'Espoir 1	76.5	9.33	0.07	0.90	3.90
Bay D'Espoir 2	76.5	14.11	0.64	0.90	3.90
Bay D'Espoir 3	76.5	0.03	0.00	0.90	3.90
Bay D'Espoir 4	76.5	0.27	0.15	0.90	3.90
Bay D'Espoir 5	76.5	0.00	0.00	0.90	3.90
Bay D'Espoir 6	76.5	1.48	0.54	0.90	3.90
Bay D'Espoir 7	154.4	1.80	0.00	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	0.89	0.07	0.90	0.70
Upper Salmon	84	0.81	0.15	0.90	0.70
Granite Canal	40	0.11	0.45	0.90	0.70
Paradise River	8	1.70	0.00	0.90	0.70

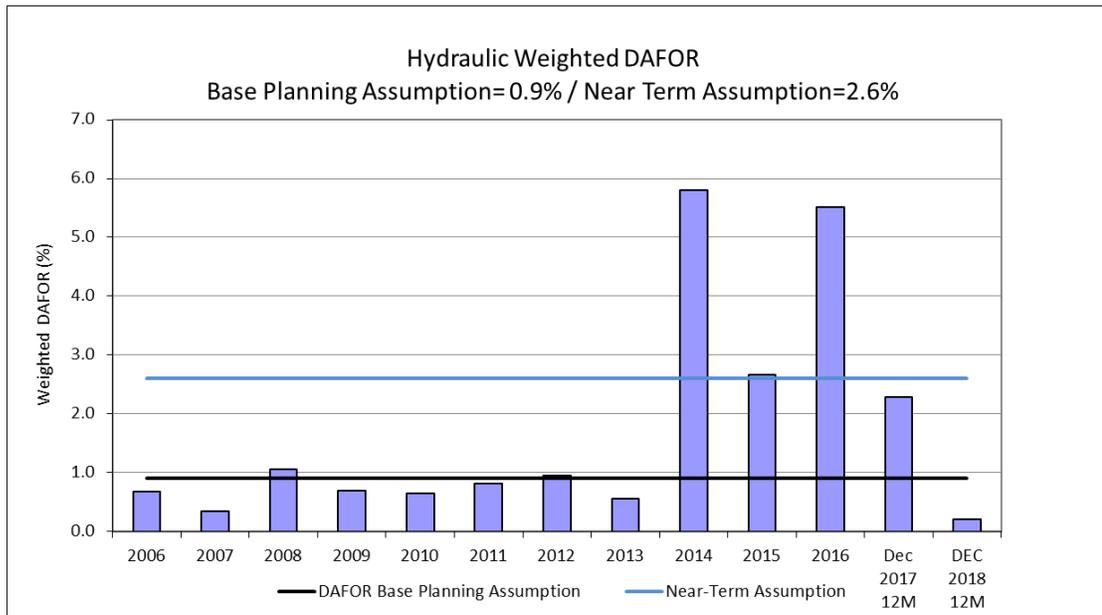


Figure 1: Hydraulic Weighted DAFOR

- 1 Considering the individual unit performance, the Hydro generation base planning DAFOR was
- 2 exceeded for Cat Arm Unit 1 for the current period.

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

7

8 **5.0 Thermal Unit DAFOR Performance**

9 Detailed results for the 12-month period ending December 31, 2018, are presented in Table 5,
 10 as well as the data for the 12-month period ending December 31, 2017. These are compared to
 11 Hydro’s short term generation adequacy assumptions, as used in the May 2018 Near-Term
 12 Generation Adequacy report, and Hydro’s long-term generation planning assumptions for the
 13 forced outage rate.

Table 5: Thermal DAFOR

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Hydro Generation Base Planning Assumption (%)	Near-Term Planning Assumption (%)
All Thermal Units - weighted					
	490	14.91	28.97	9.64	14.00
Thermal Units					
Holyrood 1	170	19.35	36.66	9.64	15.00
Holyrood 2	170	19.14	24.03	9.64	10.00
Holyrood 3	150	5.84	22.80	9.64	18.00

