New York ISO
Independent System Operator

TOTAL EAST STABILITY LIMITS ANALYSIS FOR ALL LINES I/S AND OUTAGE CONDITIONS (TE-23)

A Report by the
New York Independent System Operator

September 2023

Executive Summary

This study was conducted to examine the stability limits for the Total East interface and determine the impact of the full completion of the Segment A&B project, accounting for the Edic-Princetown (351 and 352) 345 kV lines.

The Total East Interface is a closed interface linking central NY to eastern NY. For more details refer to Table 2 and Fig 1. The study provides updates to the all-lines-in-service limit as well as the two equipment outage limits associated with Total East. The transfer limits developed in this analysis increase by 1400 to 1500 MW as shown on Table 1.

The limits recommended 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 this analysis.

On an informational basis, this study examined the system responses for contingencies involving three-phase faults, line-to-line-to-ground faults as well as the normal criteria single-phase line-to-ground faults. The new all-lines-in-service stability limits for Total East is valid for either form of contingency at the levels tested.

It is recommended that the Total East stability transfer limits be updated as reported on Table 1.

Table of Contents

List of Tables

List of Figures

Introduction

This study was conducted to examine the stability limits for the Total East interface and determine the impact of the full completion of the Segment A&B project, accounting for the Edic-Princetown (351 and 352) 345 kV lines. The study evaluated the all lines in-service condition, the outage on the 5018 line and the outage of an SVC/STATCOM. These system scenarios also assume the Marcy South Series Capacitors (MSSC) are bypassed. Sensitivities were performed on the Knickerbocker series compensation and were determined to have negligible impact on the Total East stability limit. The dynamic response of the system was gauged by examining the voltage response at Edic and Pleasant Valley, and the generator angles at Athens, Gilboa, Niagara and Moses.

Summary of Proposed Limits

Table 1 shows the new proposed limits and the existing limits for Total East. The new proposed limits would have an All Lines In-service value of 7550 MW with a 750 MW reduction for outages on the 5018 Ramapo- Hopatcong 500kV Line and for the outage of any SVC/STATCOM. The increment in transfer limit across Total East interface is mainly due to modeling of the Edic – Princetown (351 & 352) 345 kV lines in-service. When these two lines are out-of-service, the transfer limit should be reverted back as reported in the Total East stability study approved by NYISO Stakeholders in April 2023, posted at the following link: https://www.nyiso.com/documents/20142/3692388/TE-23-StabReport-OC-4-20-2023-Approved.pdf/9bacf9e5-a70e-e09f-01a0-aaf133383651. Table 1 includes these limits for quick reference.

Table 1

Proposed and Existing Total East Stability Limits

	Scenario	Proposed Limit (MW)		Existing Limit (MW)		Diff (MW)
1	All Lines In	7550		6150		+1400
2	5018 Ramapo-Hopatcong 500kV O/S	6800		5400		+1400
3	5018 Ramapo-Hopatcong 500kV & (SVC or Statcom O/S)	6800		5300		+1500
4	Edic – Princetown (351&352) 345 kV lines O/S	6150		N/A		N/A
5	Edic – Princetown (351&352) 345 kV lines & 5018 Ramapo-Hopatcong 500kV O/S	5400		N/A		N/A
6	Edic – Princetown (351&352) 345 kV lines & 5018 Ramapo-Hopatcong 500kV O/S & (SVC or Statcom O/S)	5300		N/A		N/A

System Operating Limit Methodology

The "NYSRC Reliability Rules for Planning and Operating the New York State Power System" (NYSRC Reliability Rules) provides the methodology for developing 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. Rule C.1 of the NYSRC Reliability Rules sets forth the contingencies to be evaluated and the performance requirements to be applied in developing SOLs. Rule C.1 also incorporates NYISO Transmission Planning Guideline #3-1, the "Guideline for Stability Analysis and Determination of Stability-Based Transfer Limits" found in Attachment H to the NYISO "Transmission Expansion and Interconnection Manual."

Interface Summary

Table 2: Total East Interface Definition

Name	Line ID	(kV)		Name	Line ID	(kV)
Edic-Gordon Rd*	14	345		*Waldwick-S. Mahwah	K3411	345
Edic*-Princetown	351	345		Hudson-Farragut*	C3403	345
Edic*-Princetown	352	345		Hudson-Farragut*	B3402	345
Marcy-New Scotland*	18	345		Linden-Goethals*	A2253	230
*Fraser-Gilboa	GF5-35	345		*Cresskill – Sparkill	751	69
East Springfield - Inghams*	7	115		*Harings Corners – W. Nyack	701	69
Inghams PAR	PAR	115		*Harings Corners – Corporate Drive	703	138
Inghams Bus Tie	R81	115		*Montvale – Bluehill	44	69
Middletown-Rock Tavern*	CCRT34	345		*Montvale – Bluehill	43	69
Coopers Corners- Dolson Ave*	CCDA42	345		*Montvale – Pearl River	491	69
Middletown 345*/138	BK114	345/138		*Harings Corners – Pearl River	45	34
West Woodbourne 115/69*	BK1	115/69		*S. Mahwah – Ramapo	51	138
*Plattsburgh-Sand Bar	PV20	115		*S. Mahwah - Hilburn	65	69
Hopatcong-Ramapo*	5018	500		S. Mahwah 138/345*	BK258	138/345
*Waldwick- S. Mahwah	J3410	345				

