Q. None of the studies performed have considered the consequence of a restrike on the HVDC OHL, as may occasionally happen. The scenario would be as follows:

1. Lightning strikes the HVDC OHL line (either just one pole or both poles – both should be studied)
2. The HVDC converter stops the current flow, waits for the preset re-starting time, and then energise the line again.
3. When the voltage reach say 90% the arc restrikes, and step 2 is repeated – normally with an increased de-ionization time.
4. Either the 2nd attempt is successful or a further attempt starting with a lower dc voltage setting (say 80%) will be required.

Please perform such a study both for monopolar and bipolar operation. The purpose of the study should be to identify the impact that these scenarios would have on the performance of the ISS, and if relevant to identify the additional inertia that would be required to protect the IIS.

A. GE Grid has responded as follows:

"Simulations of lightning strikes on AC and DC equipment are not performed for the following reasons:

1. *In the case of lightning striking a line outside the converter station, the effects of the current surge are absorbed by the line arrester and filter bus arrester in the same way that the connected line arresters absorb such surges; GE's converter station lightning arresters will be similar. In the case of back-flashover, only a fraction of the current surge enters the transmission line and the amplitude of the current in this branch is generally lower than the current rating of the arresters. In the*

case of direct strike, this is the result of shielding failure and can only occur for lightning strokes of current amplitude that is generally lower than the current rating of the arresters.

2. *In the case of lightning striking equipment within the converter station, this can only occur as a result of shielding failure. The shielding will be designed to limit the peak current of surges that can penetrate the shielding substantially lower when compared with the station equipment design. GE's previous experience with systems operating at 400 kV and above is that filter bus flashovers are more onerous than lightning strokes of this magnitude; both for assessing filter equipment voltage withstand levels and for assessing filter surge arrester protective levels and energy absorption requirements. Arresters will be located in close proximity to key equipment items in order to provide the necessary protection."*

From the GE Grid Protection and Control Strategy document:

"Automatic restart attempts will only be enabled when fault occurs on the overhead line. An operator facility will be provided to select number of the restart attempts for overhead line faults. The maximum restart attempt is 4 when the telecommunication is available [4][1].

1. *The first restart attempt from the inception of the fault to the time when power same as prefault DC power transfer of the Pole has been restored*

[1] [4] "CD0501 Supply and Install Converters and Transition Compounds Performance Requirements", doc# ILK-SN-CD-8000-EL-DC-0001

will occur in time E (Figure 24) time, including the time allowed for fault deionization.

2. *If the fault on the HVDC line persists after the first restart attempt, a further restart attempts will be performed using an adjustable de-ionisation period.*
3. *The last selected restart attempt will be carried out with reduced DC voltage operation. For example: During the 1 pu DC Power in monopolar operation, when the DC voltage order is at 0.8 pu and the DC current shall be maintained at the prevailing DC current order which is 1 pu and hence the DC power will be 0.8 pu [5][2]. The DC line fault restart attempt will be inhibited if the next DC line fault attempt will exceed the maximum calculated energy of the neutral surge arrester. The cooling time of the energy dissipation for the neutral surge arrestor will be coordinated with the cooling curve of the neutral surge arrester. If the DC line fault reappears again after recovery from the last attempt of the DC line fault and the DC line fault is not inhibited, then the restart attempt will be carried out as per normal strategy.*
4. *If the last attempt fails, the Pole will be blocked and tripped.*

During the bipolar operation and HV line fault is detected, the Pole associated to the HV line fault will start DC line fault sequence until the fault is extinguished. The other Pole will take up the power up to the overload capability until measure V_{dL} at the faulted pole recovers back to the pre-fault DC voltage order."

[2] [5] "Common – Main Scheme Parameter Design Report", doc# ILK-AS-SD-8000-EL-H13-0001-01

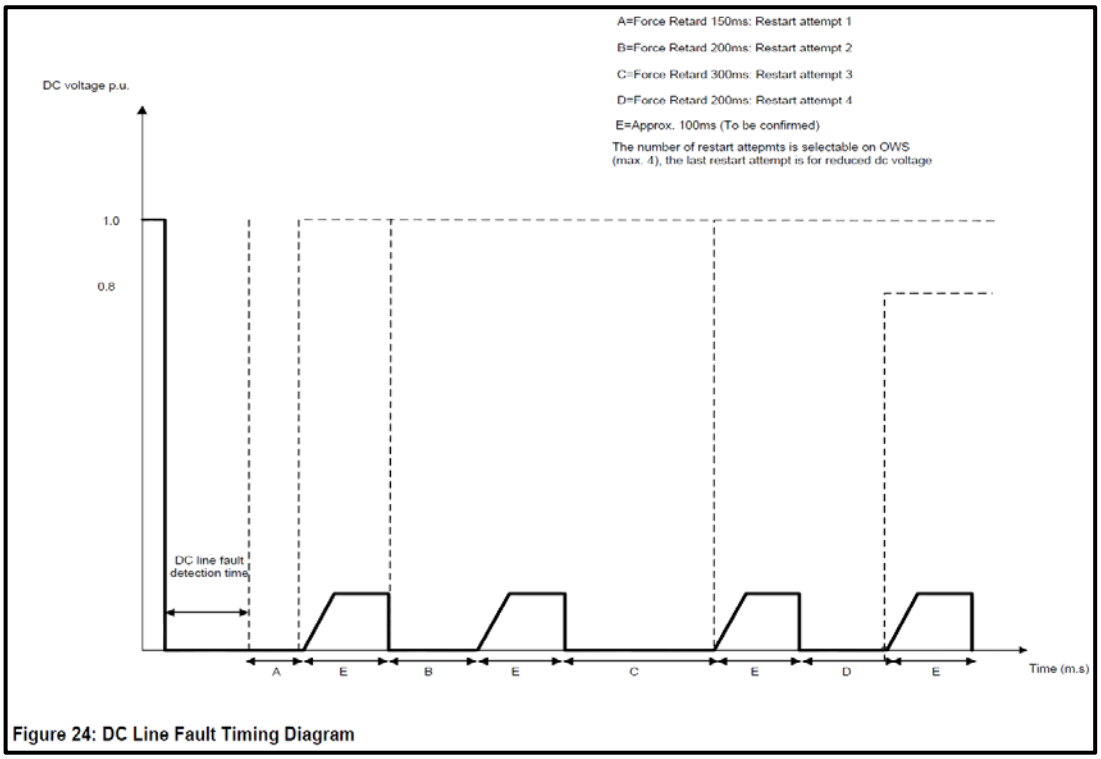

Figure 24: DC Line Fault Timing Diagram

GE Grid will study examples of such dc fault scenarios for both monopole and bipole operation during the Dynamic Performance Study (DPS) in EMTDC/PSCAD. The results of the study will be provided in document, *Common - PSCAD Dynamic Performance Study Report*; doc# ILK-AS-SD-8200-EL-H99-0013-01. Nalcor Energy expects to receive first draft of report by June 30, 2016.