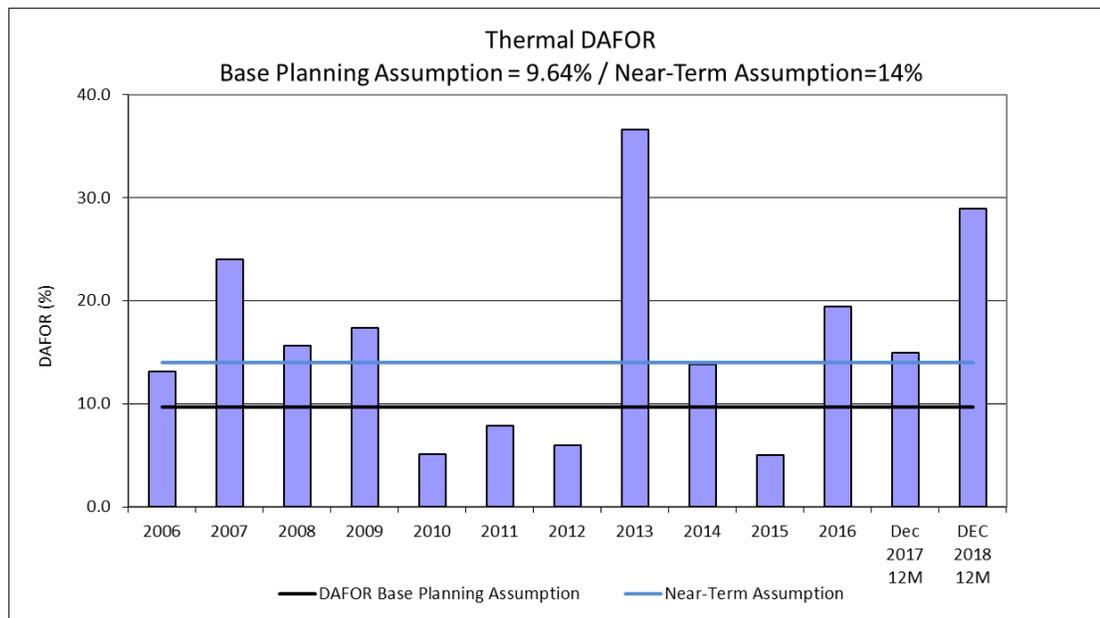


Figure 2: Thermal DAFOR

1 For the 12-month period ending December 31, 2018, the weighted DAFOR for all thermal units
 2 of 28.97%⁹ is above the assumed Hydro generation base planning DAFOR value of 9.64%, and
 3 the near-term assumption of 14.00%. Unit 1 DAFOR was 36.66% and Unit 2 DAFOR was 24.03%.
 4 The performance for both Units 1 and 2 was above the base planning assumption of 9.64% and
 5 the near-term assumption of 15% (Unit 1) and 10% (Unit 2). Unit 3 DAFOR was 22.80%, which is
 6 above the base planning assumption of 9.64% and the near-term assumption of 18.0%.

7

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

- 10 • The capability of the unit declined during the winter operating season due to ongoing
 11 fouling during operation. The capability was 150 MW at the beginning of the year. On
 12 January 3, 2018 the unit capability was reduced from 150 to 135 MW as a result of
 13 oscillations in the turbine control valve hydraulic ram. An outage was taken from
 14 January 5, 2018 to address the issue. After this work, the load was restored to 145 MW,
 15 limited by high furnace pressure, and it was noted that the control valve oscillations had
 16 not been eliminated. On January 18, 2018 the oscillations had increased and the load

⁹ The thermal DAFOR is 12.74% with the air flow derating removed.

- 1 was reduced to 140 MW as a result. On January 20, 2018 the unit was taken off line to
2 replace another control cable as recommended by General Electric to resolve the
3 oscillation issue. While the unit was off line for this work, the boiler stop valve failed,
4 which resulted in an extension to the outage. The unit remained off line until February
5 2, 2018 while stop valve refurbishment was ongoing. During this time, the hydraulic ram
6 was removed from the turbine and sent off site for refurbishment to ensure that the
7 oscillation problem had been resolved. Also a high pressure wash (12,500 psi) was
8 completed on the air heater baskets.
- 9 • The outage due to the boiler stop valve failure extended from January 20, 2018 until
10 February 21, 2018, following several solutions which attempted to address the leak. On
11 February 21, 2018 the stop valve work was complete and the unit was returned to
12 service.
 - 13 • On February 22 the unit had to be taken off line due to a turbine bearing issue. Lube oil
14 had leaked, undetected, from the bearing during the stop valve outage. This led to a
15 smoldering underneath the bearing when the components heated up. The
16 contaminated insulation was replaced and close inspection of the bearing confirmed no
17 active leak. The unit was returned to service on February 25, 2018.
 - 18 • On February 28 a load test was completed to 148 MW, with load limited by high furnace
19 pressure due to boiler and air heater fouling. By the end of March 2018 the unit's
20 capability had reduced to 137 MW as a result of continued fouling in the boiler and air
21 heaters.
 - 22 • There were two unit trips related to Forced Draft fan variable frequency drive ("VFD")
23 trips. These occurred on March 19, 2018 and March 26, 2018. In both instances the unit
24 was returned to service using replacement parts from inventory. During the outage
25 related to the March 19, 2018 trip, a problem with the Mark V turbine governor system
26 was also resolved. Hydro is continuing to work towards resolving the problems with VFD
27 reliability.
 - 28 • On April 12, 2018 the load was reduced to 126 MW, limited by high furnace pressure as
29 a result of continued boiler and air heater fouling. The capability of the unit continued

1 to decline for the same reason. On May 6, 2018 the capability was 122 MW and on May
2 15, 2018 it was 116 MW.

- 3 • On May 21, 2018 the unit tripped at 70 MW on high boiler drum level. The cause was
4 determined to be a failure of a turbine control valve stem. The valve stem was replaced
5 during the planned 2018 turbine valve outage.
- 6 • On June 4, 2018 the unit was further de-rated to 100 MW, limited by high furnace
7 pressure as a result of on-going boiler and air heater fouling. By the end of June 2018
8 this had further reduced to 88 MW.
- 9 • On June 16, 2018, while on a brief planned outage to change worn generator brushes, a
10 pressure gauge failed on the fuel oil system resulting in a spill. This had to be cleaned up
11 before the unit could be safely returned to service. On June 17, 2018 while starting up
12 the unit, a bearing failed on the east forced draft fan and had to be replaced. The unit
13 returned to service on June 18, 2018 but the same bearing failed after only a few hours
14 of operation. The bearing was again replaced and the unit was successfully returned to
15 service on June 19, 2018. A field representative from the fan's original equipment
16 manufacturer travelled to site to assist with the failure analysis of these bearings. It was
17 concluded that the bearing liner babbitted surface failed. Additional checks have been
18 added to the Preventive Maintenance work for these bearings to prevent such a failure.
- 19 • The planned maintenance outage for Unit 1 started on July 27, 2018. Outage work
20 included a chemical wash of the economizer, and replacement of the hot end air heater
21 baskets to address air flow and furnace pressure load restrictions.
- 22 • The unit was returned to service following the annual outage on October 20, 2018, with
23 a load restriction of 140 MW pending completion of on-line safety valve testing. After
24 completion of the valve testing, the available load was confirmed to be 162 MW on
25 December 6, 2018 and continued to year end. Boiler tuning was completed by a boiler
26 tuning expert from December 17, 2018 to December 20, 2018. This improved the
27 operation of the boiler, but did not increase the available load.
- 28 • On November 3, 2018, the unit tripped due to contamination in the turbine hydraulic
29 system. A full overhaul was completed and the unit was returned to service on

