FINAL – OC Approved

MOSES SOUTH STABILITY LIMITS

ALL LINES I/S AND OUTAGE CONDITIONS

Report #: MS-14

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Executive Summary

This study was conducted as a periodic review of Moses South stability limits. The study recommends updates to the existing limits for twelve (12) system configurations and the introduction of seventeen (17) new limits for system additional configurations.   The proposed limits are shown below on Table 1, "Summary of Proposed Moses South Stability Transfer Limits".

In all cases but one, the existing Moses South stability limits were increased though increased generation capacity and reduced load permitting higher transfer levels to be tested. One scenario resulted in a decreased Moses South stability limit to satisfy ISO-NE performance criteria.

Most identified limits are defined from the highest attainable transfer test levels. In six scenarios, unit instability was observed at the NYPA Moses units and Beauharnois units in Quebec. For these cases, Moses South power transfers were reduced and the limit defined is based on a stable NYPA Moses and Beauharnois units' dynamic response. In one scenario, where automatic rejection of Chateauguay imports for the loss of the Massena-Marcy 765 KV line is unavailable, the Moses South stability transfer limit is defined to maintain system response on the Vermont system within acceptable ISO-NE performance criteria. In another scenario (MSU1 O/S, 1 MAP O/S and 2 Chateauguay HVDC Pole O/S), the power flow case was tested using Moses South transfer margin limit in order to show acceptable ISO-NE performance.

It is recommended that the Moses South stability transfer limits be updated on the basis of this report. These limits will replace the Moses South stability transfer limits based on the following reports: "Moses South Stability Limits Analysis for All Lines I/S and Line Outage Conditions (MS-08), 2008" and "Moses South Stability Limit for the Proposed T-12 Chateauguay Transformer Operating Configuration With Both HVDC Poles O/S (Chat-09), 2009".

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1. Summary of Evaluated Limits

Table 1
Summary of Evaluated Stability Limit Changes (MW)

MOSES-SOUTH	Existing Limit (MW)	Proposed Limit (MW)	Delta (MW)
All Lines In, 3 Chat Banks, 2 Poles I/S	2900	3150	250
All Lines In, Marcy STATCOM O/S	N/A	3150	N/A
Alcoa Bus Tie (R8105) O/S	2600	3100	500
One MAP O/S	2450	3000	550
3 Chat Banks (T11 split with T13 and T14), Split Bus, 1 Chat HVDC Pole I/S	2600	2850	250
2 Chat Banks (any of two of T11, T13 and T14), 1 Chat HVDC Pole I/S	2350	2850	500
3 Chat Banks (T11, T13 and T14), 1 Chat HVDC Pole I/S	2150	2850	700
2 Chat HVDC Poles O/S	2000	2550	550
MSU1 I/S, SPS 7040 Cross Trip O/S, 2 Chat HVDC Poles O/S	1100	800	-300
MSU1 O/S, 2 Chat HVDC Pole O/S	675	950	275
MSU1 O/S, 2 Chat HVDC Pole O/S, STATCOM O/S	675	950	275
MSU1 O/S, 1 MAP O/S, 2 Chat HVDC Poles O/S	500	600	100
MA1 and MA2 O/S	N/A	2900	N/A
L33/L34 O/S	N/A	2700	N/A
L33/L34 O/S, Marcy STATCOM O/S	N/A	2700	N/A
Marcy T1 O/S	N/A	2650	N/A
Marcy T2 O/S	N/A	2650	N/A
Alcoa Bus Tie (R8105), MA1 O/S	N/A	3100	N/A
MSU1 O/S, 2 Chat HVDC Poles O/S, MSC7040 O/S	N/A	900	N/A
MSU1 O/S, 2 Chat HVDC Poles O/S, MSC7040 O/S, STATCOM O/S	N/A	900	N/A
MSU1 O/S, 2 Chat HVDC Poles O/S, PV-20 O/S	N/A	900	N/A
MSU1 O/S, 2 Chat HVDC Poles O/S, MSC7040 O/S, PV-20 O/S	N/A	900	N/A
1 Chat Bank (any one of T11, T13 or T14), 2 Chat HVDC Poles O/S	N/A	2200	N/A
2 Chat Banks (T12 split with any one of T11, T13 or T14), , 2 Chat HVDC Poles O/S	N/A	2550	N/A
2014 Chat T12 Configuration (T12 with any one of T11, T13 or T14), 2 Chat HVDC Poles O/S	N/A	2550	N/A
2009 Chat T12 Configuration (T12 split with any one of T11, T13 or T14), 2 Chat HVDC Poles O/S	2150	2550	400
MSU1 I/S, MSC7040 O/S	N/A	1550	N/A
MMS 1&2 O/S, 2 Chat HVDC Poles O/S	N/A	1950	N/A
MMS 1&2 O/S, MSU1 O/S, MSC7040 O/S, 2 Chat HVDC Poles O/S	N/A	900	N/A

2. Introduction

This report addresses a revaluation of the Moses South interface transient stability limits for all-lines-in-service and line outage conditions. This analysis was conducted as a periodic limit review. The geographic location of these interfaces is shown on the Internal Interface diagram below.

The stability transfer limit study for the Moses South interface was conducted in accordance with the stability criteria indicated in NPCC Regional Reliability Reference Directory # 1 Design and Operation of the Bulk Power System Section 5.4.1 and the NYSRC Reliability Rules for Planning and Operating the New York State Power System Section E-R3.

The stability transfer limits were determined using the methodology cited in the NYISO Transmission Expansion and Interconnection Manual Attachment H NYISO Transmission Planning Guideline #3-1 Section 2.

There were twenty-nine (29) Moses South stability transfer test level power flow cases developed using the 2014 NYISO Dynamics Base Case power flow case . Eighteen (18) contingencies were applied to each power flow case to evaluate system stability. Appropriate generators' angles, power output, terminal voltages and speed in the study area were monitored with bus voltages and frequencies, internal and external interface power flows, SVCs and FACTS voltage and Mvar outputs and HVDC parameters to assess system dynamic response.

Representative plots of the system response at the transfer test levels can be found in Section 10, below. Appendix A contains the powerflow summaries in graphical format and a select simulation plots for the most severe contingencies evaluated. The complete set of all the simulation plots will be made available on request.

3. Interface Summary

The Moses South interface definition is given in Table 2 and illustrated in Figure 1.

Table 2.

Moses South interface definition.

