Q. Please provide an estimate of the percentage of the year that the Island Interconnected System would be at risk of load shedding when operating with two 175 MVA synchronous condensers in service, assuming that the time to restoration of full power after a temporary bipole fault were to exceed 250 ms. In the response, include how the percentage of the year will vary during the life of the Labrador Island Link, i.e. from initial operation when loading may be low until conventional generation is shut down.

A. With two 175 MVA synchronous condensers in service there is no risk of under frequency load shedding after a temporary bipole fault having restart times up to 400 ms. This is due to the curtailment of export over the Maritime Link in the event of an interruption of power flow over the Labrador- Island HVdc Link (LIL). In peak load cases, it is assumed that 158 MW is exported at Bottom Brook Terminal Station. This export is curtailed to 0 MW in the event of a temporary bipole fault.

As indicated in the figures below, if the restart time associated with a temporary bipole fault is extended to 400 ms under peak load conditions, there is no under frequency load shedding.

Analysis indicates that if the restart time for the temporary bipole fault is extended to 450 ms, under frequency load shedding would be required when the LIL is operating at full capacity (i.e., 830 MW delivered at Soldiers Pond). The total load shed under this scenario is estimated to equal 50.5 MW.

To estimate the percentage of the year that the Island Interconnected System would be at risk of under frequency load shedding when operating with two high

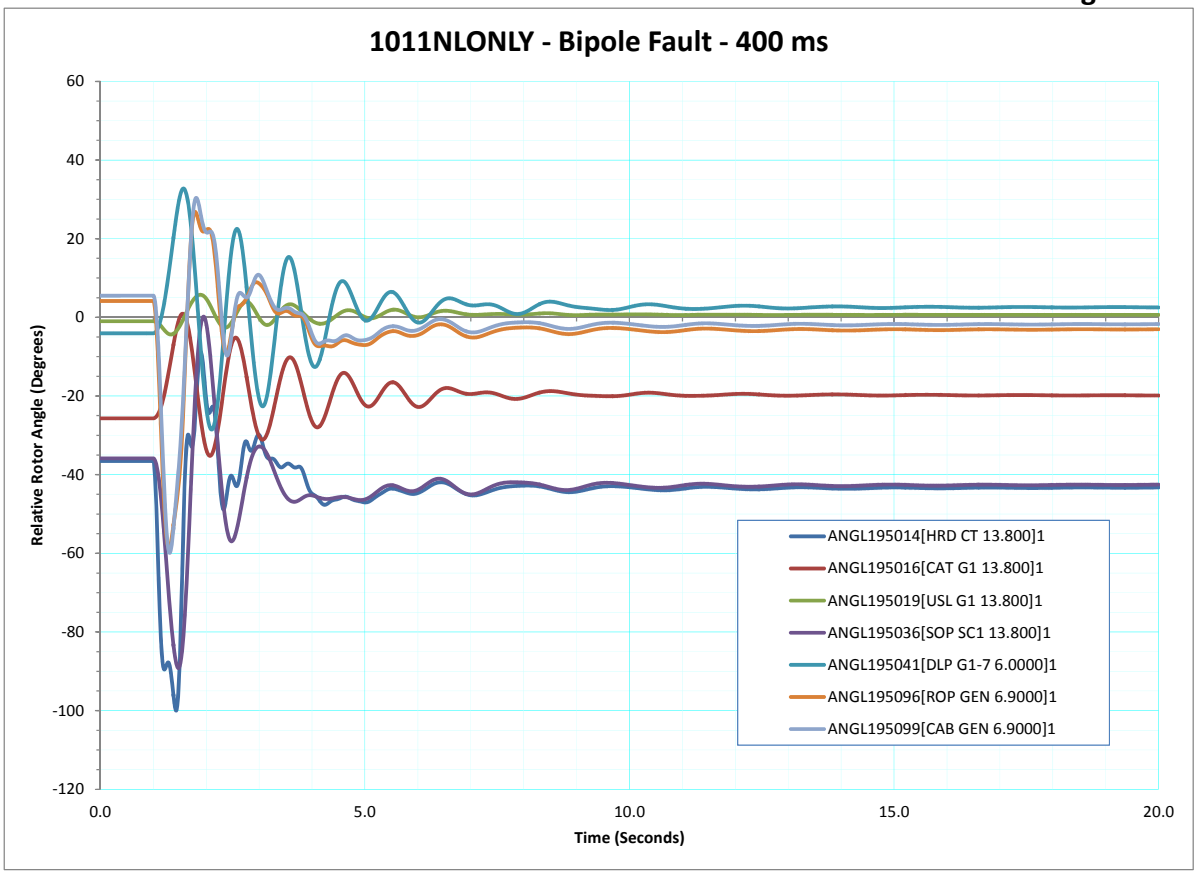
inertia synchronous condensers in operation at Soldiers Pond, it is assumed that the restart time of the HVdc equals 450 msec, or 1.8 times the design restart time. The analysis utilizes existing hourly load and generation data from Hydro's Energy Management System to develop an estimate of the required hourly deliveries over the LIL. For each hour that the LIL delivery exceeds 779.5 MW (i.e., 830 MW delivered less 50.5 MW of load shed) at Soldiers Pond, the hour is counted as an hour of exposure to the potential for under frequency load shedding. To provide a pessimistic view of the risk, it is assumed that the LIL is permitted to deliver 830 MW at Soldiers Pond, with the required 154 MW of spinning reserve carried on the Island Interconnected System. Carrying spinning reserve on the LIL in excess of 51 MW is expected to greatly reduce the risk of under frequency load shedding on the Island in the event of a temporary bipole fault at peak deliveries with a restart time of 450 msec. The following table summarizes the annual risk for the period 2018 to 2041.

