New York ISO
Independent System Operator

UPNY-CON ED STABILITY LIMIT ANALYSIS FOR ALL LINES IN-SERVICE AND OUTAGE CONDITIONS (UPCE-20)

A Report by the
New York Independent System Operator

March 2020

Executive Summary

This study was conducted to examine stability limits for the UPNY-ConEd interface after the retirement of Indian Point Unit #2 and Indian Point Unit #3. The UPNY-ConEd interface is defined in Table 2 and illustrated in Figure 1. The study provides updates to the all-lines-in-service limit and the equipment outage limits associated with the UPNY-ConEd interface.

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.

The first scenario examined the system conditions after the retirement of Indian Point Unit #2, planned to retire no later than April 30, 2020. The Consolidated Edison (ConEd) series reactors (located on the M51, M52, 71, and 72 lines) were modeled in-service for this analysis, per current system conditions. The Cricket Valley generating station was modeled in-service, and was considered to be operating at full capacity. The stability limits recommended in this study increased significantly from previously studied levels.

The second and third scenarios examined system conditions following the retirement of Indian Point #3, planned to retire no later than April 30, 2021. These cases also examined the impact of modeling the ConEd series reactors in-service and bypassed when both Indian Point units were no longer in-service. The results show an additional increase in the stability limit resulting from the retirements of both Indian Point units, and indicate that the stability limit across the UPNY-ConEd interface is greater when the ConEd series reactors are bypassed.

It is recommended that the UPNY-ConEd stability transfer limits be updated as reported in Table 1.

Table of Contents

List of Tables

List of Figures

Summary of Proposed Limits

The proposed limit revisions and the magnitude of the changes are presented in Table 1, below:

Table 1.
Summary of proposed UPNY-ConEd stability transfer limits

Case #	Dispatch Scenario	Line Outages Applied	Proposed Stability Limit (MW)	Existing Stability Limit (MW)	Change in Stability Limit (MW)
1.0	IP2 O/S, Series Reactors I/S	All lines in service	7800	5700	2100
1.1	IP2 O/S, Series Reactors I/S	Y88 Ladentown – Buchanan 345kV O/S	7350	4800	2550
1.2	IP2 O/S, Series Reactors I/S	Y94 Ramapo – Buchanan 345kV O/S	7325	4800	2525
1.3	IP2 O/S, Series Reactors I/S	RFK305 Roseton – E. Fishkill 345kV O/S	7300	4800	2500
1.4	IP2 O/S, Series Reactors I/S	5018 Hopatcong – Ramapo 500kV O/S	7375	5000	2375
1.5	IP2 O/S, Series Reactors I/S	5060 Hopatcong – Branchburg 500kV O/S	7550	5000	2550
2.0	IP2&3 O/S, Series Reactors Byp	All lines in service	9200	5700	3500
2.1	IP2&3 O/S, Series Reactors Byp	Y88 Ladentown – Buchanan 345kV O/S	9000	4800	4200
2.2	IP2&3 O/S, Series Reactors Byp	Y94 Ramapo – Buchanan 345kV O/S	9100	4800	4300
2.3	IP2&3 O/S, Series Reactors Byp	RFK305 Roseton – E. Fishkill 345kV O/S	9000	4800	4200
2.4	IP2&3 O/S, Series Reactors Byp	5018 Hopatcong – Ramapo 500kV O/S	8800	5000	3800
2.5	IP2&3 O/S, Series Reactors Byp	5060 Hopatcong – Branchburg 500kV O/S	9050	5000	4050
3.0	IP2&3 O/S, Series Reactors I/S	All lines in service	8400	5700	2700
3.1	IP2&3 O/S, Series Reactors I/S	Y88 Ladentown – Buchanan 345kV O/S	8200	4800	3400
3.2	IP2&3 O/S, Series Reactors I/S	Y94 Ramapo – Buchanan 345kV O/S	8225	4800	3425
3.3	IP2&3 O/S, Series Reactors I/S	RFK305 Roseton – E. Fishkill 345kV O/S	8150	4800	3350
3.4	IP2&3 O/S, Series Reactors I/S	5018 Hopatcong – Ramapo 500kV O/S	7900	5000	2900

3.5	IP2&3 O/S, Series Reactors I/S	5060 Hopatcong – Branchburg 500kV O/S	8350	5000	3350

Introduction

This study serves as a review of UPNY-ConEd stability limits in anticipation of the retirement of both Indian Point Unit #2 and Unit #3 nuclear units. Three major dispatch scenarios were evaluated. The first scenario covers system condition anticipated after April 30, 2020, when Indian Point Unit #2 is retired and Indian Point Unit #3 remains active. The ConEd series reactors (located on the M51, M52, 71, and 72 lines) are modeled in-service, and the Cricket Valley generating station is modeled as in service and fully dispatched. The second and third scenarios cover system conditions anticipated after April 30, 2021 when both Indian Point nuclear units are planned to be retired and the impact of the ConEd series reactors being modeled in-service and bypassed. Each scenario examines the impact of significant line outages on or near the UPNY-Con Ed interface, in addition to an all-lines-in-service condition.

This study provides recommendations to update the UPNY-Con Ed stability transfer limits for all-lines-in-service and outage scenarios as per Table 1.

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.".

The NYISO stability transfer limit, obtained from a stable simulation of the most severe contingencies, is obtained by reducing the test level of the interface by 10% of the pre-contingency transfer on that interface.

Interface Summary

The UPNY-ConEd interface definition is given below in Table 2 and illustrated in Figure 1.

