Planning Assessment of BC to Alberta Transfer Capability of the Existing System

Report No. Transmission & Stations Planning 2013-058

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Transmission and Stations Planning

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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The planning assessment of BC to Alberta (Path1) transfer capability of the existing BC Hydro transmission system was carried out at three different levels, 850 MW, 1100 MW and 1200 MW based on N-0 (Category A) and N-1 (Category B) considerations. System limitations outside BC that could affect the transfer limit were not included in the study. Impact of contingencies in Alberta or US was not studied. The assessment was done both on the steady state and transient stability performance. The study cases cover the heavy summer and heavy winter conditions with Kootenay area generation varied as a sensitivity parameter. The impact of extremely low probability simultaneous double contingencies (Category C) is not included in this assessment, but will be addressed in a future study. The applicable remedial action schemes in response to the various contingencies were simulated according to operation rules and requirements.

The findings based on Category A and B performance requirement of the selected BC Hydro system conditions are listed below:

1. No unacceptable steady-state or dynamic performance was observed for 850 MW BC to AB transfer under both summer and winter peak loading conditions.
2. Under summer loading conditions, 1200 MW BC to AB transfer does not cause Category A or B performance violations.
3. Under winter loading conditions, 1200 MW BC to AB transfer does not cause Category A or B violations, however the voltage performance was marginally acceptable. It would be prudent to adopt 1100 MW as the BC to AB transfer limit until detailed operation planning studies are completed.

1. INTRODUCTION

The WECC Path rating catalogue shows the Alberta-British Columbia path (Path 1) ratings of 1000 MW East to West and 1200 MW West to East. The 2007 BC Transmission Corporation (BCTC) studies[1,2] identified BC to Alberta transfer limit of 850 MW. This study aims at updating the 2007 studies using the latest system information and model based on BC Hydro (BCH) system considerations. Systems outside BC are modeled but not included in the study scope. The focus of the study is on the West to East transfer for which all the prepared study cases have power flows from BC to Alberta (AB).

The study cases are developed from two WECC base cases; one for heavy summer and the other for heavy winter conditions. These base cases and the study cases developed from them are introduced in more detail in Section 2. Then in Section 3 the methodology employed in assessing the system conditions is explained. The study findings are presented in Section 4 followed by the conclusion in Section 5. The appendices contain the detailed study information and results of simulations of selected cases.

2. STUDY DATA AND CONDITIONS

The data used in this study include the power flow and dynamic data models of the WECC system and contingency files of BCH system.

2.1 Heavy Summer

The 2013 heavy summer base case[3] together with dynamic files were obtained from the Montana Alberta Tie Line (MATL) study group. The case is based on a 2013 WECC case in which the MATL path is added and the case is tuned for study on MATL. The BC Hydro (area 50) load in this base case is 7727 MW. Several power flow cases were derived from this base case by adjusting the flow from BC to Alberta to different levels. The flow from BC to US was also adjusted to the study conditions.

In order to assess the effect of area generation dispatch on the system, local generation in South Interior near Selkirk (SEL) substation was varied which include Kootenay Canal (KCL) and Seven Mile (SEV) generating stations. Figure 2-1 shows the Selkirk area connections. The total generation capacity at KCL is 580 MW and at SEV is 800 MW. Reducing generation at these locations means that the power transferred to Alberta would mainly come from Ashton Creek (ACK) and Vaseux Lake (VAS) substations through 5L91 and 5L96 respectively.

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[1] "Point to Point US to BC, BC to Alberta and wheel through US to Alberta - System Impact Study"
[2] "System Impact Study For Increasing Firm ATC From BC to Alberta and From BC Interior to the US"
[3] 13hs_3s_Case2b_2.raw

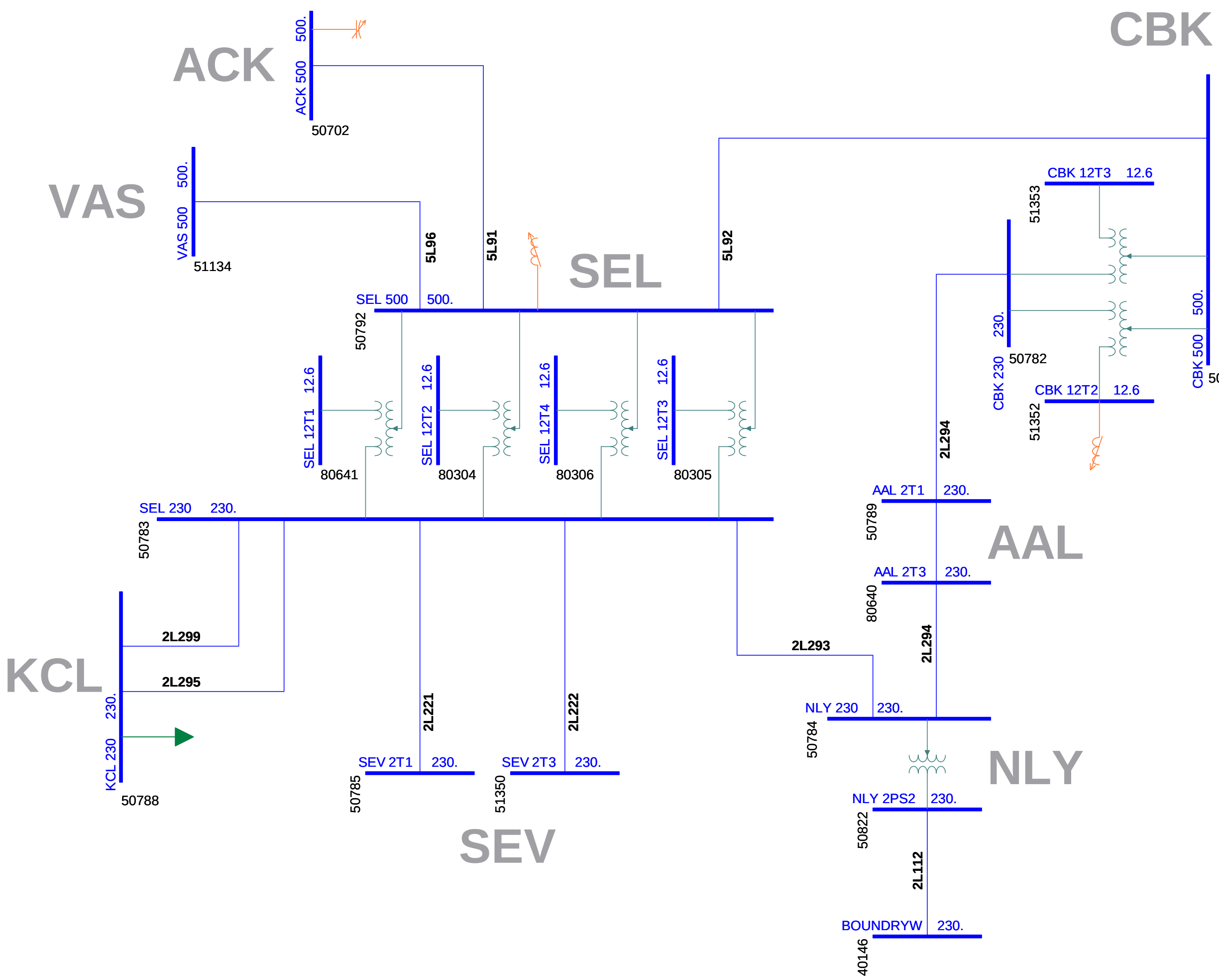

Figure 2-1: SEL area system connections

Table 2-1 shows the heavy summer cases that have been set up for the study, with BC exporting power to both Alberta and the US. In all the cases, MATL path is in service and the MATL phase shifter is adjusted to have negligible flow. The associated power flow plots are included in Appendix A.

Table 2-1: Heavy summer study cases and power flows (MW)

Case	BC to AB	BC to US	KCL Gen	SEV Gen	SEL Interface	MATL (S to N)
13hs_case1	854	1020	570	580	480	-1
13hs_case1b	851	1200	0	0	-651	0
13hs_case2a	1098	1000	130	83	-697	1
13hs_case3	1201	1033	570	580	115	0
13hs_case3a	1200	999	150	170	-699	0

Note that the SEL interface in Table 2-1 is defined as follows[4]:

SEL Interface = 5L91 SEL + 5L96 SEL + 2L112 NLY + 48L KET

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[4] According to Attachment 1 of 7T-34, Effective Date: 03 January 2013, Page 7 of 69.

Where '5L91 SEL' is the flow in the 500 kV line from SEL to ACK measured at SEL. '5L96 SEL' is the flow in the 500 kV line from SEL to VAS measured at SEL. '2L112 NLY' is the flow in the 230 kV line from Nelway (NLY) to Boundary (BDY) measured at NLY, and '48L KET' is the flow in the 161 kV line from Kettle Valley (KET) to Bentley Terminal Station (BEN) measured at KET.

A negative 'SEL Interface' flow means that the power flows from South Interior West to South Interior East. The west to east flow is normally kept below 700 MW for the present system.

2.2 Heavy Winter

The heavy winter base case[5] together with dynamic files were from Powertech Labs who prepared the case from a 2013/14 WECC case for conducting the Path 3 (tie between the BC and US) studies. The BC Hydro (area 50) load in this base case is 10752 MW. Several pre-outage power flow study cases were derived from this base case by adjusting the flow from BC to Alberta to different levels. The flow from BC to US was also modified to match the intended study conditions.

Table 2-2 shows heavy winter cases set up for the study in which BC is exporting to Alberta and importing from the US (negative numbers in BC to US Column indicate import into BC). The MATL phase shifter is at the tap limit in Case 2a, Case 3, and Case 3b. The associated power flow plots are included in Appendix A.

Table 2-2: Heavy winter study cases and power flows (MW)

Case	BC to AB	BC to US	KCL Gen	SEV Gen	SEL Interface	MATL (S to N)
13hw2ae_case1	868	-850	494	775	543	0
13hw2ae_case1a	850	-850	0	0	-692	0
13hw2ae_case2a	1099	-1095	69	195	-691	59
13hw2ae_case3	1204	-833	494	775	186	20
13hw2ae_case3b	1207	-1204	140	234	-698	101

[5] 13hw2ae_NI_500+400-MTL_300-PSE_785.pfb

3. STUDY METHODOLOGY

The study looked into both the pre and post contingency steady-state conditions and the transient stability performance of the BCH system. The pre-outage power flow cases for the study were tuned to obtain acceptable voltage profile across the system for various transfer levels and generation dispatches. The study is focused on the area close to the intertie, i.e. South Interior West and South Interior East divisions of the BCH system.

3.1 Power Flow Analysis

Both the pre-outage and post-outage power flows are solved with the following control commands turned on:

- Area Interchange Flow Control
- Continuous Shunt Adjustment
- Discrete Shunt Adjustment
- Transformer Tap Changer Adjustment
- Phase Shifter Adjustment

Distinctions are made between the manually controlled vs. automatically controlled devices. For the pre-outage cases, all controlled devices were turn on. Whereas in the post contingency power flow simulations, only automatically controlled actions were allowed.

When the Area Interchange control flag is on, the power flow solver adjusts the net exchange from each area over its tie lines such that the net exchange power specified for the area is met. In this solution method each area must have a swing bus to be used during the iterations. The difference between generation on the one hand and the load and export on the other hand is absorbed by the area swing bus.

Continuous Shunt Adjustment flag pertains to the static VAR compensators. The MVAr outputs of these fast-acting shunts are adjusted continuously within their given ranges in order to regulate the voltage of their specified controlled buses.

When the Discrete Shunt Adjustment flag is on, the shunts specified as ‘discrete’ in the model are adjusted in a stepwise manner in order to regulate the voltage of their specified controlled buses. It should be noted that shunts which are specified as ‘fixed’ or ‘frozen’ do not participate in this control action. The manually switched shunts were frozen in solving the post-outage power flows.

With the Transformer Tap Changing flag on, adjustments are done to the tap ratios of adjustable two-winding and three-winding transformers during iterations in order to regulate their controlled bus voltages. The manually operated tap changers were disabled in solving the post-outage power flows.

Phase shifters are transformers whose controlled variable is the real power. With the Transformer Tap Changing flag on, adjustments are done to angle shift between the primary and secondary windings in order to regulate the real power flow through the phase shifter within the specified range. Since the Nelway phase shifter is normally not on automatic MW flow control mode, its controller was blocked for the post contingency power flow.

After the power flow was solved with the above parameters, a manual check was done on the power flow levels and voltage magnitudes in BC to ensure they are in the acceptable ranges.

