

1 Q. Please provide performance data for each year, 2008 through 2013, for (a) each of
2 the three Holyrood units, (b) Hardwoods CT, (c) Stephenville CT, and (d) the Bay
3 d'Espoir plant. Please include at least the following parameters where applicable:

- 4 a) Capacity factor;
- 5 b) Net generation in MWh;
- 6 c) Operating hours (i.e., hours synchronized to the grid);
- 7 d) Failure rate;
- 8 e) Incapability factor;
- 9 f) DAFOR;
- 10 g) Utilization forced outage probability; and
- 11 h) Heat rate.

12 In the response include the definition used for each parameter.

13
14
15 A. Please refer to PUB-NLH-148, Attachment 1 for the generation performance data
16 (where applicable) and the definition used for each parameter. Following are some
17 additional details regarding performance.

18
19 Hydro manages and schedules its generation resources to ensure that there are
20 sufficient generation reserves to withstand the loss of the largest available
21 generating unit and avoid sustained customer interruption. Therefore, forced
22 outages to generating units do not normally result in prolonged customer
23 interruptions¹.

¹ Due to the Island Interconnected System being isolated from the larger North American grid, when there is a sudden loss of large generating units, some customer's load must be interrupted for short periods to bring generation output equal to customer demand. This automatic action of power system protection, referred to as underfrequency load shedding, is necessary to ensure the integrity and reliability of system equipment. Underfrequency events typically occur five to eight times per year on the Island Interconnected System and the resultant customer load interruptions are generally less than 30 minutes.

1 The Incapability Factor² may be impacted by the number and duration of planned
2 outages required for maintenance or capital work. Planned outages of generating
3 units are scheduled during a time when customer demand is sufficiently low and
4 there are ample generation reserves available at the remaining units to supply
5 customer demand. These outages generally occur outside of the winter demand
6 period and are required to improve or maintain the reliability of the units.

7
8 Each of the Holyrood units is typically taken out of service for a period of between
9 10-16 weeks every year for extensive maintenance and capital work to ensure that
10 they are ready for the operating season. In 2013, Unit 3 was unavailable for an
11 extended period, from May 22, 2013 to November 21, 2013, for two planned
12 outages. The planned outages were required to perform the capital work to replace
13 the unit's exciter and to replace the unit's protection and control panels.

14
15 The Incapability Factor of the Bay d'Espoir plant was higher in 2010, 2012 and 2013
16 due to the extended outages required to carry out generator rewinds on Units 2, 4
17 and 1, respectively.

18
19 The Incapability Factor of Unit 1 at Holyrood was higher in 2013 due to a major
20 bearing failure and fire on January 11. The investigation determined that the
21 bearing lubricating oil system failed to maintain sufficient oil to the bearings when
22 the unit shut down during a 230 kV system disturbance. Major repairs to the unit
23 were required and the unit was released for service again on October 9, 2013 after
24 an extended outage. After the system was restored following the initial events on
25 January 11, customers were not affected by the continued unavailability of this unit,

² Refer to PUB-NLH-148, Attachment 1, page 7 of 8 for the definition of Incapability Factor.

1 as there were sufficient generation reserves available from other sources
2 throughout its outage period.

3
4 The Incapability Factor of the Stephenville Gas Turbine was impacted from 2007
5 through to the time of its alternator failure in December 2011 because there was
6 only one turbine of its two turbines in service. This resulted in a de-rating of the
7 unit to half of its MCR³. In 2007, one of the engines (End B) was removed from
8 Stephenville and installed in Hardwoods to replace a Hardwoods' engine (End A).
9 Inspection had determined that this Hardwoods' engine had significant damage to
10 its turbine blades. It was also determined that there was damage to Hardwoods
11 End B, although less significant. At this time, it was determined that full capability at
12 Hardwoods was required due to the criticality of this unit in supporting the
13 transmission system into the Avalon Peninsula. The availability of the end at
14 Stephenville allowed for the swap-out and refurbishment of both ends of the
15 Hardwoods unit over a period of five years.