North Country (Zone D)-Mohawk Valley (Zone E)		
Name	Line ID	Voltage (kV)
Massena-Marcy	MSU1	765
Moses-Adirondack	MA1	230
Moses-Adirondack	MA2	230
Dennison-Sandstone	5	115
Dennison-Colton	4	115
Alcoa-Browning		115

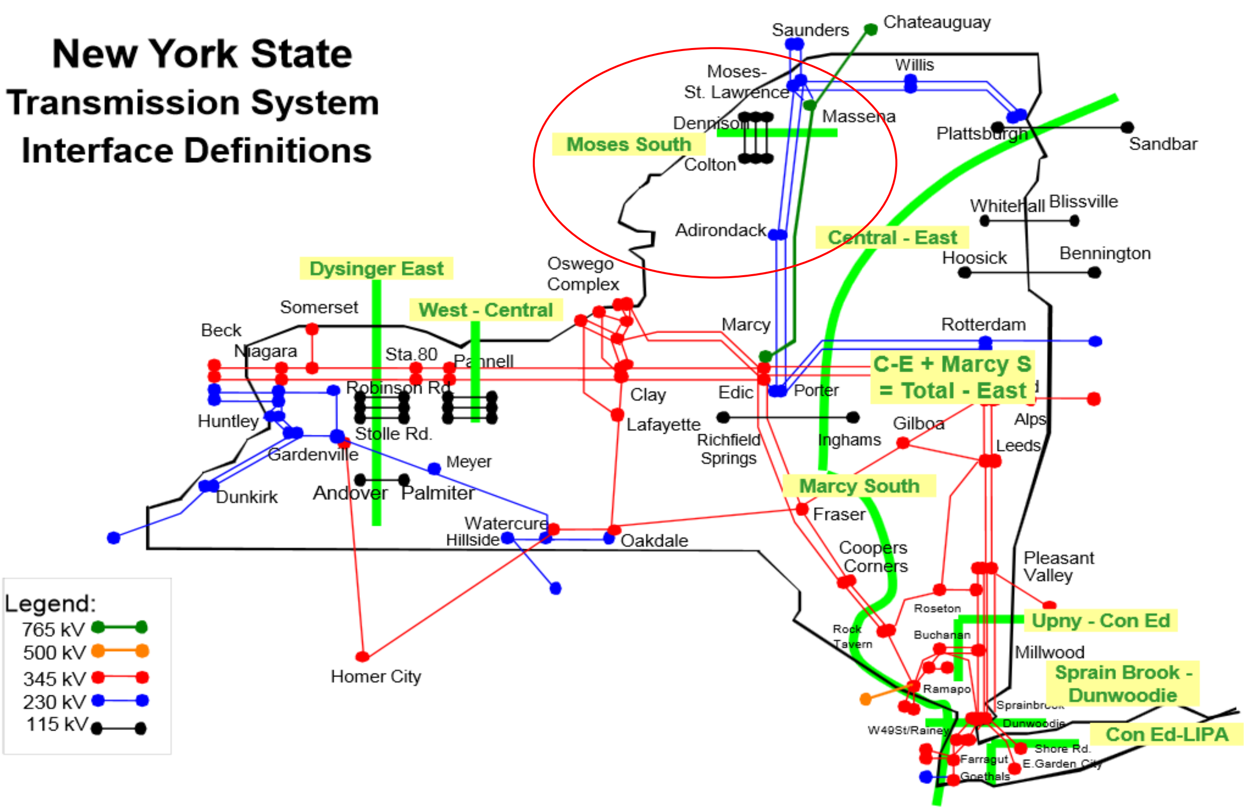

Figure 1. NYCA Transmission System Interface (Moses South inset).

4. Criteria Statement

This study is conducted in accordance with NPCC and NYSRC criteria, which include the NPCC Regional Reliability Reference Directory # 1 Design and Operation of the Bulk Power System Section 5.4.1 and the NYSRC Reliability Rules for Planning and Operating the New York State Power System Section E-R3 as quoted below:

NPCC Directory #1 Section 5.4.1

5.4.1 Stability Assessment
Stability of the bulk power system shall be maintained during and following the most severe of the contingencies stated below, with due regard to reclosing. For each of the contingencies below that involve a fault, stability shall be maintained when the simulation is based on fault clearing initiated by the "system A" protection group, and also shall be maintained when the simulation is based on fault clearing initiated by the "system B" protection group.

a. A permanent three-phase fault on any generator, transmission circuit, transformer or bus section with normal fault clearing.

b. Simultaneous permanent phase to ground faults on different phases of each of two adjacent transmission circuits on a multiple circuit tower, with normal fault clearing. If multiple circuit towers are used only for station entrance and exit purposes, and if they do not exceed five towers at each station, then this condition is an acceptable risk and therefore can be excluded. Other similar situations can be excluded on the basis of acceptable risk, provided that the Reliability Coordinating Committee specifically accepts each request for exclusion.

c. A permanent phase to ground fault on any transmission circuit, transformer, or bus section with delayed fault clearing.

d. Loss of any element without a fault.

e. A permanent phase to ground fault on a circuit breaker with normal fault clearing. (Normal fault clearing time for this condition may not always be high speed.)

f. Simultaneous permanent loss of both poles of a direct current bipolar facility without an ac fault

g. The failure of a circuit breaker to operate when initiated by a SPS following: loss of any element without a fault; or a permanent phase to ground fault, with normal fault clearing, on any transmission circuit, transformer or bus section.

NYSRC Reliability Rules Section E-R3

E-R3. Stability Assessment

System stability transfer limits shall be consistent with the Reliability Rules and all applicable guidelines and procedures in the NYISO Guideline #3-0, "Guideline for Stability Analysis and Determination of Stability-Based Transfer Limits".

a. For normal transfers, stability of the NYS Bulk Power System shall be maintained during and after the most severe of contingencies "a" through "g" specified in Table A[1]. The NYS Bulk Power System must also be stable if the faulted element as described in Table A is re-energized by

[1] Table A is on page 19 of NYSRC Reliability Rules for Planning and Operating the New York State Power System and is similar to NPCC NPCC Directory #1 Section 5.4.1 (a-g).

delayed reclosing before any manual system adjustment, unless specific alternate procedures are documented.

b. For emergency transfers, when firm load cannot be served, stability of the NYS Bulk Power System shall be maintained during and after contingencies "a" through "g" specified in Table A. The NYS bulk power system must also be stable if the faulted element as described in Table A is re-energized by delayed reclosing before any manual system adjustment.

5. System Representation

This analysis utilized the 2014 NYISO Operations Dynamics Base Case. The 2014 NYISO Operations Dynamics Base Case was developed from the NYISO Summer 2014 Operating Study base case for the New York representation and the 2013 series NERC/MMWG dynamic base case for the external network representation.

The NYISO load was modeled at 32,539 MW.

6. Transfer Cases Development

Appendix A contains the powerflow summaries in graphical format and complete set of simulation plots for the contingencies evaluated.

Moses South transfer power flows for each studied scenario, generation shifts between Hydro Quebec (Chateauguay HVDC and Beauharnois machines), eastern Ontario and New York (zones: North, Mohawk, and Capital) were primarily used to adjust flow on the said interface.

Fraser SVC, Leeds SVC and Marcy FACTs were modeled in service, if applicable in the scenario, and were set at 0 Mvar in pre-contingency conditions.

As Moses South is adjacent to the Central East interface, Central East power transfers is scheduled at operating limits as per following reports:

- Moses South Stability Limits Analysis for All Lines I/S and Line Outage Conditions (MS-08), 2008
- Moses South Stability Limit for the Proposed T-12 Chateauguay Transformer Operating Configuration With Both HVDC Poles O/S (Chat-09), 2009
- Central East Stability Limit Analysis with MSU1 Out of Service (CE-16), 2003

All transfers modeled the Cedars-Dennison power transfer at approximately 200 MW.

All transfers modeled the reduction of 240 MW of aluminum load, active at the time of the study.

All transfers modeled the Chateauguay to Massena 765 kV (MSC-7040) line flow at maximum possible injection as this line flow has no significant effect on the system response. There is no known instability issue related to the MSC-7040 flow.

Transfers were stressed with wind generation including the most recent addition of 215 MW plant at Marble River.

7. Tested Contingencies

The eighteen (18) contingencies tested for each developed Moses South transfer case scenario are identified and described in Table 3 below.