3.2 Contingency Power Flow Analysis

The list of BCH contingencies studied is provided in Appendix B. The contingency names represent the element or elements that are directly affected by the contingency and are tripped out as a result. Most of the N-1 contingencies analyzed in this study only affect a single element. However, some N-1 contingencies involve more than one element as explained below.

For example, the 'SEL T2 & T3' contingency and 'CBK T2 & T6' contingency each involve the loss of two transformers because they are in the same protection zone.

Some contingencies involve Remedial Action Schemes (RAS) that would subsequently trigger actions on other elements in the system. The RAS actions are simulated in accordance with BCH operating orders. Note that the 5L92 or 5L94 contingency would cause the MATL tie to trip due to the high Path 1 flows which consequently would result in the Alberta system to become islanded.

3.3 Transient Stability Analysis

Time domain simulations were performed for the same set of N-1 contingencies as described in Section 3.2. Equipment switching sequence and timings were applied in accordance with the protection settings of various schemes, such as equipment within the same protection zones, auto reclose, and RAS actions.

4. STUDY RESULTS

In this section the study results are presented with separate sections for heavy summer and heavy winter conditions.

4.1 Heavy Summer

Pre-outage Power Flows

With Path 1 flow at about 850 MW, the steady-state power flow voltages on the 500 kV and 230 kV levels in the BC Hydro system can be maintained at the preferred levels. However, as Path 1 flow is increased from 850 MW to 1200 MW the voltages around Cranbrook (CBK) and Natal (NTL) area drop to lower values.

Table 4-1 lists the pre-outage study case voltages at CBK and NTL for three levels of BC to Alberta transfer. At 1200 MW of transfer the voltage at NTL can be as low as 0.95 p.u. The associated power flow plots of these cases are displayed in Appendix A.

Table 4-1: Pre-outage Voltage levels at CBK and NTL, heavy summer conditions

Case	BC-AB Flow	CBK 500 kV	CBK 230 kV	NTL 230 kV
	[MW]	[p.u.]	[p.u.]	[p.u.]
Heavy Summer 1	850	1.039	1.025	1.0154
Heavy Summer 1b	850	1.036	1.023	1.014
Heavy Summer 2a	1100	1.006	0.994	0.978
Heavy Summer 3	1200	0.987	0.974	0.942
Heavy Summer 3a	1200	0.988	0.974	0.946

Post Outage Power Flows

The two single contingencies that produced the worst post contingency power flow results are 5L91 and 2L294. Their respective results for the above cases are shown in Tables 4.2 and 4.3.

Table 4-2: Post 5L91 Contingency Voltage levels at CBK and NTL, heavy summer conditions

Case	BC-AB Flow	CBK 500 kV	CBK 230 kV	NTL 230 kV
	[MW]	[p.u.]	[p.u.]	[p.u.]
Heavy Summer 1	850	1.032	1.018	1.010
Heavy Summer 1b	850	1.032	1.019	1.010
Heavy Summer 2a	1100	0.994	0.983	0.968
Heavy Summer 3	1200	0.973	0.962	0.932
Heavy Summer 3a	1200	0.968	0.956	0.931

Table 4-3: Post 2L294 Contingency Voltage levels at CBK and NTL, heavy summer conditions

Case	BC-AB Flow	CBK 500 kV	CBK 230 kV	NTL 230 kV
	[MW]	[p.u.]	[p.u.]	[p.u.]
Heavy Summer 1	850	1.033	1.020	1.012
Heavy Summer 1b	850	1.029	1.017	1.009
Heavy Summer 2a	1100	1.000	0.989	0.974
Heavy Summer 3	1200	0.968	0.956	0.922
Heavy Summer 3a	1200	0.968	0.956	0.932

Loss of 5L92 or 5L94 causes Alberta disconnected from BC which would result in MATL line tripped and subsequent islanding of Alberta system. Generator shedding in BC was applied to reduce the surplus power. No violation was observed in post contingency power flows.

Post contingency power flow voltages of cases 3 & 3a are displayed in Appendix C – Power Flow Contingency Results.

Transient Stability Performance

No transient stability issues were observed for the studied system conditions after applying the contingencies listed in Appendix B. Selected transient stability performance cases are listed in Table 4-4 with their time domain simulation plots displayed in Appendix D.

Table 4-4: Transient Stability Plots, heavy summer conditions

Case	BC-AB Flow [MW]	Contingency Name	Plots
Heavy Summer 3a	1200	5L91, 3ph flt@SEL500	HS1200_5L91
Heavy Summer 3a	1200	5L92, 3ph flt@CBK500	HS1200_5L92
Heavy Summer 3a	1200	2L294, 3ph flt@CBK230	HS1200_2L294

4.2 Heavy Winter

Pre-outage Power Flows

The BCH load is significantly higher in heavy winter than in heavy summer cases, resulting in more stressed system conditions. With Path 1 flow at 850 MW, pre-outage steady state power flow voltages on the 500 kV and 230 kV levels in the BC Hydro system can be maintained within the acceptable range. However, compared to heavy summer conditions these voltages are generally lower. Increasing the transfer to 1100 MW or 1200 MW would significantly reduce the area voltages. Table 4-5 lists the pre-outage voltages at CBK and NTL for three different levels of BC to Alberta flow.

Table 4-5: Pre-outage Voltage levels at CBK and NTL, heavy winter conditions

Case	BC-AB Flow [MW]	CBK 500 kV [p.u.]	CBK 230 kV [p.u.]	NTL 230 kV [p.u.]
Heavy Winter 1	850	1.020	1.003	0.988
Heavy Winter 1a	850	1.025	1.009	0.993
Heavy Winter 2a	1100	0.985	0.971	0.952
Heavy Winter 3	1200	0.950	0.933	0.913
Heavy Winter 3b	1200	0.961	0.945	0.926

Post Outage Power Flows

Similar to the summer cases, the two single contingencies that produced the worst post contingency power flow results were 5L91 and 2L294. Their respective results for the above cases are shown in Tables 4.6 and 4.7 below. As expected the performance of winter cases are worse than the summer cases. At 1200 MW transfer the voltage performance is only marginally acceptable.

Table 4-6: Post 5L91 Contingency Voltage levels at CBK and NTL, heavy winter conditions

Case	BC-AB Flow [MW]	CBK 500 kV [p.u.]	CBK 230 kV [p.u.]	NTL 230 kV [p.u.]
Heavy Winter 1	850	1.006	0.989	0.973
Heavy Winter 1a	850	1.020	1.006	0.991
Heavy Winter 2a	1100	0.961	0.947	0.925
Heavy Winter 3	1200	0.932	0.917	0.896
Heavy Winter 3b	1200	0.942	0.928	0.909

Table 4-7: Post 2L294 Contingency Voltage levels at CBK and NTL, heavy winter conditions

Case	BC-AB Flow [MW]	CBK 500 kV [p.u.]	CBK 230 kV [p.u.]	NTL 230 kV [p.u.]
Heavy Winter 1	850	1.009	0.996	0.981
Heavy Winter 1a	850	1.018	1.006	0.991
Heavy Winter 2a	1100	0.964	0.951	0.931
Heavy Winter 3	1200	0.928	0.915	0.895
Heavy Winter 3b	1200	0.941	0.928	0.910

Similar to the summer cases, loss of 5L92 or 5L94 causes Alberta disconnected from BC which would result in MATL line tripped and subsequent islanding of Alberta system. Generator shedding in BC was applied to reduce the surplus power in the simulations. No violation was observed in post disturbance power flows of these contingencies.

Post contingency power flow voltages of cases 2a, 3 & 3b are displayed in Appendix C – Power Flow Contingency Results.

Transient Stability Performance

No transient stability issues were observed for the studied system cases after applying the contingencies in Appendix B except marginal performance at 1200 MW BC to AB transfer, particularly when Kootenay area generations are high. Selected transient stability performance cases are listed in Table 4-8 with their time domain simulation plots displayed in Appendix D.

Table 4-8: Transient Stability Plots, heavy winter conditions

Case	BC-AB Flow [MW]	Contingency Name	Plots
Heavy Winter 2a	1100	5L91, 3ph flt@SEL500	HW1100_5L91
Heavy Winter 3	1200	5L91, 3ph flt@SEL500	HW1200_5L91
Heavy Winter 3b	1200	5L91, 3ph flt@SEL500	HW1200_5L91
Heavy Winter 3b	1200	5L92, 3ph flt@CBK500	HW1200_5L92
Heavy Winter 3b	1200	5L94, 3ph flt@CBK500	HW1200_5L94
Heavy Winter 3b	1200	2L294, 3ph flt@CBK230	HW1200_2L294

Given the poor performance of 1200 MW BC to AB transfer, It would be prudent to adopt 1100 MW transfer as an acceptable limit for winter conditions before detailed operation planning studies are completed.

5. CONCLUSION

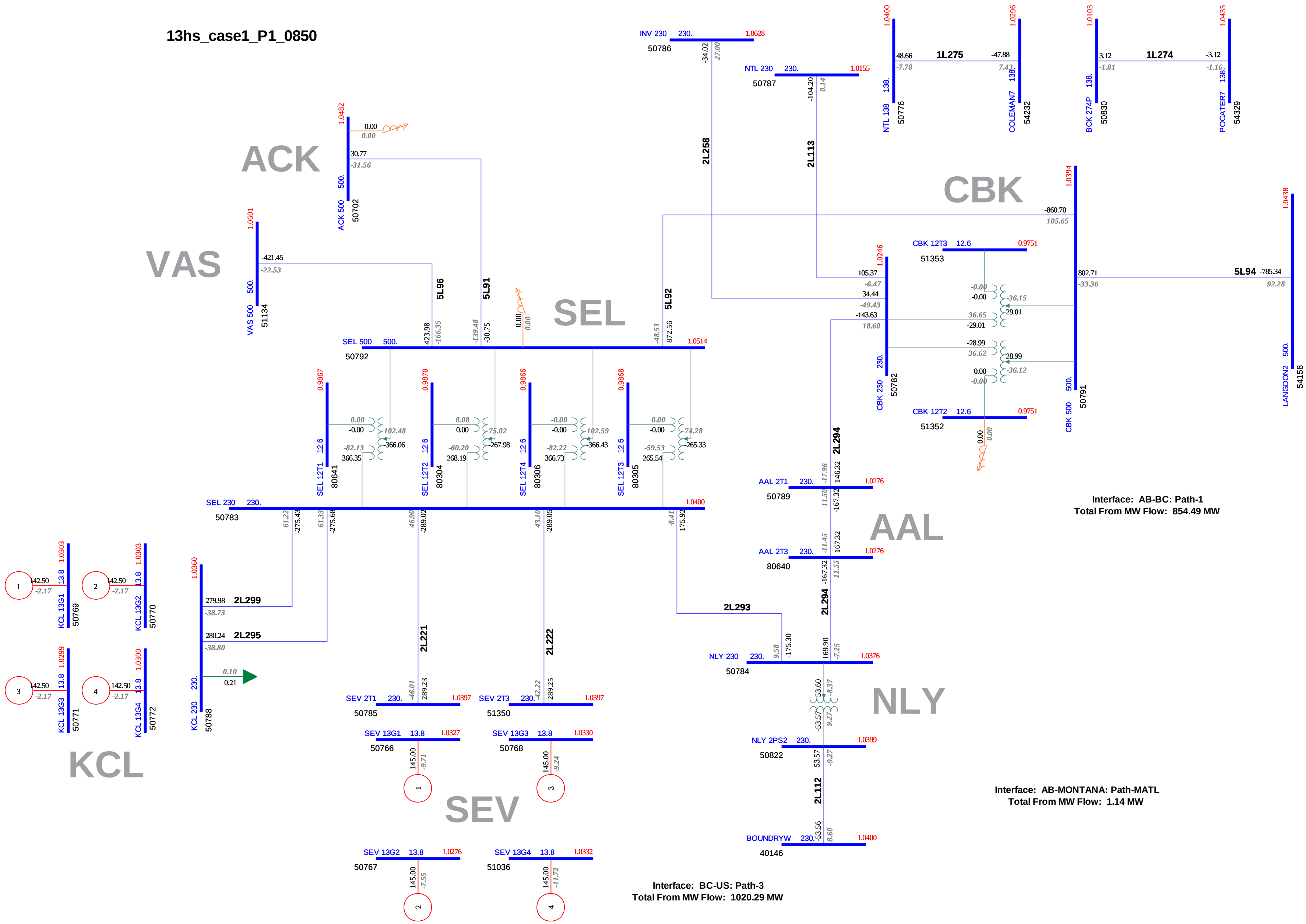
The steady-state and transient stability of the BC Hydro system were assessed for three different levels of BC to Alberta transfers: 850 MW, 1100 MW, and 1200 MW based on heavy summer and heavy winter loading conditions of WECC base cases. Single contingencies (Category B) in the South Interior West and South Interior East regions of BCH were applied for the assessment. No contingency in Alberta or US was applied.