16
17 The availability of the turbine end for this period of time was realized because the
18 generation requirements for the Stephenville unit⁴ were very low. System demand
19 was significantly reduced with the shut of the paper mills in Stephenville and Grand
20 Falls-Windsor and the decline in operations at Corner Brook. The unit was primarily
21 required in synchronous condenser mode to support the system voltages⁵ in the
22 region. Full synchronous condenser capability was still available even with the
23 removal of one engine end. The de-rating of the Stephenville unit from 2007

³ Maximum Continuous Rating.

⁴ Refer to PUB-NLH-148, Attachment 1, page 4 of 8 for an indication of the operating requirements during this period.

⁵ Higher voltages are experienced in the western region of the Island Interconnected System due to the light loadings experienced on the relatively long 230 kV transmission lines supplying the area.

1 through to the time of its alternator failure in December 2011 did not result in
2 generation supply issues on the System.

3
4 In each of 2010 and 2013, the Incapability Factor at Hardwoods was affected by
5 long duration, planned and maintenance outages. In 2010, the unit was out of
6 service from October 25 to December 2 for planned refurbishment and engine
7 reinstallation. In 2013, the unit was unavailable from October 3 to December 19 in
8 order to replace the alternator under a capital project.

9
10 The Failure Rate⁶ for standby units can be impacted by a small number of forced
11 outages because the operating requirements are generally low. The Failure Rates
12 for the Hardwoods Gas Turbine in the years 2011-2013 and for the Stephenville Gas
13 Turbine in 2009 were impacted by the low operating requirements for the units⁷.

⁶ Refer to PUB-NLH-148, Attachment 1, page 6 of 8 for the definition of Failure Rate.

⁷ For example, in 2009 the Stephenville Gas Turbine experienced one forced outage while in generation mode. At a total 2013 annual operating requirement of 9,566 hours, this resulted in a failure rate of $1/9.566 \times 8,760 = 915.68$.

Holyrood Thermal Generating Station	2008	2009	2010	2011	2012	2013
Unit 1						
Gross Unit Rating (MW)	170	170	170	170	170	170
Gross Capacity Factor (%)	19.6%	24.2%	22.9%	26.4%	26.0%	11.7%
Gross Generation (MWh)	292,915	360,410	340,820	392,490	388,490	173,740
Gross Unit Efficiency (%)	34.4%	34.8%	34.3%	34.1%	34.4%	34.0%
Gross Unit Heat Rate (BTUs/kWh)	9,919	9,805	9,948	10,006	9,919	10,026
Unit Operating Time (hours)	3,486	4,520	4,420	4,952	4,555	1,985
Unit Planned Outage Time (hours)	2,622	1,925	1,760	1,808	2,350	1,366
Unit Maintenance Outage Time (hours)	77	60	103	10	7	60
Unit Forced Outage Time (hours)	1,476	1,670	128	218	221	5,186
Number of Planned Outages	3	1	2	4	3	2
Number of Maintenance Outages	2	1	2	3	3	1
Number of Forced Outages	8	10	3	4	6	5
Failure Rate (Forced Outages/Oper. Hours x 8760)	17.64	15.30	-	3.54	7.71	13.24
Incapability factor (% of time)	49.38	44.23	23.47	23.52	29.85	78.35
DAFOR (% of time)	32.35	32.52	4.22	4.21	4.73	75.70
Utilization Forced Outage Probability (% of time)	n/a	n/a	n/a	n/a	n/a	n/a
Unit 2						
Gross Unit Rating (MW)	170	170	170	170	170	170
Capacity factor (%)	36.7%	26.5%	20.6%	24.2%	22.9%	33.2%
Gross Generation (MWh)	548,220	394,200	306,590	360,310	342,210	494,710
Gross Unit Efficiency (%)	35.0%	33.5%	33.6%	33.8%	33.4%	33.2%
Gross Unit Heat Rate (BTUs/kWh)	9,749	10,185	10,155	10,095	10,216	10,280
Unit Operating Time (hours)	4,994	4,922	3,954	4,470	3,906	5,280
Unit Planned Outage Time (hours)	1,581	2,258	1,079	1,805	1,369	1,140
Unit Maintenance Outage Time (hours)	238	-	295	23	48	945
Unit Forced Outage Time (hours)	175	34	137	119	15	237
Number of Planned Outages	2	2	3	4	3	4
Number of Maintenance Outages	5	-	5	4	2	6
Number of Forced Outages	3	3	5	1	4	8
Failure Rate (Forced Outages/Oper. Hours x 8760)	1.76	3.56	11.08	-	9.00	8.34
Incapability factor (% of time)	23.10	29.04	18.15	24.85	17.03	27.84
DAFOR (% of time)	3.54	5.50	5.28	3.64	0.77	6.44
Utilization Forced Outage Probability (% of time)	n/a	n/a	n/a	n/a	n/a	n/a