Annual Risk of Under Frequency Load Shedding
Assuming a 450 msec Restart Time on the Labrador-Island HVdc Link

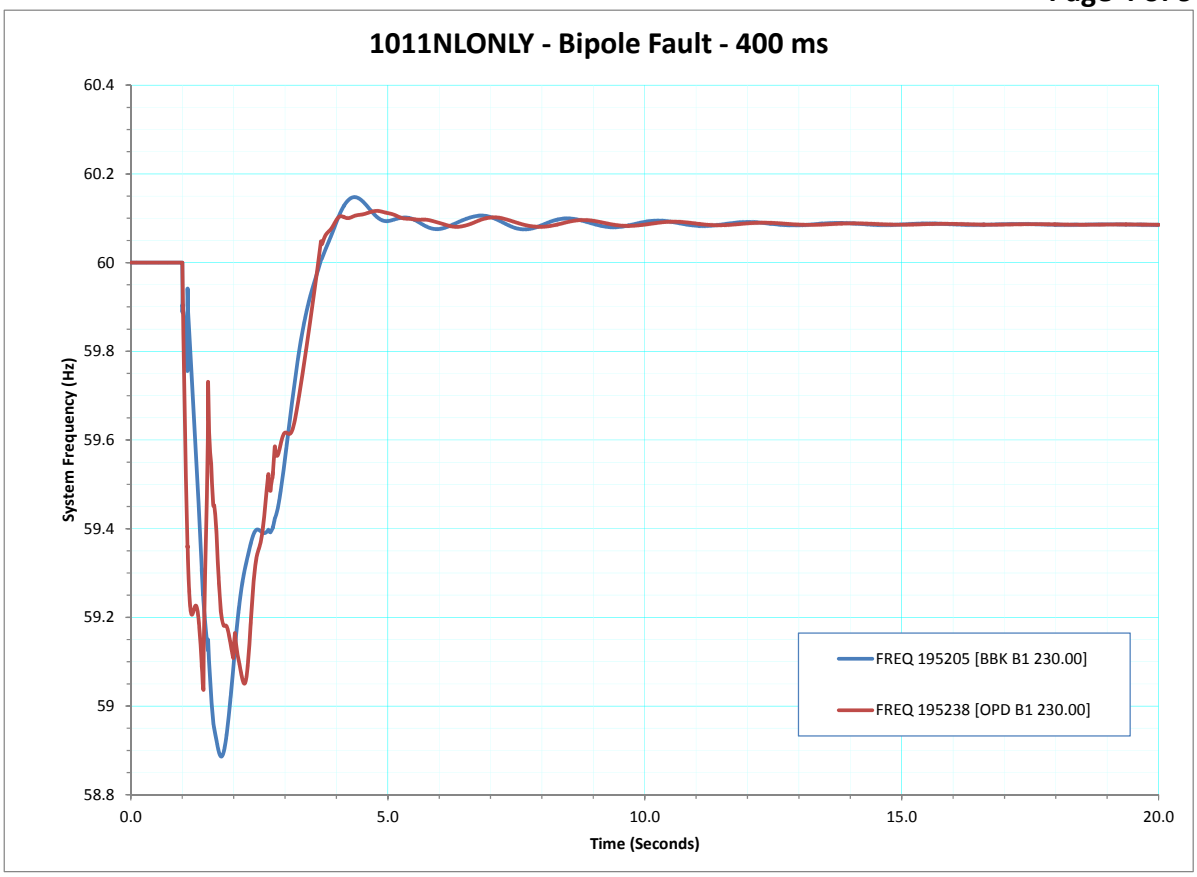
Year	Exposure Hours	% of Year
2018 – 2028[1]	0	0
2029	7	0.08
2030	16	0.18
2031	34	0.39
2032 – 2041[2]	36	0.41