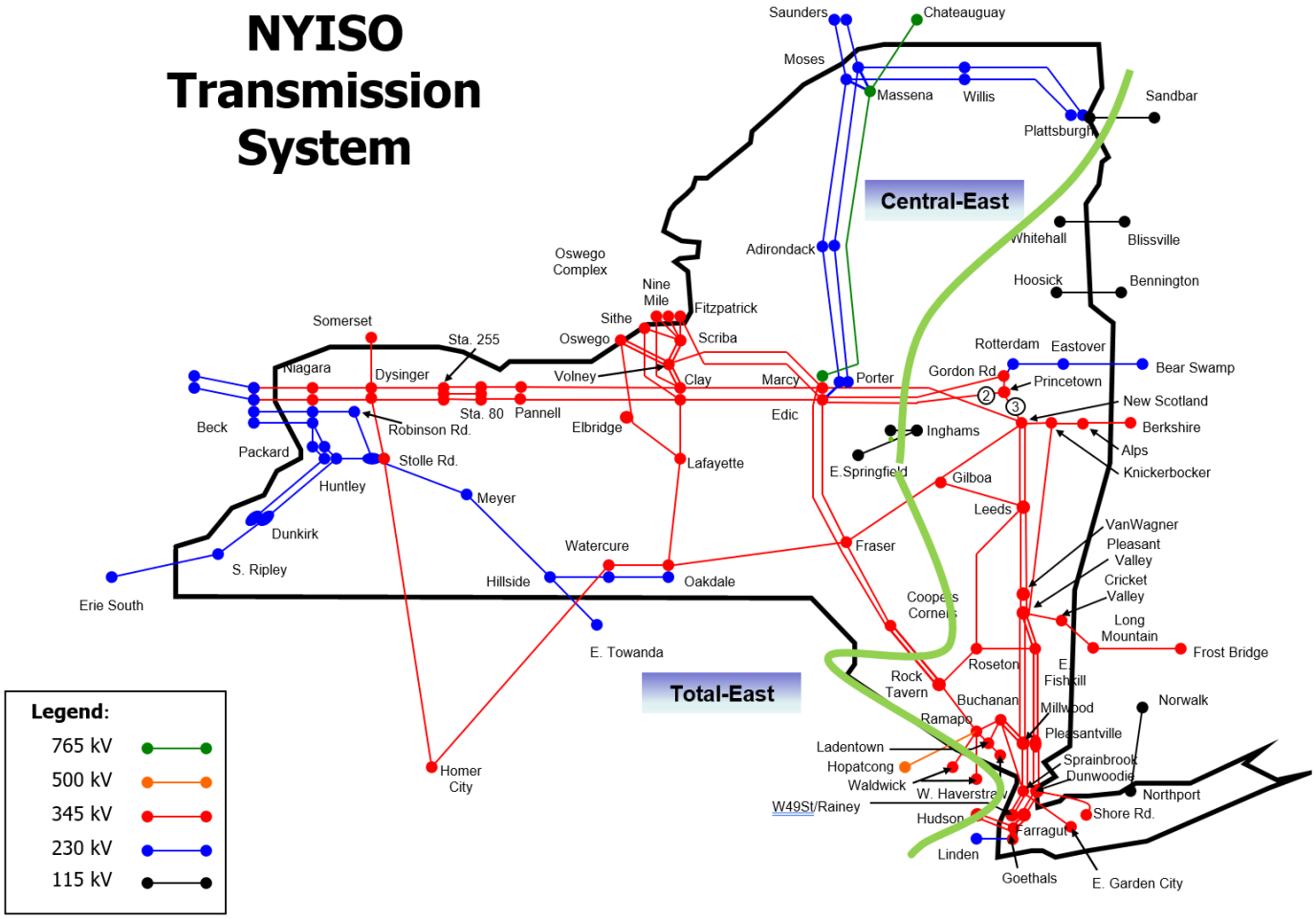

Figure 1. NYCA Transmission System Interface (Total East inset)

System Representation and Transfer Case Development

The analysis was based on the 2022 NYISO Dynamics Base Case that was developed from the 2021 MMWG Dynamics Base Case with the NYISO representation updated to reflect the results of the NYISO 2022 Summer Operating Study.

The base case model includes the following:

- 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.

Total East transfers were developed from generation shifts between IESO and NYISO West (Zone A) through Central (Zone C) to Capital (Zone F), and ISO New England, as well as transfers from PJM into Capital (Zone F) and Hudson (Zone G) along the terms of the joint operating agreement between NYISO and PJM. The base case was established with a high transfer on Dysinger East (> 2900 MW), Moses South (> 2900 MW) and NY-ISO-NE (1800 MW).

This study was performed with Chateauguay HVDC terminals taken out-of-service with the Chateauguay transfers maintained with the Beauharnois units. The Fraser SVC, Leeds SVC and Marcy FACTs were modeled in-service, the base case load flow were solved with the SVCs/FACTs set to minimum (0MVAr) output by adjusting their respective voltage schedules in the pre-contingency case.

The capacitor banks at Oakdale and Edic were producing maximum VAR output of 135MVAR and 200MVAR respectively. This study placed the Knickerbocker series compensation in service at 0% compensation. Three transfer cases were developed as shown on Table 3.

Table 3 Transfer Cases	
A	TE 8415, Marcy Statcom I/S, Leeds I/S, Fraser I/S, 5018 I/S
B	TE 7560, Marcy Statcom I/S, Leeds I/S, Fraser I/S, 5018 O/S
C	TE 7560, Any SVC/Statcom O/S, 5018 O/S

Tested Contingencies

Sixty One (61) contingencies were tested for each developed Total East transfer case scenario. Table 4 provides the identification and description of these contingencies.

Table 4.

Contingencies applied for evaluating Total East stability transfer limits.