The findings based on Category A and B performance requirements are listed below:

1. No unacceptable steady-state or dynamic performance was observed for 850 MW BC to AB transfer under both summer and winter peak load conditions.
2. Under summer loading conditions, 1200 MW BC to AB transfer does not cause Category A or B performance violations.
3. Under winter loading conditions, 1200 MW BC to AB transfer does not cause Category A or B violations, however the voltage performance was only marginally acceptable. It would be prudent to adopt 1100 MW as the BC to AB transfer limit until detailed operation planning studies are completed.

APPENDIX A – PRE-OUTAGE POWER FLOWS

The pre-outage power flows of study cases listed in Tables 2-1, 2-2, 4-1, and 4-5 are displayed below.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1L275
1L274
5L94
2L294
2L293
2L299
2L295
2L221
2L222
2L112
Interface: AB-BC: Path-1
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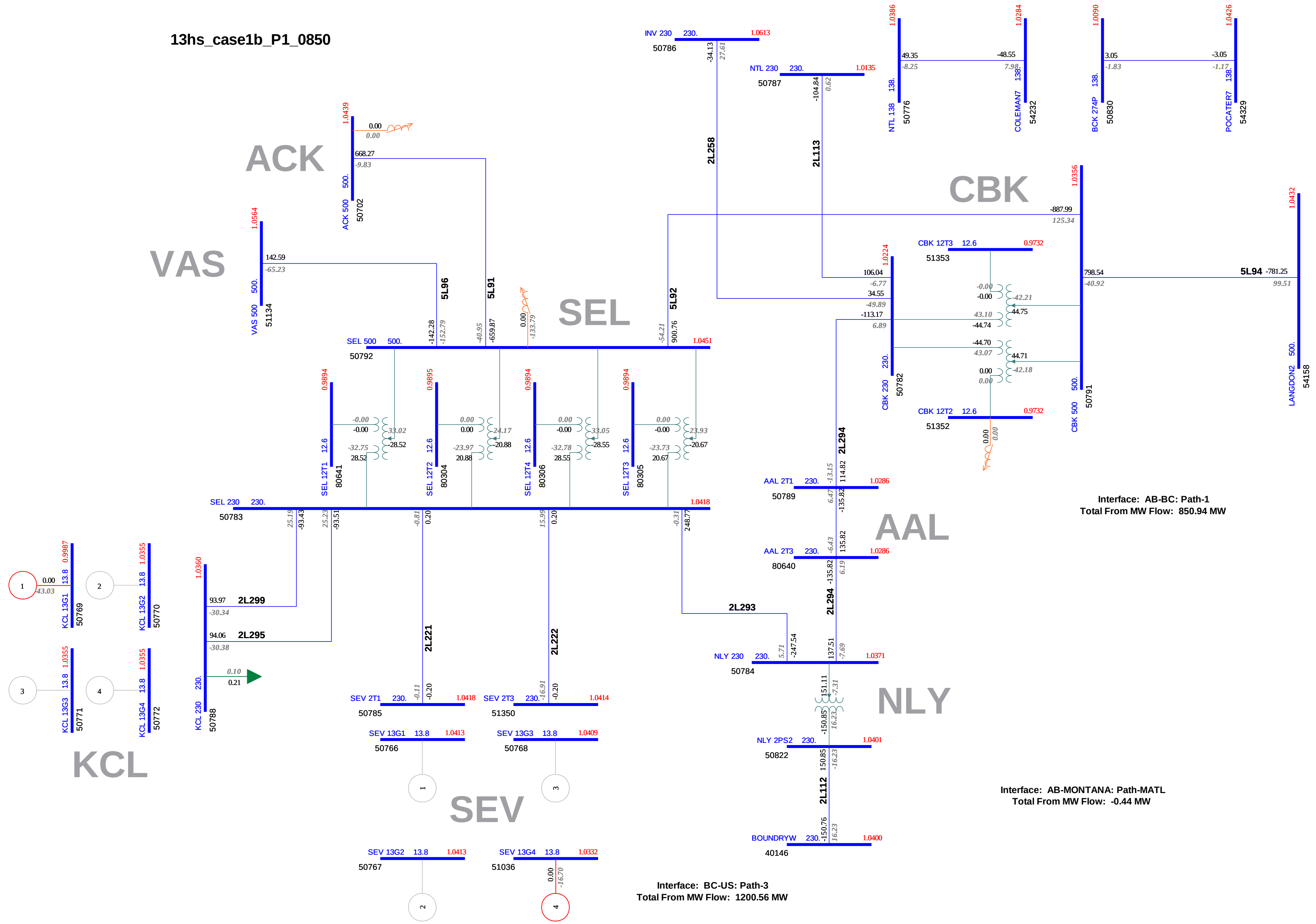
Interface: AB-MONTANA: Path-MATL
Total From MW Flow: 1.14 MW
Interface: BC-US: Path-3
Total From MW Flow: 1020.29 MW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2L113
NTL 138
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POCATER7
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ACK 500
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VAS 500
51134
5L96
5L91
5L92
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50792
CBK 12T3 12.6 0.9732
51353
CBK 12T2 12.6 0.9732
51352
CBK 230
50782
CBK 500
50791
5L94
LANGDON2
54158
SEL 12T1
80641
SEL 12T2
80304
SEL 12T4
80306
SEL 12T3
80305
SEL 230 230. 1.0418
50783
2L294
AAL 2T1 230. 1.0286
50789
AAL 2T3 230. 1.0286
80640
Interface: AB-BC: Path-1
Total From MW Flow: 850.94 MW
KCL 13G1
50769
KCL 13G2
50770
KCL 13G3
50771
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NLY 230 230. 1.0371
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SEV 13G1 13.8 1.0413
50766
SEV 13G3 13.8 1.0409
50768
NLY 2PS2 230. 1.0401
50822
2L112
BOUNDRYW 230. 1.0400
40146
SEV 13G2 13.8 1.0413
50767
SEV 13G4 13.8 1.0332
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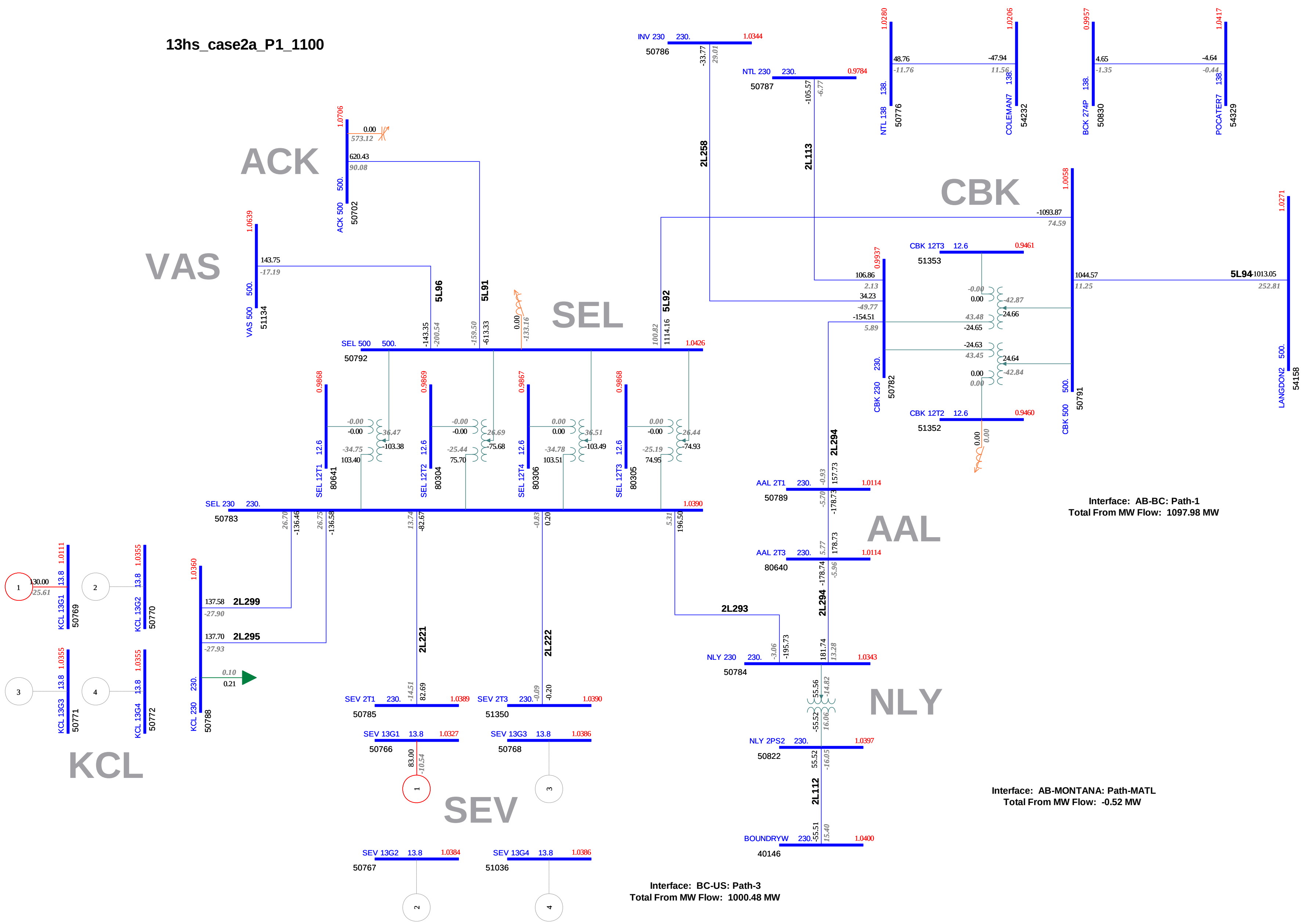
Total From MW Flow: -0.44 MW
Interface: BC-US: Path-3
Total From MW Flow: 1200.56 MW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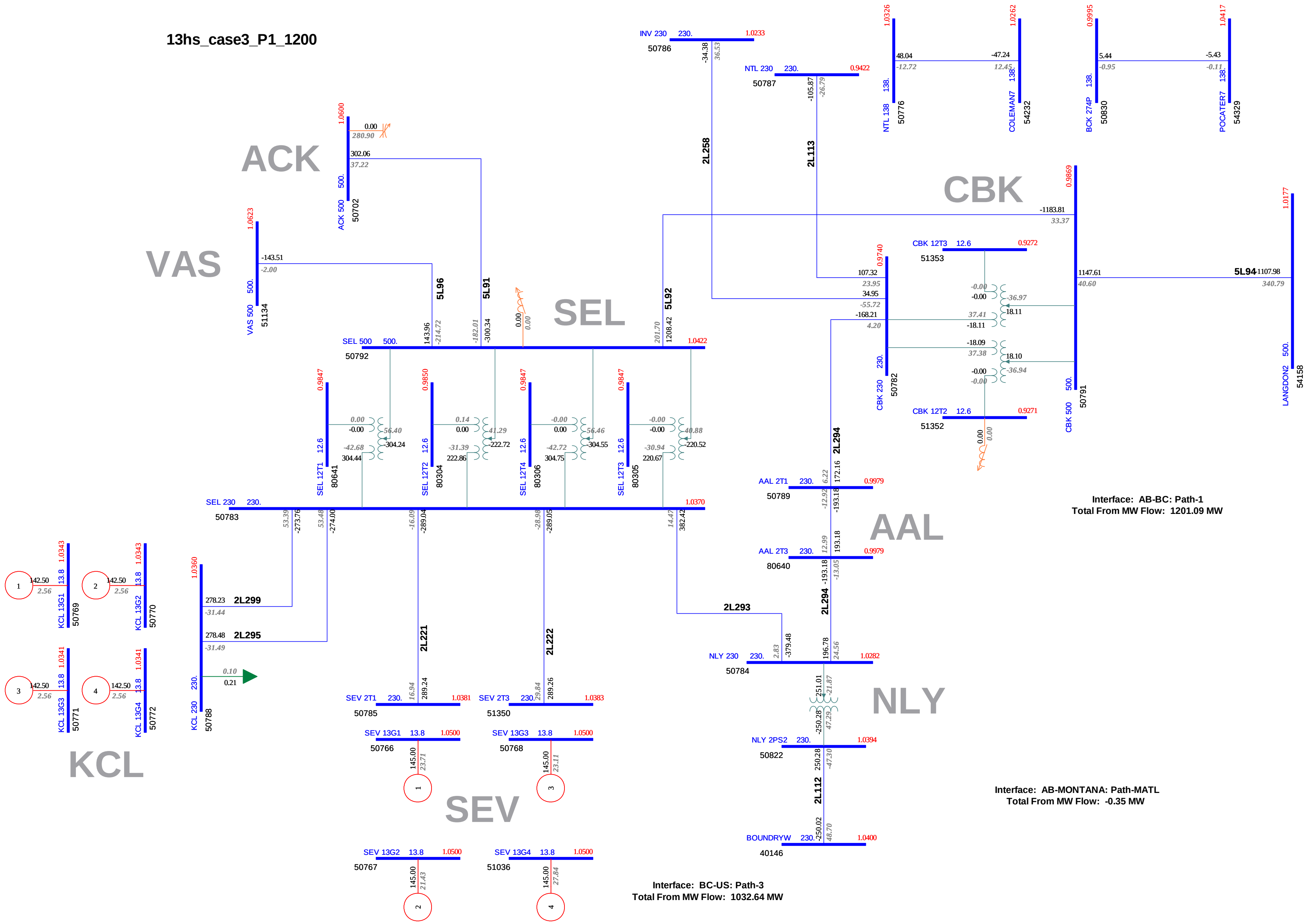
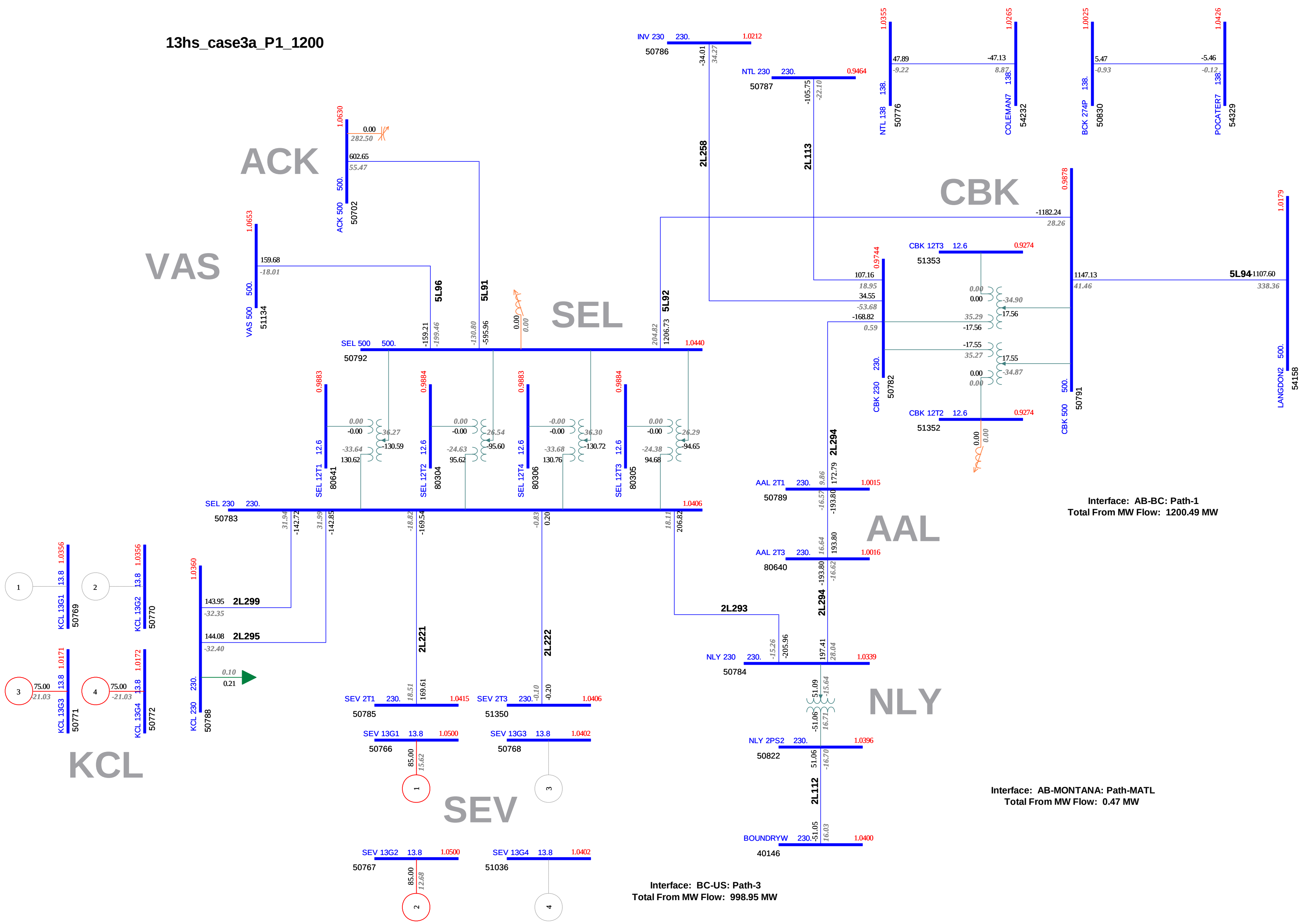
CBK 230
CBK 500
LANGDON2
AAL 2T1
AAL 2T3
NLY 230
NLY 2PS2
BOUNDRYW
SEV 2T1
SEV 2T3
KCL 230
5L91
5L92
5L94
5L96
2L258
2L113
2L294
2L293
2L299
2L295
2L221
2L222
2L112
Interface: AB-BC: Path-1
Total From MW Flow: 1097.98 MW
Interface: AB-MONTANA: Path-MATL
Total From MW Flow: -0.52 MW
Interface: BC-US: Path-3
Total From MW Flow: 1000.48 MW