Notes:

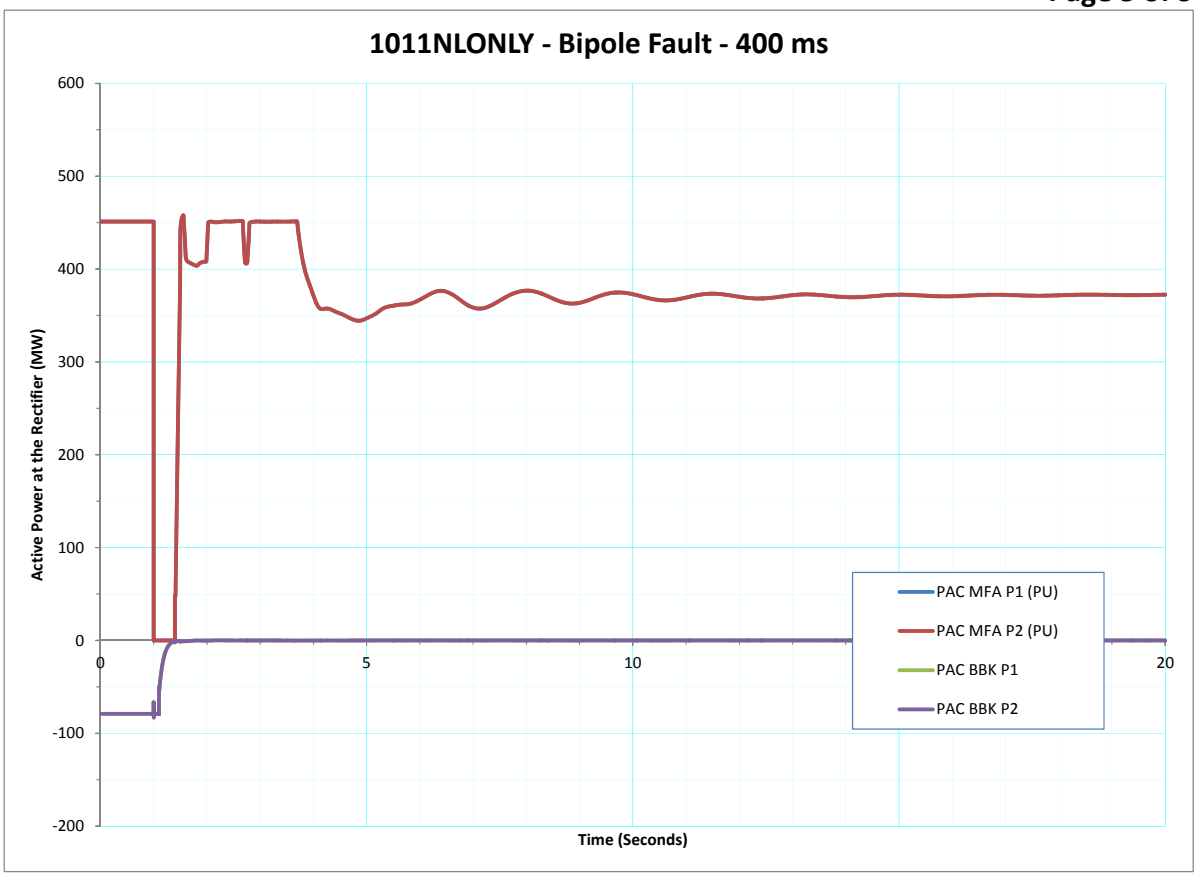
1. LIL deliveries at Soldiers Pond do not exceed 779.5 MW over peak. Reserves met by combination of LIL, Island hydro-electric and combustion turbine.
2. LIL deliveries capped at 830 MW in this period with additional capacity and reserve requirements met by addition of on Island combustion turbine.



