Q. Please refer to page 7, footnote 4 of the Upgrade Transmission Line Corridor Report. Explain in detail why the 200ms shutdown time for a short circuit near Soldiers Pond was assumed. Include in the response the fault detection and fault clearance time assumed and whether the contingencies of second stage protection are considered.

A. For a temporary bipole fault, it is assumed that a duration of 200 ms is required for detection and the de-ionisation of the HVdc system. It is assumed that faults can be detected in 25 ms and that of 175 ms is required for de-ionisation. These values have been provided by TransGrid Solutions.

The recommendations are based on their experience and on a review of HVdc systems that include a submarine cable section of similar or greater length, combined with overhead line sections. The following systems were found to have de-ionisation times of approximately 150 ms:

HVdc System	Overhead Line Length (km)	Cable Length (km)
Fennoskann	33	200
Gritta	110	163 (Sea) + 43 (Land)
Konti Skan	17	87
New Zealand	572	40

The actual de-ionisation time will not be known until system testing. This value is also dependent on other factors including temperature, humidity, and pollution. Based on the above, a 200 ms re-start time for a bipole overhead line fault was deemed to be a reasonable approximation.

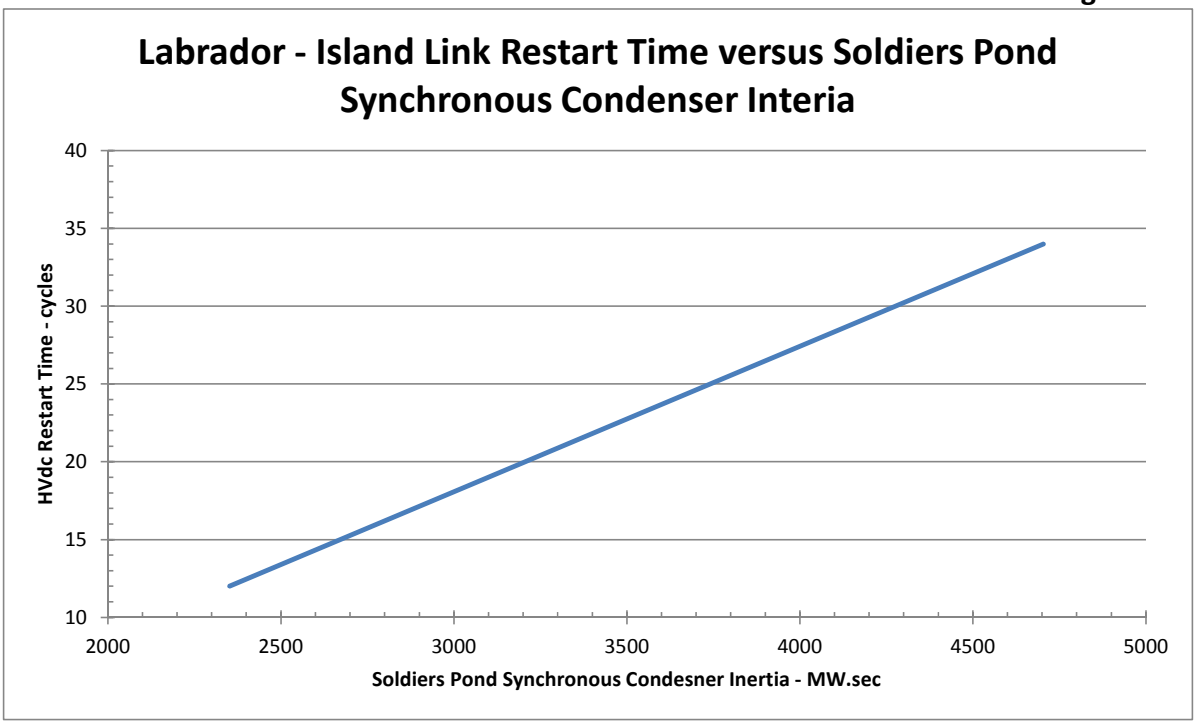
Contingencies of second stage protection have not been considered for this investigation. Hydro's approach to the failure of primary protection and other disturbances classified by NERC as being "Category D" or "Extreme Events" are discussed in Hydro's response to PUB-NLH-061.

Appendix C10 SNC-Lavalin Stability studies March 2012 provided in Section 3.6, page 121 provides a sensitivity analysis to the temporary bipole fault restart time. The results of the analysis are provided in the table below.

Maximum Restart Time for Temporary Bipole Fault
SNC-Lavalin Stability Study March 2012

No of High Inertia Synchronous Condensers	Synchronous Condenser Size MVAR	Inertia Constant H MW.sec/MVA	Total Soldiers Pond Inertia MW.sec	Maximum Restart Time cycles
2	150	7.84	2352	12
3	150	7.84	3528	23
4	150	7.84	4704	34

A graph of restart time versus total Soldiers Pond inertia (provided on the following page) demonstrates the linear relationship between inertia and restart time for the temporary bipole fault.



Given that the project now includes three 175 MVAR high inertia synchronous condensers, the SNC-Lavalin results indicate that with two 175 MVAR synchronous condensers in service with a total inertia contribution of 2744 MW.sec, one expects the maximum restart time for the temporary bipole failure to be approximately 15 cycles or 250 msec. With three 175 MVAR synchronous condensers in service at Soldiers Pond (4116 MW.sec) the maximum restart time is estimated to be 28 cycles or 467 msec.