UPNY-CONED		
Hudson Valley (Zone G) – Millwood (Zone H)		
Name	**Line ID**	**Voltage (kV)**
*Ladentown-Buchanan South	Y88	345
*Pleasant Valley-Wood St.	F30	345
*Pleasant Valley-Wood St.	F31	345
*Pleasant Valley-East Fishkill	F36	345
*Pleasant Valley-East Fishkill	F37	345
*Ramapo-Buchanan North	Y94	345
Roseton-East Fishkill*	RFK305	345
*Fishkill Plains–Sylvan Lake	FP/990	115
East Fishkill 115/345*	BK1	115/345
East Fishkill 115/345*	BK2	115/345

Table 2. UPNY-ConEd Interface Definition

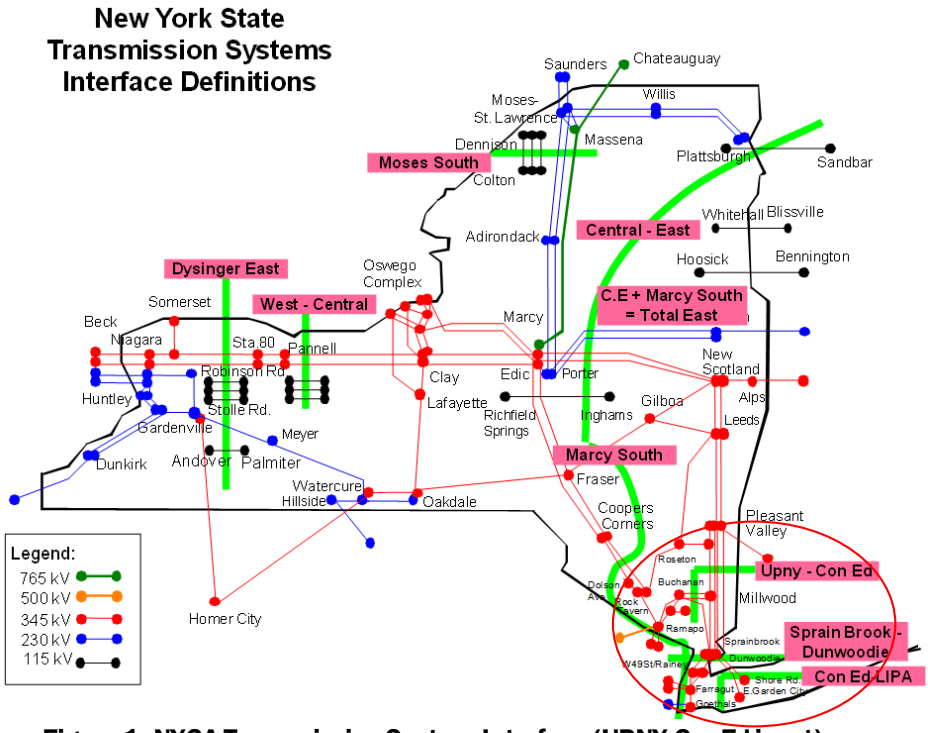

Figure 1. NYCA Transmission System Interface (UPNY-ConEd inset)

System Representation and Transfer Case Development

The analysis was based on the 2019 NYISO Dynamics Base Case, which was developed from the 2019 MMWG Dynamics Base Case with the NYISO representation updated to reflect the results of the NYISO 2019 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

Generation shifts between Capital, Hudson, and New York City zones were primarily used to adjust UPNY-ConEd transfer power flows. In order to achieve the maximum transfer levels possible in the scenarios with both Indian Point units out-of-service, generation output in the New York Control Area was maximized and additional generation imports from PJM and ISO-NE were modeled.

This study was performed with Chateauguay HVDC terminals and the Marcy South Series Compensation in-service. 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.

Tested Contingencies

Forty-two (42) contingencies were tested for each developed UPNY-ConEd transfer case scenario. Table 3 provides the identification and description of these contingencies.

Table 3.
Contingencies Applied for Evaluating UPNY-ConEd Stability Transfer Limits

#	ID	Description
1	CE18-UC30	LLG@ROCK – L/O CPV(DOLSON)-ROCK TAVERN DCT
2	CE18AR-UC30AR	LLG@ROCK – L/O COOPERS CORNERS-ROCK TAVERN DCT W/ RCL
3	CE19	LLG@COOPERS – L/O COOPERS CORNERS- CPV_VALY(DOLSON) DCT
4	CE19AR	LLG@COOPERS – L/O COOPERS CORNERS-ROCK TAVERN DCT W/ RCL
5	UC01	SLG-STK@PLTVLLEY (BKR RNS4) – L/O PLTVLLEY-MILLWOOD (F31) / BKUP CLR#91
6	UC04	SLG-STK@BUCHANAN N (BKR#9) – L/O IP#2 / BKUP CLR#W93/W79
7	UC06	SLG-STK@DUNWODIE (BKR#8) – L/O DUNWODIE-PL VILLW (W90) / BKUP CLR#72
8	UC07	SLG-STK@FISHKILL (BKR#11) – L/O FISHKILL-PV (F36) / BKR CLR# FISHKILL T1
9	UC08	SLG-STK@LADENTOWN (BKR#1-56-2) - L/O RAMAPO-LADENTWN (W72) / BKUP CLR BOWL#1
10	UC09	SLG-STK@MILLWOOD (BKR#16) – L/O MILLWOOD-SPRAIN (W99/W64) / BKUP CLR#W98
11	UC11	SLG-STK@SPRAIN (BKR#RNS6) – L/O SPRAIN-TREMONT (X28) / BKUP CLR#W93/W79
12	UC13	SLG-STK@LEEDS (BKR#R94301) – L/O LEEDS-N.SCOTLAND (94)/ BKUP CLR#301@HURLEY
13	UC19	3PH@MILLWOOD - L/O MILLWOOD-SPRAINBROOK (W82/W65 & W85/W78) DCT W/RCL
14	UC22	SLG-STK@LADENTWN (BKR#3-56-2) – L/O BUCHANAN-LADENTWN (Y88) / BKUP CLR BOWL#1
15	UC23	SLG-STK@RAMAPO (BKR#T77-94-2) – L/O RAMAPO-BUCHANAN (Y94) / BKUP CLR#77
16	UC23B	SLG-STK@RAMAPO (BKR#T77-94-2) – L/O RAMAPO-BUCHANAN (Y94) / BKUP CLR#77
17	UC24	SLG-STK@ROCK (BKR#31153) – L/O ROCK TAVERN-ROSESTON (311) / BKUP CLR# CCRT-34
18	UC25A	3PH-NC@RAVENSWOOD#3 – L/O RAVENSWOOD#3
19	UC25B	3PH-NC@RAINEY – L/O RAVENSWOOD#3 60L CABLE
20	UC26	LLG@LADENTWN - L/O 67/68 DCT / REJECT BOWLINE
21	UC28	SLG-STK@COOPERS – L/O CCDA-42 / BKUP CLR UCC2-41@MARCY
22	UC29	SLG-STK@LADENTWN (BKR#6-56-2) – L/O LADENTWN-BUCHANAN (Y88) / BKUP /CLR BOWL#2