1 **Figure 1 - 1011NLONLY – Temporary Bipole Fault - 400 ms - Relative Rotor Angle (Degrees)**



1 **Figure 2 - 1011NLONLY – Temporary Bipole Fault - 400 ms - System Frequency (Hz)**



1 **Figure 3 - 1011NLONLY – Temporary Bipole Fault - 400 ms - Active Power at the Rectifier**
2 **(MW)**

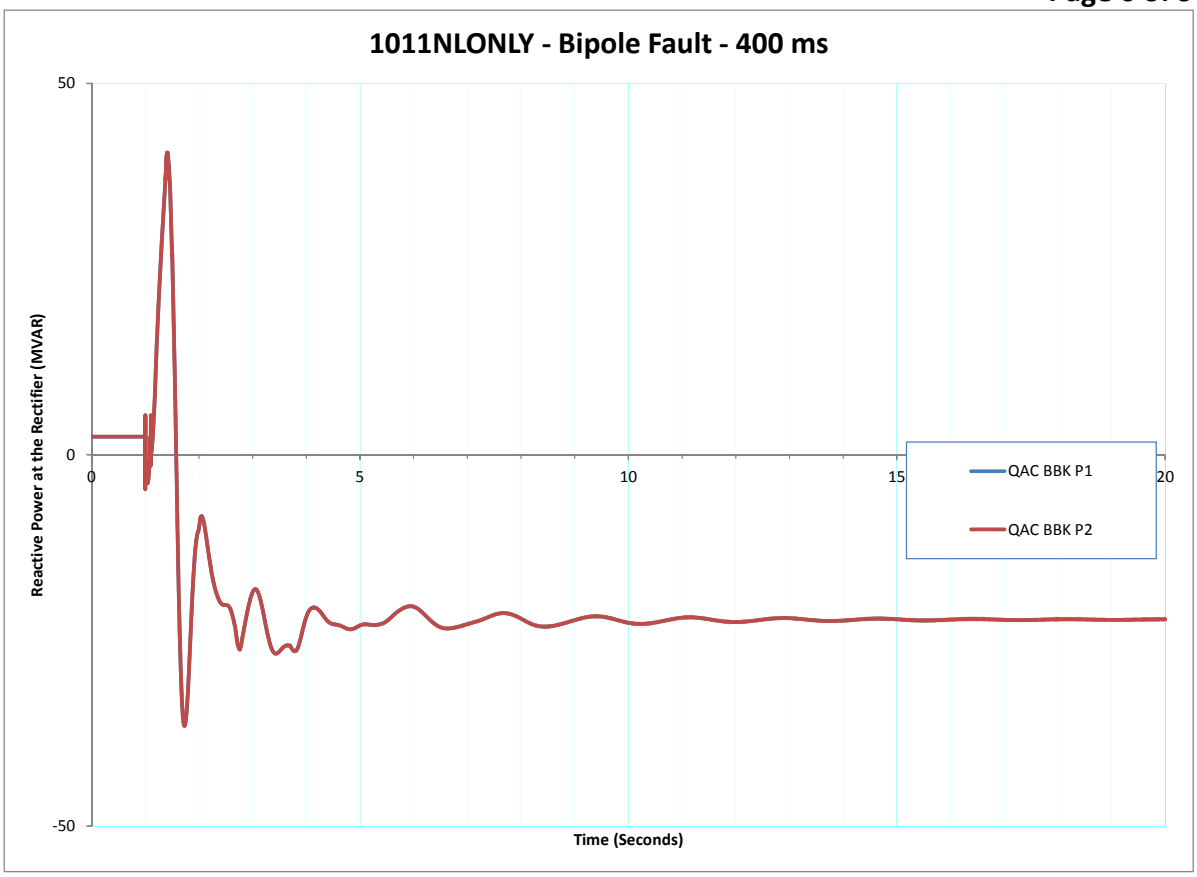


Figure 4 - 1011NLONLY – Temporary Bipole Fault - 400 ms

Reactive Power at the Rectifier (MVAR)

