

Undertaking 57

RE: Rolling 12 Month Performance of Hydro's Generating Unit Reports

Please see Undertaking 57, Attachment 1 for Hydro's 3rd Quarter Rolling 12 Month Performance of Hydro's Generating Units Report filed the Board on October 19, 2015.

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

**QUARTERLY REPORT
ON
PERFORMANCE OF GENERATING UNITS
FOR THE QUARTER ENDED SEPTEMBER 30, 2015**

NEWFOUNDLAND AND LABRADOR HYDRO

October 19, 2015



Table of Contents

1.0	Introduction	1
2.0	Period Ending September 30, 2015 Overview	3
3.0	Generation Planning Assumptions.....	5
4.0	Hydraulic Unit Forced Outage Rate Performance	6
5.0	Thermal Unit Forced Outage Rate Performance	9
6.0	Gas Turbine UFOP Performance	13

1 **1.0 Introduction**

2

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

7

8 The forced outage rates are provided for individual generating units at hydraulic facilities;
9 the three units at the Holyrood Thermal Generating Station (HTGS) and Hydro's gas turbines
10 for the current 12-month reporting period of October 1, 2014 to September 30, 2015. The
11 report also provides, for comparison purposes, the individual generating unit data on forced
12 outage rates for the previous period October 1, 2013 to September 30, 2014. Further, total
13 asset class data is presented on an annual basis for years the 2004-2013. 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 two measures:
17 Derated Adjusted Forced Outage Rate (DAFOR) for the hydraulic and thermal units and
18 Utilization Forced Outage Probability (UFOP) for the gas turbines.

19

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

27

28 Utilization Forced Outage Probability (UFOP) is a metric that measures the percentage of
29 time that a unit or group of units will encounter a forced outage and not be available when
30 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 September 30, 2015 Overview**

2

Class of Units	October 1, 2013 to September 30, 2014 (%)	October 1, 2014 to September 30, 2015 (%)	Base Planning Assumption (%)
Hydraulic	5.89	2.82	0.90
Thermal	12.00	9.86	9.64
Gas Turbine (Combined) ¹	25.24	17.93	10.62
Gas Turbine (Holyrood)	N/A	5.01	5.00

3

4 The hydraulic and thermal DAFOR and the combined¹ gas turbine UFOP performance (in
5 table above) improved for the current period, the 12-month period ending September 2015
6 compared to the previous period, the 12-month period ending September 2014.

7

8 In the ten 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 ten years is higher
10 primarily due to vibration problems on Unit 1 at Bay d’Espoir.

11

12 The thermal units, in the ten year period prior to 2014, exhibit more variability in DAFOR
13 than the hydraulic units, but many years were close to a rate of approximately 10%.

14 Considering the forced outage rate of the current period ending September 2015 compared
15 to the previous ten years, the 9.86% DAFOR is near the rate of many years, and improved
16 compared to the previous 12-month period when the rate was 12%.

17

18 Hydro’s combined gas turbines UFOP in the ten year period prior to 2014 was generally
19 consistent at approximately 10% until 2012 when the rate exceeded 50%. Since 2012, the
20 UFOP has been improving each year. The current 12-month period ending September 30,

¹ Combined Gas Turbines include the Hardwoods, Happy Valley, and Stephenville units. In the previous Quarterly Reports on Performance of Generating Units, the Holyrood CT was included in the combined data. 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. Hydro has now removed the Holyrood CT from the combined number. Removal of the Holyrood CT data from the combined data results in a slightly higher UFOP for the combined data, by approximately three percentage points.

- 1 2015 performance was mainly affected by the Hardwoods unit being derated and forced
2 outages on both the Stephenville and Hardwoods units. The Holyrood CT, the newest unit in
3 this asset class, is a 123.5 MW unit and the data for this unit started to be measured in
4 March 2015. This unit is not included in the combined gas turbine UFOP rate.
5
6 Note that the data in the charts for 2004 to 2013 are annual numbers (January 1 to
7 December 31), while the data for September 2014 and September 2015 are 12-month rolling
8 (October 1 to September 30 for each period).

