ADDENDUM TO MOSES SOUTH STABILITY LIMITS ANALYSIS FOR ALL LINES I/S AND OUTAGE CONDITIONS (MS-24)

A Report by the
New York Independent System Operator

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Executive Summary

This stability analysis of the Moses South interface was conducted to analyze the impact of N-2 and N-3 scenarios inside the North Country/Area D pocket. The study covers outage scenarios for the 765 kV path (the Hydro Quebec HVDC line to Chateauguay 765kV, the Chateauguay – Massena (7040) 765kV line, and the Massena – Marcy (MSU1) 765kV Line, the 230 kV path (MAP 1 and MAP2 from Moses – Adirondack – Porter 230kV), and the St Lawrence PARs path (the IESO L33 and L34 PARs from St. Lawrence – Moses 230 kV).

The existing all lines in service and outage condition limits not explicitly stated in this report have been confirmed and remain in effect. A future comprehensive analysis of the Moses South interface will be conducted for the implementation of the Smart Path and Smart Path Connect projects.

The limits recommended in this report are based on a stable system response at the highest transfer level tested. There were no instances of any system or unit instability observed.

It is recommended that the Moses South stability transfer limits be implemented as reported in Table 1.

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Introduction

This study serves as an analysis of N-2 and N-3 scenarios on stability limits of the Moses South interface. The study covers outage scenarios for the 765 kV path (the Hydro Quebec HVDC line to Chateauguay 765kV station, the Chateauguay – Massena (7040) 765kV line, and the Massena – Marcy (MSU1) 765kV line), the 230 kV path (MAP 1 and MAP2 from Moses – Adirondack – Porter 230kV), and the St Lawrence PARs path (the IESO St. Lawrence – Moses (L33P) 230 kV and St. Lawrence – Moses (L34P) 230 kV PARs). The existing Moses South stability transfer limits as reported in the "Moses South Stability Limits All Lines I/S and Outage Conditions" (https://www.nyiso.com/documents/20142/1411640/MS-14%20Report_12092014_-FINAL.pdf/36b0d5e8-60cb-9e07-26b8-e5c4e3ffd0bf) are studied as part of this analysis and found to be still valid.

This study recommends adding stability transfer limits for outage conditions as listed in Table 1 in addition to the existing Moses South stability transfer limits.

Summary of Evaluated Limits

Table 1: Summary of Evaluated Stability Limits (MW)

Scenario	Moses South Stability Limit with Margin (MW)
MSU1&7040&HVDC & (L33 or L34) O/S	750
MSU1&7040&HVDC & (MAP1 or MAP2) O/S	500
MSU1&7040&HVDC & (L33 or L34) & (MAP1 or MAP2) O/S	500*
MSU1&7040&HVDC & MAP1 & MAP2 O/S	100
MSU1&7040&HVDC & MAP1 & MAP2 & (L33 or L34) O/S	100*
MSU1&7040&HVDC & R8105 O/S	750
MSU1&7040&HVDC & R8105 & (MAP1 or MAP 2) O/S	500
MSU1&7040&HVDC & R8105 & (L33 or L34) O/S	750*
MSU1&7040&HVDC & R8105 & DS 5 115 kV O/S	750*
MSU1&7040&HVDC & R8105 & NS 4 115 kV O/S	750*
MSU1&7040&HVDC & DS 5 115 kV O/S	750
MSU1&7040&HVDC & NS 4 115 kV O/S	750
L33 & L34 & (MAP1 or MAP2) O/S	2050*
L33 & L34 & (MAP1 or MAP2) & (MMS1 or MMS2) O/S	2050*
L33 & L34 & MAP1 & MAP2 O/S	1650*
MAP1&MAP2 O/S	2750*
MAP1&MAP2 & (L33 or L34) O/S	2550*
MAP1&MAP2 & (L33 or L34) & (MMS1 or MMS2) O/S	2450*

*More restrictive limits will control flows below these limits therefore these limits will not be implemented in the Energy Management System.

System Operating Limit Methodology

As identified in the “FAC-011-4_Methodology for Establishing SOL for the Operations Horizon_20240401”, the NYSRC Reliability Rules for Planning and Operating the New York State Power System provide the documented methodology employed to develop System Operating Limits (SOLs) within the NYISO Reliability Coordinator Area. NYSRC Reliability Rules require compliance with all North American Electric Reliability Corporation (NERC) Standards and Northeast Power Coordinating Council (NPCC) Standards and Criteria. NYSRC Rule C.1 addresses the contingencies to be evaluated and the performance requirements to be applied. Rule C.1 also incorporates by reference Attachment H, NYISO Transmission Planning Guideline #3-1, “Guideline for Stability Analysis and Determination of Stability-Based Transfer Limits” of the NYISO Transmission Expansion and Interconnection Manual.

Interface Summary

The Moses South limit is defined as the maximum transfer permissible across the Moses South interface. Table 2 presents the elements forming the Moses South interface and Figure 1 gives a graphical representation of it.