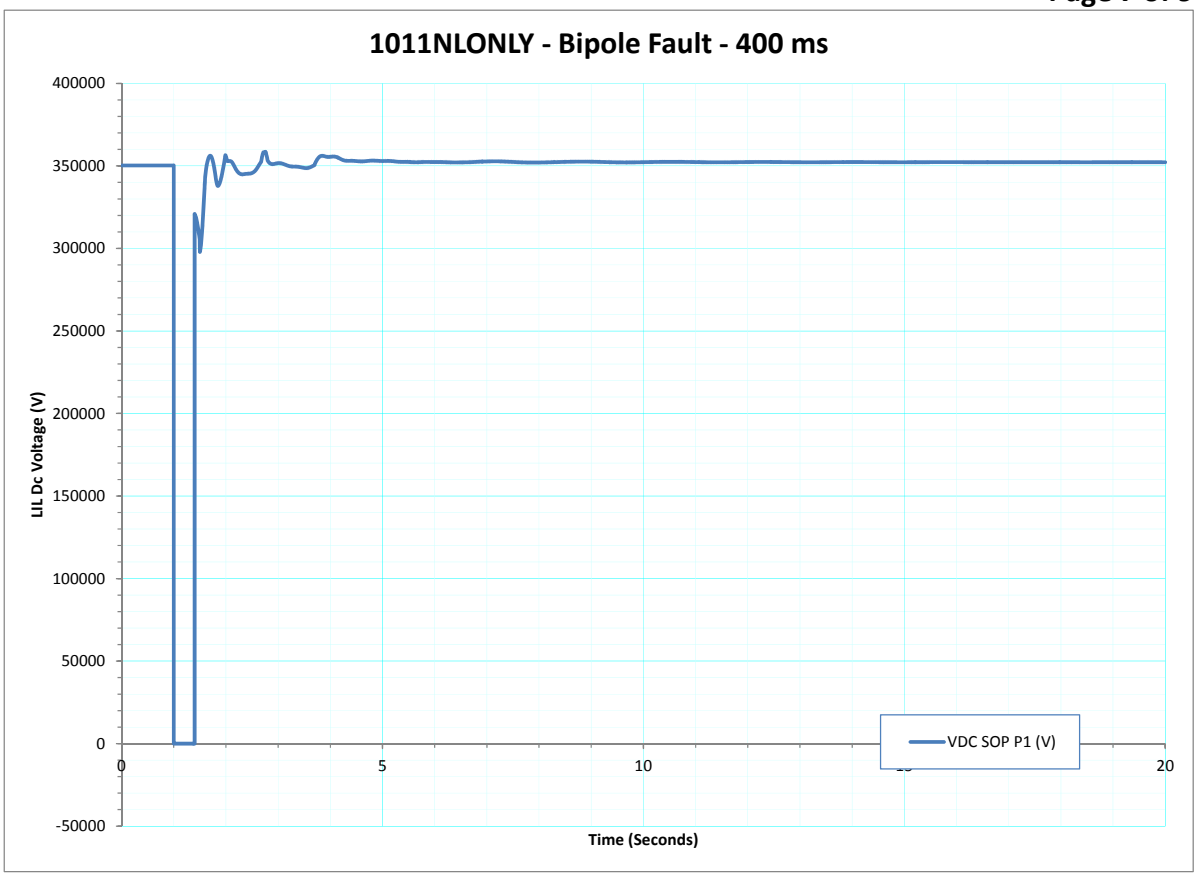