1 **3.0 Generation Planning Assumptions**

2

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

6

7 Hydro also provides a sensitivity number for DAFOR and UFOP as part of its generation
8 planning analysis. This number takes into account a higher level of unavailability, should it
9 occur, to assess the impact of higher unavailability of these units on overall generation
10 requirements. During the 12-month period ending September 30, 2015, the thermal and gas
11 turbine units performed within this sensitivity range for DAFOR and UFOP. Further, the
12 analysis demonstrated that with the implementation of the new gas turbine generating unit
13 and the capacity assistance arrangements, the LOLH reliability criterion will be met beyond
14 2018 for the full range of sensitivity in the table below.

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.²

19

20 Hydro’s current generation planning assumptions for DAFOR and UFOP are:

21

	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 ³

² 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)*.

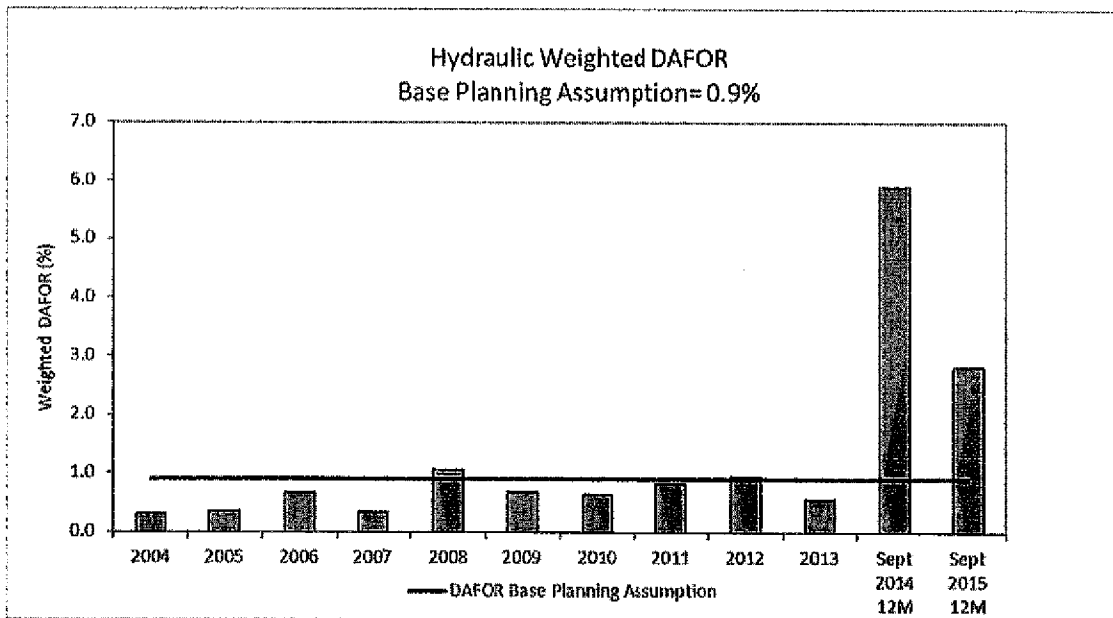
³ In previous reports, this sensitivity value was reported as 5.0%. The generation planning sensitivity for the Holyrood CT was updated to 10% since the last report for system planning purposes.

2 4.0 Hydraulic Unit Forced Outage Rate Performance

3

7 The hydraulic unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
8 results for the 12-month period ending September 30, 2015 is presented as well as the data
9 for the 12-month period ending September 30, 2014 and Hydro's generation planning
10 assumption for the forced outage rate.

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending September 2014 (%)	12 months ending September 2015 (%)	Hydro Generation Base Planning Assumption (%)
<i>All Hydraulic Units - weighted</i>	954.4	5.89	2.82	0.90
Hydraulic Units				
Bay D'Espoir 1	76.5	0.03	25.6	0.90
Bay D'Espoir 2	76.5	3.04	0.00	0.90
Bay D'Espoir 3	76.5	0.00	0.00	0.90
Bay D'Espoir 4	76.5	0.75	0.23	0.90
Bay D'Espoir 5	76.5	0.19	2.46	0.90
Bay D'Espoir 6	76.5	58.59	0.00	0.90
Bay D'Espoir 7	154.4	2.08	0.00	0.90
Hinds Lake	75	0.11	0.32	0.90
Upper Salmon	84	1.27	0.98	0.90
Granite Canal	40	1.53	1.51	0.90
Cat Arm 1	67	0.00	0.63	0.90
Cat Arm 2	67	1.39	1.42	0.90
Paradise River	8	0.65	0.19	0.90



1 The weighted "All Hydraulic Units" DAFOR was 2.82% for the current 12 month period
2 ending September 30, 2015. The forced outage and derating of Unit 1 at Bay d'Espoir was
3 the primary contributor to the DAFOR of 2.82% as compared to a base planning assumption
4 of 0.9%.