#	ID	Description
1	TE02(LLG)	LLG@FISHKILL-L/O TOWER(2-1938)FISHKILL*PLEASANTVILLE
2	TE03(LLG)	LLG@SPRAIN BK-L/O TOWER(2-1956)MILLWOOD*SPRAIN BROOK
3	TE10	SLG-STK@RAMAPO (BKR T77-94-2) – L/O RAMAPO-ROCK TAVERN (77) / BKUP CLR Y94
4	TE12	SLG-STK@RAMAPO500 (BRK T1500-W72-2) – L/O RAMAPO-HOPATCONG (5018) / BKUP CLR#W72
5	TE14	SLG/STK@LEEDS*GILBOA / STK R391 / CLR#91 PL.VALLEY
6	TE15	SLG-STK LEEDS BKRR9293 L/O LEEDS-VW59BKUPCLR93N.SCOT
7	TE16	SLG/STK @ ROSETON/ROSETON*ROCK TAVERN#311/STK 31151
8	TE18(LLG)	LLG@LADENTOWN-L/O TOWER Y88/Y94 DOUBLE CIRCUIT
9	TE20(LLG)	LLG@DUNWOODIE-L/O TOWER(2-1938)PLEASANTVILLE*DUNWO.
10	TE21	3PH@PLEAS.VAL-L/O TOWER(2-1961)PV*MILLWOOD DBL CKT
11	TE27	SLG/STK@ROCK TAVERN*COOPERS/CLR ROCK TAVN*RAMAPO
12	TE29	3PH@N.SCOT / N.SCOT-LEEDS#93 W/HS RCL
13	TE30	3PH@LEEDS / GILBOA * LEEDS GL-3
14	TE31	3PH@GILBOA – L/O GILBOA - NEW SCOTLAND (GNS-1)
15	TE32	3PH@NEW SCOTLAND - 77 BUS
16	TE33	3PH@NEW SCOTLAND - 99 BUS
17	TE34	SLG-STK@GILBOA/GILBOA*NSCOT / STUCK 3208
18	TE35	3PH-NC@LEEDS – L/O LEEDS-ATHENS#95 W/HS RCL
19	TE36	3PH @ LEEDS / LEEDS - HURLEY AVENUE
20	TE38	3PH/NC @ ROCK TAVERN / ROSETON * ROCK TAVERN #311
21	TE39	STORM-L/O 69/J3410 W/OUT FAULT & 1.1SEC LATER LLG@LADENTOWN – L/O Y88/Y94 DCT W/RCL
22	TE40 (LLG)	LLG@RAMAPO - L/O 69/J3410+70/K3411 DCT
23	TE41	SLG-STK@GILBOA (BKR 3208) – L/O GILBOA - LEEDS (GL-3) / BKUP CLR GILBOA#1, 2

24	TE42	3PH-NC@RAMAPO500 – L/O RAMAPO-HOPATCONG
25	TE43	3PH-NC@VANWGNR - LO-VANWGNR-PLTVLLEYY59WHSRCL
26	TE44(LLG)	LLG@RAMAPO - L/O RAMAPO - ROCK-TAVERN 77 & 76 / DCT
27	TE45	3PH-NCLEEDS/LO LEEDS-VANWGNR59WHSRCL
28	TE46	SLG-STK/VANWGNR BKRR12/LO PLTVLLEY-VANWGNRY58BKUPCLR91
29	TE47	SLG-STK/VANWGNR BKRR12/LO ATHENS-VANWGNR91 BKUP CLR Y58
30	CE03	SLG-STK@EDIC345 (BKR R935) – L/O EDIC-GORDON ROAD #14 / BKUP CLR FE1
31	CE06	3PH-NC@MARCY345 – L/O EDIC-MARCY (UE1-7)
32	CE07(LLG)	LLG@MARCY/EDIC - L/O MARCY-COOPERS (UCC2-41) & EDIC-FRASER (EF24-40) DCT
33	CE07AR(LLG)	LLG@MARCY/EDIC - L/O MARCY-COOPERS (UCC2-41) & EDIC-FRASER (EF24-40) DCT W/RCL
34	CE09	SLG-STK@EDIC345KV – L/O FITZ-EDIC #FE-1/BKUP CLR#14
35	CE15	SLG-STK@MARCY345(BKR 3108) – L/O VOLNEY-MARCY (VU-19) / BKUP CLR#UE1-7
36	CE36	SLG--STK@SCRIBA345 (BKR R100)/SCRIBA-FITZ #10/ BKUP CLR SCRIBA 345-SCRIBA 115 XFMR
37	CE99	SLG-STK@SCRIBA345 (BKR R935) – L/O SCRIBA-VOLNEY 21 / BKUP CLR FITZ-SCRIBA #10
38	SA01_Q556	SLG-STK@EDIC345 (BKR R915) – L/O EDIC-FRASER EF24-40 / BKUP CLR 2-15
39	SA24_Q556	LLG@PRINCETOWN- L/O PRINCETOWN-EDIC (351) & PRINCETOWN-EDIC (352)
40	SA25_Q556	LLG@MARCY/EDIC - L/O MARCY-COOPERS (UCC2-41) & EDIC-PRINCETOWN (351) DCT
41	SA26_Q556	LLG@PRINCETOWN/EDIC - L/O EDIC-FRASER (EF24-40) & EDIC-PRINCETOWN (352) DCT
42	SA27_Q556	SLG-STK@EDIC345 (BKRR915) – L/O EDIC-PRINCETOWN / BKUP CLR#2-15
43	P1-2-F14	3PH@KNICKERBOCKER – L/O KNICKERBOCKER – ALPS (6)
44	P1-2-F15	3PH@ALPS – L/O ALPS – KNICKERBOCKER (6)
45	P1-2-F20	3PH@KNICKERBOCKER – L/O KNICKERBOCKER – PLEASANT VALLEY (Y57)
46	P1-2-F21	3PH@PLEASANT VALLEY – L/O PLEASANT VALLEY – KNICKERBOCKER (Y57)
47	P1-2-F31	3PH@NEW SCOTLAND – 66 BUS – L/O NEW SCOTLAND – KNICKERBOCKER (2)
48	P1-2-F32	3PH@KNICKERBOCKER – L/O NEW SCOTLAND – KNICKERBOCKER (2)
49	P4-2-F13_#4	SLG-STK@KNICKERBOCKER (BKR 4) – L/O KNICKERBOCKER – NEW SCOTLAND (2)
50	P4-2-F13_#7	SLG-STK@KNICKERBOCKER (BKR 7) – L/O KNICKERBOCKER – NEW SCOTLAND (2)
51	P4-2-F14_#5	SLG-STK@KNICKERBOCKER (BKR 5) – L/O KNICKERBOCKER – ALPS (6)
52	P4-2-F14_#7	SLG-STK@KNICKERBOCKER (BKR 7) – L/O KNICKERBOCKER – ALPS (6)
53	P4-2-F15	SLG-STK@ALPS (BKR R2) – L/O ALPS – KNICKERBOCKER (6)