23	UC30_Q444	3PH@CRICKET VALLEY - L/O FDR F83
24	UC31_Q444	3PH@CRICKET VALLEY - L/O FDR F84
25	UC32_Q444	3PH@CRICKET VALLEY - L/O FDR 398
26	UC33_Q444	3PH@PLEASANT VALLEY - L/O FDR F83
27	UC34_Q444	3PH@PLEASANT VALLEY - L/O FDR F84
28	UC35_Q444	3PH@LONG MOUNTAIN - L/O FDR 398
29	UC36_Q444	LLG@CRICKET VALLEY - ST BRK 1 / L/O FDR 398
30	UC37_Q444	LLG@CRICKET VALLEY - ST BRK 1 / L/O GEN 3
31	UC38_Q444	LLG@CRICKET VALLEY - ST BRK 2 / L/O FDR 398
32	UC39_Q444	LLG@CRICKET VALLEY - ST BRK 2 / L/O GEN 2
33	UC40_Q444	LLG@CRICKET VALLEY - ST BRK 3 / L/O GEN 3
34	UC41_Q444	LLG@CRICKET VALLEY - ST BRK 3 / L/O FDR F83
35	UC42_Q444	LLG@CRICKET VALLEY - ST BRK 4 / L/O GEN 2
36	UC43_Q444	LLG@CRICKET VALLEY - ST BRK 5 / L/O FDR F83
37	UC44_Q444	LLG@CRICKET VALLEY - ST BRK 5 / L/O GEN 1
38	UC45_Q444	LLG@CRICKET VALLEY - ST BRK 6 / L/O FDR F84
39	UC46_Q444	LLG@CRICKET VALLEY - ST BRK 6 / L/O GEN 1
40	UC47_Q444	LC_Q#444-03
41	UC48_Q444	SLG/STKBRK @ Q444APDUYARD 345 (STK BKR 6)
42	UC56_RCL_Q444	3PH@LONG MOUNTAIN - L/O FDR 398 WITH RCL

Monitored Elements

In order to assess system stability response for the UPNY-ConEd power transfer scenarios including contingencies, the following parameters were monitored and analyzed:

- generators' angles, power outputs, terminal voltages, and speeds in the following areas/zones (North, Capital, representative generators from West, Central, Hudson, and NYC); and
- bus voltages and frequencies around UPNY-ConEd and Central East.

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

General Comments

Angle and Voltage Monitoring

Machine angles and bus 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 appendix for all simulations conducted. 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.

UPNY-ConEd Stability Limit with Indian Point Unit #2 Out-of-Service

Case 1: Indian Point Unit #2 Out-of-Service, ConEd Reactors In-Service

Stability Limit Results

Stability limit results for all cases derived from Case 1 are found in Table 4 below:

Table 4.
Indian Point Unit #2 Out-of-Service & ConEd Reactors In-Service
Stability Limit Results

Outage (if any)	UPNY-ConEd Transfer (MW)
All lines in service	7800
Y88 O/S	7350
Y94 O/S	7325
RFK305 O/S	7300
5018 O/S	7375
5060 O/S	7550

Most Severe Contingency – UC25B, Loss of Ravenswood 3

The most severe system response among tested contingencies for Case 1 with all lines in-service resulted from contingency UC25B, a three-phase fault at Rainey 345 kV resulting in the loss of Ravenswood 3. As shown in Figures 2 and 3, the UC25B contingency stands out in its larger angle magnitude response compared to the other tested contingencies. System responses for outage cases show similar responses to those shown in Figures 2-4 and can be found in the Appendices.