Table 2: Moses South Interface Elements

Name	Line ID	Voltage (kV)
*Massena-Marcy	MSU1	765
*Moses-Adirondack	MA1	230
*Moses-Adirondack	MA2	230
*Dennison-Norfolk	4	115
*Dennison-Sandstone	5	115
*Alcoa-N. Ogdensburg	13	115
Parishville-Colton*	3	115

Table 2: The Moses South interface definition. * Indicates line metering location

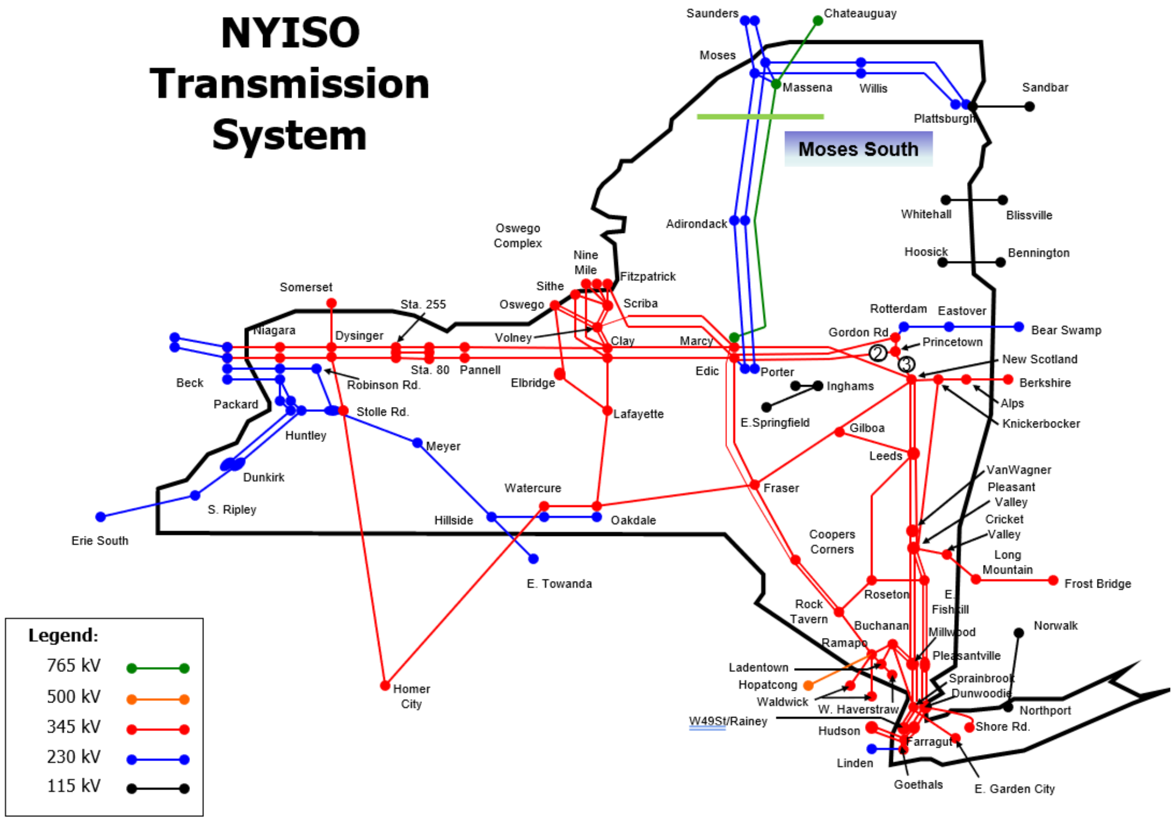


Figure 1. Moses South Interface Definition Highlighted by the Bold Green Line

System Representation and Transfer Case Development

The analysis was based on the 2023 NYISO Operations dynamics base case, which was developed from the 2023 MMWG dynamics base case with the NYISO representation updated to the representation of the NYISO 2023 Summer Operating Study.

The base case model includes:

- the NYISO Transmission Operator area;
- all Transmission Operator areas contiguous with NYISO;
- all system elements modeled as in-service;
- all generation represented;
- phase shifters in the regulating mode;
- the NYISO Load Forecast;
- transmission facility additions and retirements;
- generation facility additions and retirements;
- Remedial Action Scheme (RAS) models currently existing or projected for implementation within the studied time horizon;
- series compensation for each line at the expected operating level; and
- facility ratings as provided by the Transmission Owner and Generator Owner

The Moses-St. Lawrence PARs (Phase Angle Regulators) connecting the NYCA with IESO were set to control to their maximum limit. The PV20 PAR connecting NYCA with ISO-NE was set to control 0 MW flowing from NY to VT. Fraser SVC, Leeds SVC and Marcy FACTs were modeled out of service in pre-contingency conditions and put back in service, if applicable in the scenario, with their pre-contingency terminal voltage as their set point.

Generation output of the Moses units and Hydro Quebec (HQ) generation were adjusted depending on the desired transfer levels across Moses South. In some cases, to be able to achieve the desired transfer level, the out-of-service units at Beauharnios (HQ) were put back in service and generation at Cedars (HQ) was also connected to NYCA to push the transfer level further. All transfers modeled the Cedars-Dennison power transfer at approximately 270 MW importing into NYISO. All transfers modeled the Chateauguay to Massena 765 kV (MSC-7040) line flow at 1500 MW importing into NYISO.

Tested Contingencies

Eighteen (18) contingencies were tested for each developed Moses South transfer case scenario. Table 3 provides the identification and description of these contingencies.