54	P4-2-F20_#4	SLG-STK@KNICKERBOCKER (BKR 4) – L/O KNICKERBOCKER – PLEASANT VALLEY (Y57)
55	P4-2-F20_#5	SLG-STK@KNICKERBOCKER (BKR 5) – L/O KNICKERBOCKER – PLEASANT VALLEY (Y57)
56	P4-2-F21	SLG-STK@PLEASANT VALLEY (BKR RNS3) – L/O PLEASANT VALLEY – KNICKERBOCKER (Y57)
57	P4-2-F31	SLG-STK@NEW SCOTLAND – 66 BUS (BKR R2) – L/O NEW SCOTLAND – KNICKERBOCKER (2)
58	P7_F1	L/O TOWER KNICKERBOCKER – PLEASANT VALLEY 345 & FORT ORANGE – VALKIN 115 DBL CKT
59	P7_F5	L/O TOWER KNICKERBOCKER – PLEASANT VALLEY 345 & ADM MILLING – CHURCHTOWN 115 DBL CKT
60	P7_F6	L/O TOWER KNICKERBOCKER – PLEASANT VALLEY 345 & CHURCHTOWN – BLUE STORES 115 DBL CKT
61	P7_F8	L/O TOWER KNICKERBOCKER – PLEASANT VALLEY 345 & MILAN – PLEASANT VALLEY 115 DBL CKT

Contingencies 1, 2, 8, 9 and 10 are tower three-phase faults, which are beyond NYSRC criteria for the determination of NYISO System Operating Limits. Those contingencies were only examined on an informational basis.

Monitored Parameters

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

- Generators' angles, power outputs, terminal voltages in the following areas/zones (West, North, Mohawk, Capital, representative generators from West, Central, Hudson and Capital);
- Bus voltages around Total East, Western NY and Central East especially at Edic and Pleasant Valley.

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

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 Niagara and Athens, voltages at Edic and Pleasant Valley stations and frequency at New Scotland station were plotted for the CE-99 contingency on the all lines in-service scenario, as shown in Figure 2. The CE99 contingency consists of a SLG-STK@SCRIBA345 (BKR R935) – L/O SCRIBA-VOLNEY 21 / BKUP CLR FITZ-SCRIBA #10.

Edic voltage was selected as the representative indicator of system performance for the CE-99 contingency in the discussions that follow. Similar plots for all the Total East contingencies simulated are included in the appendices.

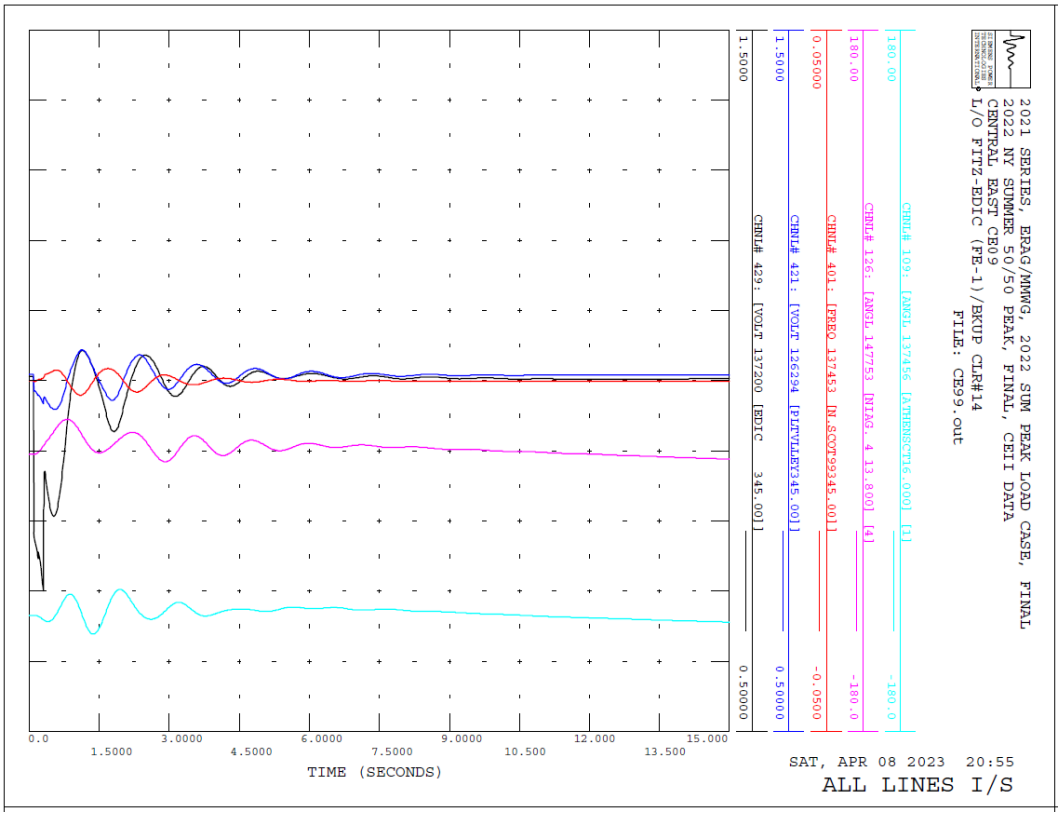

Figure 2. Voltage Angle and Frequency for scenario with all equipment in-service

Most Severe Contingency

Edic voltages were plotted for all the Total East contingencies as shown in Figure 3. It can be seen from Figure 3 that the voltage response at Edic 345KV is most severe for CE-99 contingency compared to all other Total East contingencies. The magnitude of the post contingency voltage swings was found to be the largest when the CE-99 contingency was applied. Similar plots for all the Total East contingencies simulated are included in the appendices.