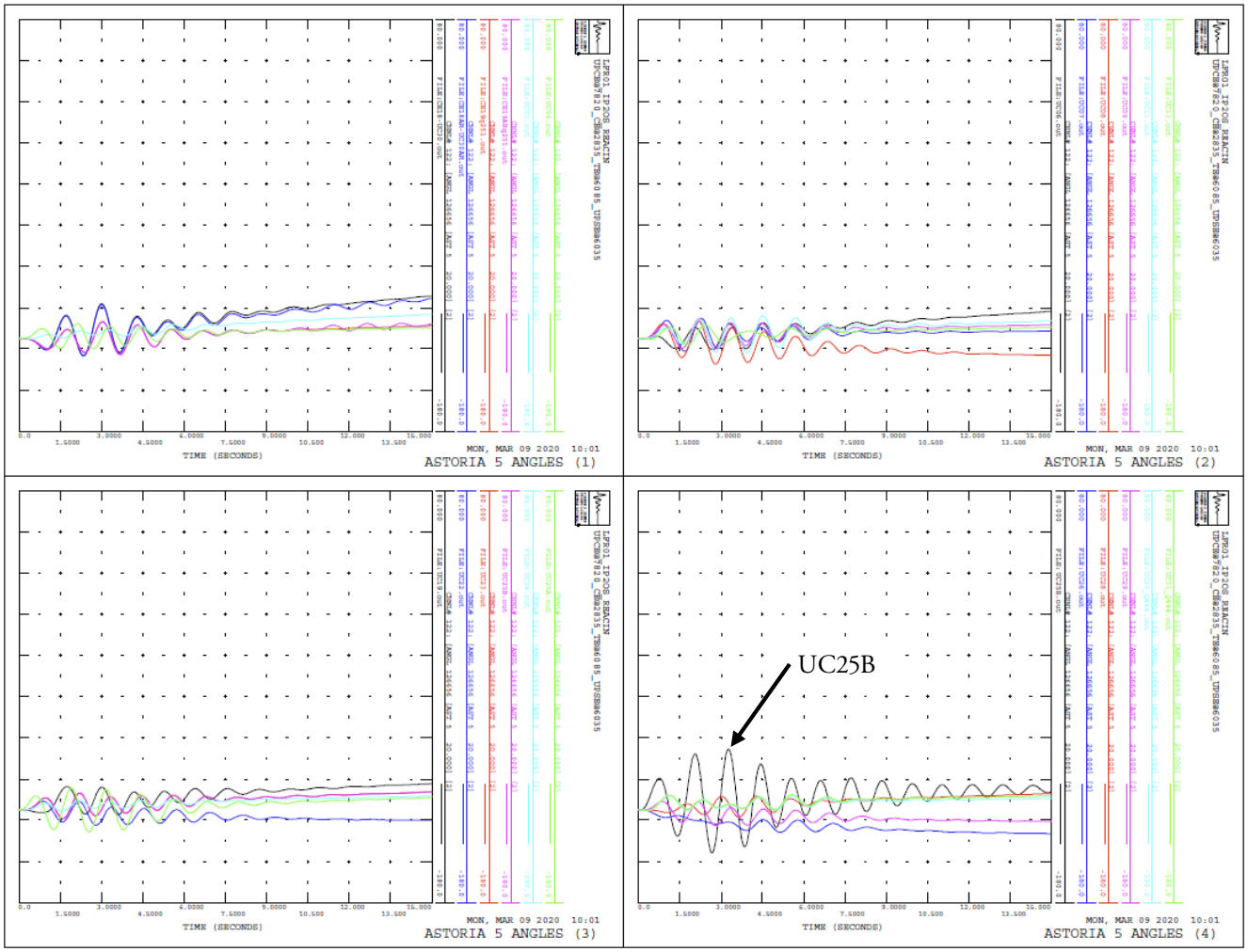

Figure 2: Astoria 5 Angles with Indian Point Unit #2 Out-of-Service, ConEd Reactors In-Service

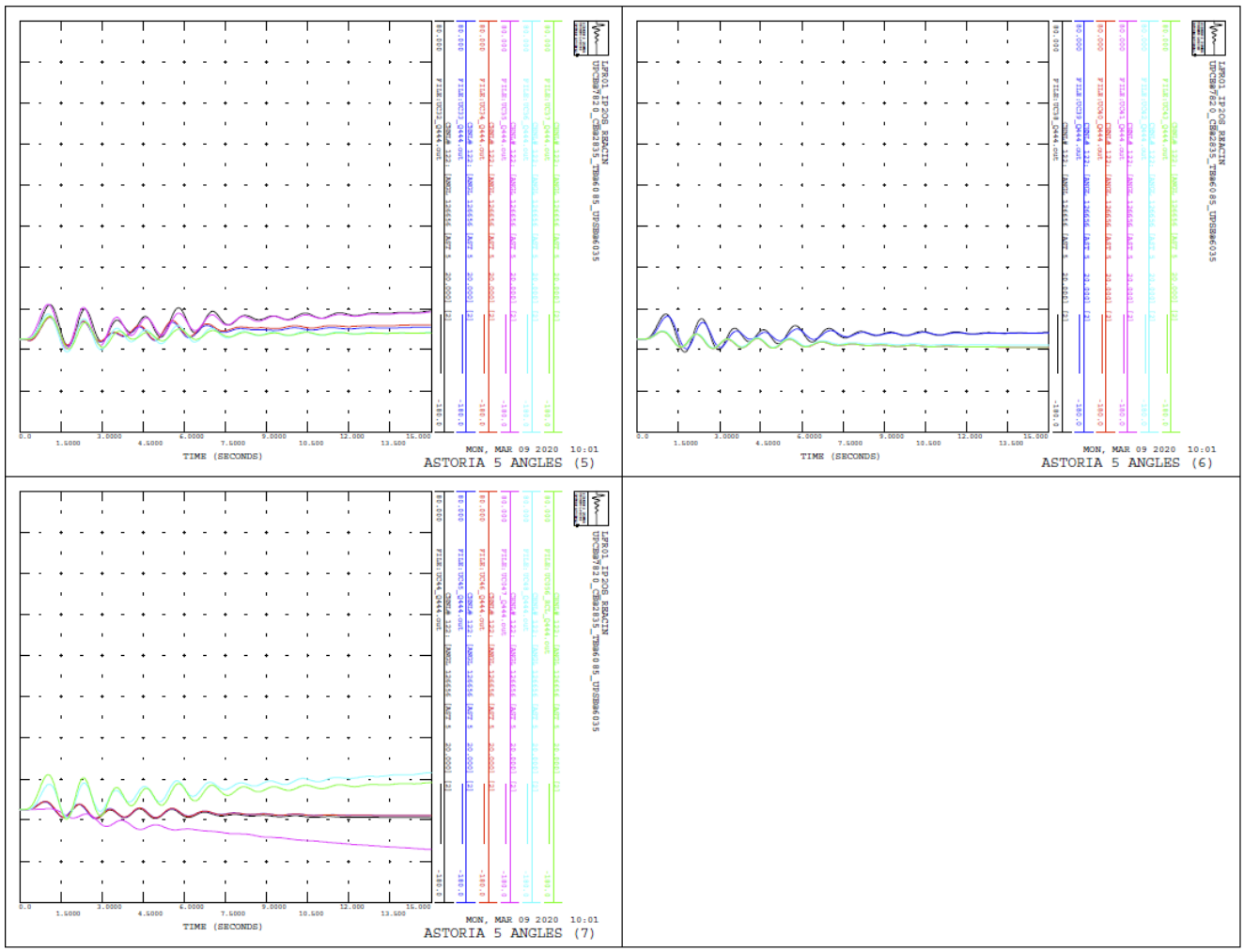

Figure 3: Astoria 5 Angles with Indian Point Unit #2 Out-of-Service, ConEd Reactors In-Service, ctd.

Figure 4 below shows the angle response at four major generators along the UPNY-ConEd interface (Astoria 5, Ravenswood 1, Bowline, and Roseton), as well as the voltage response at four major buses along the interface (Astoria 345, Roseton 345, Sprain Brook 345, and Pleasant Valley 345).