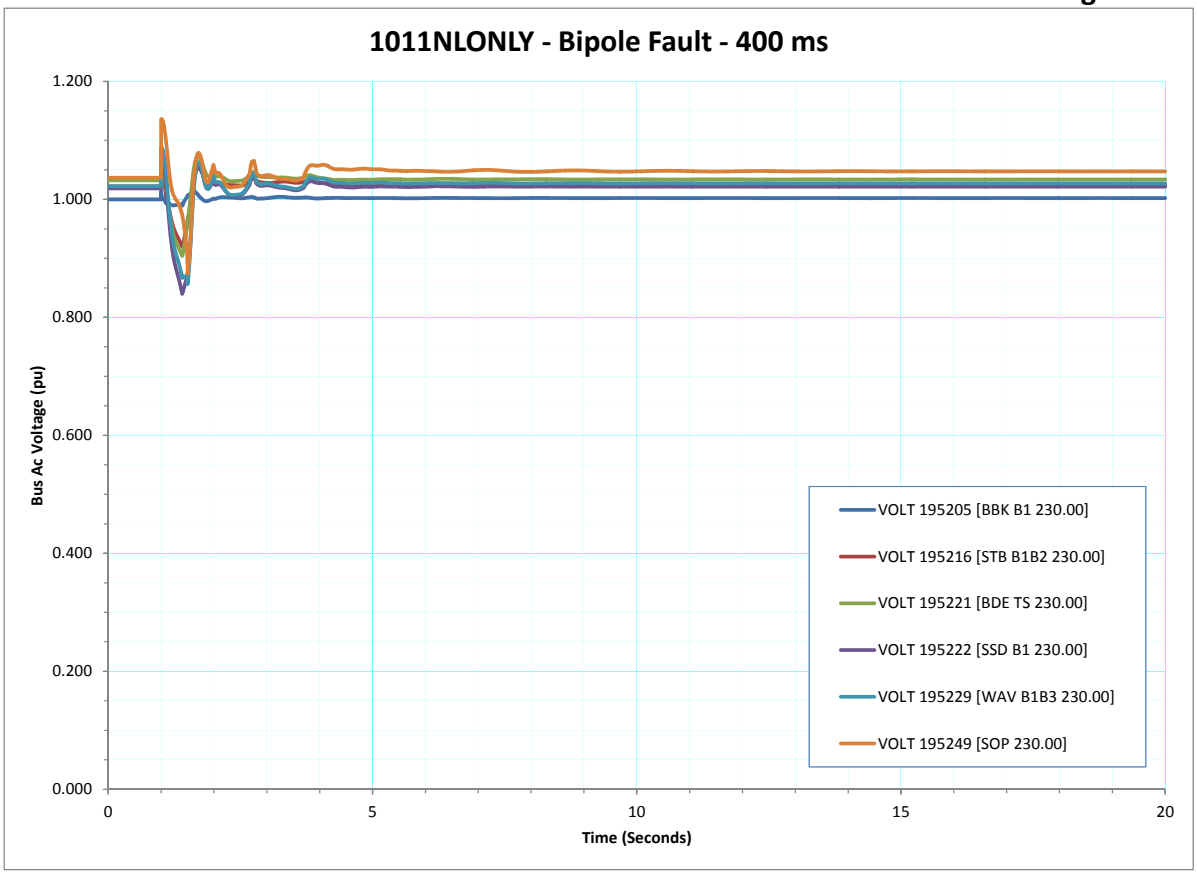