BChydro FOR GENERATIONS

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SEL 12T3 12.6 80305
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COLEMAN7 138. 54232
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Total From MW Flow: 1200.49 MW
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Total From MW Flow: 0.47 MW
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Total From MW Flow: 998.95 MW

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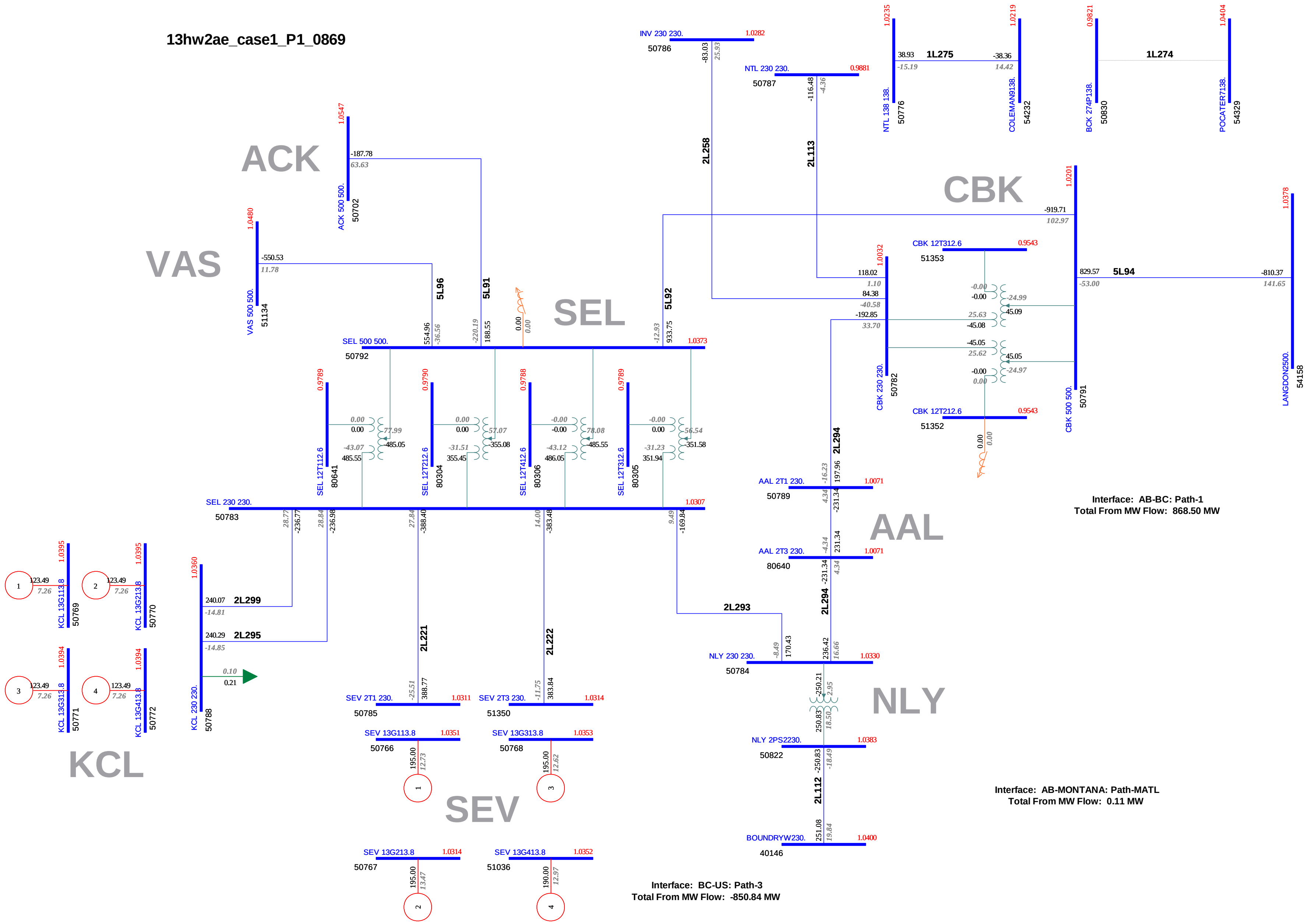