Table 3

Contingencies applied for evaluating Moses South stability transfer limits.

#	ID	Description
1	MS01	3PH-NC@MARCY 765/MASSENA-MARCY MSU-1 W/REJ
2	MS02	3PH-NC@MOSES 230KV/MOSES-ADIR W/NO REJ.
3	MS03	LLG@MOSES 230KV ON MOSES-ADIRONDACK 1&2
4	MS04	3PH-NC@MOSES 230/MASSENA-MOSES 765/230 MMS-1
5	MS05	3PH-NC@MASSENA 765/MASSENA-MOSES 765/230 MMS-1
6	MS06	SLG-STK@MOSES/MASSENA-MOSES MMS-2 W/NO REJ
7	MS07	SLG-STK@MASSENA765/MASSENA-MOSES 765/230 MMS-1
8	MS08	SLG-STK@MOSES /MOSES-ADIRONDACK 230 W/NO REJ
9	MS09	3PH-NC@MASSENA 765/MASSENA-MARCY MSU-1 W/REJ
10	MS10	SLG-STK@MOSES /MOSES-WILLIS 230
11	MS13	LLG@MOSES /MOSES-MASSENA 230
12	MS15	LLG@MOSES 230/MOSES-ST.LAWRENCE L33/34P
13	CE03	SLG/STK@EDIC345KV EDIC-N.SCOT #14/BKUP CLR@FITZ 345
14	CE07AR	LLG @MARCY/EDIC ON MARCY-COOPER & EDIC-FRASER DBL CKT
15	CE15	SLG/STK@MARCY345/VOLNEY-MARCY VU-19/STK@MARCY 345
16	CE23	LLG@FRASER ON MARCY-COOPERS/EDIC-FRASER D/C
17	CE23AR	LLG@FRASER ON MARCY-COOPERS/EDIC-FRASER D/C w/ AR
18	CE99	SLG/STK@SCRIBA345/SCRIBA-VOLNEY 21/FITZ-SCRIBA #10

8. Monitored Key Parameters

In order to assess system stability response for the Moses South power transfer scenarios considering contingencies, the following parameters were monitored and analyzed:

- Generators' angles, power outputs, terminal voltages, and speeds in the following areas/zones (HQ, ONT, North, Mohawk, Capital, representative generators from West, Central, ISO-NE, Hudson and NYC)
- Bus voltages and frequencies around Moses South and Central East
- Internal and External Interface flows
- SVCs and FACTs voltage and Mvar output
- HVDC parameters

9. Limit Development Process

The stability transfer limits indicated in this study were developed in accordance with the NYISO Transmission Expansion and Interconnection Manual Attachment H NYISO Transmission Planning Guideline #3-1 Section 2 excerpted below:

2 TRANSFER LEVEL

The determination of interface transfer limits requires the consideration of thermal, voltage and stability limitations. When determining a stability limit, a margin also shall be applied to the power transfer level to allow for uncertainties associated with system modeling. This margin shall be the larger of ten percent of the highest stable transfer level simulated or 200 MW. The margin also shall be applied in establishing a stability limit for faults remote from the interface for which the power transfer limit is being determined.

To confirm that power transfer levels will not be restricted by a stability constraint, the stability simulation shall be initially conducted at a value of at least ten percent above the controlling thermal or voltage-based transfer limit. The voltage-based transfer limit ("voltage transfer limit") shall be determined in accordance with NYISO Transmission Planning Guideline #2, "Guideline for Voltage Analysis and Determination of Voltage-Based Transfer Limits." If a converged powerflow cannot be achieved at this higher transfer level, then the stability simulation shall be conducted at the highest achievable transfer level above the voltage transfer limit. If the stability simulation at that level is deemed to be stable, then voltage control facilities in the form of capacitive compensation shall be artificially added to the powerflow case to achieve a convergence at a transfer level equal to the voltage transfer limit divided by 0.90. This procedure ensures that the application of the margin does not result in the determination of a "stability limit" that is lower than the voltage transfer limit when the restriction is actually due to voltage. The amount and location of any such artificially added capacitive compensation shall be reported in the study results.

Stability limits shall be determined for interfaces on an independent basis. In doing so, it is recognized that interfaces for which the stability limit is not being determined may exceed their thermal, voltage or stability transfer capabilities. To assess the stability performance of the bulk power system, system stability and generator unit stability shall be considered.

2.1 System Stability

Overall power system stability is that property of a power system which ensures that it will remain in operating equilibrium through normal and abnormal conditions. The bulk power system shall be deemed unstable if, following a disturbance, the stability analysis indicates increasing angular displacement between various groups of machines characterizing system separation. Further, a power system exhibits "oscillatory instability" (sustained or cumulative oscillations) for a particular steady-state operating condition if, following a disturbance, its instability is caused by insufficient damping torque.

For a stability simulation to be deemed stable, oscillations in angle and voltage must exhibit positive damping within ten seconds after initiation of the disturbance. If a secondary mode of oscillation exists within the initial ten seconds, then the simulation time shall be increased sufficiently to demonstrate that successive modes of oscillation exhibit positive damping before the simulation may be deemed stable.

2.2 Generator Unit Stability

A generator is in synchronous operation with the network to which it is connected if its average electrical speed (the product of its rotor angular velocity and the number of pole pairs) is equal to the angular frequency of the alternating current network voltage.

For those cases where the stability simulation indicates generator unit instability, the NYISO shall determine whether a power transfer limit shall be invoked or whether the unit instability shall be considered to be acceptable. To determine whether the generator unit instability may be deemed acceptable, the stability simulation shall be re-run with either the generator unit in question tripped due to relay action or modeled unstable to assess such impact on overall bulk power system performance. The result of this latter simulation shall determine whether a stability-based transfer limit shall be applied at the simulated power transfer level.

In determining the NYISO operating stability transfer limits for outage conditions, the employed margin in this study was ten percent of the highest stable transfer level simulated.

From the discussion above, Moses generation unit angle and voltage dynamic performance are utilized as one of the key indicators of system response. An example of Moses generation unit angle and voltage dynamic performance is depicted in Figure 2 with other selected machines.

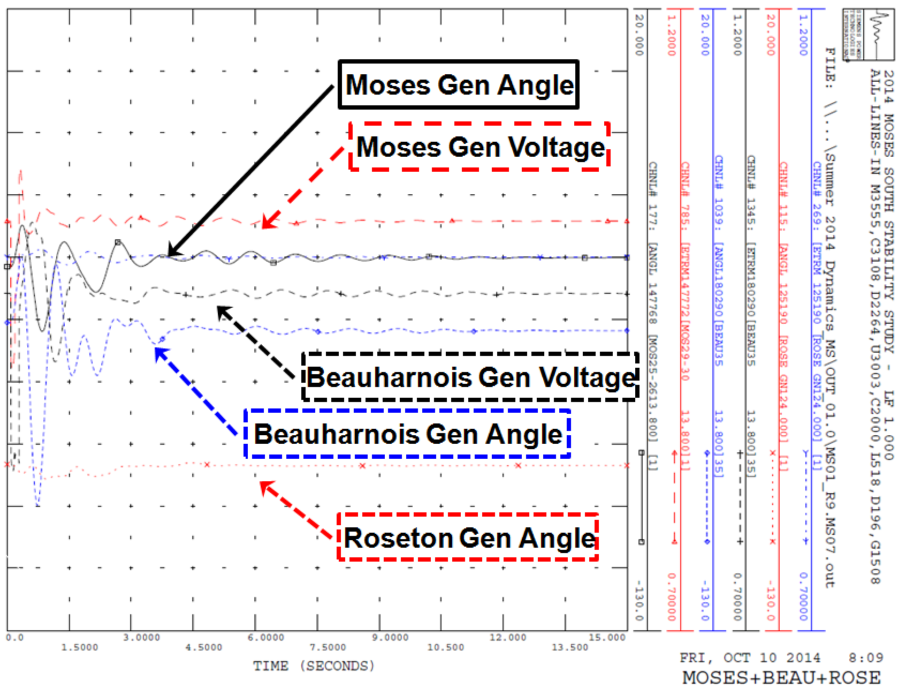

Figure 2. Angle and voltage dynamic response plots for Moses, Beauharnois and Roseton units.