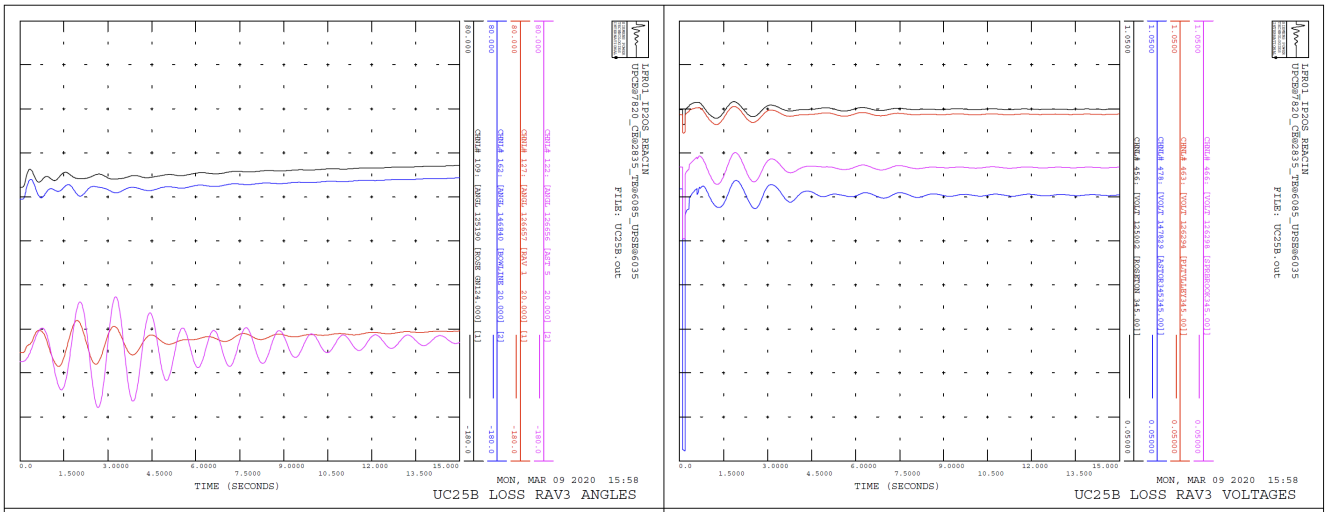

Figure 4: Contingency UC25B with Loss of Ravenswood 3 Volt/Angle Plots, with Indian Point Unit #2 Out-of-Service, ConEd Reactors In-Service

UPNY-ConEd Stability Limit with Indian Point Unit #2 and #3 Out-of-Service

Case 2: Indian Point Unit #2 & #3 Out-of-Service, ConEd Reactors Bypassed

Stability Limit Results

Stability limit results for all cases derived from Case 2 are found in Table 5 below:

Table 5.
Indian Point Unit #2 & #3 Out-of-Service, ConEd Reactors Bypassed Stability Limit Results

Outage (if any)	UPNY-ConEd Transfer (MW)
All lines in service	9200
Y88 O/S	9000
Y94 O/S	9100
RFK305 O/S	9000
5018 O/S	8800
5060 O/S	9050

Most Severe Contingency – UC25B, Loss of Ravenswood 3

As with Case 1, the most severe system response emerged from contingency UC25B. As shown in Figures 5 and 6, the UC25B contingency stands out in its larger angle magnitude response compared to the other tested contingencies. Figure 7 shows the angle and voltage responses for the UC25B contingency. System responses for outage cases show similar responses to those shown in Figures 5-7and can be found in the Appendices.