1 November 24, 2018. The observations on Unit 1 triggered the same refurbishment of
2 the Unit 2 turbine hydraulic system, which was completed in December 2018.

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

8

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

- 11 • The capability of the unit declined during the winter operating season due to ongoing
12 fouling during operation. On January 4, 2018 the capability had reduced to 154 MW. On
13 January 25, 2018 the capability had reduced to 135 MW due to high furnace pressure as
14 a result of boiler and air heater fouling. On February 14, 2018 the capability had reduced
15 to 117 MW. At the end of February 2018 the capability had reduced to 100 MW. System
16 requirements, given the issues with Unit 1, had precluded an air heater wash on this
17 unit during the month of February 2018. An air heater wash was completed from March
18 5, 2018 to March 6, 2018; however this was not successful in restoring any capacity. By
19 the end of March 2018, the unit capability had reduced to 90 MW as a result of
20 continued boiler and air heater fouling during operation.
- 21 • On February 7, 2018 the unit was taken off for a short, planned outage to replace
22 generator brushes. There was a forced extension to this outage when a unit board
23 breaker tripped during re-start of the unit. Electricians were called in to reset the
24 breaker.
- 25 • The unit was further de-rated to 70 MW from March 1, 2018 to March 2, 2018 due to an
26 issue with the west boiler feed pump. A water leak from a reference line nearby caused
27 contamination of the pump lube oil and the pump was taken off line until the repairs
28 were completed.
- 29 • On March 22, 2018, one of the turbine reheat intercept valves became stuck during
30 regular on-line testing and the unit had to be taken off line for approximately eight

- 1 hours to replace the servos on these valves. To address this problem, the hydraulic fluid
2 was replaced and the system flushed during the 2018 annual outage. Additional flushing
3 and maintenance of the hydraulic system was completed in a maintenance outage in
4 December 2018 based on observations and issues observed in Unit 1 in November 2018.
- 5 • At the beginning of April 2018 the unit was rated at 80 MW due to high furnace pressure
6 as a result of boiler and air heater fouling. This capability further reduced to 70 MW on
7 April 24, 2018 and remained at this level until the unit was taken off line for the annual
8 outage.
 - 9 • On April 3, 2018 the unit was taken off line on a forced outage to repair a leak in the
10 turbine control valve hydraulic ram. The ram was rebuilt and the unit returned to
11 service on April 4, 2018; however, once installed the seals required additional
12 adjustment. The unit was returned to service April 5, 2018. Return to service after this
13 outage was delayed by approximately eight hours on April 5, 2018 due to an issue in the
14 switchyard. TRO replaced the B2T2 breaker during the 2018 annual outage, which
15 resolved this issue.
 - 16 • Unit 2 was available but not operating from April 26, 2018 to May 18, 2018, with the
17 available load de-rated to 70 MW due to high furnace pressure as a result of boiler and
18 air heater fouling. During this time the unit was kept in hot standby, maintaining an
19 eight hour return to service time if recalled. On May 18, 2018 the unit was taken offline
20 to address a suspected stress failure, not a thinning failure, of a tube in the lower water
21 wall (not in the area of previous boiler tube issues). At the time of the failure, Hydro
22 determined that the unit was no longer required for system reliability reasons prior to
23 the scheduled planned outage and could be placed on planned outage in preparation for
24 the annual overhaul.
 - 25 • The tube leak was corrected during the overhaul. Two adjacent leaking tubes were
26 found in the lower front wall. Through investigation and laboratory failure analysis it
27 was determined that the original failure occurred at a butt welded joint in the tube, and
28 that this weld was part of the original construction, and of relatively poor quality. Other
29 welds in the area were inspected with no damage found. The leak had been present for
30 an unknown period of time underneath the boiler casing and impinged upon the

1 adjacent tube, which also failed as a result. Several other tubes in the immediate area
2 were corroded due to the presence of the leak, but had not failed. A total of seven tube
3 sections were replaced.

- 4 • Also during the planned overhaul, work was completed to correct the air flow and
5 furnace pressure issues in the boiler. A chemical wash of the economizer was completed
6 and the hot end air heater baskets were replaced. The unit was returned to service on
7 September 15, 2018 with the fuel additive system in service and it was immediately
8 noted that the furnace pressure and air flow conditions had been greatly improved.
9 Equipment issues related to start up caused a number of short forced outages and de-
10 rates during the first few days of operation. On September 21, 2018, the unit was load
11 tested to 140 MW, limited because the on-line safety valve testing had not been
12 completed. However, it was clear from the boiler performance that full load should be
13 achievable. This was later confirmed on October 11, 2018 when the unit was tested to
14 171 MW and was capable of more.
- 15 • On September 26, 2018 there was a boiler trip related to starting a boiler feed pump.
16 The fan was in vane control and it was demonstrated that this trip would not occur in
17 VFD air flow control. The fans were switched to VFD control mode, which ensures that
18 the drives are more reliable, and that the savings on auxiliary power use can be realized.
- 19 • On October 16, 2018, there was a bypass of a power cell in one VFD drive, which caused
20 a fan to trip resulting in a short derating to 70 MW until the fan could be restarted.