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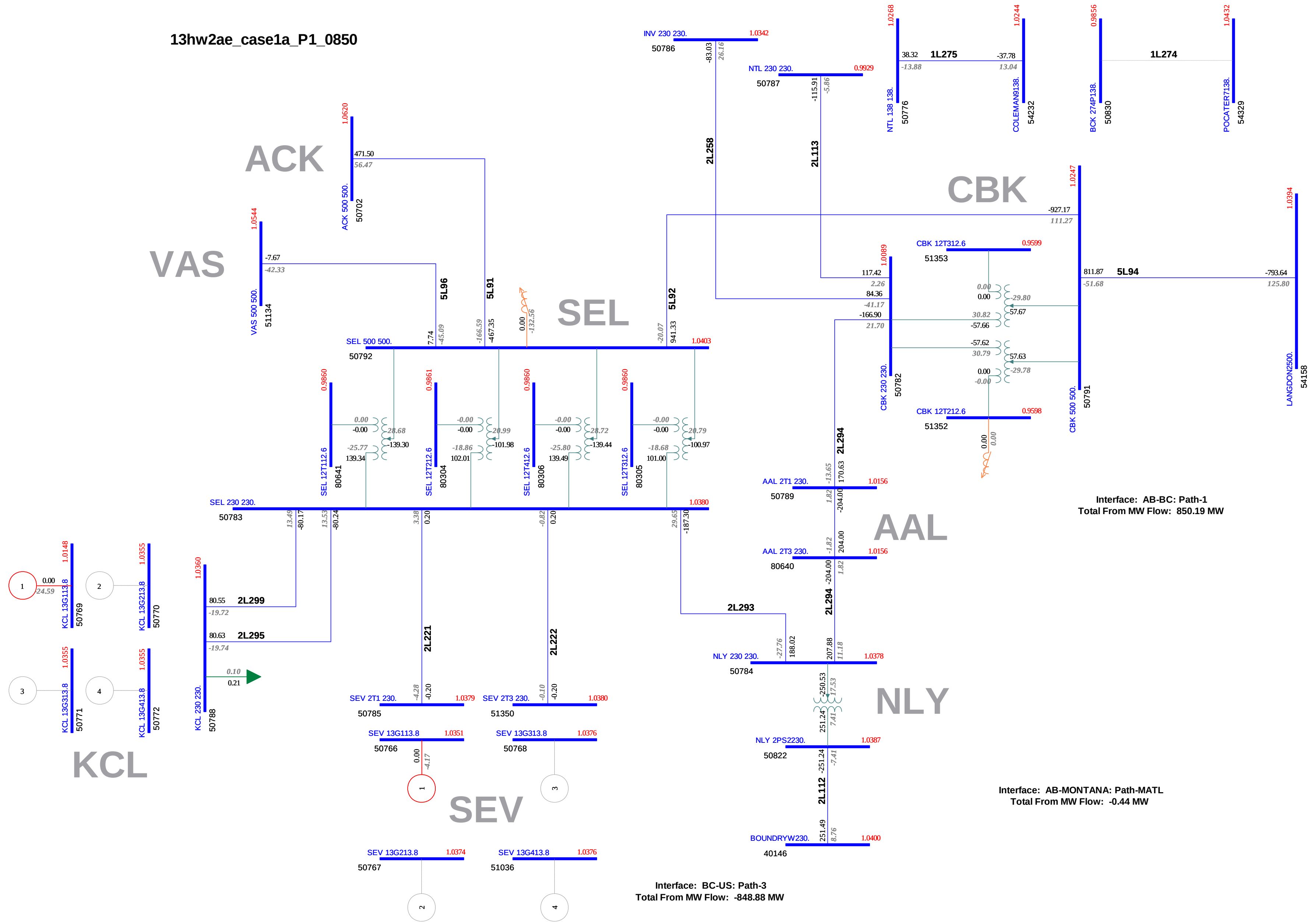
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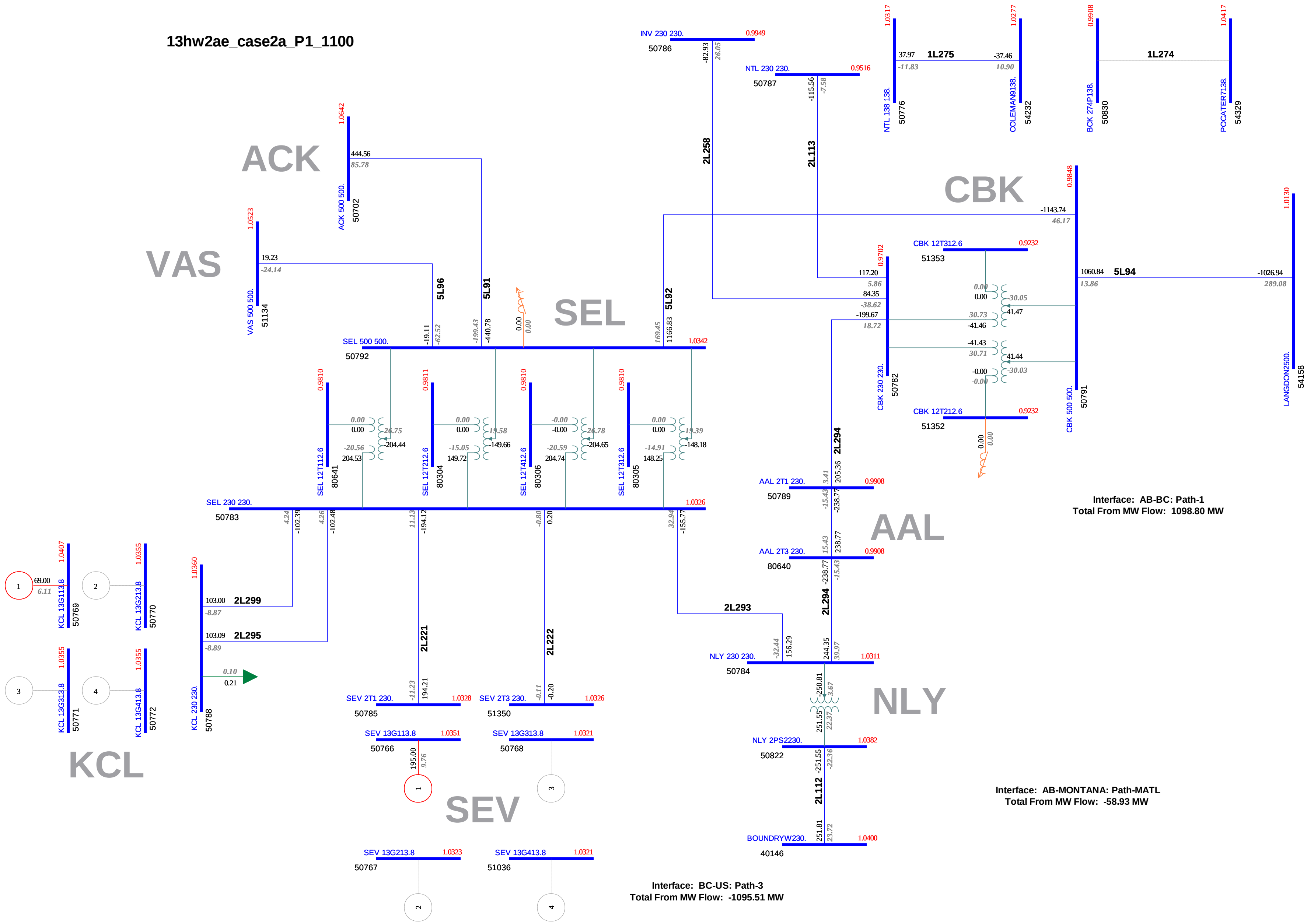
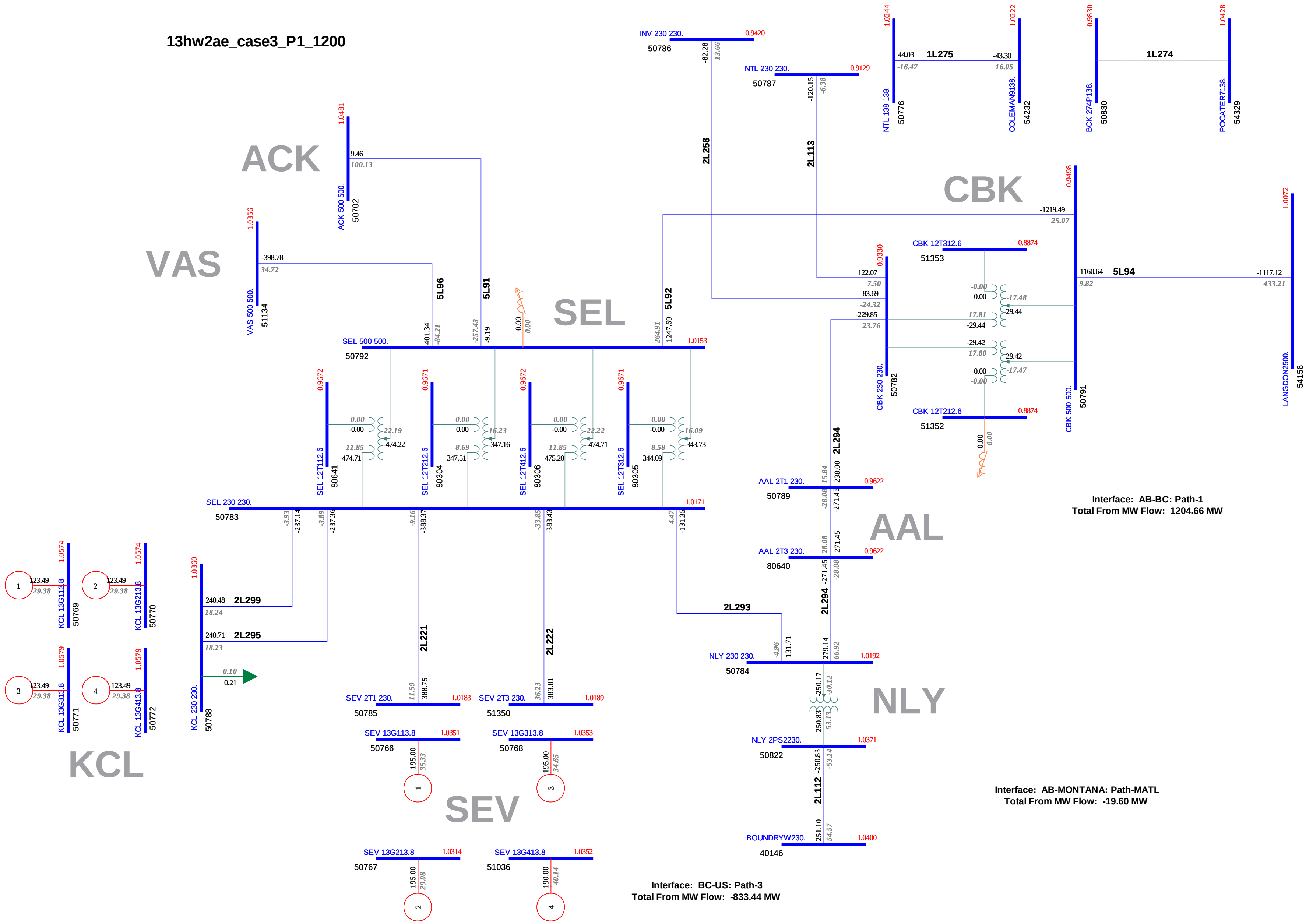
50772
KCL 230 230.
50788
SEV 2T1 230.
50785
SEV 2T3 230.
51350
SEV 13G113.8
50766
SEV 13G313.8
50768
SEV 13G213.8
50767
SEV 13G413.8
51036
1L275
1L274
2L258
2L113
5L94
5L96
5L91
5L92
2L294
2L299
2L295
2L221
2L222
2L293
2L112
Interface: AB-BC: Path-1
Total From MW Flow: 850.19 MW
Interface: AB-MONTANA: Path-MATL
Total From MW Flow: -0.44 MW
Interface: BC-US: Path-3
Total From MW Flow: -848.88 MW

13hw2ae_case2a_P1_1100

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ACK
VAS
SEL
CBK
AAL
NLY
KCL
SEV
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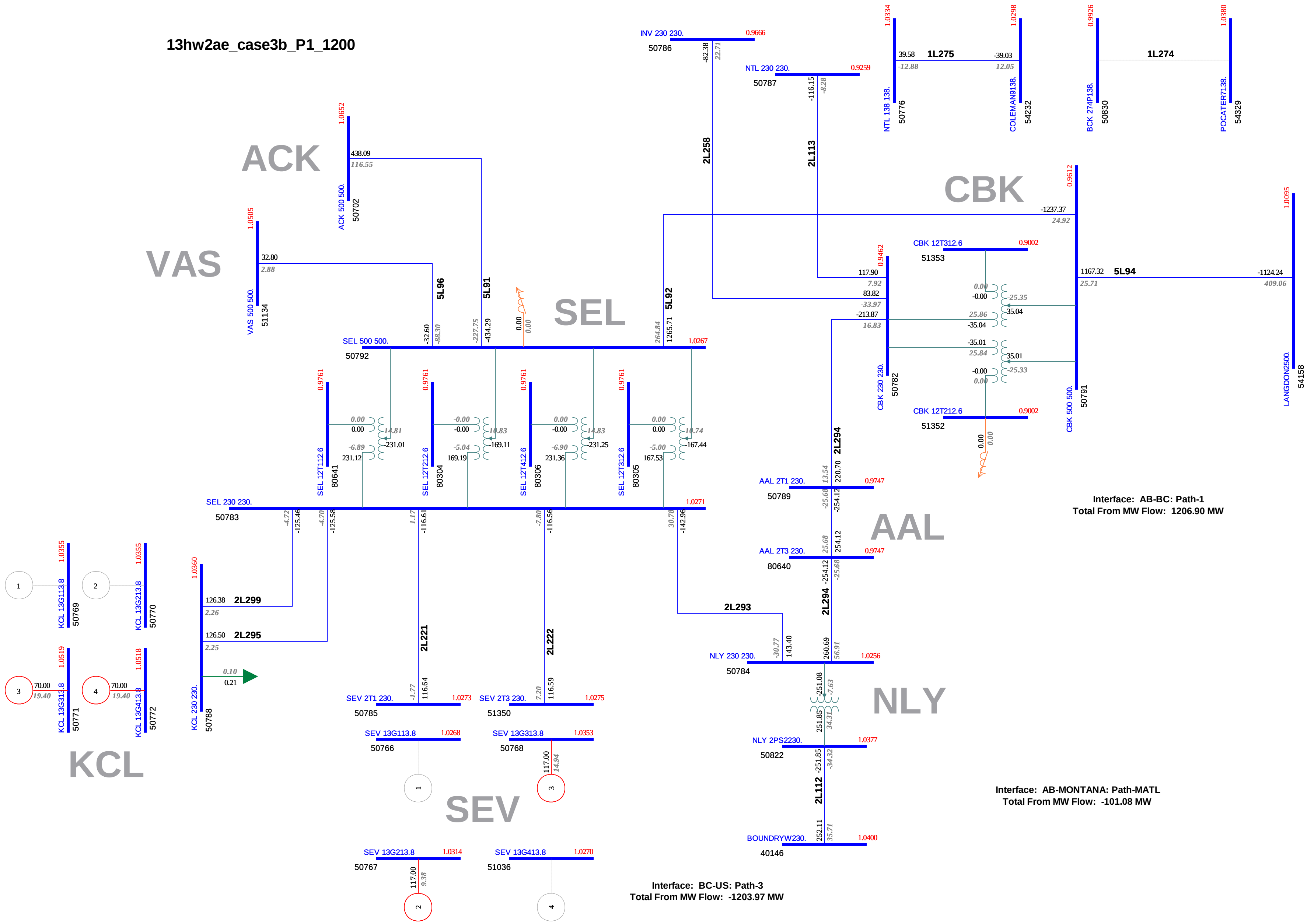
50702
VAS 500 500.
51134
SEL 500 500.
50792
SEL 230 230.
50783
INV 230 230.
50786
NTL 230 230.
50787
NTL 138 138.
50776
COLEMAN9138.
54232
BCK 274P138.
50830
POCATER7138.
54329
1L275
1L274
2L258
2L113
5L96
5L91
5L92
5L94
CBK 12T312.6
51353
CBK 12T212.6
51352
CBK 230 230.
50782
CBK 500 500.
50791
LANGDON2500.
54158
SEL 12T112.6
80641
SEL 12T212.6
80304
SEL 12T412.6
80306
SEL 12T312.6
80305
2L294
AAL 2T1 230.
50789
AAL 2T3 230.
80640
2L293
NLY 230 230.
50784
NLY 2PS2230.
50822
2L112
BOUNDRYW230.
40146
KCL 13G113.8
50769
KCL 13G213.8
50770
KCL 13G313.8
50771
KCL 13G413.8
50772
KCL 230 230.
50788
2L299
2L295
2L221
2L222
SEV 2T1 230.
50785
SEV 2T3 230.
51350
SEV 13G113.8
50766
SEV 13G313.8
50768
SEV 13G213.8
50767
SEV 13G413.8
51036
Interface: AB-BC: Path-1
Total From MW Flow: 1204.66 MW
Interface: AB-MONTANA: Path-MATL
Total From MW Flow: -19.60 MW
Interface: BC-US: Path-3
Total From MW Flow: -833.44 MW