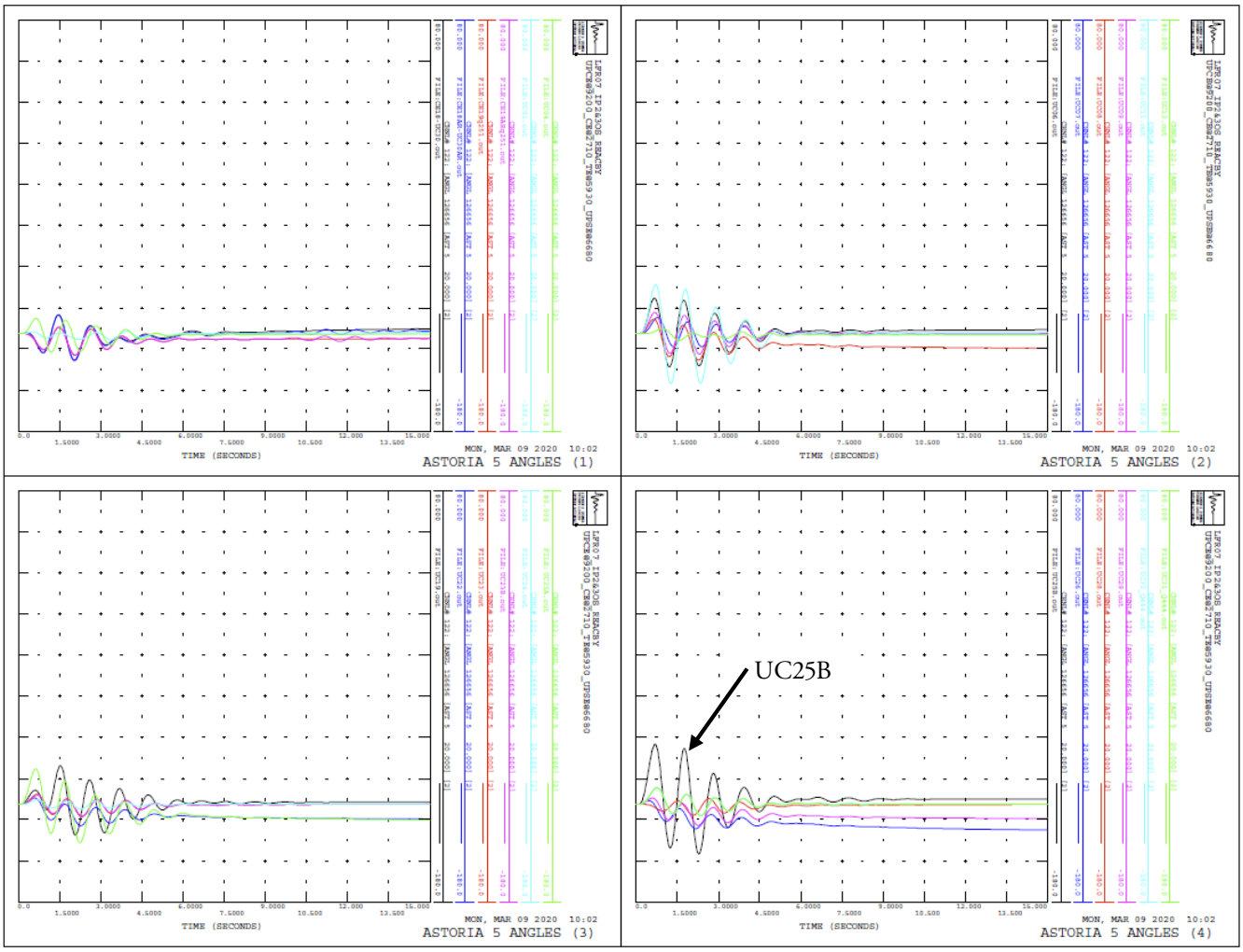

Figure 5: Astoria 5 Angle Plots with Indian Point Unit #2 & #3 Out-of-Service, ConEd Reactors Bypassed

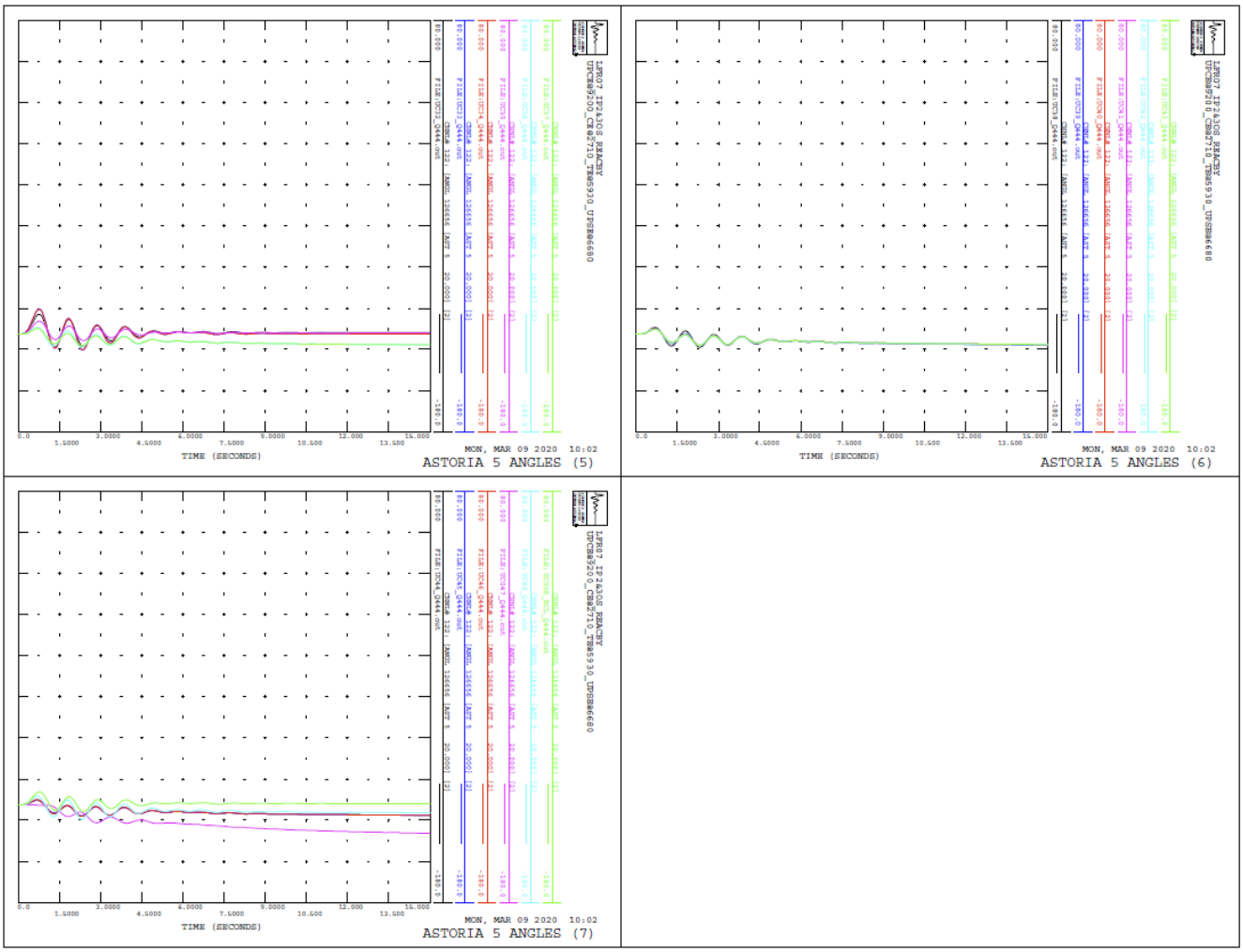

Figure 6: Astoria 5 Angle Plots, with Indian Point Unit #2 & #3 Out-of-Service, ConEd Reactors Bypassed