Holyrood Thermal Generating Station	2008	2009	2010	2011	2012	2013
Unit 3						
Gross Unit Rating (MW)	150	150	150	150	150	150
Capacity factor (%)	23.6%	19.1%	16.3%	14.9%	14.1%	27.1%
Gross Generation (MWh)	310,380	251,130	214,450	196,100	186,180	355,930
Gross Unit Efficiency (%)	35.3%	34.3%	33.6%	33.6%	32.7%	33.5%
Gross Unit Heat Rate (BTUs/kWh)	9,666	9,948	10,155	10,155	10,434	10,179
Unit Operating Time (hours)	3,082	2,946	2,811	2,443	2,221	3,664
Synchronous Condensor Time (hours) ⁽¹⁾	4,403	4,117	3,181	4,889	4,361	3
Unit Planned Outage Time (hours)	1,899	3,524	3,264	3,847	1,655	4,320
Unit Maintenance Outage Time (hours)	27	292	2	13	54	36
Unit Forced Outage Time (hours)	213	236	20	584	299	13
Number of Planned Outages	6	22	5	14	6	6
Number of Maintenance Outages	1	1	2	3	3	2
Number of Forced Outages	3	3	4	3	4	3
Failure Rate (Forced Outages/Oper. Hours x 8760)	5.70	5.95	9.35	7.17	7.91	7.17
Incapability factor (% of time)	25.61	46.35	39.31	51.60	24.87	55.68
DAFOR (% of time)	8.80	7.69	6.20	21.80	16.87	12.77
Utilization Forced Outage Probability (% of time)	n/a	n/a	n/a	n/a	n/a	n/a
Overall Plant						
Gross Plant Rating (MW)	490	490	490	490	490	490
Gross Capacity Factor (%)	26.8%	23.4%	20.1%	22.1%	21.3%	23.9%
Gross Generation (MWh)	1,151,515	1,005,740	861,860	948,900	916,880	1,024,380
Station Services (MWh)	71,287	65,875	58,790	63,586	61,054	66,938
Net Generation (MWh)	1,080,228	939,865	803,070	885,314	855,826	957,442
No. 6 fuel usage (bbbls)	1,728,681	1,534,707	1,363,179	1,469,169	1,428,337	1,610,966
Plant Net Fuel Conversion Factor (kWh/bbl)	625	612	589	603	599	594
Failure Rate (Forced Outages/Oper. Hours x 8760)	7.60	8.11	6.27	2.95	8.22	8.84
Incapability factor (% of time)	32.70	39.88	26.98	33.32	26.92	53.96
Weighted DAFOR (% of time)	15.65	17.38	5.07	7.88	5.98	36.58
Utilization Forced Outage Probability (% of time)	n/a	n/a	n/a	n/a	n/a	n/a

Note: 1. In 2013 Unit 3 sync condense time was for testing only. The unit was not available for synchronous condensor operation during the late spring and summer due to planned capital work. Avalon voltage support was provided by the capacitor banks at Come by Chance.