Table 3:

Contingencies Applied for Evaluating Moses South Stability Transfer Limits

#	ID	Description
1	NYPA01-SPS41C	3PH-NC @MARCY765 L/O MASSENA-MARCY (MSU1) W/REJ
2	NYPA02	3PH-NC @MOSES230 L/O MOSES-ADIRONDACK (MA2) W/NOREJ.
3	NYPA03	LLG @MOSES230 L/O MOSES-ADIRONDACK (MA1 & MA2)
4	NYPA04	3PH-NC @MOSES230 L/O MASSENA-MOSES765230 (MMS1)
5	NYPA05	3PH-NC@MASSENA765 – L/O MASSENA-MOSES 765/230 MMS1
6	NYPA06	SLG-STK MOSES230 BKR2108 L/O MASSENA-MOSES230(MMS2 BKUP_CLR AT4) W/NOREJ
7	NYPA07	SLG-STK@MASSENA765 – L/O MASSENA-MOSES 765/230 MMS-1
8	NYPA08	SLG-STK @MOSES230 BKR2408 L/O MOSES-ADIRONDACK (MA2 BKUP_CLR MW1)) W/NOREJ
9	NYPA09	3PH-NC @MASSENA765 L/O MASSENA-MARCY (MSU1) W/REJ
10	NYPA10	SLG-STK @WILLIS230 BKR2108 L/O MOSES-WILLIS (MW2 BKUP_CLR WRY-2)
11	NYPA13	LLG- @MOSES L/O MOSES-MASSENA230 (MMS1 & MMS2) DCT
12	NYPA150	LLG- @MOSES230 L/O MOSES-ST. LAWRENCE (L33P & L34P) PDCT W/NOREJ
13	CE03_AC-SegA	SLG-STK@EDIC345 (BKR R935) – L/O EDIC-GORDON ROAD #14 / BKUP CLR FE1
14	CE07AR	LLG@MARCY/EDIC - L/O MARCY-COOPERS (UCC2-41) & EDIC-FRASER (EF24-40) DCT W/RCL
15	CE15	SLG-STK@MARCY345(BKR 3108) – L/O VOLNEY-MARCY (VU-19) / BKUP CLR#UE1-7
16	CE23	LLG@FRASER – L/O MARCY-COOPERS(UCC2-41)/EDIC-FRASER(EF24-40) DCT
17	CE23AR	LLG@FRASER – L/O MARCY-COOPERS(UCC2-41)/EDIC-FRASER(EF24-40) DCT W/RCL
18	CE99	SLG-STK@SCRIBA345 (BKR R935) – L/O SCRIBA-VOLNEY 21 / BKUP CLR FITZ-SCRIBA #10

Monitored Parameters

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 interfaces
- Internal and external Interface flows
- SVCs and FACTs voltage and MVAR output
- HVDC parameters

The recommended limits in this report are all based on stable system response at the highest transfer level tested. There were no instances of any system or unit instability observed in any of the simulations.

Discussion

Moses South limits are required to be established for element outages in north part of NYCA. With regards to Moses South, there are four major corridors linking the North NYCA to the rest of the Eastern interconnection and HQ as shown in Figure 2. Table 4 below presents the Moses South stability transfer limits that were validated as part of this re-evaluation. All the dynamic responses of each developed Moses South stability transfer cases are available and upon request plots related to any specific scenario will be provided.

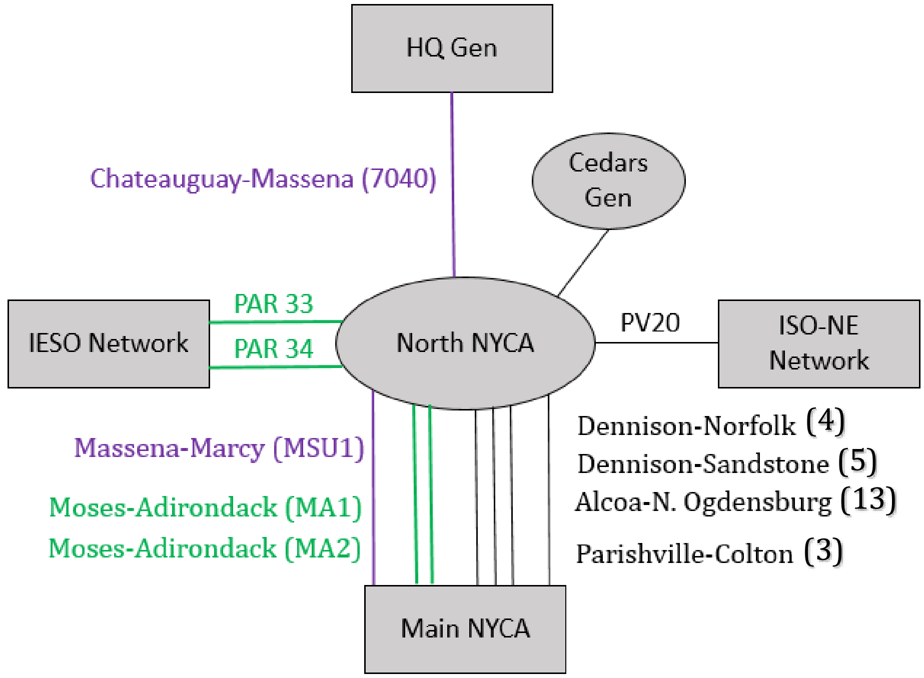


Figure 2. Main Transmission Elements Around North NYCA

Angle and Voltage Monitoring

Machine angles and system voltages were employed in this analysis as the key indicators of system stability. The discussions that follow include representative plots of generation unit angle response for illustration purposes. Similar plots are included in the Appendices for all the simulations conducted.

The representative plots for the dynamic response of Moses machine angle for all the evaluated contingencies at the limiting transfer level are shown below.

Generation Rejection at Moses Plant

The NYPA-06 and NYPA-15 contingencies (described in Table 3), 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.

Representative Plots

Three representative outage cases were chosen to demonstrate system response:

- MSU1&7040&HVDC & (L33 or L34) O/S
- L33 & L34 & (MAP1 or MAP2) O/S
- MAP1&MAP2 O/S

MSU1&7040&HVDC & (L33 or L34) Out of Service

Most Severe Contingency

Moses voltages were plotted for all the Moses South contingencies as shown in Figure 3 for MSU1&7040&HVDC & (L33 or L34) O/S. It can be seen from Figure 3 that the voltage response at Moses 230kV is most severe for NYPA-02 contingency compared to all other Moses South contingencies. The magnitude of the post contingency voltage swings was found to be the largest when the NYPA-02 contingency was applied. The NYPA-02 contingency was selected as the most severe contingency in the discussions that follow for this outage condition.