21

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

- 24 • The capability of the unit declined during the winter operating season due to ongoing
25 fouling during operation. On December 31, 2017, the available load was 131 MW. On
26 January 18, 2108 the available load was determined to be 120 MW, and on February 10,
27 2018, this had further reduced to 100 MW. An air heater wash outage was completed
28 from February 10, 2018 to February 11, 2018. System requirements, with Unit 1 already
29 off line, had precluded an air heater wash on this unit until that time. When the unit was
30 returned to service there was a de-rating to 70 MW for approximately 10 hours when

1 the west boiler feed pump failed to start. This was resolved and the available load was
2 determined to be 110 MW, still limited by air heater fouling. The unit was capable of
3 100 MW at the beginning of March 2018. This capability further reduced to 75 MW on
4 March 20, 2018. An air heater wash outage was completed on March 28, 2018 and the
5 predicted load after this wash was 110 MW. This unit was not required for the system,
6 and was left on standby until the planned unit outage started on April 2, 2018.

- 7 • On January 11, 2018, a ¾" diameter domestic water pipe located above the Unit 3
8 exciter ruptured at a cap and the resulting water leak contacted the exciter causing a
9 unit trip. There was no significant equipment damage resulting from this incident and
10 once the exciter was safely dried, the unit was returned to service on January 12, 2018.
11 This event was investigated and the leak repaired. A shut off valve was relocated for
12 improved access in the event of a further trip, regular inspections of the area were
13 implemented, and a plan was formulated to replace this piping during the annual
14 outages. On February 14, 2018 the unit load was reduced to 50 MW for approximately
15 eight hours as a precautionary measure because of another leak in a domestic water
16 line in close proximity to the exciter. After this event, the piping was relocated so that
17 further leaks would not impact the exciter.
- 18 • The annual outage was from April 2, 2018 until June 1, 2018. Air flow issues could not be
19 corrected during the annual outage because of the long lead times for replacement air
20 heater materials. The remainder of the planned work was completed, and a two week
21 outage was planned for October 2018 to complete the air heater work required to
22 restore load capability.
- 23 • The Unit 3 generator was put in service in synchronous condenser mode on June 1, 2018
24 and ran until September 24, 2018, when it was taken off line for a maintenance outage
25 to replace some generator brushes. There was a problem with the drive controller that
26 prevented re-start of the synchronous condenser. On September 28, 2018 the unit was
27 placed on a maintenance outage to prepare for conversion to generation mode.
- 28 • The hot end air heater baskets were replaced during the outage in October 2018 to
29 address the air flow restrictions on the unit. The unit returned to service on October 30,
30 2018, limited to 140 MW pending on-line testing of the safety valves, which was

1 completed on November 6, 2018. Full load capability to 150 MW was confirmed by load
2 test on December 2, 2018, and available at 150 MW for the remainder of 2018.

- 3 • On November 13, 2018, the unit tripped due to an issue with the west boiler feed pump
4 discharge valve. The unit was returned to service later that same day after
5 troubleshooting.
- 6 • On November 15, 2018 the unit was taken off line on a forced outage to repair a water
7 wall tube leak. The unit was returned to service on November 20, 2018.
- 8 • On December 3, 2018 the unit tripped when an operator changed control to a drum
9 level transmitter that had a fault. Unit protection operated properly and the unit was
10 returned to service within an hour.

11

12 **6.0 Gas Turbine UFOP Performance**

13 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was 3.62%
14 for the 12-month period ending December 31, 2018 (see Table 6 and Figure 3). This is below the
15 base planning assumption of 10.62%, and the near-term assumption of 20.00%. The current
16 period UFOP is significantly better than the previous period UFOP of 6.93%. The Hardwoods
17 UFOP for the current period is 4.80%, which is better than the base planning assumption of
18 10.62%. The Stephenville UFOP for the current period is 1.45%, which is better than the base
19 planning assumption of 10.62%. The Happy Valley UFOP is 2.11% for the current period, which
20 is below the base planning assumption of 10.62%.

Table 6: Gas Turbine UFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Hydro Generation	
				Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Combined Gas Turbines	125	6.93	3.62	10.62	20.00
Stephenville	50	5.59	1.45	10.62	20.00
Hardwoods	50	2.91	4.80	10.62	20.00
Happy Valley	25	19.32	2.11	10.62	20.00