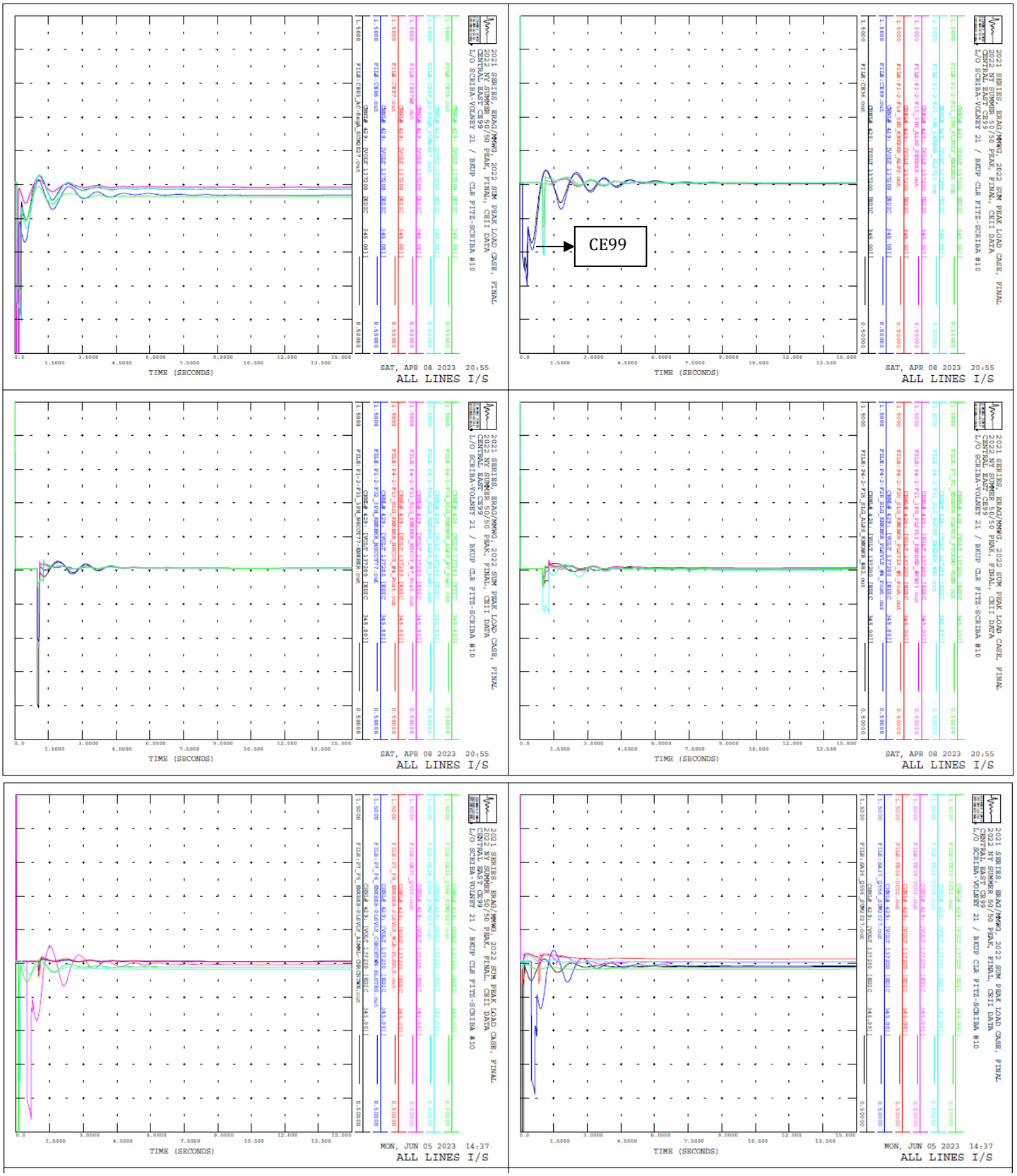

Figure 3. Edic Voltage response for all contingencies for all equipment in-service