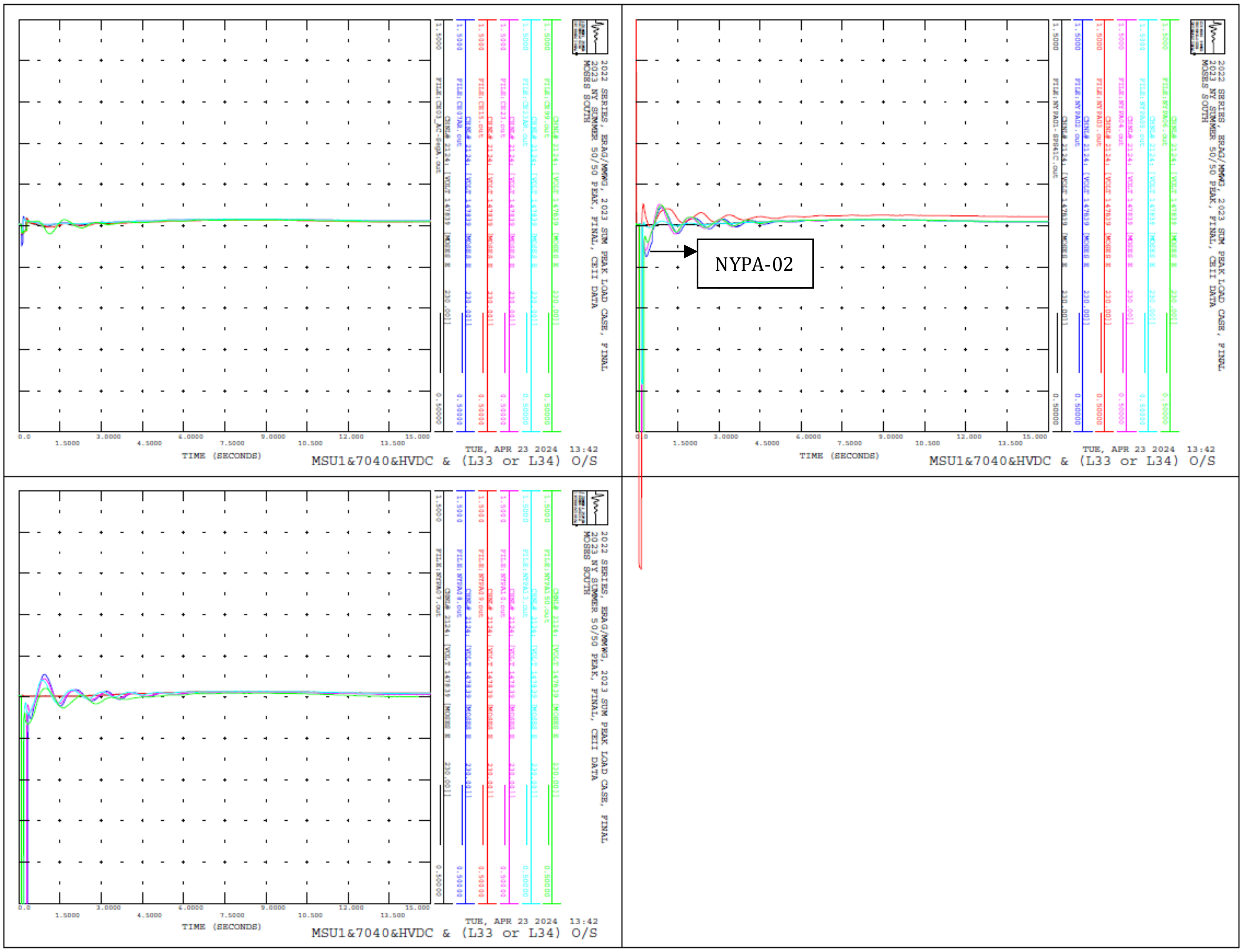


Figure 3. Moses Voltage response for all contingencies for MSU1&7040&HVDC & (L33 or L34) O/S

Angle, Voltage, and Frequency Monitoring

Machine angle, voltage and frequency were employed in this analysis as the key indicators of system stability. Machine angles at Moses and Fitzpatrick, voltages at Moses and Marcy stations and frequency at Marcy station were plotted for the NYPA-02 contingency on the MSU1&7040&HVDC & (L33 or L34) O/S scenario, as shown in Figure 4. The NYPA-02 contingency consists of a 3PH-NC @MOSES230 L/O MOSES-ADIRONDACK (MA2) W/NOREJ.