Hardwoods Gas Turbine Plant	2008	2009	2010	2011	2012	2013
Overall Plant (Hardwoods Gas Turbine)						
Gross Unit Rating (MW) ⁽¹⁾	54	54	50	50	50	50
Gross Capacity Factor (%)	0.83%	0.50%	0.71%	0.14%	0.35%	0.39%
Gross Generation (MWh)	3,938	2,369	3,089	634	1,534	1,699
Station Services (MWh)	939	964	1,198	823	873	714
Synchronous Condensor Use (MWh)	<u>3,521</u>	<u>3,406</u>	<u>6,336</u>	<u>3,319</u>	<u>4,068</u>	<u>266</u>
Net Generation (MWh)	(522)	(2,001)	(4,445)	(3,508)	(3,407)	719
No. 2 fuel usage (gal) ⁽²⁾	397,039	223,967	289,309	73,044	151,158	140,958
Unit Gross Fuel Conversion Factor (kWh/gal)	9.9	10.6	10.7	8.7	10.1	12.1
Operating Time (hours)	206.40	104.13	150.00	38.38	103.30	80.98
Synchronous Condensor Time (hours)	3,398	3,458	5,943	3,187	3,790	75
Unit Planned Outage Time (hours)	-	-	953	594	51	-
Unit Maintenance Outage Time (hours)	41	211	163	19	-	1,831
Unit Forced Outage Time (hours)	8	40	221	28	474	300
Number of Planned Outages	5	-	5	4	5	-
Number of Maintenance Outages	4	10	8	2	-	3
Number of Forced Outages	14	12	7	5	13	4
Failure Rate (Forced Outages/Oper. Hours x 8760)	85.11	168.25	-	228.22	255.10	216.34
Incapability factor (% of time)	8.42	14.45	23.47	7.58	13.42	30.89
DAFOR (% of time)	n/a	n/a	n/a	n/a	n/a	n/a
Utilization Forced Outage Probability (% of time)	13.23	16.84	19.34	10.20	35.14	15.94

Note: 1. The gas turbine unit was derated to 50 MW as of January 1, 2010, however it remained as a 54 MW rated MCR unit in Hydro's Generation Equipment Status (GES) database until January 1, 2013.

2. There was fuel consumed at the Hardwoods GT in December 2013 that was not reported until January 2014

Stephenville Gas Turbine Plant	2008	2009	2010	2011	2012	2013
Overall Plant (Stephenville Gas Turbine)						
Gross Unit Rating (MW) ⁽¹⁾	54	54	50	50	50	50
Gross Capacity Factor (%)	0.05%	0.04%	0.09%	0.04%	0.00%	0.44%
Gross Generation (MWh)	223	202	382	173	-	1,908
Station Services (MWh)	1,525	1,286	1,221	1,083	466	1,285
Synchronous Condensor Use (MWh)	<u>6,077</u>	<u>4,550</u>	<u>5,105</u>	<u>5,803</u>	<u>-</u>	<u>2,858</u>
Net Generation (MWh)	(7,379)	(5,634)	(5,944)	(6,713)	(466)	(2,235)
No. 2 fuel usage (gal) ⁽²⁾	27,081	21,291	48,665	18,446	-	39,674
Unit Gross Fuel Conversion Factor (kWh/gal)	8.2	9.5	7.8	9.4	n/a	48.1
Operating Time (hours) ⁽³⁾	22.97	9.57	51.45	13.03	-	65.63
Synchronous Condensor Time (hours)	7,929	6,421	6,433	8,096	-	4,169
Unit Planned Outage Time (hours)	53	37	262	65	-	295
Unit Maintenance Outage Time (hours)	209	163	71	37	-	283
Unit Forced Outage Time (hours)	11	220	28	189	8,784	3,663
Number of Planned Outages	9	5	8	6	-	1
Number of Maintenance Outages	8	7	7	7	-	6
Number of Forced Outages	6	6	4	7	-	5
Failure Rate (Forced Outages/Oper. Hours x 8760)	-	915.68	-	-	n/a	266.94
Incapability factor (% of time)	51.72	56.09	49.63	54.76	100.00	54.28
DAFOR (% of time)	n/a	n/a	n/a	n/a	n/a	n/a
Utilization Forced Outage Probability (% of time)	9.77	12.70	5.83	16.41	n/a	50.00

Note: 1. The gas turbine unit was derated to 50 MW as of January 1, 2010, however it remained as a 54 MW rated MCR unit in Hydro's Generation Equipment Status (GES) database until January 1, 2013.