Figure 5 - 1011NLONLY – Temporary Bipole Fault - 400 ms - LIL Dc Voltage (V)



1 **Figure 6 - 1011NLONLY – Temporary Bipole Fault - 400 ms – AC Bus Voltage (pu)**

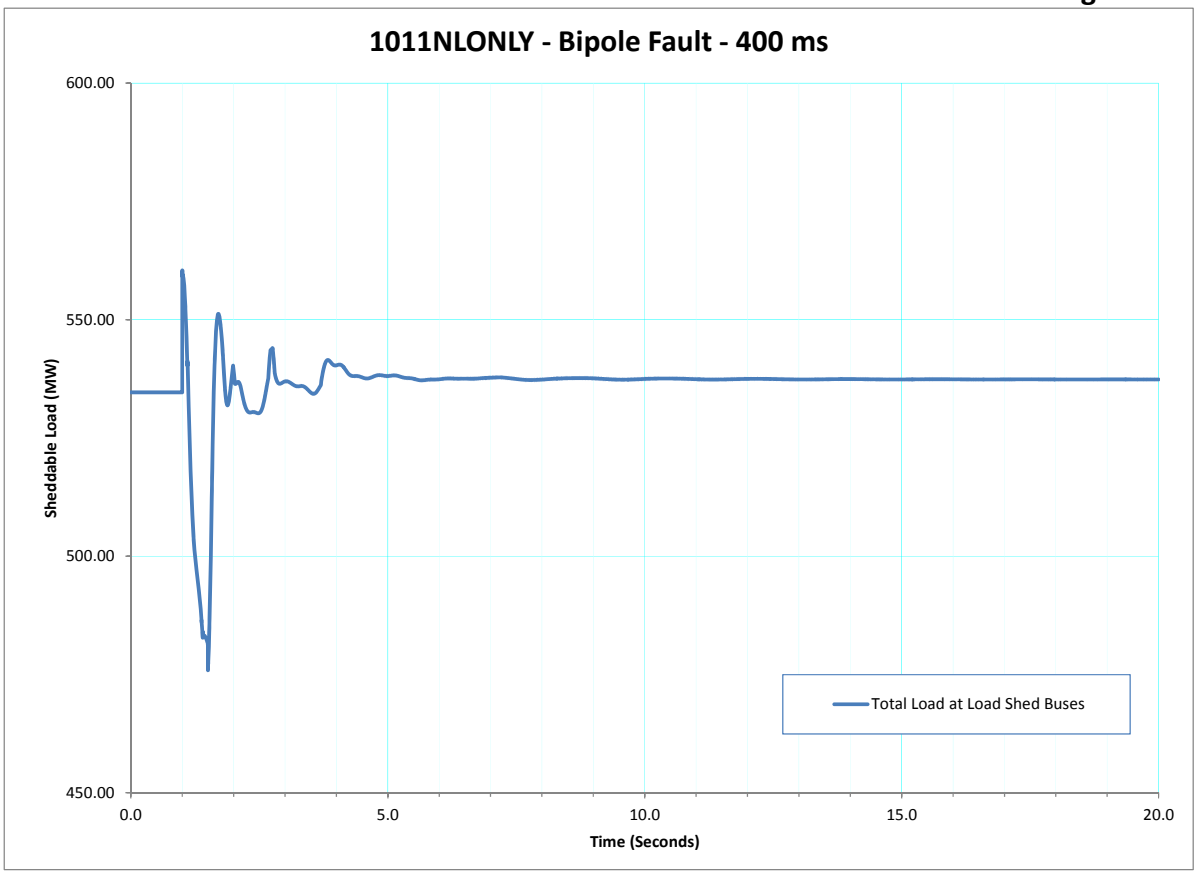


Figure 7 - 1011NLONLY – Temporary Bipole Fault - 400 ms - Sheddable Load (MW)