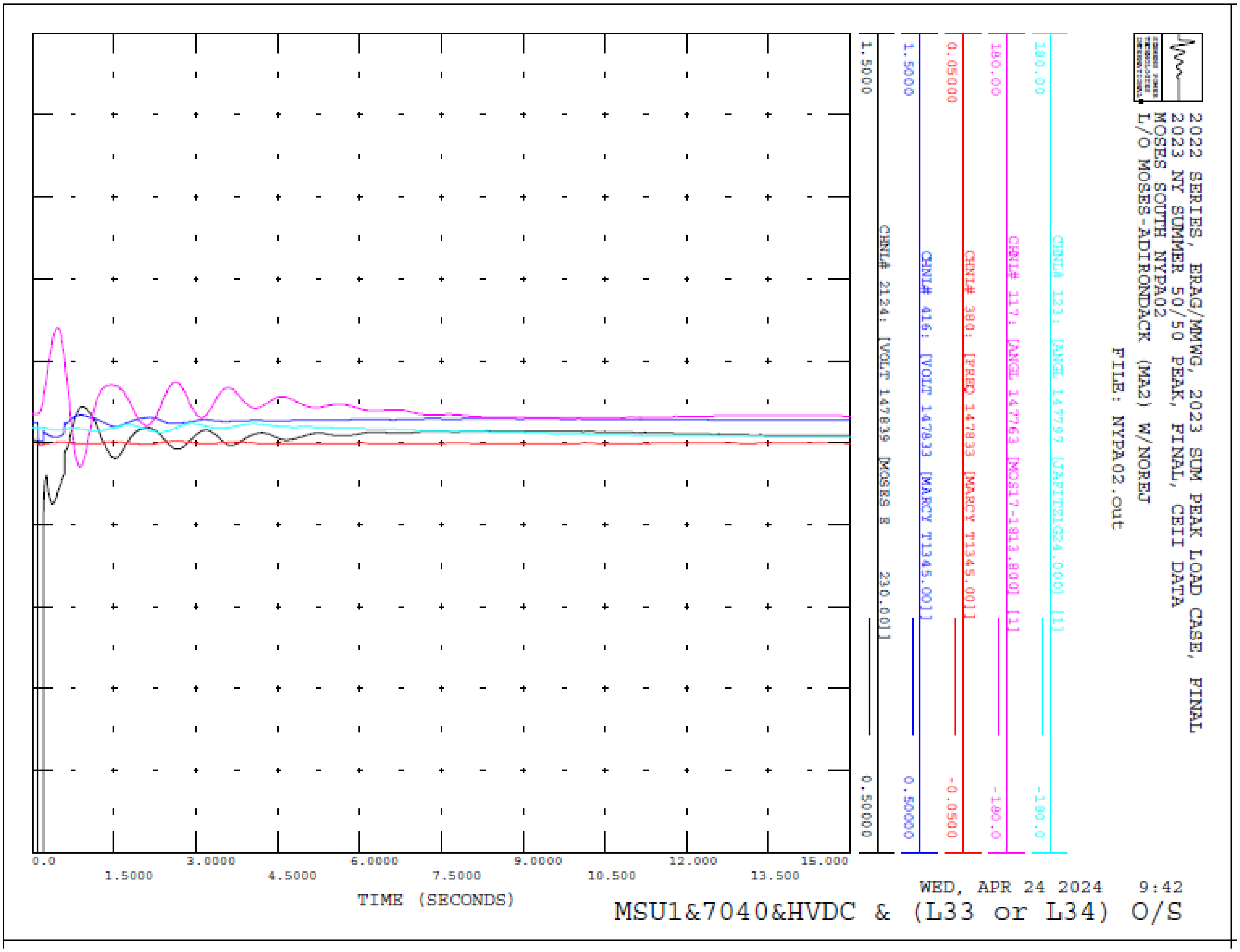
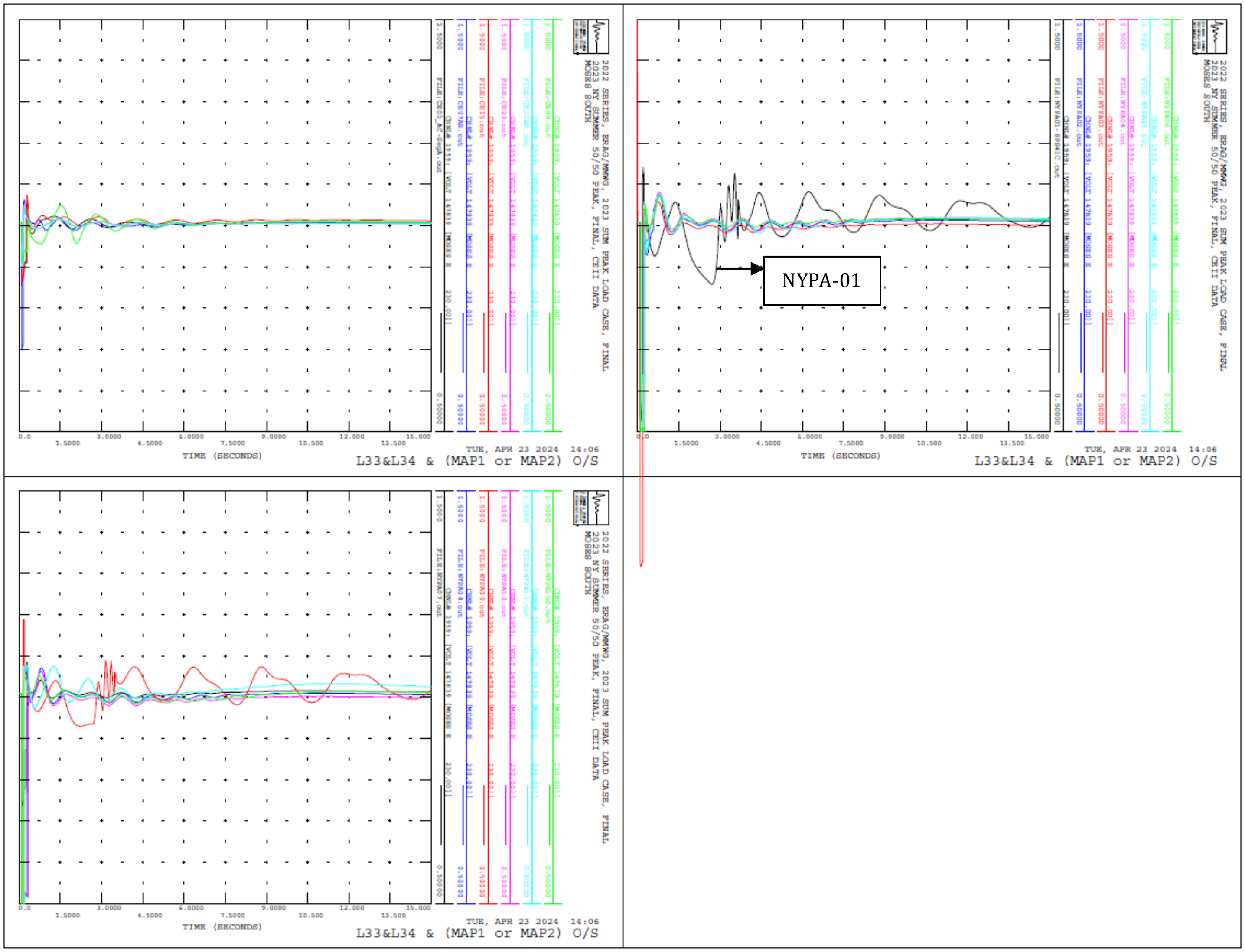