5

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

10

11 The Bay d'Espoir Unit 1 DAFOR of 25.6% compared to the base planning assumption of 0.9%
12 was the result of a forced extension of a planned outage. The planned annual maintenance
13 was scheduled from April 26 to May 15, 2015. The extension is the result of having to
14 replace the turbine bearing. It was identified in the annual work plan to check the turbine
15 bearing clearances due to an increase in bearing temperatures. The bearing clearances were
16 checked and damage was found to the turbine bearing, so it was replaced with a new
17 bearing. Vibration issues continued with the unit after the bearing was replaced, which
18 extended the planned outage. Two vibration experts, Hydro staff, as well as the Original
19 Equipment Manufacturer were involved in troubleshooting the issue, with the unit
20 eventually being returned to service at reduced capacity. The original turbine bearing was
21 reinstalled after being refurbished (with reduced clearances), and while the vibration issue
22 remained, a further dismantle of the unit revealed other issues including a damaged thrust
23 bearing. Additional repairs were made and a new thrust bearing installed, which resolved
24 the vibration issue, and the unit was returned to service at full capability on September 30,
25 2015.

26

27 The Bay d'Espoir Unit 5 DAFOR of 2.46% compared to the base planning assumption of 0.9%
28 was the result of a forced outage after the completion of the planned annual maintenance.
29 The planned annual maintenance was completed from May 27 to August 7, 2015. Upon

1 starting the unit, a stator ground fault occurred which required five days to repair before the
2 unit was placed in service on August 12, 2015.

3

4 The DAFOR for the Upper Salmon unit was 0.98% compared to the base planning assumption
5 of 0.9%. The actual DAFOR was primarily attributable to one outage of about two days and
6 three one day outages.

7

8 Granite Canal unit DAFOR of 1.51% compared to the base planning assumption of 0.9% was
9 the result of a forced outage after a lightning strike to transmission line TL263 resulted in a
10 bearing issue on the restart of the unit. From August 10, 2015 to August 14, 2015, the unit
11 was forced unavailable while repairs were completed on the thrust bearing due to a low
12 water flow problem on the shaft seal.

13

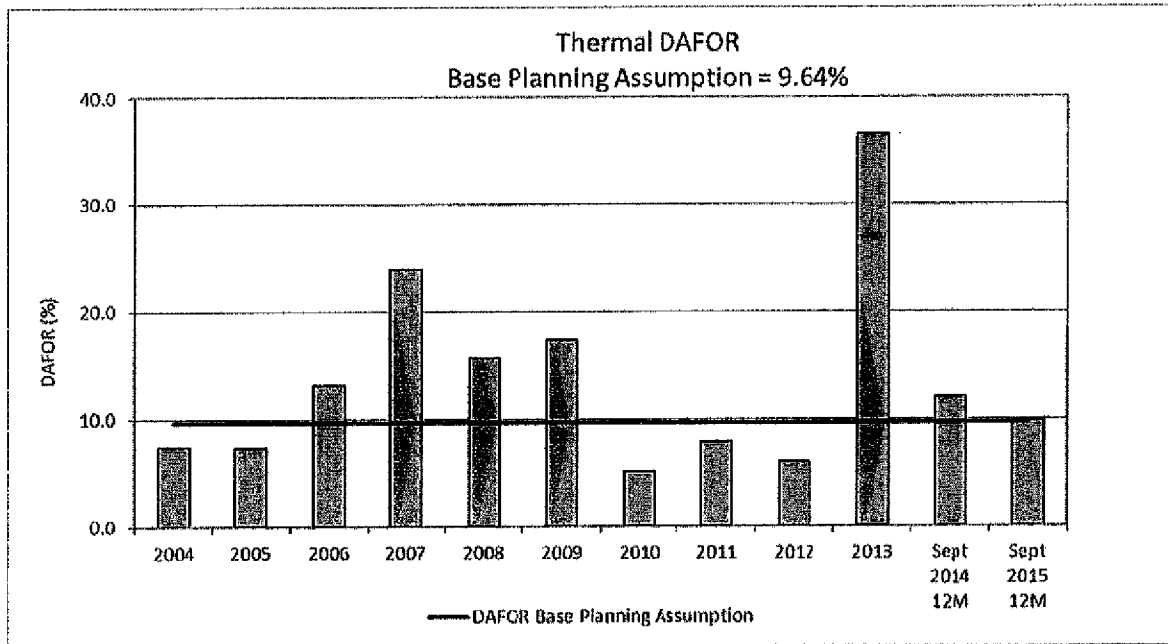
14 The DAFOR for Cat Arm Unit 2 was 1.42% compared to the base planning assumption of
15 0.9%. The actual DAFOR was attributable to two forced outages, of approximately two days
16 each.