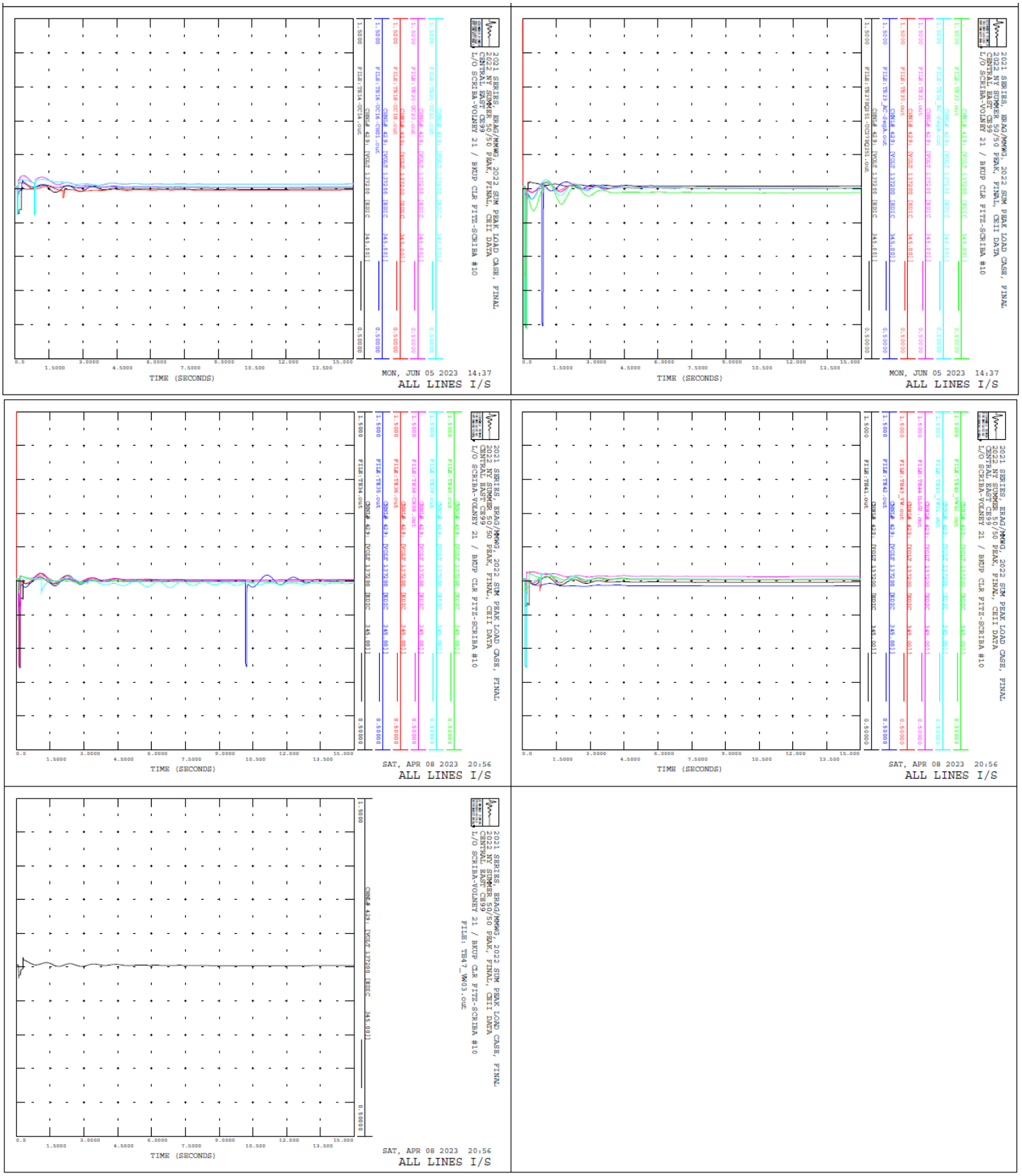

Figure 3 (Continued). Edic Voltage response for all contingencies for all equipment in-service

5018 Out of Service

Machine angle, voltage and frequency were employed in this analysis as the key indicators of system stability and the dynamic response of the system under this outage condition is shown in Fig 4. All dynamic responses were clearly stable for this configuration at a test level of 7560 MW. The Edic voltage response for all 57 contingencies with 5018 Line out of service is found in Appendix B.