10. Observations

Table 4 below presents the Moses South stability transfer limits that were developed as part of this re-evaluation. Appendix A contains all the plots of dynamic responses of each developed Moses South stability transfer cases.

Categorization of system response

In six scenarios, unit instability was observed at the NYPA Moses units and Beauharnois units in Quebec. For these cases, Moses South power transfers were reduced and the limit defined based on a stable NYPA Moses and Beauharnois units' dynamic response.

The last column on Table 4 categorizes the stability transfer limits as follows:

- Power Flow Transfer Limit – the test transfer level case no longer solves prior to utilization of generation in the North Country and transfer capacity from neighboring systems.

- Capacity Transfer Limit – all generation in the North Country and available transfer capacity from neighboring systems have been utilized.

- ISO-NE Stability Criteria – the Moses South stability transfer limit is defined to maintain acceptable ISO-NE performance criteria, specifically on the Vermont system.

- Unit Out of Step – Units lose synchronism from the rest of the system. Figure 3 below indicates a stable and an unstable response for NYPA Moses units and Beauharnois units for the simultaneous outage of MSU1, 1 MAP and 2 Chateauguay HVDC poles scenario at test levels of 720 MW and 760 MW. In this analysis, Moses South test limit was based on a stable NYPA Moses and Beauharnois units' dynamic response. A similar discussion of reducing Moses South power transfer from 1100 MW to 1000 MW in order to attain stable response for NYPA Moses units and Beauharnois units applies to the following outage scenarios:
  - MSU1 O/S, 2 HVDC Pole O/S, MSC7040 O/S
  - MSU1 O/S, 2 HVDC Pole O/S, MSC7040 O/S, STAT O/S
  - MSU1 O/S, 2 HVDC Pole O/S, PV-20 O/S
  - MSU1 O/S, 2 HVDC Pole O/S, MSC7040 O/S, PV-20 O/S
  - MSU1 O/S, 1&2 MMS O/S, MSC7040 O/S, 2 HVDC O/S

  Power flow summaries and simulation plots of unstable response for the cited scenarios are included in the Appendix after the corresponding cases and plots with stable response.

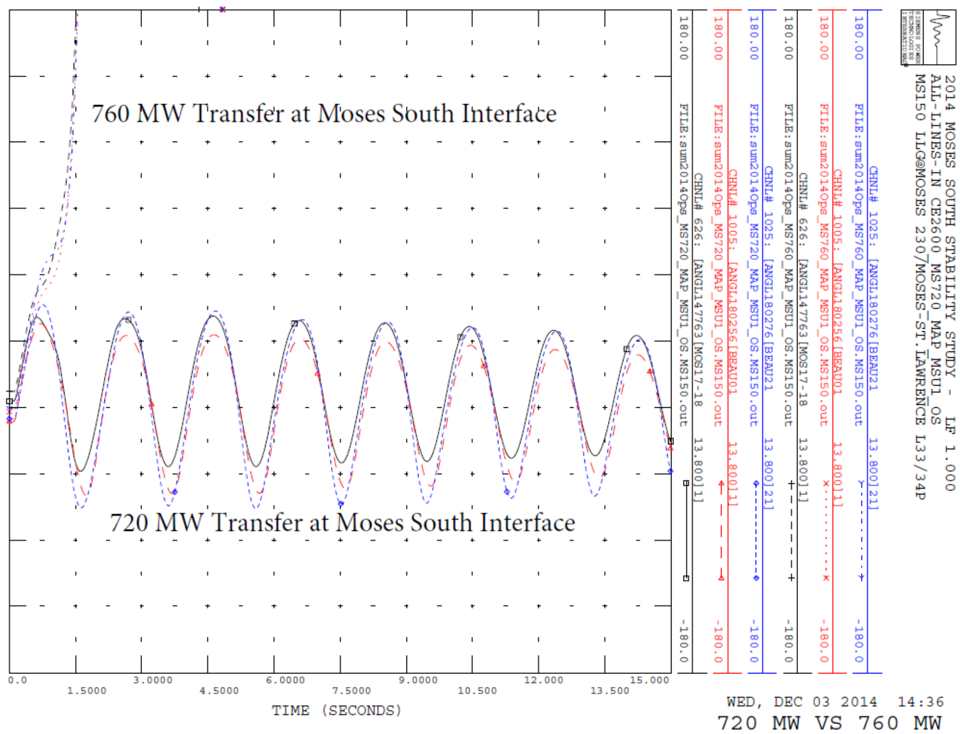

Figure 3. NYPA Moses units' and Beauharnois units' dynamic angle response for the simultaneous outage of MSU1, 1 MAP and 2 Chateauguay HVDC poles scenario with the application of MS15 contingency.

Generation Rejection at Moses Plant

The MS06 and MS15 contingencies (described in Table 3, above), were stable for all stability transfer limits indicated in Table 4 below. When deemed unstable, these two contingencies may require generation rejection at NYPA Moses plant. For this study, the update of the Moses South stability limits will not require the generation rejection at Moses plant at all times.

Note that generation rejection at the Moses plant is still required for the existing Central East stability limits as per Central East Stability Limit Analysis with MSU1 out-of-service (CE-16), 2003.

Chateauguay Transformer Configurations with two Chateauguay HVDC Poles O/S

Combined with the outage of the two Chateauguay HVDC poles, four different of Chateauguay transformer configurations were evaluated and these different scenarios yielded Moses South limits of 2550 MW. For the purposes of establishing Moses South limits, a single value of 2550 MW may be used when two Chateauguay HVDC poles are out of service, regardless of the Chateauguay transformer configurations. Appendix B contains all investigated Chateauguay transformer configurations. Diagrams of all Chateauguay transformer bank configurations are provided in Appendix B.

Inter-Area Considerations

The limiting transfer scenarios for Moses-South stability limits as defined by NYISO methodology were evaluated applying ISO-NE performance criteria which are as follows:

- No unit unstable or tripped (this precludes wind farms tripping on under or over voltage setpoints).[2]
- Damping of 53% over the last four swings, in a single mode, for simulations which may extend up to 30 seconds.[3]
- Post fault voltage dips below 70% not allowed, and below 80% not allowed for more than 250 ms.[4]

The ISO-NE performance criteria were applied to key parameters in Vermont to verify absence of adverse impacts on the neighboring system. In all but one scenario, MSU1 O/S, 1 MAP O/S and 2 Chateauguay HVDC Poles O/S, the limiting contingency for the proposed NYISO defined Moses South stability transfer margin limit resulted in acceptable system damping response in Vermont as per ISO-NE damping criteria. Figure 4 provides the damping response analysis for Essex StatCom Mvar output. For this scenario, the Moses South transfer margin level of 600 MW provides acceptable ISO-NE system performance.