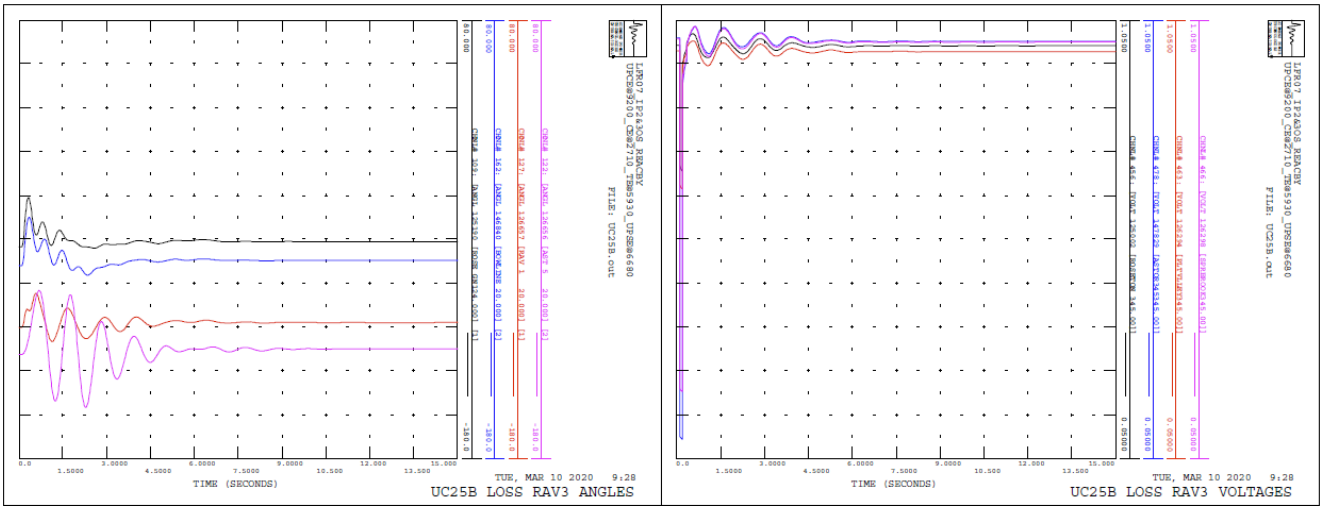

Figure 7: Contingency UC25B Loss of Ravenswood 3 Volt/Angle Plots with Indian Point Unit #2 & #3 Out-of-Service, ConEd Reactors Bypassed

Case 3: Indian Point #2 & #3 Out-of-Service, Con Ed Reactors In-Service

Stability Limit Results

Stability limit results for all cases derived from Case 3 are found in Table 6 below:

Table 6.
Indian Point #2 & #3 Out-of-Service, ConEd Reactors In-Service
Stability Limit Results

Outage (if any)	UPNY-ConEd Transfer (MW)
All lines in service	8400
Y88 O/S	8200
Y94 O/S	8225
RFK305 O/S	8150
5018 O/S	7900
5060 O/S	8350

Most Severe Contingency – UC25B, Loss of Ravenswood 3

As with Cases 1 and 2, the most severe system response emerged from contingency UC25B. Figures 8 and 9 show the UC25B contingency angle magnitude response compared to the other tested contingencies. Figure 10 shows the angle and voltage responses for the Case 3 UC25B contingency response. System responses for outage cases show similar responses to those shown in Figures 8-10 and can be found in the Appendices.

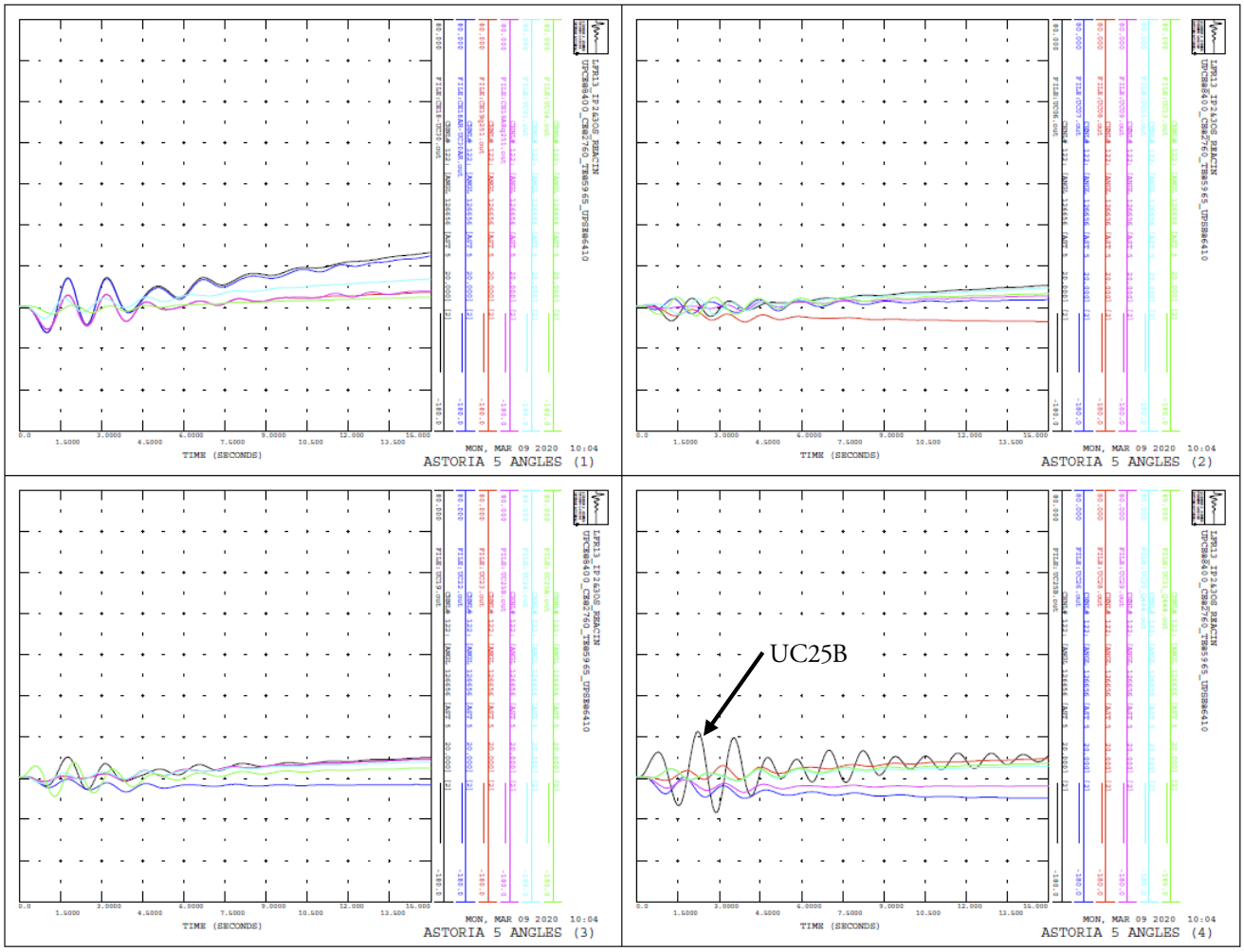

Figure 8: Astoria 5 Angle Plots with Indian Point #2 & #3 Out-of-Service, Con Ed Reactors In-Service