2 **5.0 Thermal Unit Forced Outage Rate Performance**

3

7 The thermal unit forced outage rates are measured using the CEA metric, DAFOR. Detailed
 8 results for the 12-month period ending September 30, 2015 is presented as well as the data
 9 for the 12-month period ending September 30, 2014 and the Hydro generation base
 10 planning assumption for the forced outage rate.

Generating Unit	Maximum Continuous Unit Rating (MW)	12 months ending September 2014 (%)	12 months ending September 2015 (%)	Hydro Generation Base Planning Assumption (%)
<i>All Thermal Units - weighted</i>	490	12.00	9.86	9.64
Thermal Units				
Holyrood 1	170	16.73	12.22	9.64
Holyrood 2	170	6.53	7.15	9.64
Holyrood 3	150	11.65	10.08	9.64



11 For the 12-month period ending September 30, 2015, the weighted all thermal units DAFOR
 12 of 9.86% was not materially different than the assumed Hydro generation base planning
 13 DAFOR value of 9.64%, and improved compared to the previous 12-month period rate of
 14 12.00%. The variance compared to plan in the current period was primarily attributable to

1 an exceedance for Unit 1 DAFOR. Unit 2 performance, at 7.15%, was better than the base
2 planning assumption of 9.64%. Unit 3 DAFOR improved compared to that of the previous
3 period of 11.65% and finished the current period at 10.08% compared to a plan of 9.64%.

4

5 The DAFOR for the three Holyrood units combined, at 9.86%, is less than the sensitivity value
6 of 11.64%.

7

8 The DAFOR performance for Holyrood Unit 1 (170 MW) was primarily affected by several
9 events.

10

11 From November 2 to 19, 2014, there was a forced extension to the 2014 planned
12 maintenance outage due to concrete damage found in the condenser cooling water
13 sump. The damage was a safety hazard that had to be mitigated prior to returning the
14 unit to service.

15

16 During the 2014 maintenance outage, repairs and adjustments were made to one of the
17 turbine bearings to improve operation. This work was a follow-up to the work that was
18 done in 2013 following the January 2013 failure. Subsequent to the turbine bearing
19 adjustments, the turbine rotor had to be re-balanced. This is an iterative and time
20 consuming process that requires the unit to be brought on line for measurements and
21 calculations and taken off line for placement of balance weights. Four iterations were
22 required to successfully balance the rotor. This work started November 19, and the unit
23 was deemed within standards and returned to service November 30. As system load
24 permitted, Hydro took an additional day to complete another adjustment, improving
25 balancing results even further, on December 3 and the unit was returned to service
26 December 4.

27

28 From March 11 to 13, 2015 the unit was taken off line for a forced outage to replace a
29 bearing in the west forced draft fan motor. Through failure analysis, the bearing failure
30 was attributed to a shock loading that occurred sometime in the past while the motor

1 was at rest. The source of the shock loading could not be confirmed but may have
2 happened during transportation/handling of the motor or during installation of the
3 bearing. There were no signs of electrical arc damage or other operational problem.
4 There have been no further issues.