For the condition where the redundant Special Protection System (SPS) automatic rejection of HQ Chateauguay imports coincident with the loss of the Massena-Marcy 765 kV line (MSU-1) was unavailable, Moses South flow was limited to maintain system parameters in Vermont within the ISO-NE performance criteria. A series of power flow cases with Moses South transfer level reductions were developed in order to attain acceptable ISO-NE performance criteria. Figure 5 presents the post fault voltage dips comparison at Sandbar 115 kV bus between Moses South transfer test levels of 2100 MW and 800 MW for the limiting MS01 contingency. The test level of 2100 MW results to post fault voltage dip of below 0.70 pu while the 800 MW transfer level showed acceptable post fault voltage dip magnitude. Figure 6 provides the damping response analysis for Essex StatCom Mvar output at Moses South test levels of 1500 MW, 900 MW and 800 MW. As per ISO-NE criteria, the 800 MW transfer level provides acceptable damping response. For this scenario, the Moses South transfer test level of 800 MW will be the margin level since the criteria applied is of ISO-NE's as NYISO's criteria was acceptable at 2100 MW transfer test level.

[2] ISO New England Operating Procedure No. 19 - Transmission Operations (http://www.iso-ne.com/rules_proceds/operating/isone/op19/op19j_rto_final.pdf)
[3] ISO New England Planning Procedure No. 3 (http://www.iso-ne.com/static-assets/documents/rules_proceds/isone_plan/pp03/pp3_final.pdf)
[4] ISO New England Transmission Planning Technical Guide Appendix E Dynamic Stability Simulation Voltage Sag Guideline (http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/plan_guides/plan_tech_guide/technical_planning_guide_appendix_e_voltage_sag_guideline.pdf)

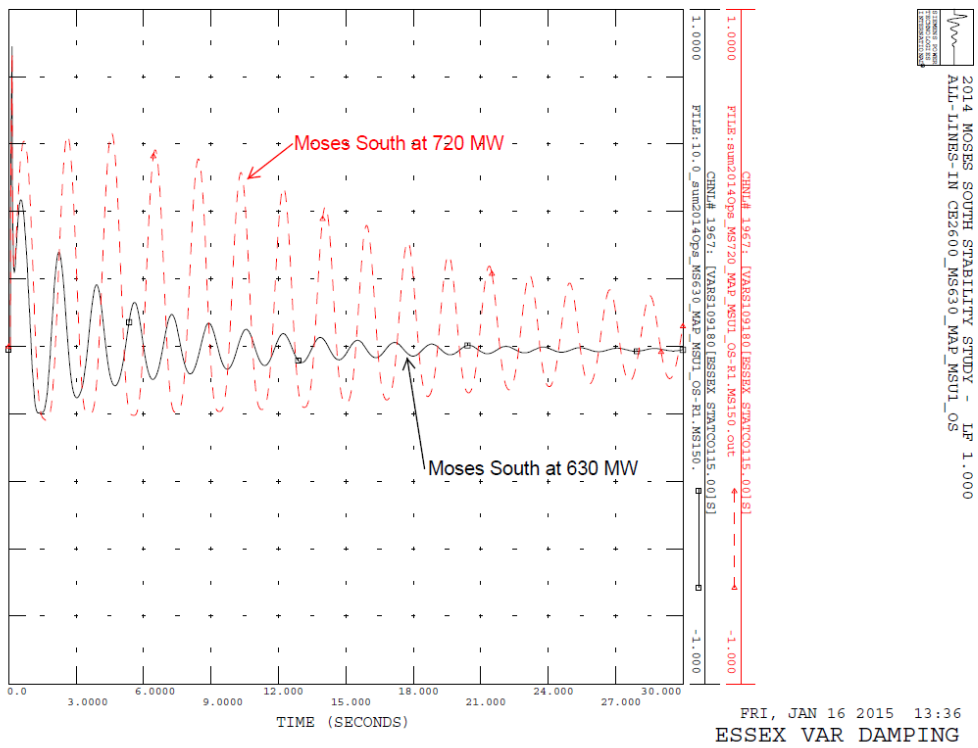

Figure 4. Essex StatCom damping response for the scenario, MSU1 O/S, 1 MAP O/S, 2 Chat HVDC Poles O/S, with MS150 contingency.

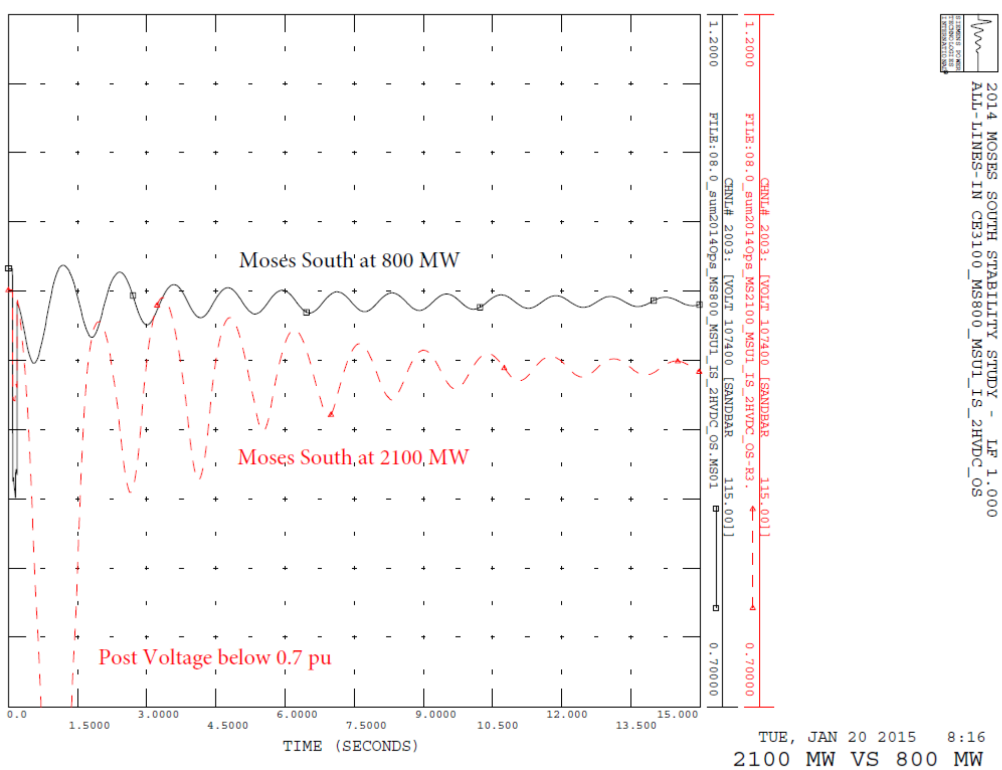

Figure 5. Post fault voltage dip comparison for Sandbar 115 kV bus for Moses South transfer level of 2100 MW and 800 MW for the scenario, MSU1 I/S, SPS 7040 Cross Trip O/S, 2 Chat HVDC Poles O/S, with MS01 contingency.