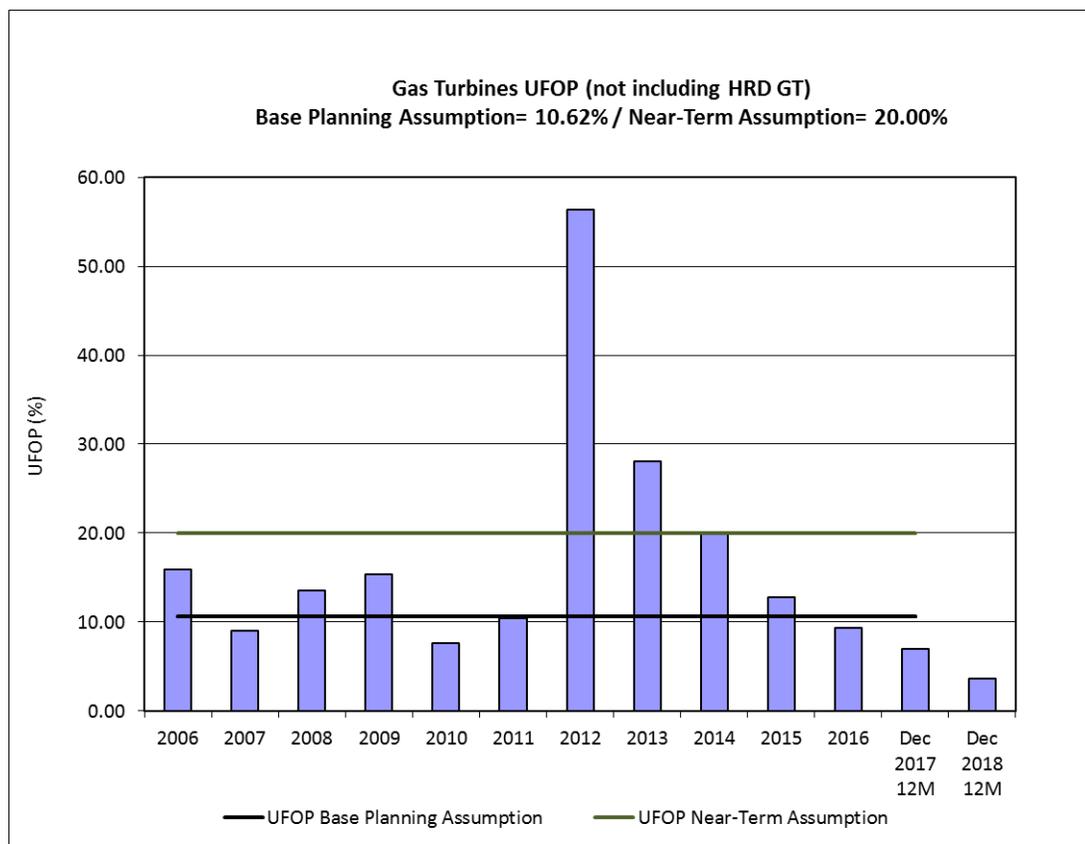


Figure 3: Gas Turbine UFOP – Hardwoods/Happy Valley/Stephenville Units

- 1 The Holyrood UFOP of 0.00% for the current period is better than the base and near-term
- 2 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 December 2017 (%)	12 months ending December 2018 (%)	Hydro Generation	
				Base Planning Assumption (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	2.02	0.00	5.00	5.00

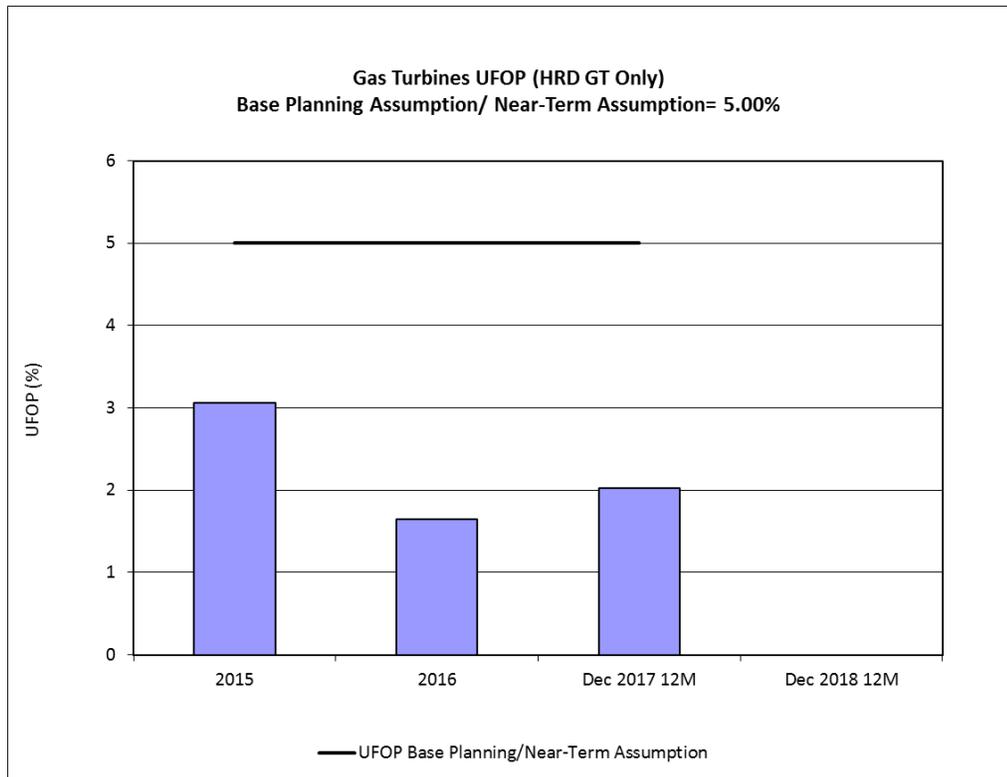


Figure 4: Gas Turbine UFOP – Holyrood Unit

1 **7.0 Gas Turbine DAUFOP Performance**

2 The combined DAUFOP for the Hardwoods and Stephenville gas turbines was 21.67% for the
 3 12-month period ending December 31, 2018 (refer to Table 8 and Figure 5). This is below the
 4 near-term planning assumption of 30.00%. The Hardwoods DAUFOP for the current period is
 5 8.28%, which is better than the near-term planning assumption of 30.00%. The Stephenville
 6 DAUFOP for the current period is 47.48%, which is above the near-term planning assumption of
 7 30.00%.