2. There was fuel consumed at the Stephenville GT in December 2013 that was not reported until January 2014

3. The unit was on a forced outage in 2012.

Bay d'Espoir Generating Station	2008	2009	2010	2011	2012	2013
Overall Plant (Units 1-7)						
Gross Unit Rating (MW)	613.4	613.4	613.4	613.4	613.4	613.4
Gross Capacity Factor (%)	53.8%	45.5%	45.8%	52.3%	48.8%	53.5%
Gross Generation (MWh)	2,897,002	2,445,773	2,462,069	2,811,437	2,627,702	2,876,419
Station Services (MWh)	6,477	5,171	5,178	5,776	5,203	5,482
Synchronous Condensor Use (MWh)	49	110	152	148	172	112
Net Generation (MWh)	2,890,476	2,440,492	2,456,739	2,805,513	2,622,327	2,870,825
Plant Net Hydraulic Conversion Factor (GWh/MCM)	0.433	0.434	0.436	0.434	0.434	0.432
Total Unit Operating Time (hours)	39,349	32,749	33,809	39,509	36,641	40,275
Synchronous Condensor Time (hours) ⁽¹⁾	130	290	399	391	444	296
Unit Planned Outage Time (hours)	2,689	2,363	5,042	3,450	4,148	5,741
Unit Maintenance Outage Time (hours)	59	1,234	797	520	2,064	283
Unit Forced Outage Time (hours)	285	72	5	12	379	332
Number of Planned Outages	15	14	15	8	12	13
Number of Maintenance Outages	13	21	22	10	20	11
Number of Forced Outages	7	4	2	3	14	9
Failure Rate (Forced Outages/Oper. Hours x 8760)	0.45	-	0.26	0.22	0.71	1.08
Incapability factor (% of time)	4.93	5.98	9.55	6.54	10.72	10.37
Weighted DAFOR (% of time)	0.60	0.18	0.05	0.08	0.83	0.68
Utilization Forced Outage Probability (% of time)	n/a	n/a	n/a	n/a	n/a	n/a

Note: 1. Synchronous condensor capability is for Unit 7 only.

Parameter Definitions

Gross Capacity Factor (%) - *determined by the ratio of the gross electricity generated at a unit or plant to the maximum that the unit or plant could produce at continuous full power operation during the same period.*

Net Generation (MWh) – *determined as gross generation less station service consumption and synchronous condenser use (if applicable). Net generation is tracked by Hydro on a plant basis only, and therefore cannot be provided on an individual unit basis for the Holyrood units as requested.*

Operating Hours (hours) - *number of hours that the generating unit is synchronized to the grid and capable of producing real power.*

Synchronous Condenser Hours (hours) - *number of hours that the generating unit is synchronized to the grid with no prime mover supply and capable of producing reactive power only.*

Failure Rate (FAILRATE) - *Failure Rate indicates the rate a unit encounters a forced outage. Failure Rate is determined by dividing the number transitions from an operating state to a forced outage by the total operating time times 8760⁶.*

⁶ Total Operating Time (hours) is the sum of all operating hours, including forced and scheduled derating operating hours.

Parameter Definitions (cont'd)

Incapability Factor (ICbF-%) - *Incapability Factor indicates the percent of time a generating unit is not able to produce its rated output. The factor is calculated by dividing the total equivalent outage time⁷ (includes adjustments for de-ratings) by the number of unit hours.*

Derating-Adjusted Forced Outage Rate (DAFOR-%) - *DAFOR measures the percentage of the time that a unit or group of units is unable to generate at its Maximum Continuous Rating (MCR) due to forced outages. In generating plants with multiple units, this measure is weighted to reflect differences in generating unit sizes.*

Utilization Forced Outage Probability (UFOP-%) - *Utilization Forced Outage Probability provides the probability that a generating unit will not be available when required. The statistic is very useful for comparing combustion turbine units.*

Gross Thermal Efficiency (%) - *determined by the ratio of the gross electricity generated by a unit to the thermal energy of the fuel consumed during the same period.*

⁷ Total Equivalent Outage Time (years) is the total forced outage time plus planned and maintenance outages time plus any derated times, all divided by 8760.

Parameter Definitions (cont'd)

Gross Heat Rate (BTUs/kWh) - *is determined by the amount of BTUs required in the oil admitted to the Boiler furnace to produce 1 kWh (3412 BTUs) at the generator terminals⁸.*

Fuel Conversion Factor – *this parameter tracks the efficiency in converting fuel oil into electrical energy at Hydro's thermal units and gas turbines and is measured as the ratio of the kWhs generated to the number of barrels or gallons of fuel oil consumed.*

Hydraulic Conversion Factor (GWh/MCM) - *This measure tracks the efficiency in converting water to energy and it is calculated as the ratio of Net GWh generated for every one million cubic metres (MCM) of water turbined.*

⁸ Hydro does not track heat rate at its gas turbine units.