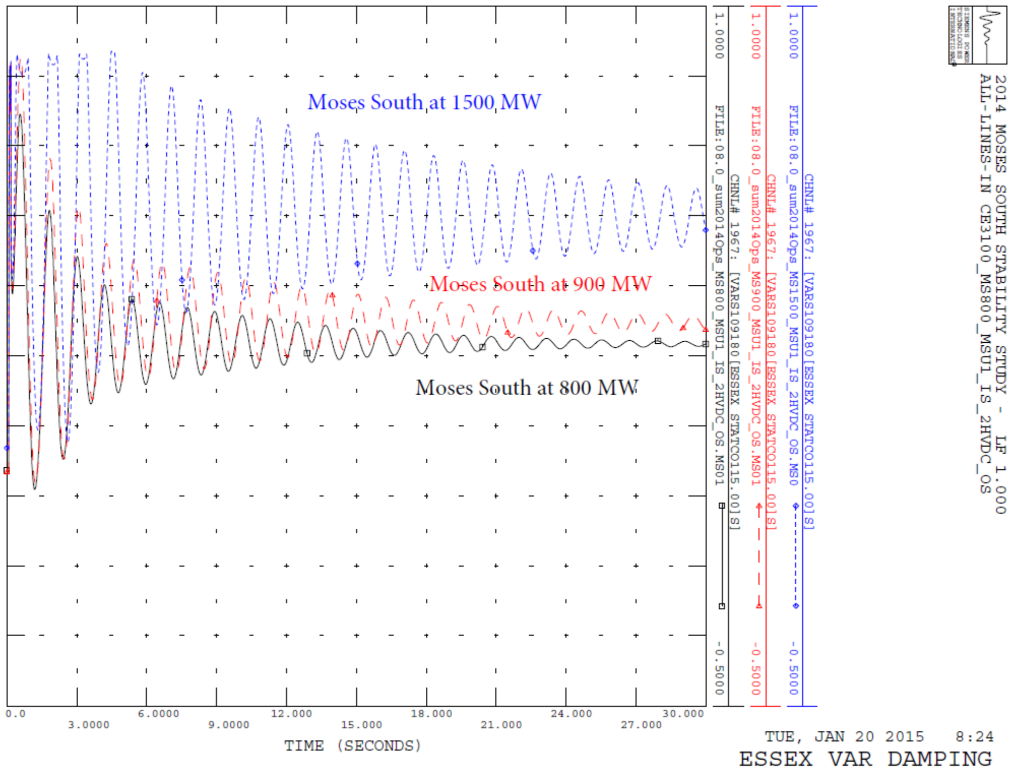

Figure 6. Essex StatCom damping response for the scenario, MSU1 I/S, SPS 7040 Cross Trip O/S, 2 Chat HVDC Poles O/S, with MS01 contingency.

Table 4.

Moses South Stability Transfer Limit Testing

#	Scenario	2014		Limiting Contingency	Remarks on Limit
		Moses South Test Level (MW)	Moses South Stability Limit (MW)		
1.0	All Lines In, 3 Chat Banks, 2 Poles I/S	3550	3150	MS07	Power Flow Transfer Limit
1.1	All Lines In, Marcy STATCOM O/S	3550	3150	MS07	Power Flow Transfer Limit
2.0	Alcoa Bus Tie (R8105) O/S	3480	3100	MS07	Power Flow Transfer Limit
3.0	MAP (B2) O/S	3360	3000	MS07	Power Flow Transfer Limit
4.0	3 Chat Banks (T11 split with T13 and T14), Split Bus, 1 HVDC Pole I/S	3200	2850	MS07	Power Flow Transfer Limit
5.0	2 Chat Banks (any of two of T11, T13 and T14), 1 HVDC Pole I/S	3200	2850	MS07	Power Flow Transfer Limit
6.0	3 Chat Banks (T11, T13 and T14), 1 HVDC Pole I/S	3200	2850	MS07	Power Flow Transfer Limit
7.0	2 Chat HVDC Poles O/S	2850	2550	MS07	Capacity Transfer Limit
8.0	MSU1 I/S, SPS 7040 Cross Trip O/S, 2 HVDC Pole O/S	800	800	MS01	ISO-NE Stability Criteria
9.0	MSU1 O/S, 2 HVDC Pole O/S	1100	950	MS10	Power Flow Transfer Limit
9.1	MSU1 O/S, 2 HVDC Pole O/S, STATCOM O/S	1100	950	MS10	Power Flow Transfer Limit
10.0	MSU1 O/S, 1 MAP O/S, 2 Chat HVDC Pole O/S	720	600	MS15	Moses and Beauharnois OOS
11.0	MA1 and MA2 O/S	3260	2900	MS07	Power Flow Transfer Limit
12.0	L33/L34 O/S	3050	2700	MS07	Capacity Transfer Limit
13.0	L33/L34 O/S, Marcy STATCOM O/S	3050	2700	MS07	Capacity Transfer Limit
14.0	Marcy T1 O/S	2950	2650	MS07	Power Flow Transfer Limit
15.0	Marcy T2 O/S	2950	2650	MS07	Power Flow Transfer Limit
16.0	Alcoa Bus Tie (R8105), MA1 O/S	3480	3100	MS07	Power Flow Transfer Limit
17.0	MSU1 O/S, 2 Chat HVDC Poles O/S, MSC7040 O/S	1000	900	MS15	Moses and Beauharnois OOS
17.1	MSU1 O/S, 2 Chat HVDC Poles O/S, MSC7040 O/S, STATCOM O/S	1000	900	MS15	Moses and Beauharnois OOS
18.0	MSU1 O/S, 2 Chat HVDC Poles O/S, PV-20 O/S	1000	900	MS15	Moses and Beauharnois OOS
19.0	MSU1 O/S, 2 Chat HVDC Poles O/S, MSC7040 O/S, PV-20 O/S	1000	900	MS15	Moses and Beauharnois OOS
20.0	1 Chat Bank (any one of T11, T13 or T14), 2 Chat HVDC Poles O/S	2450	2200	MS07	Power Flow Transfer Limit
21.0	2 Chat Banks (T12 split with any one of T11, T13 or T14), 2 Chat HVDC Poles	2850	2550	MS07	Capacity Transfer Limit

Table 4.

Moses South Stability Transfer Limit Testing

#	Scenario	2014		Limiting Contingency	Remarks on Limit
		Moses South Test Level (MW)	Moses South Stability Limit (MW)		
	O/S				
22.0	2014 Chat T12 Configuration (T12 with any two of T11, T13 or T14), 2 Chat HVDC Poles O/S	2850	2550	MS07	Capacity Transfer Limit
23.0	2009 Chat T12 Configuration (T12 split with any two of T11, T13 or T14), 2 Chat HVDC Poles O/S	2850	2550	MS07	Capacity Transfer Limit
24.0	MSU1 I/S, MSC7040 O/S	1740	1550	MS07	Capacity Transfer Limit
25.0	MMS 1&2 O/S, 2 Chat HVDC Poles O/S	2200	1950	MS10	Power Flow Transfer Limit
26.0	MMS 1&2 O/S, MSU1 O/S, MSC7040 O/S, 2 Chat HVDC Poles O/S	1000	900	MS15	Moses and Beauharnois OOS

Angle and Voltage Dynamic Response

As discussed in Section 9, the Moses generation unit angle and voltage dynamic response were used as one of the key indicators of system stability. Figures 7 to 10 provide the representative plots of Moses generation unit angle and voltage dynamic response for specified Moses South stability transfer cases with the relative worst contingency as shown in Table 4. It was observed that stability is maintained with each presented Moses South stability transfer cases with the application of indicated contingencies.