Table 8: Hardwoods/Stephenville Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Near-Term Planning Assumption (%)
Gas Turbines (HWD/SVL)	100	19.72	21.67	30.00
Stephenville	50	40.06	47.48	30.00
Hardwoods	50	10.86	8.28	30.00

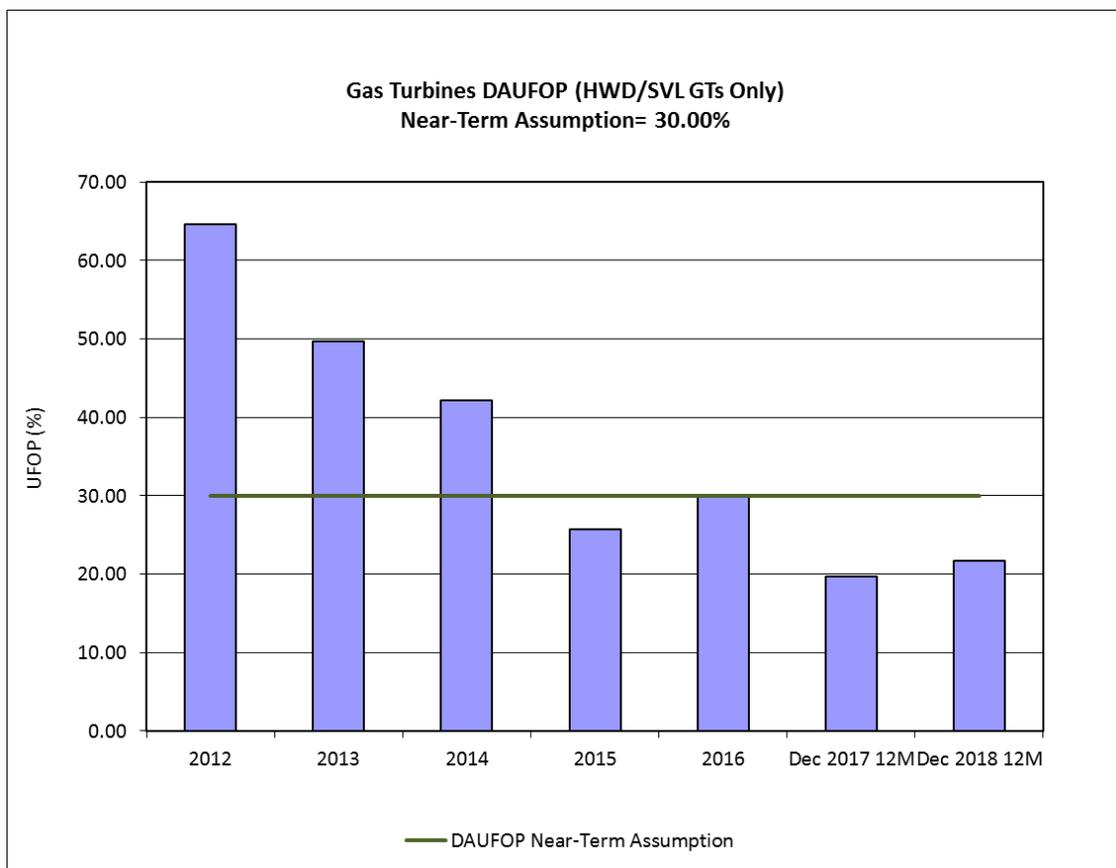


Figure 5: Gas Turbine DAUFOP – Hardwoods/Stephenville Units

- 1 The DAUFOP for the Happy Valley gas turbine was 2.11% for the 12-month period ending
- 2 December 31, 2018 (refer to Table 9 and Figure 6). This is below the near-term planning
- 3 assumption of 15.00%.

Table 9: Happy Valley Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Near-Term Planning Assumption (%)
Happy Valley	25	22.18	2.11	15.00