13hw2ae_case3b_P1_1200
ACK
VAS
SEL
CBK
AAL
NLY
KCL
SEV
INV 230 230.
50786
NTL 230 230.
50787
2L258
2L113
1L275
1L274
NTL 138 138.
50776
COLEMAN9138.
54232
BCK 274P138.
50830
POCATER7138.
54329
ACK 500 500.
50702
VAS 500 500.
51134
5L96
5L91
5L92
5L94
SEL 500 500.
50792
CBK 12T312.6
51353
CBK 230 230.
50782
CBK 500 500.
50791
LANGDON2500.
54158
CBK 12T212.6
51352
SEL 12T112.6
80641
SEL 12T212.6
80304
SEL 12T412.6
80306
SEL 12T312.6
80305
SEL 230 230.
50783
2L294
AAL 2T1 230.
50789
AAL 2T3 230.
80640
Interface: AB-BC: Path-1
Total From MW Flow: 1206.90 MW
KCL 13G113.8
50769
KCL 13G213.8
50770
KCL 230 230.
50788
2L299
2L295
KCL 13G313.8
50771
KCL 13G413.8
50772
2L221
2L222
2L293
NLY 230 230.
50784
SEV 2T1 230.
50785
SEV 2T3 230.
51350
SEV 13G113.8
50766
SEV 13G313.8
50768
NLY 2PS2230.
50822
2L112
BOUNDRYW230.
40146
SEV 13G213.8
50767
SEV 13G413.8
51036
Interface: AB-MONTANA: Path-MATL
Total From MW Flow: -101.08 MW
Interface: BC-US: Path-3
Total From MW Flow: -1203.97 MW

APPENDIX B – CONTINGENCIES

The following table lists the contintencies applied in post contingency power flows and transient stability analses. The contingencies used in the heavy summer and heavy winter cases are identical while the RAS control actions could differ depending on the actual flows, etc. For transient stability simulation, the switching sequence consisted of 3-phase fault applied at either side of the device, followed by subsequent trip out by protection. Appropriate RAS actions were applied where applicable, according to BCH operating order instructions. Multiple devices in the same protection zone are regarded as a single contingency and are tripped with timings according to protection settings. For post disturbance steady-state performance simulation, post contingency power flows were performed with all applicable protection and RAS actions and automatically controlled devices turned on.

Contingency Name	Contingency Description	Comment
SEL T1	SEL T1 contingency and trip out	
SEL T2 & T3	Contingency on SEL T2 or T3, Trip out both T2 & T3	SEL T2 & T3 in the same protection zone
CBK T2 & T6	Contingency on CBK T2 or T6, Trip out both T2 & T6	CBK T2 & T6 in the same protection zone
5L71 MCA-NIC	5L71 contingency and trip out, Generation shedding applied at MCA	
5L75 REV-ACK	5L71 contingency and trip out	
5L76 ACK-NIC	5L76 contingency and trip out	
5L81 NIC-ING	5L81 contingency and trip out	Series-compensated line
5L82 NIC-MDN	5L82 contingency and trip out	Series-compensated line
5L87 NIC-KLY	5L87 contingency and trip out	Series-compensated line
5L91 ACK-SEL	5L91 contingency and trip out	
5L92 CBK-SEL	5L92 contingency and trip out 5L94 trip out Open 1L275 at Natal Open 1L274 at Britt Creek if normally closed Trip open MATL Generation shedding applied in BCH	During high transfer, loss of 5L92 would result in tripping 5L94 and separation of 138kV ties with AB. Appropriate amount of generation shedding was applied in BCH.
5L94 CBK-LGN	5L94 contingency and trip out Open 1L275 at Natal Open 1L274 at Britt Creek if normally closed	During high transfer, loss of 5L94 would result in tripping open 138kV ties with AB. Appropriate amount of generation shedding was applied in BCH.

	Trip open MATL Generation shedding applied in BCH	
5L96 VAS-SEL	5L96 contingency and trip out 48L (BEN-KET 161) tripped by RAS	
5L98 NIC-VAS	5L98 contingency and trip out	
2L112 NLY-BDY	2L112 contingency and trip out	
2L221 SEV-SEL	2L221 contingency and trip out	
2L277 WAN-NLY	2L277 contingency and trip out , generation shedding at WAN	For the winter case, generation shedding applied to maintain transient stability
2L288 KCL-BTS	2L288 contingency and trip out	
2L289 SEL-BTS	2L289 contingency and trip out	
2L293 SEL-NLY	2L293 contingency and trip out	
2L294 CBK-NLY	2L294 contingency and trip out	
2L295 SEL-KCL	2L295 contingency and trip out	
1L274 NTL-POCATER	1L274 contingency and trip out	
1L275 NTL-COLEMAN	1L275 contingency and trip out	

APPENDIX C – POWER FLOW CONTINGENCY RESULTS

The tables in this appendix show more detailed contingecy analysis results for BC to AB transfers of 1100 MW (heavy winter) and 1200 MW(heavy winter and heavy summer).

HS Case 3 – 1200 MW BC to AB

Cont. Name	NIC 500 [50703]	ACK 500 [50702]	SEL 500 [50792]	SEL 230 [50783]	VAS 500 [51134]	CBK 500 [50791]	CBK 230 [50782]	NTL 230 [50787]	NTL 138 [50776]	NLY 230 [50784]	LNGDN 500 [54158]
Pre Contingency	1.054	1.060	1.042	1.037	1.062	0.987	0.974	0.942	1.032	1.028	1.018
SEL T1	1.054	1.060	1.043	1.036	1.063	0.988	0.974	0.942	1.033	1.027	1.018
SEL T2&T3	1.054	1.060	1.044	1.035	1.063	0.988	0.974	0.942	1.032	1.026	1.018
CBK T2&T6	1.053	1.060	1.041	1.036	1.062	0.982	0.973	0.942	1.032	1.028	1.017
5L71 MCA-NIC	1.029	1.045	1.034	1.032	1.044	0.980	0.968	0.937	1.029	1.024	1.016
5L75 REV-ACK	1.047	1.048	1.038	1.034	1.056	0.984	0.971	0.940	1.030	1.026	1.017
5L76 ACK-NIC	1.043	1.051	1.036	1.033	1.052	0.982	0.970	0.938	1.029	1.024	1.016
5L81 NIC-ING	1.039	1.052	1.036	1.033	1.051	0.982	0.969	0.938	1.029	1.021	1.016
5L82 NIC-MDN	1.039	1.052	1.037	1.033	1.051	0.982	0.970	0.939	1.030	1.021	1.017
5L87 NIC-KLY	1.045	1.056	1.039	1.035	1.056	0.985	0.972	0.940	1.031	1.026	1.017
5L91 ACK-SEL	1.049	1.058	1.025	1.027	1.051	0.973	0.962	0.932	1.024	1.022	1.014
5L96 VAS-SEL	1.050	1.056	1.026	1.027	1.055	0.974	0.962	0.932	1.025	1.019	1.015
5L98 NIC-VAS	1.047	1.057	1.040	1.035	1.056	0.985	0.972	0.941	1.031	1.027	1.017
2L112 NLY-BDY	1.049	1.057	1.040	1.035	1.058	0.986	0.972	0.940	1.031	1.029	1.017
2L221 SEV-SEL	1.050	1.055	1.038	1.034	1.058	0.984	0.972	0.940	1.031	1.027	1.017
2L277 WAN-NLY	1.053	1.060	1.041	1.036	1.062	0.986	0.973	0.941	1.032	1.026	1.017
2L288 KCL-BTS	1.053	1.060	1.041	1.036	1.062	0.986	0.974	0.942	1.032	1.028	1.018
2L289 SEL-BTS	1.054	1.060	1.042	1.037	1.062	0.987	0.974	0.942	1.033	1.029	1.018
2L293 SEL-NLY	1.050	1.058	1.039	1.036	1.058	0.983	0.974	0.943	1.033	1.028	1.017
2L294 CBK-NLY	1.053	1.059	1.035	1.033	1.059	0.968	0.956	0.922	1.035	1.031	1.013
2L295 SEL-KCL	1.053	1.060	1.041	1.036	1.062	0.986	0.974	0.942	1.032	1.028	1.018
1L274 NTL-POCATER	1.055	1.061	1.045	1.039	1.064	0.995	0.984	0.973	1.033	1.030	1.019
1L275 NTL-COLEMAN	1.053	1.060	1.040	1.036	1.061	0.980	0.969	0.941	1.033	1.027	1.013
5L92 CBK-SEL	1.058	1.061	1.048	1.040	1.062	1.047	1.024	1.000	1.031	1.024	0.000
5L94 CBK-LGN	1.060	1.063	1.056	1.045	1.067	1.054	1.032	1.007	1.038	1.030	0.000

HS Case 3a – 1200 MW BC to AB

Cont. Name	NIC 500 [50703]	ACK 500 [50702]	SEL 500 [50792]	SEL 230 [50783]	VAS 500 [51134]	CBK 500 [50791]	CBK 230 [50782]	NTL 230 [50787]	NTL 138 [50776]	NLY 230 [50784]	LNGDN 500 [54158]
Pre Contingency	1.059	1.063	1.044	1.041	1.065	0.988	0.974	0.946	1.036	1.034	1.018
SEL T1	1.060	1.063	1.045	1.040	1.066	0.989	0.975	0.947	1.036	1.034	1.018
SEL T2&T3	1.060	1.064	1.046	1.040	1.066	0.989	0.975	0.947	1.036	1.033	1.018
CBK T2&T6	1.059	1.063	1.043	1.040	1.065	0.983	0.973	0.945	1.035	1.033	1.017
5L71 MCA-NIC	1.036	1.049	1.035	1.035	1.047	0.981	0.968	0.941	1.031	1.030	1.016
5L75 REV-ACK	1.054	1.053	1.040	1.038	1.059	0.985	0.972	0.944	1.034	1.032	1.017
5L76 ACK-NIC	1.051	1.055	1.039	1.037	1.058	0.984	0.971	0.943	1.033	1.031	1.017
5L81 NIC-ING	1.046	1.056	1.039	1.037	1.055	0.984	0.971	0.944	1.034	1.031	1.017
5L82 NIC-MDN	1.048	1.057	1.039	1.037	1.055	0.984	0.971	0.944	1.034	1.031	1.017
5L87 NIC-KLY	1.053	1.060	1.042	1.039	1.061	0.986	0.973	0.945	1.035	1.033	1.018
5L91 ACK-SEL	1.049	1.058	1.019	1.024	1.039	0.968	0.956	0.931	1.024	1.024	1.013
5L96 VAS-SEL	1.057	1.059	1.023	1.027	1.062	0.972	0.960	0.934	1.026	1.025	1.014
5L98 NIC-VAS	1.052	1.057	1.037	1.036	1.051	0.982	0.969	0.942	1.032	1.031	1.017
2L112 NLY-BDY	1.059	1.063	1.044	1.040	1.065	0.988	0.974	0.946	1.035	1.033	1.018
2L221 SEV-SEL	1.057	1.059	1.039	1.037	1.061	0.984	0.971	0.944	1.034	1.032	1.017
2L277 WAN-NLY	1.059	1.063	1.044	1.040	1.065	0.988	0.974	0.946	1.036	1.033	1.018
2L288 KCL-BTS	1.059	1.063	1.044	1.040	1.065	0.988	0.974	0.946	1.035	1.034	1.018
2L289 SEL-BTS	1.060	1.063	1.045	1.042	1.066	0.989	0.975	0.947	1.036	1.035	1.018
2L293 SEL-NLY	1.058	1.063	1.045	1.042	1.065	0.987	0.976	0.948	1.036	1.030	1.018
2L294 CBK-NLY	1.058	1.062	1.036	1.036	1.061	0.968	0.956	0.932	1.024	1.036	1.013
2L295 SEL-KCL	1.059	1.063	1.044	1.041	1.065	0.988	0.974	0.946	1.036	1.034	1.018
1L274 NTL-POCATER	1.060	1.064	1.048	1.043	1.068	0.997	0.986	0.982	1.030	1.036	1.020
1L275 NTL-COLEMAN	1.059	1.063	1.042	1.040	1.064	0.982	0.970	0.949	1.032	1.033	1.014
5L92 CBK-SEL	1.072	1.073	1.072	1.059	1.085	1.044	1.021	1.004	1.026	1.045	0.000
5L94 CBK-LGN	1.070	1.072	1.077	1.062	1.086	1.062	1.032	1.014	1.024	1.049	0.000