For detailed plots of dynamic response, Appendix A contains all the plots of dynamic response of each developed Moses South stability transfer cases, cited in Tables 1 and 4, applying all contingencies cited in Table 3.

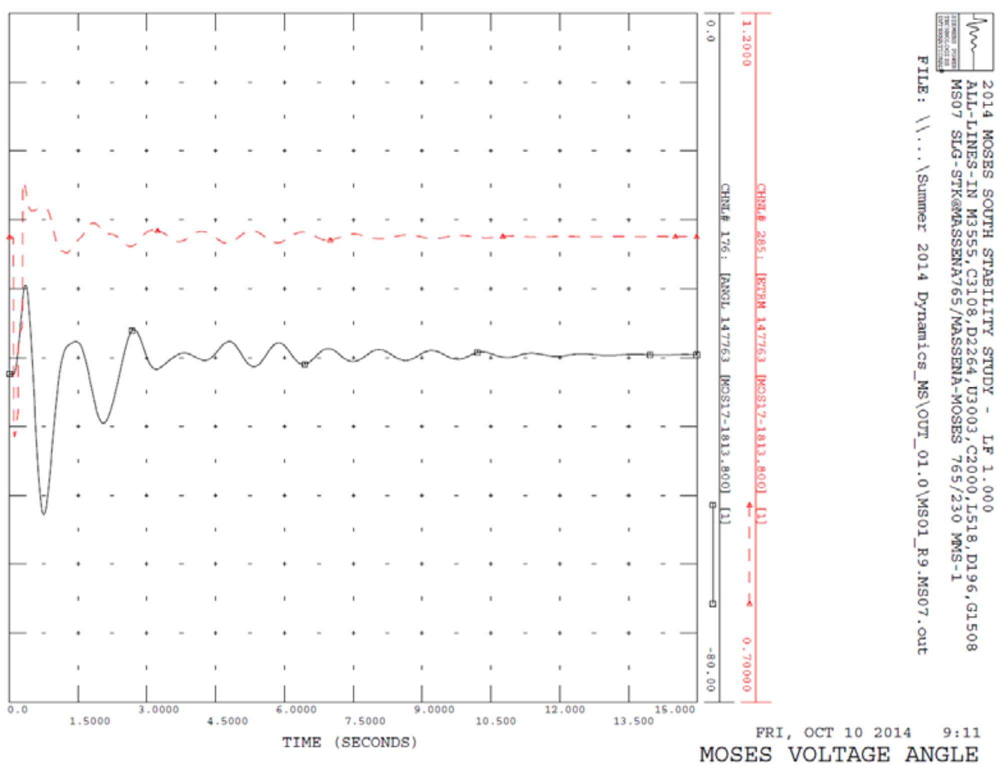

Figure 7. Moses unit angle and voltage and angle dynamic response plots all-line-in-service scenario with MS07 contingency.

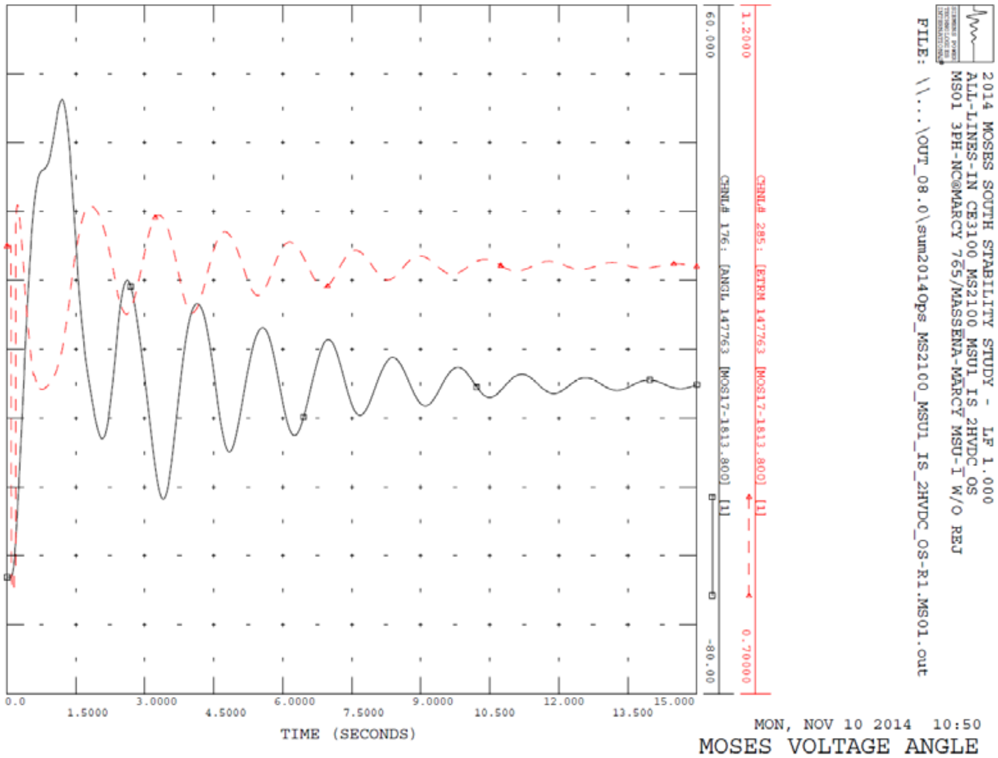

Figure 8. Moses unit angle and voltage and angle dynamic response plots for MSU1 I/S, no Direct Transfer Trip for Generation Rejection, 2 HVDC Pole O/S scenario with MS01 contingency.