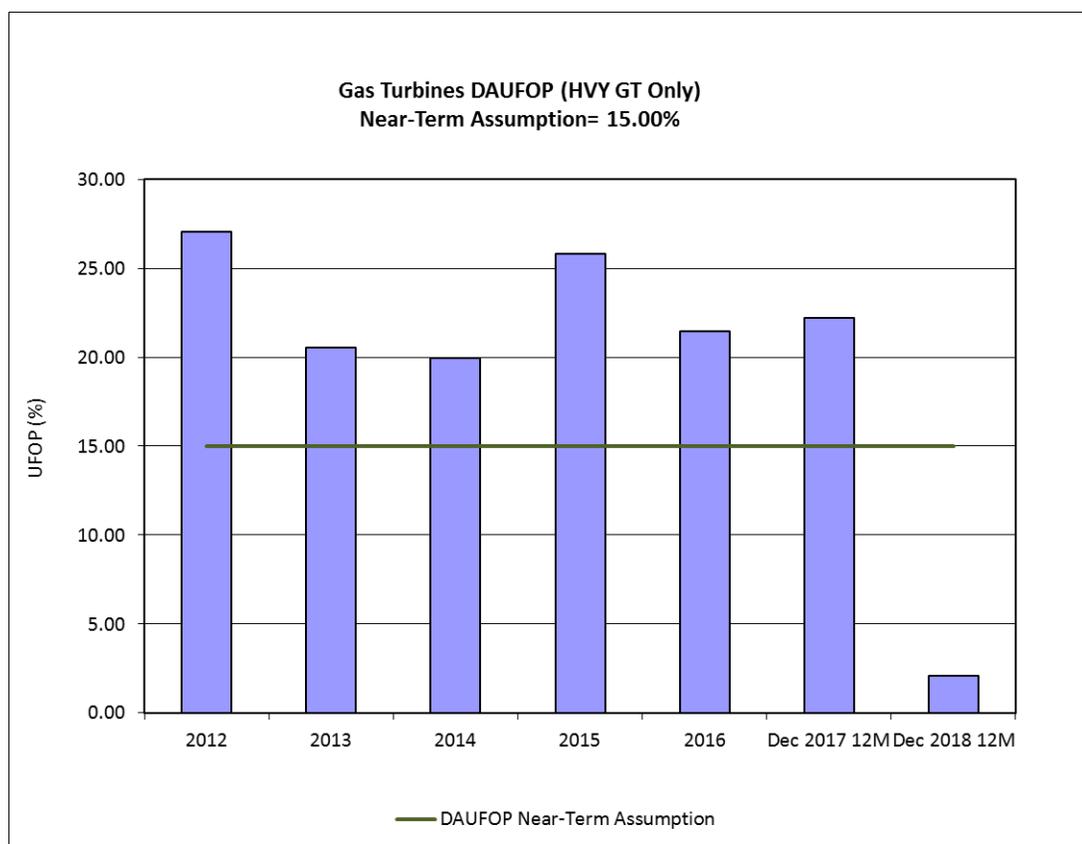


Figure 6: Gas Turbine DAUFOP – Happy Valley Unit

- 1 The Holyrood gas turbine DAUFOP of 0.00% 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 Gas Turbine DAUFOP

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Near-Term Planning Assumption (%)
Holyrood GT	123.5	2.02	0.00	5.00

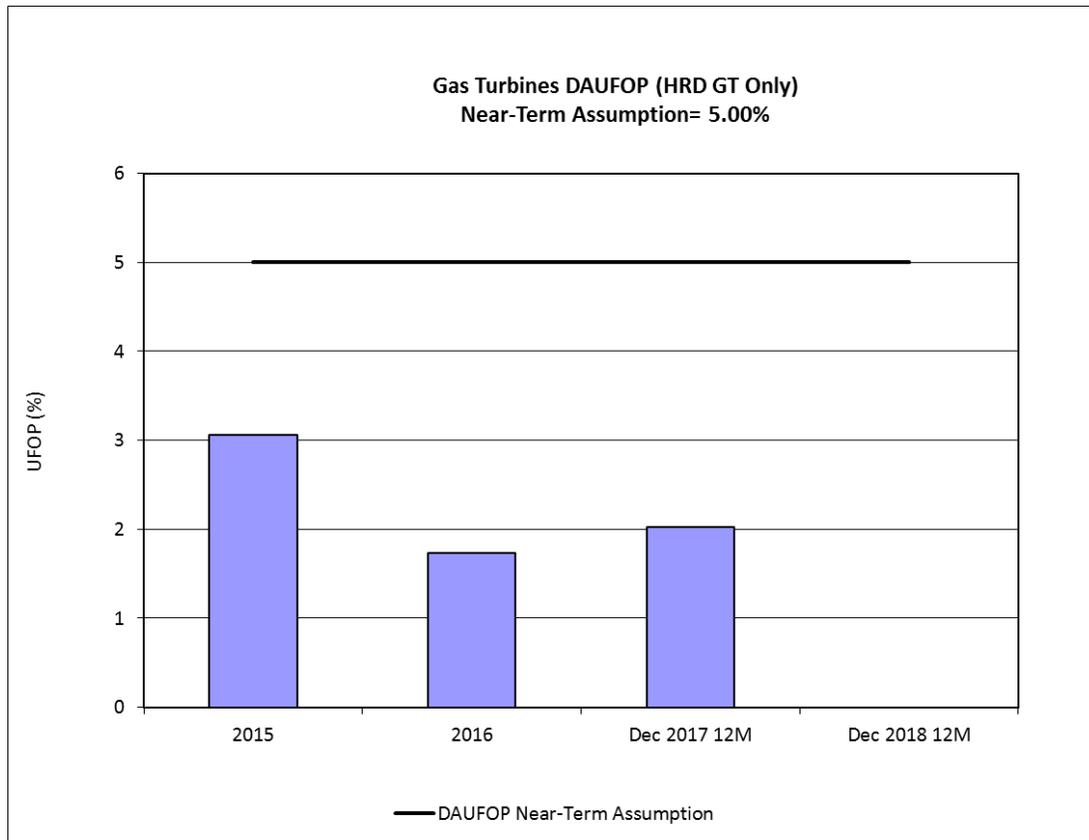


Figure 7: Gas Turbine DAUFOP – Holyrood Unit

1 The Stephenville gas turbine DAUFOP for the period is impacted by the unavailability of End A
2 as a result of an exhaust bellows failure at Hardwoods gas turbine End A on December 28, 2017.
3 Stephenville End A was unavailable at this time due to issues with the power turbine rear
4 bearing, which required the bearing to be replaced. Hydro decided to remove the bellows from
5 End A at Stephenville and install it at Hardwoods End A to return that unit to full capacity.