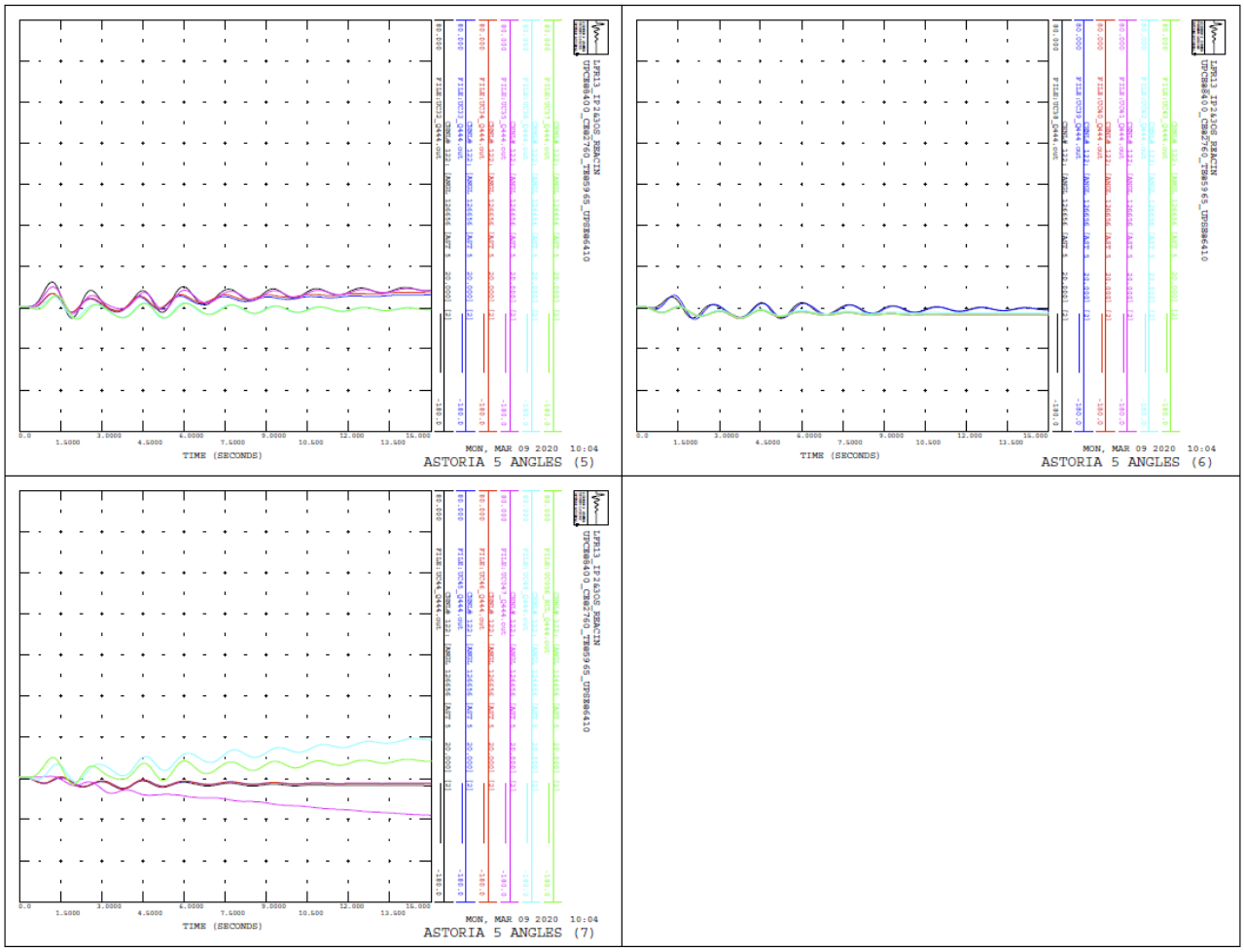

Figure 9: Astoria 5 Angle Plots with Indian Point #2 & #3 Out-of-Service, Con Ed Reactors In-Service ctd.

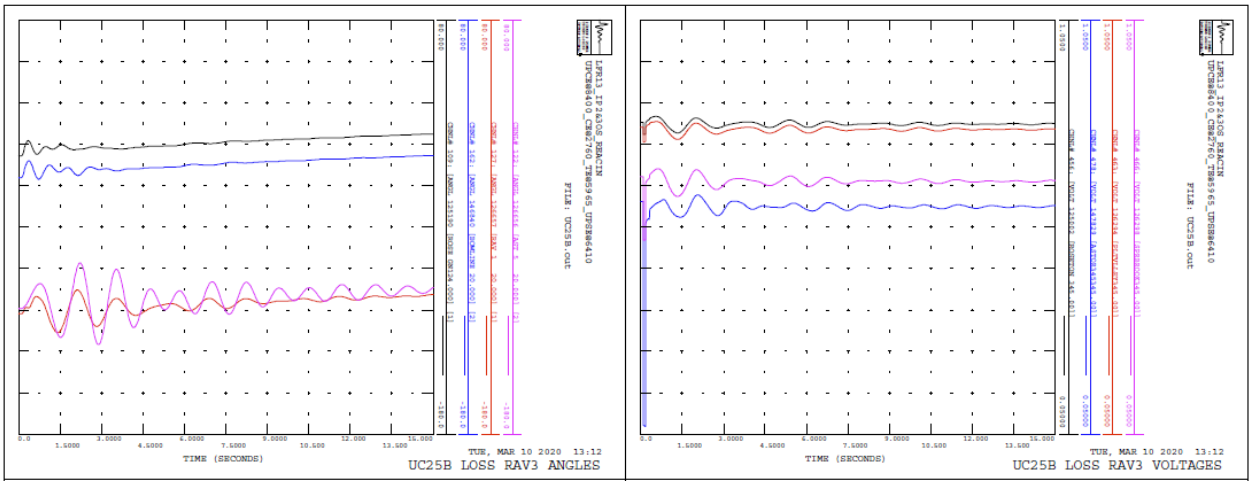

Figure 10: Contingency UC25B Loss of Ravenswood 3 Angle/Volt Plots with Indian Point #2 & #3 Out-of-Service, Con Ed Reactors In-Service