

1 Q. Please explain the forced outage probabilities used in Hydro's planning for Muskrat
2 Falls, distinguishing between the probabilities of forced outage related to:

- 3 • Mechanical or electrical faults at the MF generating station;
- 4 • Events concerning the integrity of the MF reservoir (e.g. a North Spur
5 slide);
- 6 • Outages related to the aerial transmission lines in Labrador;
- 7 • Outages related to the submarine lines;
- 8 • Outages related to the aerial transmission lines in Newfoundland; and
- 9 • Outages related to energy interchanges with CF(L)Co, based on the
10 Water Management Agreement.

11 If, for any of the risks mentioned, Hydro considers the outage probability to be zero,
12 please so indicate.

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15 A. From an Interconnected Island scenario point of view, the AC side of the converter
16 station at Soldier's Pond is the interconnection point between Muskrat Falls and the
17 island system. Given this, the forced outage rate for Muskrat Falls is the composite
18 reliability of the Muskrat Falls plant and the Labrador-Island Link (LIL).

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20 The forced outage rate of the LIL is a combination of forced outage rates for loss of
21 the bipole (complete outage) and for reduced power capability modes (loss of one
22 pole).

LIL - Bipole Reliability

Table 3-2: Composite Island Link Bipole Reliability (please see Hydro's response to PUB-NLH-124) gives reliability figures for loss of the bipole link. The Labrador – Island HVdc Link converter specification includes a maximum permissible design value bipole forced outage rate of ≤ 0.1 per bipole per year, or no more than one bipole outage in ten years for both converters. Given this performance requirement, the summary Table 3-2 was adjusted for the BP failure rates (i.e., 0.05 per converter). Please see Hydro's response to PUB-NLH-124 for a more detailed explanation.

Table 3-2: Composite Island Link Bipole Reliability

Modification to PUB-NLH-212 Attachment 2 Table 3-2: For Labrador - Island HVdc Link Converter Bipole Failure Rates			
Element	Failure Rate (f/yr)	Repair Time (hrs)	Downtime (hrs/yr)
Bipole – Muskrat Falls	0.05	0.13	0.007
Converter Pole + Converter Pole – Muskrat Falls	0.0084	6.86	0.057
Bipole HVdc L1 (Labrador) – 388 km	0.074	24	1.776
Pole 1 + Pole 2 (submarine cables)	0.007	621.7	4.479
Bipole HVdc L2 (Island) – 680 km	0.13	24	3.12
Converter Pole + Converter Pole – Soldiers Pond	0.0084	6.86	0.057
Bipole - Soldiers Pond	0.05	0.13	0.007
Total	0.3278	683.4	9.503

LIL - Reduced Power Capability Modes

Table 3-3: Reduced Power Capability Modes (please see Hydro's response to PUB-NLH-124) gives the forced outage rates for loss of a single pole, leading to a reduced power capability mode.

Table 3-3: Reduced Power Capability Modes

PUB-NLH-212 Attachment 2 Table 3-3: Reduced Power Capability Modes			
Element	Failure Rate (f/yr)	Repair Time (hrs)	Downtime (hrs/yr)
Converter Pole – Muskrat Falls	1.64	13.8	22.42
Pole 1 HVdc	2.04	6.3	12.87
Pole 2 HVdc	2.04	6.3	12.87
Converter Pole – Soldier's Pond	1.64	13.8	22.42
Total	7.36	40.2	70.58

LIL - Combined – Forced Outage Rates

Table: Combined – Forced Outage Rates is the combination of Table 3-2 and Table 3-3, giving the combined forced outage rates for:

- Outages related to the aerial transmission lines in Labrador;
- Outages related to the submarine cables;
- Outages related to the aerial transmission lines in Newfoundland; and
- Outages related to the converter stations.

Table: Combined – Forced Outage Rates

Combined – Forced Outage Rates		
Element	Downtime (hrs/yr)	Forced Outage Rate (%)
Converter Pole – Muskrat Falls	22.48	0.26
Bipole HVdc L1 (Labrador) – 388 km	11.13	0.13
Submarine Cables	4.479	0.05
Bipole HVdc L2 (Island) – 680 km	19.51	0.22
Converter Pole – Soldier's Pond	22.48	0.26
Total	80.1	0.91

Muskrat Falls Generating Station

- *Mechanical or electrical faults at the MF generating station.* The plant is being designed to have independent systems for each unit and to have redundancy in common systems. Therefore, forced outages to each unit are assumed to be independent. Regarding forced outage rates for the Muskrat Falls generating station, assuming that having three or more units in-service is a reasonable full and/or reduced power capability, then if a forced outage rate of 0.9% is assumed for each unit, the forced outage rate for two or more units out simultaneously would be 0.05%.
- *Events concerning the integrity of the MF reservoir (e.g., a North Spur slide).* As stated in Board Order P.U. 41(2014), at page 15, this proceeding does not involve a technical review of any aspects of the construction of the Muskrat Falls Project and it would not be relevant or useful in this proceeding to require the production of detailed technical information in relation to

1 physical risks associated with the Muskrat Falls development. Please also refer
2 to Hydro's response to GRK-NLH-044. In that response, Hydro specifically
3 describes in detail the options available to Hydro in the very unlikely event of a
4 dam breach at Muskrat Falls. Other than to consider a potential dam breach at
5 Muskrat Falls to be very unlikely, Hydro has not assigned a forced outage
6 probability to "events concerning the integrity of the MF reservoir". Hydro
7 likewise does not assign a forced outage probability to catastrophic events
8 concerning the integrity of any of its dams. Hydro notes that the Muskrat Falls
9 dam is being designed similar to all other Hydro dam facilities so that the
10 probability of risk of failure is negligible.

- 11
- 12 • *Outages related to energy interchanges with CF(L)Co, based on the Water*
13 *Management Agreement.* [] Hydro does not assign forced outage
14 probabilities to matters of contractual interpretation or the implications
15 thereof and does not believe that forced outage rates are meaningful in
16 such regard. As such, Hydro has not assigned a forced outage probability to
17 this item.