Figure 4. Voltage Angle and Frequency for scenario with MSU1&7040&HVDC & (L33 or L34) O/S

L33 & L34 & (MAP1 or MAP2) Out of Service

Most Severe Contingency

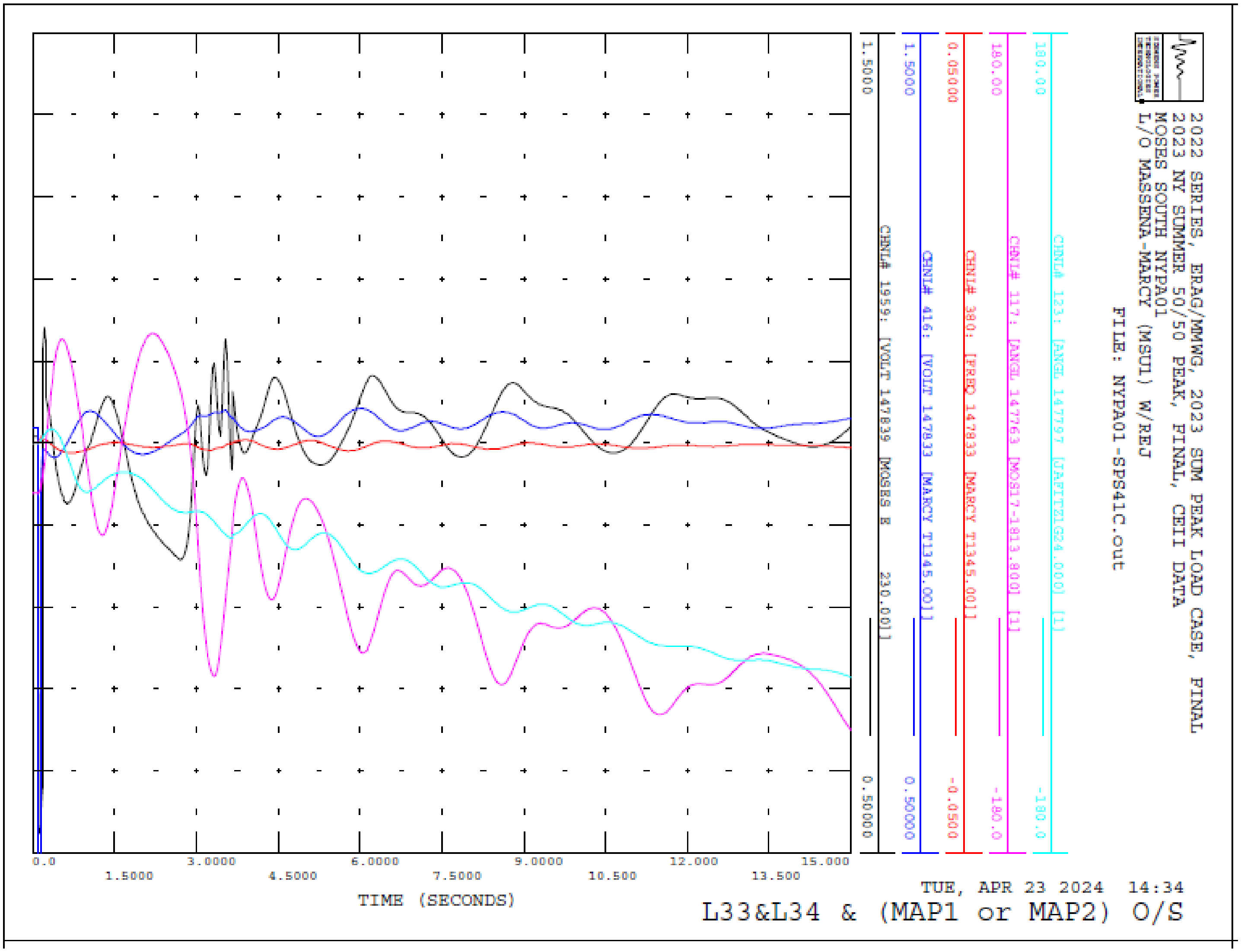
Moses voltages were plotted for all the Moses South contingencies as shown in Figure 5 for L33 & L34 & (MAP1 or MAP2) O/S. It can be seen from Figure 5 that the voltage response at Moses 230kV is most severe for NYPA-01 contingency compared to all other Moses South contingencies. The magnitude of the post contingency voltage swings was found to be the largest when the NYPA-01 contingency was applied. The NYPA-01 contingency was selected as the most severe contingency in the discussions that follow for this outage condition.