6

7 **8.0 Updated Planning Assumptions/Analysis Values**

8 As part of its Reliability and Resource Adequacy Study filed with the Board in November 2018,
9 Hydro detailed the process undertaken for determining the forced outage rates most
10 appropriate for use in its near-term reliability assessments and long-term resource adequacy
11 analysis. The 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

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

7
 8 DAFORs of 15, 18, and 20% were applied to the Holyrood Thermal Generating Station in order
 9 to determine the sensitivity of the system to Holyrood availability in the near term. This is
 10 consistent with the May 2018 Near-Term Generation Adequacy Report. As the Holyrood units
 11 are being retired from generation mode in 2021, they were not included in the long term
 12 analysis and thus there is no resource planning analysis value listed for these units. For the total
 13 plant, an all units weighted value of 15.00% is used.

14
 15 As the gas turbines in the existing fleet are in varied condition, each was considered on an
 16 individual basis, rather than applying a weighted average across all units. For the Happy Valley
 17 gas turbine, a three-year capacity-weighted average was applied to the unit for the near-term
 18 analysis, resulting in a DAUFOP of 13.92%, while a ten-year capacity-weighted average was
 19 applied for use in the resource planning model resulting in a DAUFOP of 12.59%. The DAUFOP

1 values were based on historical data founded upon the unit's past reliable performance. As the
2 Holyrood gas turbine has only been in operation for the past three years, the near-term analysis
3 considered performance in the worst case year of its operational history¹⁰. For the long term
4 analysis, the average of the three years of operational data was applied for the unit, resulting in
5 a long-term DAUFOP of 2.24%. For the Hardwoods and Stephenville gas turbines, a DAUFOP of
6 30% was used for the near-term analysis, consistent with what was considered in Hydro's May
7 2018 Near-Term Generation Adequacy Report. As the Hardwoods and Stephenville gas turbines
8 are being considered for retirement in 2021, they were not included in the longer term analysis
9 and thus there is no resource planning analysis value listed for these units.

10

11 **9.0 Comparison of Planning Assumptions/Analysis Values**

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

16

17 Hydro notes that the Reliability and Resource Adequacy Study did not utilize UFOP in its
18 analysis. The analysis utilized instead the DAUFOP measure with changes as shown in the table.

¹⁰ 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

- 1 The generating unit performance presented previously in this report is again presented in
- 2 Tables 13 to 17 with comparison to the previous assumptions as well as the recently revised
- 3 values. No table is provided for the UFOP performance, as Hydro does not plan to use this
- 4 metric in future for reliability assessments.

Table 13: Hydraulic Weighted DAFOR Performance Comparison

Generating Unit	May 2018				November 2018			
	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Base Assumption (%)	Near-term Assumption (%)	Near-term Planning Value (%)	Resource Planning Analysis Value (%)	
All Hydraulic Units - weighted	954.4	2.29	0.21	0.9	2.6	3.50	1.93	
Hydraulic Units								
Bay D'Espoir 1	76.5	9.33	0.07	0.90	3.90	3.50	1.93	
Bay D'Espoir 2	76.5	14.11	0.64	0.90	3.90	3.50	1.93	
Bay D'Espoir 3	76.5	0.03	0.00	0.90	3.90	3.50	1.93	
Bay D'Espoir 4	76.5	0.27	0.15	0.90	3.90	3.50	1.93	
Bay D'Espoir 5	76.5	0.00	0.00	0.90	3.90	3.50	1.93	
Bay D'Espoir 6	76.5	1.48	0.54	0.90	3.90	3.50	1.93	
Bay D'Espoir 7	154.4	1.80	0.00	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	0.89	0.07	0.90	0.70	3.50	1.93	
Upper Salmon	84	0.81	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	1.70	0.00	0.90	0.70	3.50	1.93	

Table 14: Thermal Unit DAFOR Performance Comparison

Generating Unit	May 2018				November 2018			
	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Base Assumption (%)	Near-term Assumption (%)	Near-term Planning Value (%)	Resource Planning Analysis Value (%)	
All Thermal Units - weighted	490	14.91	28.97	9.64	14.00	15.00	N/A	
Thermal Units								
Holyrood 1	170	19.35	36.66	9.64	15.00	15.00	-	
Holyrood 2	170	19.14	24.03	9.64	10.00	15.00	-	
Holyrood 3	150	5.84	22.80	9.64	18.00	15.00	-	

Table 15: Hardwoods/Stephenville Gas Turbine DAUFOP Performance Comparison

Gas Turbine Units	May 2018				November 2018				
	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Base Planning Assumption (%)	Near-term Planning Assumption (%)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Near-Term Planning Analysis Value (%)	Resource Planning Analysis Value (%)
<i>Gas Turbines (HWD/SVL)</i>	100	19.72	21.67	N/A	30.00			30.00	N/A
Stephenville	50	40.06	47.48	N/A	30.00			30.00	N/A
Hardwoods	50	10.86	8.28	N/A	30.00			30.00	N/A

Table 16: Happy Valley Gas Turbine DAUFOP Performance Comparison

Gas Turbine Units	May 2018				November 2018				
	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Base Planning Assumption (%)	Near-term Planning Assumption (%)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Near-Term Planning Analysis Value (%)	Resource Planning Analysis Value (%)
Happy Valley	25	22.18	2.11	N/A	15.00			13.92	12.59

Table 17: Holyrood Gas Turbine DAUFOP Performance Comparison

Gas Turbine Units	May 2018				November 2018				
	Maximum Continuous Unit Rating (MW)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Base Planning Assumption (%)	Near-term Planning Assumption (%)	12 months ending December 2017 (%)	12 months ending December 2018 (%)	Near-Term Planning Analysis Value (%)	Resource Planning Analysis Value (%)
Holyrood	123.5	2.02	0.00	N/A	5.00			3.06	2.24