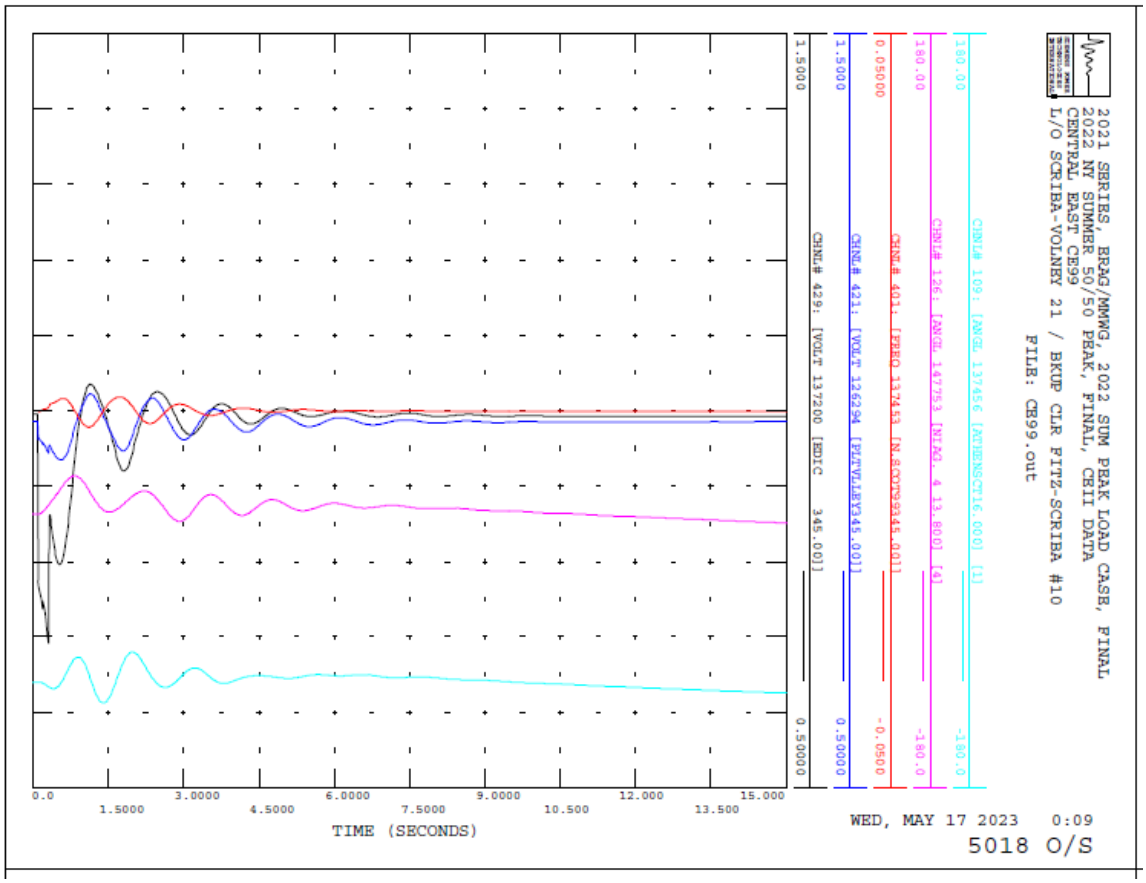

Figure 4. Voltage Angle and Frequency for scenario with 5018 O/S

5018 Out of Service and SVCs and STATCOM's Out of Service

Machine angle, voltage and frequency were employed in this analysis as the key indicators of system stability and the dynamic response of the system under this outage condition is shown in Fig 5, 6, 7. All responses were clearly stable for this configuration at a test level of 7560 MW.

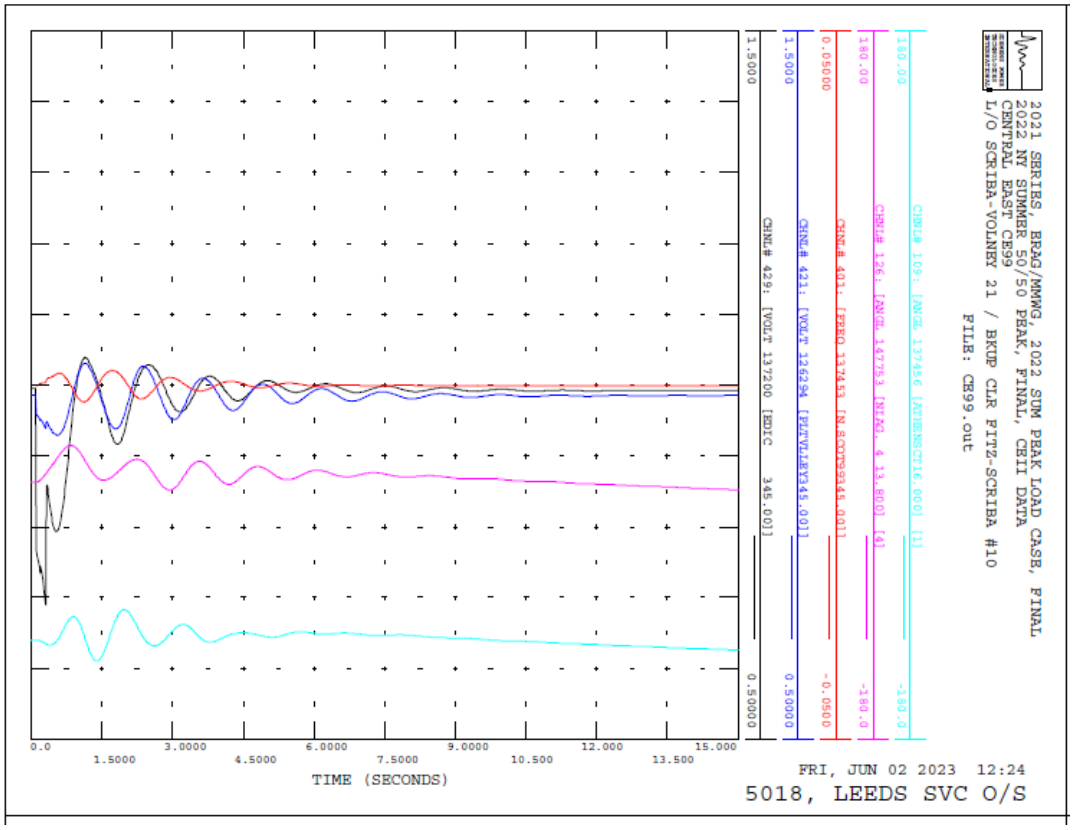

Figure 5. Voltage Angle and Frequency for scenario with 5018 O/S and Leeds SVC O/S