- Figure 5. Moses Voltage response for all contingencies for L33 & L34 & (MAP1 or MAP2) O/S

Angle, Voltage, and Frequency Monitoring

Machine angle, voltage and frequency were employed in this analysis as the key indicators of system stability. Machine angles at Moses and Fitzpatrick, voltages at Moses and Marcy stations and frequency at Marcy station were plotted for the NYPA-01 contingency on the L33 & L34 & (MAP1 or MAP2) O/S scenario, as shown in Figure 6. The NYPA-01 contingency consists of a 3PH-NC @MARCY765 L/O MASSENA-MARCY (MSU1) W/REJ.



- Figure 6. Voltage Angle and Frequency for scenario with L33 & L34 & (MAP1 or MAP2) O/S

MAP1&MAP2 Out of Service

Most Severe Contingency

Moses voltages were plotted for all the Moses South contingencies as shown in Figure 7 for MAP1&MAP2 O/S. It can be seen from Figure 7 that the voltage response at Moses 230kV is most severe for NYPA-01 contingency compared to all other Moses South contingencies. The magnitude of the post contingency voltage swings was found to be the largest when the NYPA-01 contingency was applied. The NYPA-01 contingency was selected as the most severe contingency in the discussions that follow for this outage condition.

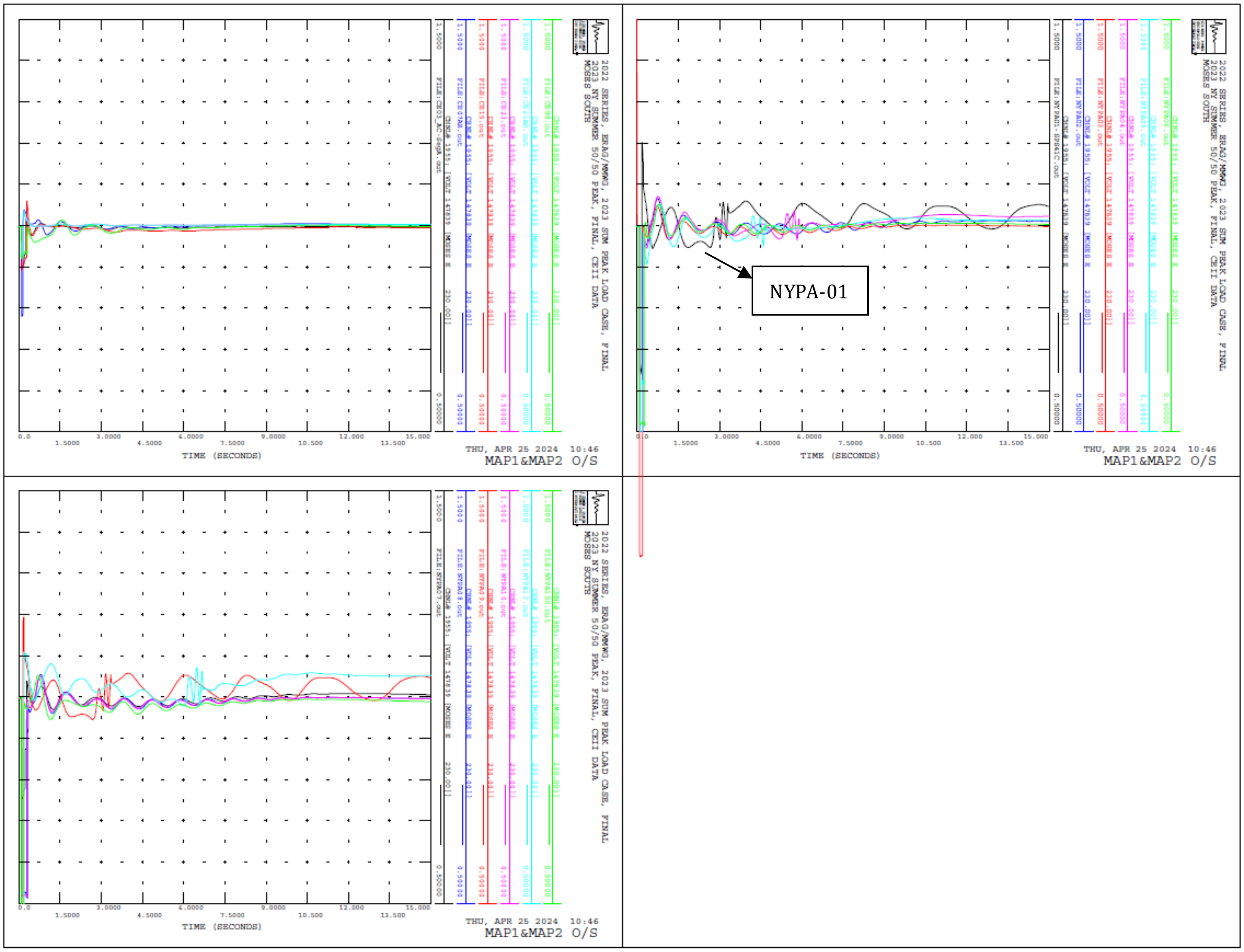


Figure 7. Moses Voltage response for all contingencies for MAP1&MAP2 O/S

Angle, Voltage, and Frequency Monitoring

Machine angle, voltage and frequency were employed in this analysis as the key indicators of system stability. Machine angles at Moses and Fitzpatrick, voltages at Moses and Marcy stations and frequency at Marcy station were plotted for the NYPA-01 contingency on the MAP1&MAP2 O/S scenario, as shown in Figure 8. The NYPA-01 contingency consists of a 3PH-NC @MARCY765 L/O MASSENA-MARCY (MSU1) W/REJ.