HW Case 2a – 1100 MW BC to AB

Cont. Name	NIC 500 [50703]	ACK 500 [50702]	SEL 500 [50792]	SEL 230 [50783]	VAS 500 [51134]	CBK 500 [50791]	CBK 230 [50782]	NTL 230 [50787]	NTL 138 [50776]	NLY 230 [50784]	LNGDN 500 [54158]
Pre Contingency	1.052	1.064	1.034	1.033	1.053	0.985	0.971	0.952	1.032	1.031	1.013
SEL T1	1.052	1.065	1.035	1.032	1.053	0.985	0.970	0.952	1.032	1.031	1.013
SEL T2&T3	1.052	1.065	1.035	1.032	1.053	0.986	0.971	0.952	1.032	1.030	1.014
CBK T2&T6	1.052	1.064	1.032	1.031	1.052	0.978	0.965	0.948	1.029	1.030	1.009
5L71 MCA-NIC	1.032	1.051	1.026	1.027	1.037	0.977	0.963	0.945	1.027	1.027	1.009
5L75 REV-ACK	1.052	1.060	1.033	1.032	1.051	0.984	0.969	0.951	1.031	1.031	1.012
5L76 ACK-NIC	1.045	1.060	1.030	1.030	1.047	0.980	0.965	0.947	1.028	1.029	1.010
5L81 NIC-ING	1.044	1.059	1.030	1.030	1.046	0.977	0.963	0.945	1.027	1.029	1.007
5L82 NIC-MDN	1.043	1.059	1.029	1.030	1.045	0.977	0.963	0.945	1.026	1.029	1.007
5L87 NIC-KLY	1.047	1.062	1.032	1.031	1.049	0.982	0.967	0.949	1.030	1.030	1.011
5L91 ACK-SEL	1.047	1.064	1.005	1.011	1.033	0.961	0.947	0.925	1.038	1.016	1.004
5L96 VAS-SEL	1.050	1.063	1.028	1.028	1.047	0.979	0.964	0.947	1.028	1.028	1.010
5L98 NIC-VAS	1.047	1.060	1.026	1.027	1.032	0.979	0.965	0.947	1.028	1.027	1.011
2L112 NLY-BDY	1.055	1.066	1.036	1.035	1.055	0.992	0.978	0.958	1.037	1.030	1.020
2L221 SEV-SEL	1.052	1.063	1.033	1.032	1.052	0.985	0.970	0.951	1.031	1.031	1.013
2L277 WAN-NLY	1.054	1.065	1.032	1.029	1.052	0.982	0.967	0.949	1.030	1.026	1.011
2L288 KCL-BTS	1.052	1.064	1.034	1.032	1.052	0.984	0.970	0.951	1.032	1.031	1.013
2L289 SEL-BTS	1.052	1.064	1.034	1.032	1.052	0.984	0.970	0.951	1.031	1.030	1.013
2L293 SEL-NLY	1.055	1.066	1.037	1.035	1.055	0.986	0.968	0.950	1.031	1.026	1.014
2L294 CBK-NLY	1.051	1.063	1.026	1.027	1.048	0.964	0.951	0.931	1.034	1.034	1.004
2L295 SEL-KCL	1.052	1.064	1.033	1.031	1.052	0.984	0.969	0.951	1.031	1.030	1.013
1L274 NTL-POCATER	1.054	1.066	1.039	1.036	1.055	0.997	0.985	0.993	1.030	1.034	1.019
1L275 NTL-COLEMAN	1.052	1.064	1.033	1.032	1.052	0.980	0.966	0.952	1.034	1.031	1.007
5L92 CBK-SEL	1.064	1.071	1.048	1.043	1.064	1.032	1.009	0.994	1.028	1.038	0.000
5L94 CBK-LGN	1.065	1.073	1.054	1.047	1.068	1.043	1.015	1.001	1.023	1.045	0.000

HW Case 3 – 1200 MW BC to AB

Cont. Name	NIC 500 [50703]	ACK 500 [50702]	SEL 500 [50792]	SEL 230 [50783]	VAS 500 [51134]	CBK 500 [50791]	CBK 230 [50782]	NTL 230 [50787]	NTL 138 [50776]	NLY 230 [50784]	LNGDN 500 [54158]
Pre Contingency	1.043	1.048	1.015	1.017	1.035	0.950	0.933	0.913	1.024	1.019	1.007
SEL T1	1.043	1.047	1.013	1.015	1.034	0.948	0.930	0.911	1.023	1.018	1.007
SEL T2&T3	1.043	1.047	1.011	1.014	1.033	0.947	0.930	0.909	1.030	1.017	1.007
CBK T2&T6	1.043	1.047	1.014	1.016	1.034	0.945	0.928	0.907	1.029	1.018	1.006
5L71 MCA-NIC	1.018	1.032	1.007	1.012	1.016	0.943	0.927	0.906	1.028	1.016	1.005
5L75 REV-ACK	1.038	1.036	1.011	1.015	1.030	0.946	0.930	0.910	1.022	1.018	1.006
5L76 ACK-NIC	1.032	1.038	1.009	1.014	1.025	0.944	0.928	0.907	1.028	1.017	1.005
5L81 NIC-ING	1.030	1.041	1.011	1.015	1.026	0.942	0.926	0.905	1.027	1.017	1.004
5L82 NIC-MDN	1.029	1.040	1.010	1.015	1.025	0.942	0.927	0.906	1.028	1.017	1.004
5L87 NIC-KLY	1.026	1.039	1.010	1.014	1.024	0.944	0.928	0.907	1.029	1.017	1.006
5L91 ACK-SEL	1.043	1.051	0.993	1.003	1.025	0.932	0.917	0.896	1.029	1.010	1.003
5L96 VAS-SEL	1.040	1.043	1.007	1.012	1.033	0.939	0.924	0.903	1.025	1.015	1.004
5L98 NIC-VAS	1.040	1.045	1.007	1.012	1.007	0.942	0.927	0.906	1.028	1.016	1.005
2L112 NLY-BDY	1.046	1.050	1.019	1.020	1.040	0.958	0.942	0.920	1.030	1.015	1.011
2L221 SEV-SEL	1.040	1.043	1.015	1.017	1.034	0.951	0.934	0.914	1.025	1.019	1.008
2L277 WAN-NLY	1.042	1.047	1.011	1.012	1.032	0.946	0.929	0.910	1.022	1.011	1.006
2L288 KCL-BTS	1.043	1.047	1.014	1.016	1.034	0.949	0.932	0.912	1.024	1.019	1.007
2L289 SEL-BTS	1.042	1.047	1.012	1.013	1.033	0.947	0.930	0.911	1.023	1.016	1.007
2L293 SEL-NLY	1.044	1.048	1.017	1.018	1.036	0.951	0.932	0.912	1.024	1.020	1.008
2L294 CBK-NLY	1.042	1.046	1.006	1.012	1.030	0.928	0.915	0.895	1.028	1.025	1.003
2L295 SEL-KCL	1.043	1.047	1.012	1.013	1.034	0.947	0.930	0.911	1.023	1.017	1.007
1L274 NTL-POCATER	1.044	1.049	1.019	1.020	1.037	0.962	0.949	0.958	1.024	1.022	1.010
1L275 NTL-COLEMAN	1.043	1.047	1.014	1.016	1.034	0.945	0.929	0.912	1.034	1.019	1.004
5L92 CBK-SEL	1.051	1.055	1.034	1.029	1.039	1.032	1.009	0.994	1.029	1.031	0.000
5L94 CBK-LGN	1.053	1.056	1.042	1.034	1.045	1.040	1.019	1.005	1.027	1.038	0.000