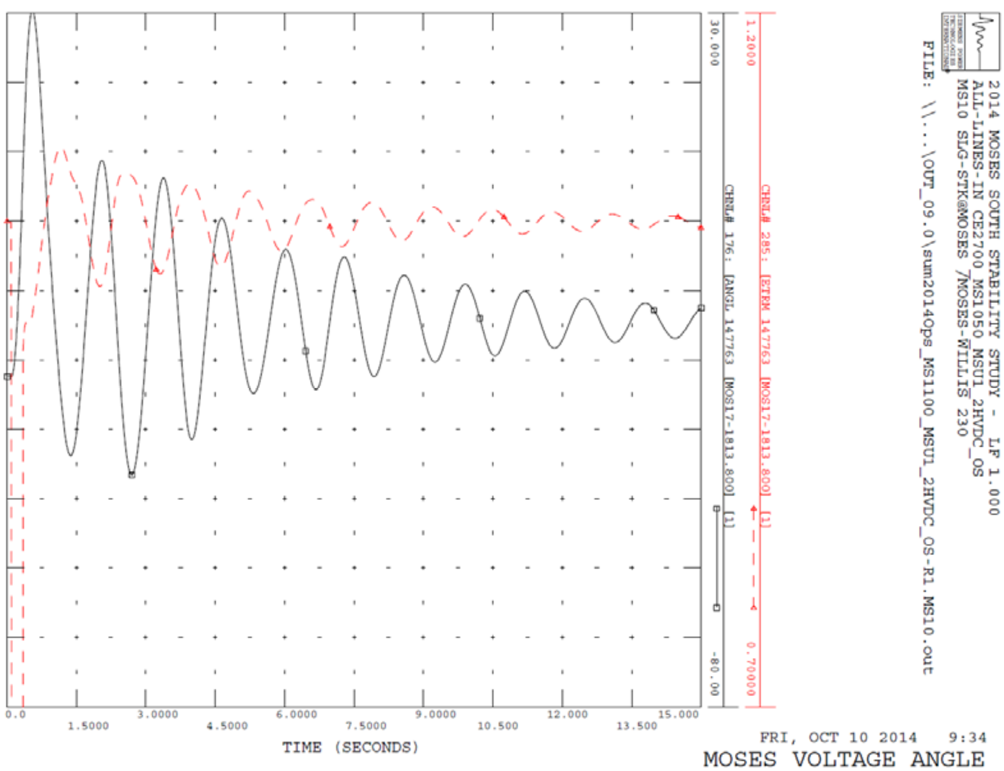

Figure 9. Moses unit angle and voltage and angle dynamic response plots for MSU1 O/S, 2 HVDC Pole O/S scenario with MS10 contingency.

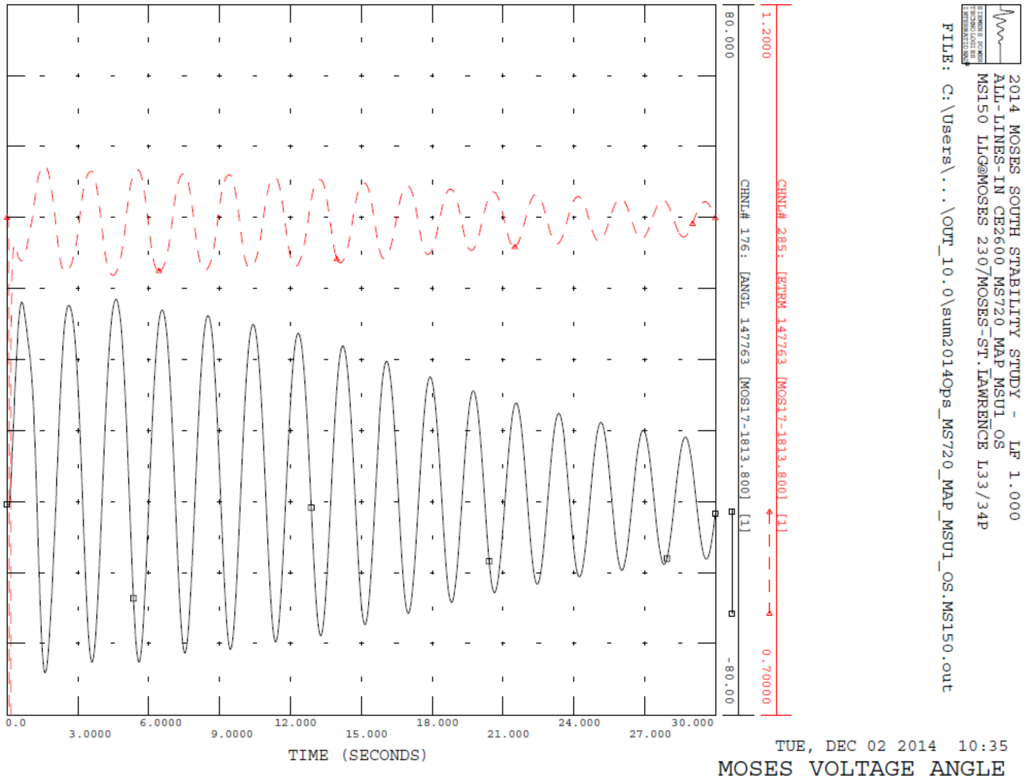

Figure 10. Moses unit angle and voltage dynamic response plots for MSU1 O/S, 1 MAP O/S, 2 HVDC Pole O/S scenario with MS15 contingency.

11. Recommendations

Based on the results of this study, it is recommended that the NYISO Moses South stability transfer limits on "Summary of Interface Limits & Operating Studies" be updated according to Table 5.

Table 5

Recommended Moses South stability transfer limits

MOSES-SOUTH	Limit (MW)	Report	Date
All Lines In, 3 Chat Banks, 2 Chat HVDC Poles I/S	3150	MS-14	2/15
All Lines In, Marcy STATCOM O/S	3150	MS-14	2/15
Alcoa Bus Tie (R8105) O/S	3100	MS-14	2/15
One MAP O/S	3000	MS-14	2/15
3 Chat Banks (T11 split with T13 and T14), Split Bus, 1 Chat HVDC Pole I/S	2850	MS-14	2/15
2 Chat Banks (any of two of T11, T13 and T14), 1 Chat HVDC Pole I/S	2850	MS-14	2/15
3 Chat Banks (T11, T13 and T14), 1 Chat HVDC Pole I/S	2850	MS-14	2/15
2 Chat HVDC Poles O/S	2550	MS-14	2/15
MSU1 I/S, SPS 7040 Cross Trip O/S, 2 Chat HVDC Poles O/S	800	MS-14	2/15
MSU1 O/S, 2 Chat HVDC Poles O/S	950	MS-14	2/15
MSU1 O/S, 2 Chat HVDC Poles O/S, STATCOM O/S	950	MS-14	2/15
MSU1 O/S, 1 MAP O/S, 2 Chat HVDC Poles O/S	600	MS-14	2/15
MA1 and MA2 O/S	2900	MS-14	2/15
L33/L34 O/S	2700	MS-14	2/15
L33/L34 O/S, Marcy STATCOM O/S	2700	MS-14	2/15
Marcy T1 O/S	2650	MS-14	2/15
Marcy T2 O/S	2650	MS-14	2/15
Alcoa Bus Tie (R8105), MA1 O/S	3100	MS-14	2/15
MSU1 O/S, 2 Chat HVDC Poles O/S, MSC7040 O/S	900	MS-14	2/15
MSU1 O/S, 2 Chat HVDC Poles O/S, MSC7040 O/S, STATCOM O/S	900	MS-14	2/15
MSU1 O/S, 2 Chat HVDC Poles O/S, PV-20 O/S	900	MS-14	2/15
MSU1 O/S, 2 Chat HVDC Poles O/S, MSC7040 O/S, PV-20 O/S	900	MS-14	2/15

Table 5

Recommended Moses South stability transfer limits

MOSES-SOUTH	Limit (MW)	Report	Date
1 Chat Bank (any one of T11, T13 or T14), 2 Chat HVDC Poles O/S	2200	MS-14	2/15
2 Chat Banks (T12 split with any one of T11, T13 or T14), 2 Chat HVDC Poles O/S	2550	MS-14	2/15
2014 Chat T12 Configuration (T12 with any two of T11, T13 or T14), 2 Chat HVDC Poles O/S	2550	MS-14	2/15
2009 Chat T12 Configuration (T12 split with any two of T11, T13 or T14), 2 Chat HVDC Poles O/S	2550	MS-14	2/15
MSU1 I/S, MSC7040 O/S	1550	MS-14	2/15
MMS 1&2 O/S, 2 Chat HVDC Poles O/S	1950	MS-14	2/15
MMS 1&2 O/S, MSU1 O/S, MSC7040 O/S, 2 Chat HVDC Poles O/S	900	MS-14	2/15