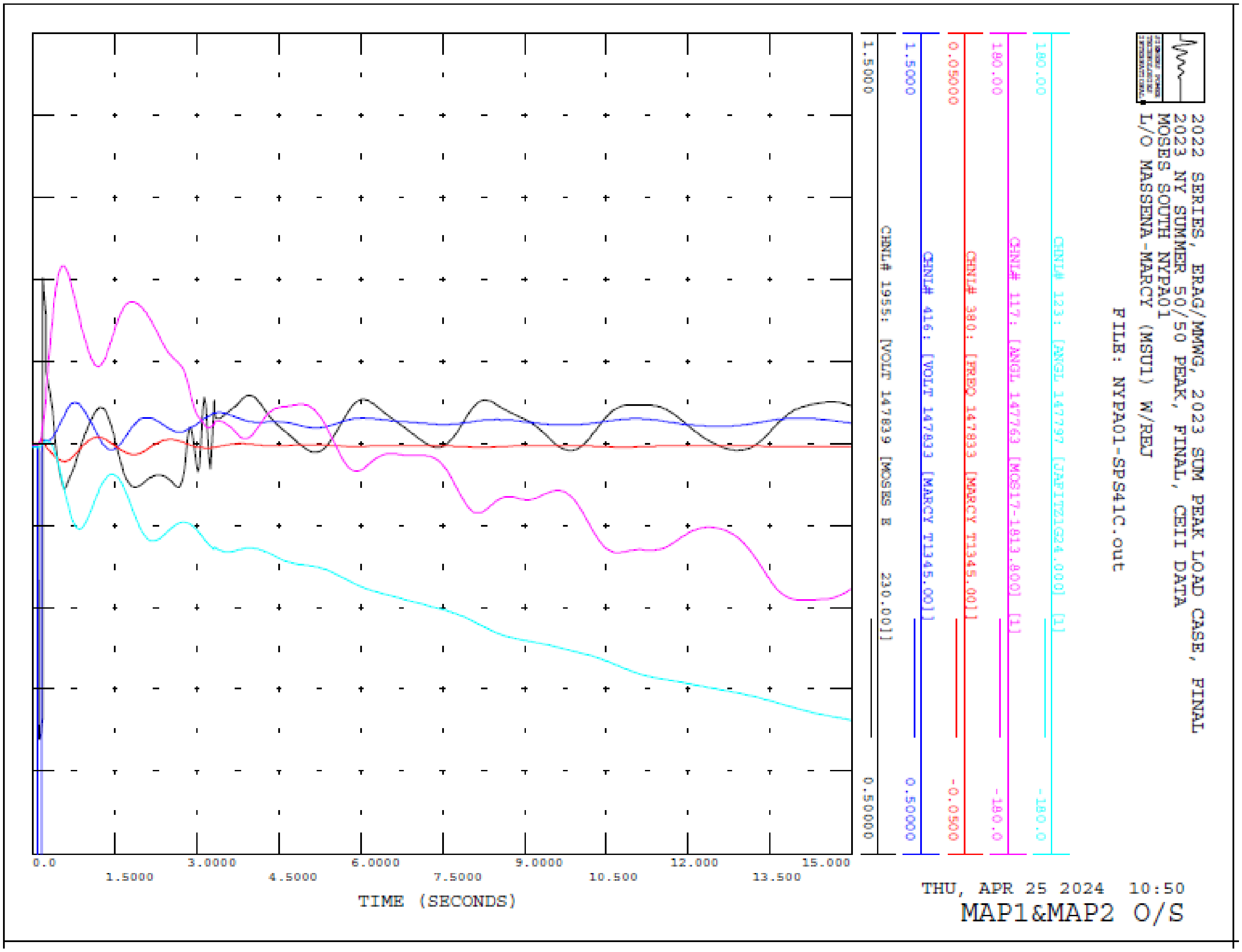


Figure 8. Voltage Angle and Frequency for scenario with MAP1&MAP2 O/S

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 4.

Table 4: Summary of Evaluated Stability Limits (MW)

Scenario	Moses South Stability Limit with Margin (MW)
MSU1&7040&HVDC & (L33 or L34) O/S	750
MSU1&7040&HVDC & (MAP1 or MAP2) O/S	500
MSU1&7040&HVDC & (L33 or L34) & (MAP1 or MAP2) O/S	500*
MSU1&7040&HVDC & MAP1 & MAP2 O/S	100
MSU1&7040&HVDC & MAP1 & MAP2 & (L33 or L34) O/S	100*
MSU1&7040&HVDC & R8105	750
MSU1&7040&HVDC & R8105 & (MAP1 or MAP 2) O/S	500
MSU1&7040&HVDC & R8105 & (L33 or L34) O/S	750*
MSU1&7040&HVDC & R8105 & DS 5 115 kV O/S	750*
MSU1&7040&HVDC & R8105 & NS 4 115 kV O/S	750*
MSU1&7040&HVDC & DS 5 115 kV O/S	750
MSU1&7040&HVDC & NS 4 115 kV O/S	750
L33 & L34 & (MAP1 or MAP2) O/S	2050*
L33 & L34 & (MAP1 or MAP2) & (MMS1 or MMS2) O/S	2050*
L33 & L34 & MAP1 & MAP2 O/S	1650*
MAP1&MAP2 O/S	2750*
MAP1&MAP2 & (L33 or L34) O/S	2550*
MAP1&MAP2 & (L33 or L34) & (MMS1 or MMS2) O/S	2450*

*More restrictive limits will control flows below these limits therefore these limits will not be implemented in the Energy Management System.