5
6 From March 13 to 30, 2015 the unit was derated to 160 MW due to airflow limitations,
7 suspected to be related to the commissioning of the new variable frequency drives on
8 the forced draft fans. Changes were made after the critical system load period had
9 ended to correct this issue. However the expected results were not achieved. At that
10 time, testing indicated that the problem may be related to unit fouling or airflow control.
11 During the 2015 planned maintenance outage from August to October, the air heaters
12 were found to be heavily fouled. They were cleaned during the outage. It is expected
13 that the air flow problem that led to the load restriction has been resolved as a result of
14 this clearing. Testing of the air flow controls during the maintenance outage did not
15 reveal any problems. A separate derating to 155 MW which occurred from May 14 to
16 August 1, 2015 was attributable to the same airflow limitations as described above.

17
18 Holyrood Unit 3 (150 MW) DAFOR performance was affected by several events.

19
20 From September 30 to October 13, 2014, the unit was operating with a forced derating
21 of 135 MW due to condenser fouling. From October 13 to October 19, 2014, the unit was
22 available but not operating in the same derated state. The condenser was cleaned while
23 off line and returned to operation at full capacity on October 22, 2014.

24
25 From August 27 to September 9, 2015, the unit experienced a forced derating to 70 MW.
26 The derating was the result of a steam leak in a newly installed cold reheat drain pot.
27 Shortly after the unit was started up after a planned unit outage, a leak was detected in
28 the new drain pot at a pipe weld. The unit was maintained at a low load until repairs
29 could be completed. From September 9 to September 12, the unit was off-line on a
30 maintenance outage and the leak was repaired.

1 From September 12 to October 1, 2015, the unit experienced a forced derating to 70
2 MW. The derating was caused by a ground fault in the west cooling water (CW) pump
3 motor. The motor failed during the start-up of the unit after repair of the drain pot leak.
4 With one CW pump out of service, the unit is normally able to produce approximately
5 100 MW. However due to the relatively warm sea water temperature, 70 MW was the
6 maximum available capacity. The failed motor was repaired and put back in service.

1 **6.0 Gas Turbine UFOP Performance**

2

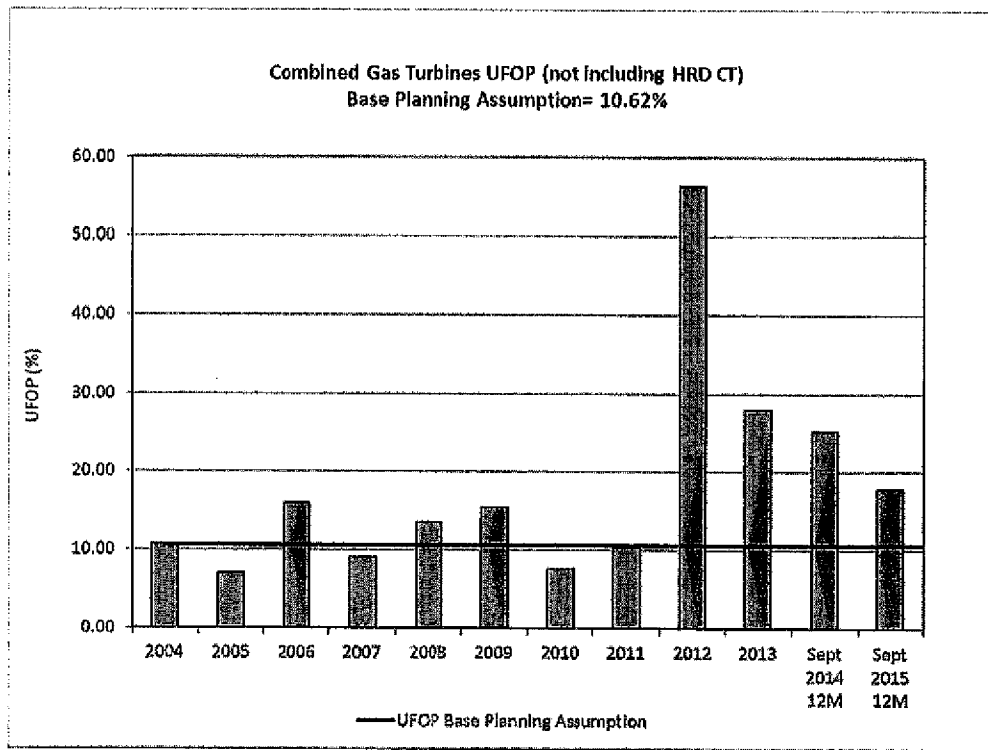
3 The combined UFOP for the Hardwoods, Happy Valley and Stephenville gas turbines was
4 17.93% for the 12-month period ending September 30, 2015. This is higher than the base
5 planning assumption of 10.62%, but lower than the sensitivity UFOP of 20.62%. The current
6 period UFOP improved from the previous period UFOP of 25.24%. The Hardwoods UFOP for
7 the current period is 18.99% compared to a base planning assumption of 10.62%. The
8 Stephenville unit's current period UFOP is 17.70% compared to that of the previous period
9 of 16.86%. Happy Valley's UFOP is 13.77% for the current period compared to that of 4.00%
10 in the previous period.