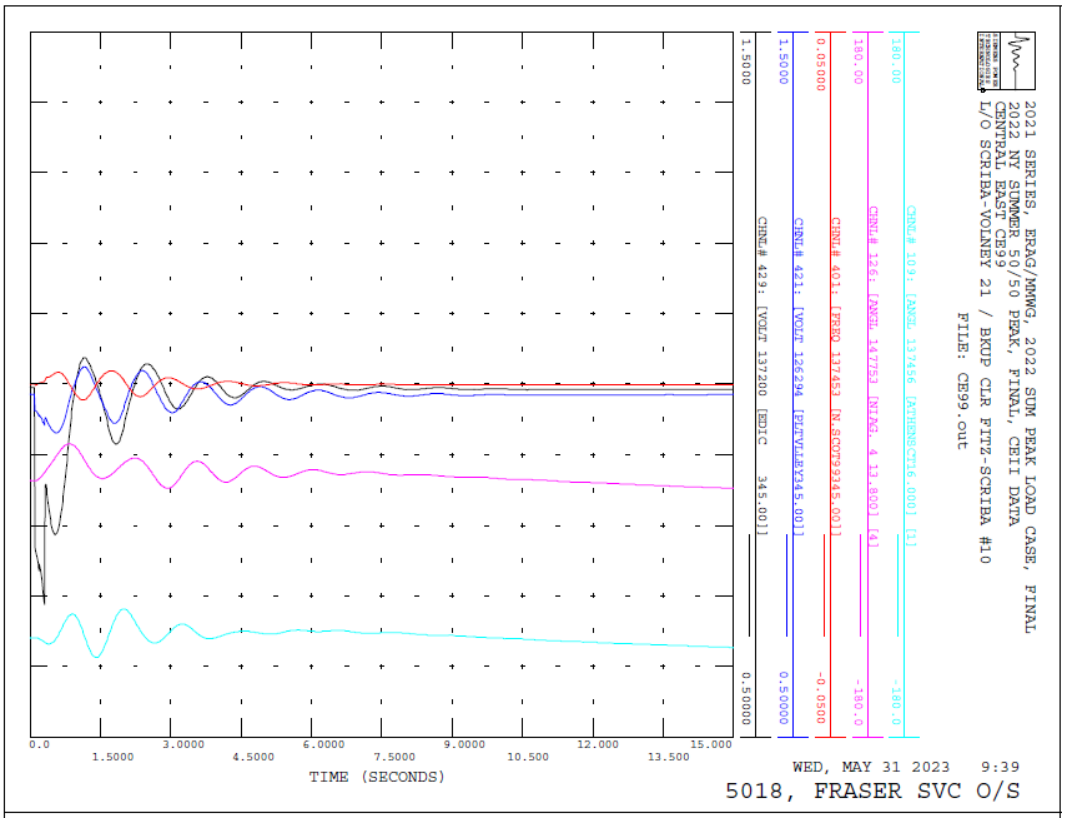

Figure 6. Voltage Angle and Frequency for scenario with 5018 O/S and Fraser SVC O/S

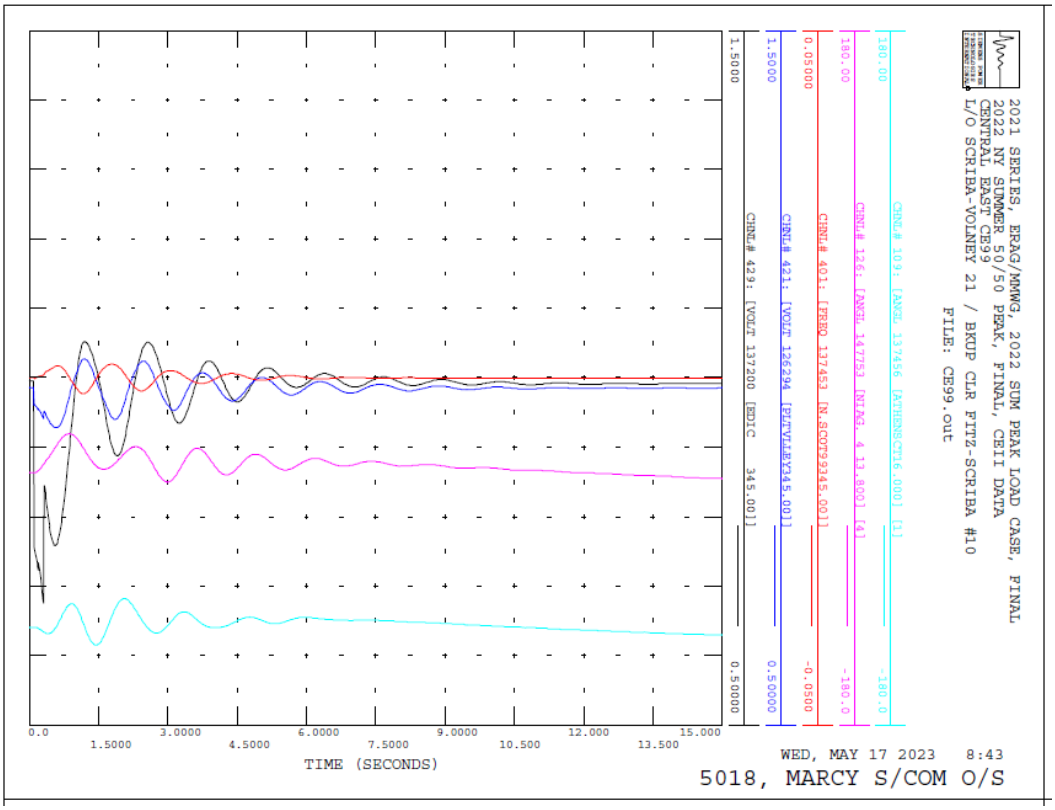

Figure 7. Voltage Angle and Frequency for scenario with 5018 O/S and Marcy STATCOM O/S

Recommendations

This report has been reviewed and recommended for NYISO Operating Committee approval by the NYISO Operating Studies Task Force (OSTF) and the System Operations Advisory Subcommittee (SOAS).

It is recommended that the stability limit of Total East be increased. The transfer case was set up for a transfer level of 8415MW and a stability limit of 7550MW across Total East. Table 5 outlines the proposed stability limits for Total East and also the stability limit under outage conditions.

#	Scenario	2023		2023		Difference (MW)
		Total East Stability Limit(MW)	Total East Tested Transfer Level(MW)	Total East Stability Limit (MW)	Total East Tested Transfer Level (MW)	
1	All Lines In	7550	8415	6150	6845	+1400
2	5018 Ramapo-Hopatcong 500kV O/S	6800	7560	5400	6015	+1400
3	5018 Ramapo-Hopatcong 500kV & Any SVC/STATCOM O/S	6800	7560	5300	5915	+1500
4	Edic – Princetown (351&352) 345 kV lines O/S	6150	6845	N/A	N/A	N/A
5	Edic – Princetown (351&352) 345 kV lines O/S & 5018 Ramapo-Hopatcong 500 kV O/S	5400	6015	N/A	N/A	N/A
6	Edic – Princetown (351&352) 345 kV lines O/S & 5018 Ramapo-Hopatcong 500 kV O/S & (SVC or Statcom O/S)	5300	5915	N/A	N/A	N/A

Table 5: Summary of proposed Total East Stability Transfer Limits