Gas Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2014 (%)	12 months ending September 2015 (%)	Hydro Generation Base Planning Assumption (%)
<i>Combined Gas Turbines</i>	125	25.24	17.93	10.62
Stephenville	50	16.86	17.70	10.62
Hardwoods	50	38.83	18.99	10.62
Happy Valley	25	4.00	13.77	10.62

11 The Holyrood (HRD) CT UFOP at 5.01% for the current period is essentially equal to the base
12 planning assumption.

Combustion Turbine Units	Maximum Continuous Unit Rating (MW)	12 months ending September 2014 (%)	12 months ending September 2015 (%)	Hydro Generation Base Planning Assumption (%)
Holyrood CT*	123.5		5.01	5.00

*data presented from March to September 2015 only



3 The combined gas turbines UFOP base planning assumption was exceeded in the current
 4 period primarily due to the Hardwoods and Stephenville gas turbines' UFOP.

4

5 Hardwoods UFOP was affected by several events in the reporting period.

6

10 A forced outage of Hardwoods End B from December 12 to 30, 2014 resulted from a
 11 flexible fuel line failure. Replacement of the affected fuel lines was completed at both
 12 Hardwoods and Stephenville, and the replacement of all flexible fuel lines has been
 13 completed during planned maintenance outages on both units in 2015.

11

16 In 2015, a forced outage of Hardwoods End B beginning on March 1 has impacted the
 17 unit's UFOP performance to date. The outage was due to a fire caused by a failed
 18 component on a fuel oil vent line. The failed components have been replaced on all
 19 units. Inspection revealed internal damage to the Hardwoods End B engine which
 20 occurred during the fire event. Following this inspection, it was determined that the

1 engine would have to be refurbished at an offsite facility. A replacement unit has been
2 installed in its place and will remain there while the engine refurbishment is completed.

3
4 Stephenville UFOP was affected by several events in the reporting period.

5
6 In 2014, the Stephenville gas turbine experienced two forced outages in November
7 beginning on November 10 and extending to November 28. The first outage was a result
8 of a failed fuel line on End A which resulted in End A not being available. A second
9 forced outage which began on November 17 was a result of faulted control cables inside
10 a common junction box and resulted in the entire unit being removed from service until
11 repairs could be made. The unit was returned to full capability on November 28 after the
12 fuel lines were replaced and the necessary repairs completed on End A and the control
13 cables and junction box.

14
15 Following a similar failure of a fuel line at Hardwoods on December 12, 2014, the
16 Stephenville gas turbine was removed from service for generation until the issue with
17 the fuel lines was thoroughly investigated and they were verified safe for ongoing
18 operation. The root cause of the fuel line failures was determined to be a manufacturing
19 defect. Hydro removed the affected fuel lines from service and completed quality
20 assurance checks on the remaining fuel lines to assure their suitability for service. It was
21 determined that the remaining fuel lines were suitable and Stephenville End A was
22 returned to service on December 21, 2014. There were insufficient fuel lines available to
23 return End B to service. Replacement fuel lines were ordered, quality assurance checks
24 of all new fuel lines were completed, and End B was returned to service on January 29,
25 2015.

26
27 In 2015, the UFOP for Stephenville Gas Turbine has been primarily impacted by a forced
28 outage from May 1, to May 27, due to an alternator bearing problem. The bearing was
29 inspected, repaired, and all operating parameters checked and confirmed prior to
30 returning the unit to service.

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

2

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