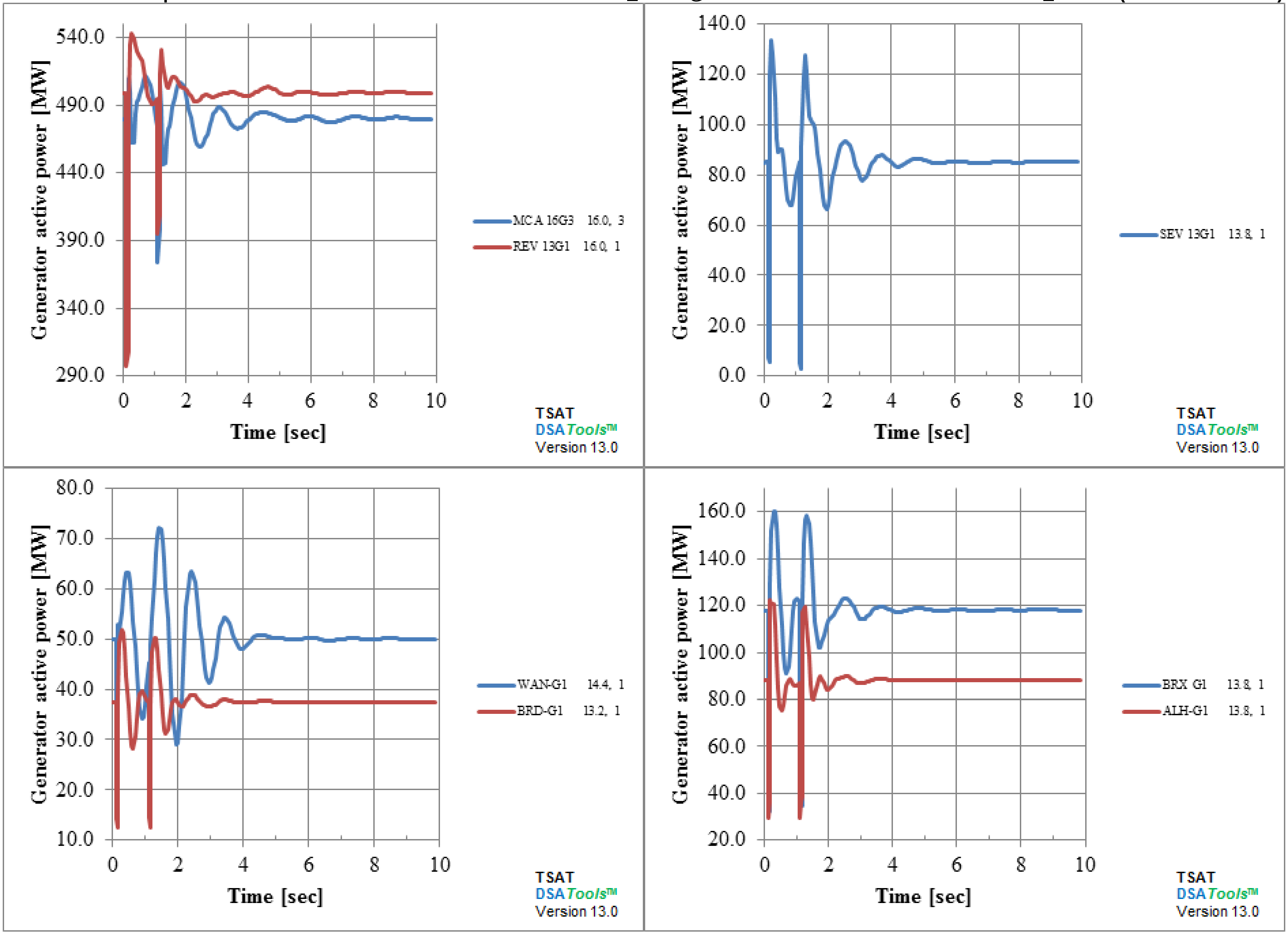
HW Case 3b – 1200 MW BC to AB

Cont. Name	NIC 500 [50703]	ACK 500 [50702]	SEL 500 [50792]	SEL 230 [50783]	VAS 500 [51134]	CBK 500 [50791]	CBK 230 [50782]	NTL 230 [50787]	NTL 138 [50776]	NLY 230 [50784]	LNGDN 500 [54158]
Pre Contingency	1.055	1.065	1.027	1.027	1.050	0.961	0.945	0.925	1.033	1.025	1.009
SEL T1	1.055	1.065	1.026	1.026	1.050	0.961	0.945	0.925	1.033	1.025	1.009
SEL T2&T3	1.055	1.065	1.026	1.026	1.050	0.960	0.945	0.925	1.033	1.025	1.009
CBK T2&T6	1.055	1.065	1.025	1.026	1.050	0.955	0.941	0.923	1.031	1.025	1.008
5L71 MCA-NIC	1.034	1.052	1.019	1.022	1.035	0.954	0.939	0.920	1.029	1.022	1.008
5L75 REV-ACK	1.053	1.060	1.025	1.026	1.048	0.959	0.944	0.924	1.032	1.025	1.009
5L76 ACK-NIC	1.046	1.059	1.022	1.024	1.044	0.957	0.942	0.922	1.030	1.024	1.008
5L81 NIC-ING	1.046	1.060	1.022	1.024	1.043	0.954	0.940	0.920	1.029	1.024	1.007
5L82 NIC-MDN	1.044	1.059	1.022	1.024	1.042	0.954	0.939	0.920	1.029	1.023	1.007
5L87 NIC-KLY	1.049	1.062	1.025	1.026	1.046	0.959	0.944	0.924	1.032	1.025	1.009
5L91 ACK-SEL	1.050	1.066	0.998	1.007	1.032	0.942	0.928	0.909	1.029	1.012	1.007
5L96 VAS-SEL	1.055	1.064	1.018	1.021	1.051	0.954	0.939	0.920	1.029	1.022	1.008
5L98 NIC-VAS	1.051	1.061	1.016	1.020	1.022	0.954	0.939	0.921	1.029	1.021	1.009
2L112 NLY-BDY	1.055	1.065	1.027	1.028	1.050	0.966	0.951	0.930	1.037	1.022	1.012
2L221 SEV-SEL	1.054	1.064	1.025	1.026	1.049	0.960	0.945	0.925	1.033	1.025	1.010
2L277 WAN-NLY	1.054	1.064	1.023	1.024	1.048	0.958	0.943	0.923	1.031	1.019	1.009
2L288 KCL-BTS	1.055	1.065	1.026	1.026	1.050	0.960	0.945	0.925	1.033	1.025	1.009
2L289 SEL-BTS	1.055	1.065	1.025	1.025	1.050	0.959	0.944	0.924	1.032	1.024	1.009
2L293 SEL-NLY	1.055	1.066	1.028	1.029	1.051	0.961	0.943	0.924	1.032	1.020	1.010
2L294 CBK-NLY	1.053	1.063	1.018	1.022	1.046	0.940	0.928	0.910	1.029	1.031	1.006
2L295 SEL-KCL	1.055	1.065	1.025	1.025	1.050	0.959	0.944	0.924	1.032	1.024	1.009
1L274 NTL-POCATER	1.056	1.067	1.031	1.030	1.053	0.974	0.962	0.973	1.025	1.029	1.012
1L275 NTL-COLEMAN	1.054	1.065	1.025	1.026	1.050	0.957	0.942	0.926	1.023	1.025	1.007
5L92 CBK-SEL	1.070	1.078	1.050	1.043	1.068	1.034	1.011	0.996	1.031	1.039	0.000
5L94 CBK-LGN	1.071	1.080	1.057	1.048	1.073	1.050	1.027	1.012	1.034	1.047	0.000

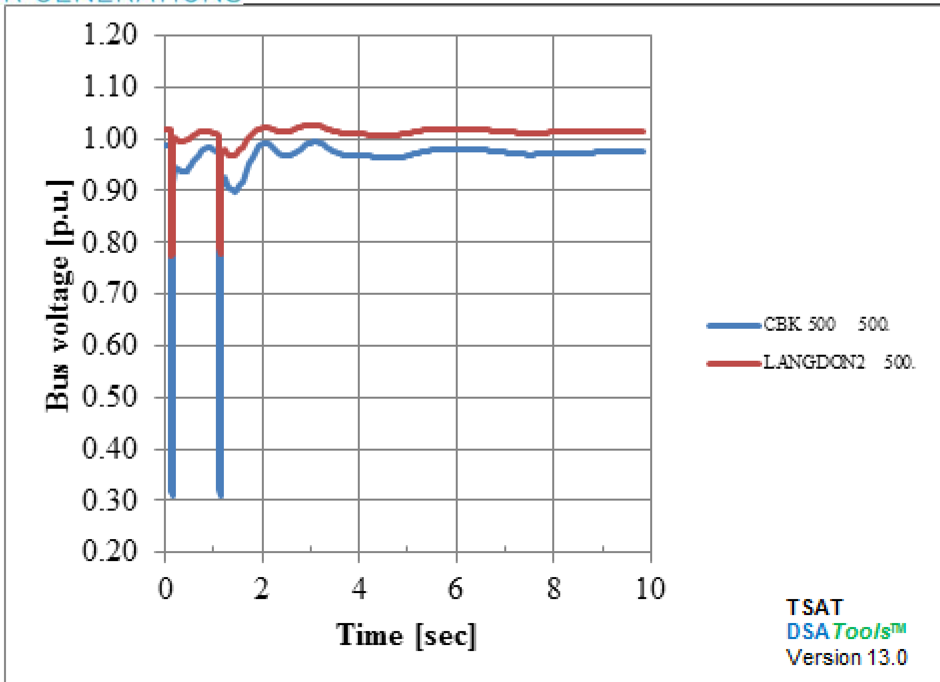
APPENDIX D – TRANSIENT STABILITY PERFORMANCE PLOTS

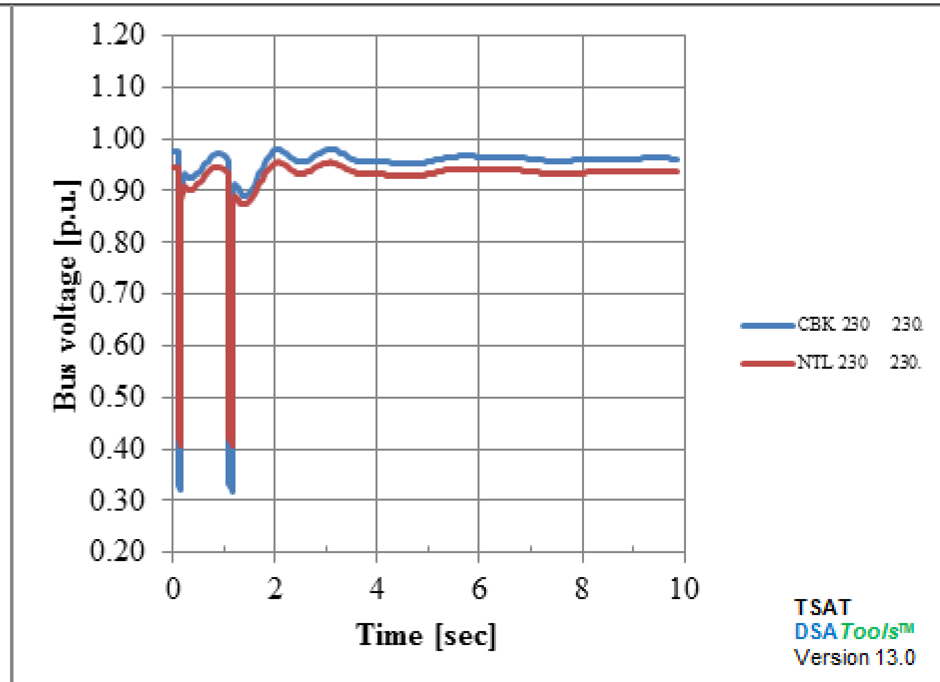
Selected transient stability response to single contingencies listed in Appendix B and as listed in Tables 4-4 and 4-8 are displayed below.

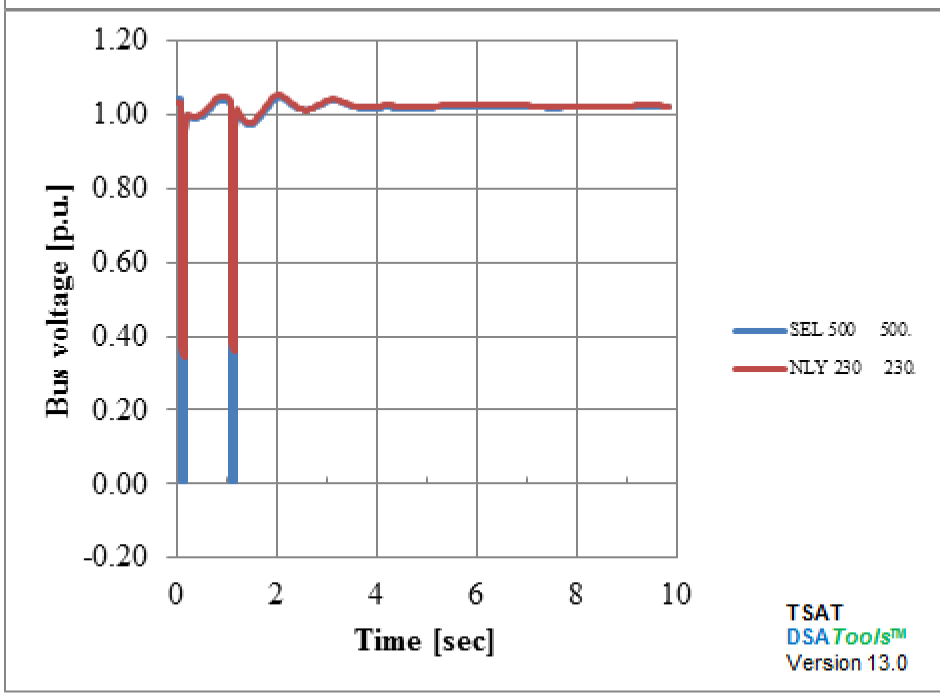
Generator MW Outputs **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hs_case3a (BC-AB = 1200MW)**

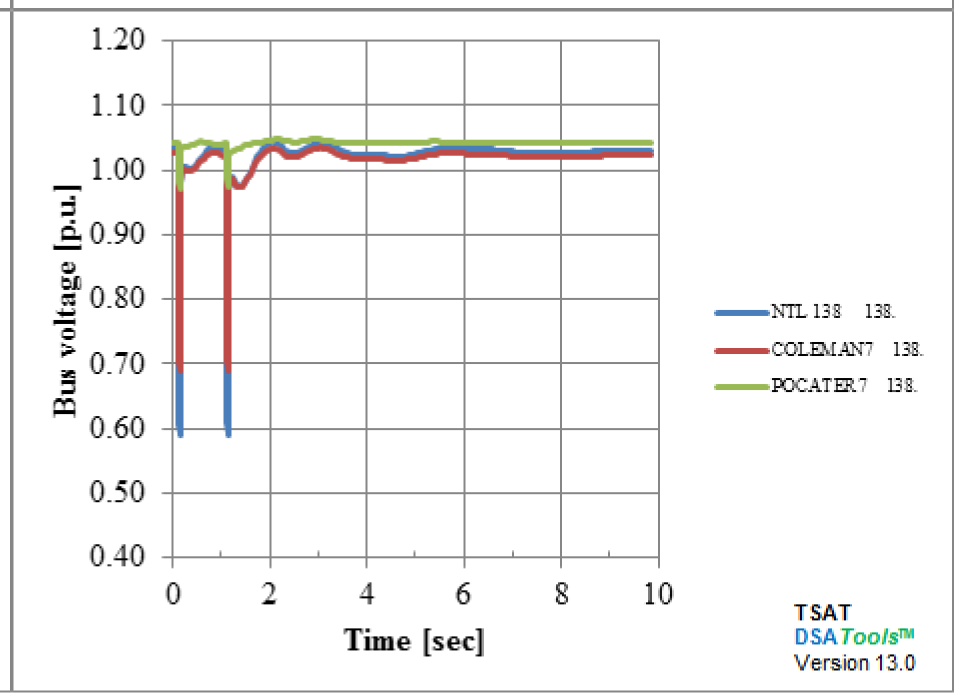


Bus Variables **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hs_case3a (BC-AB = 1200MW)**

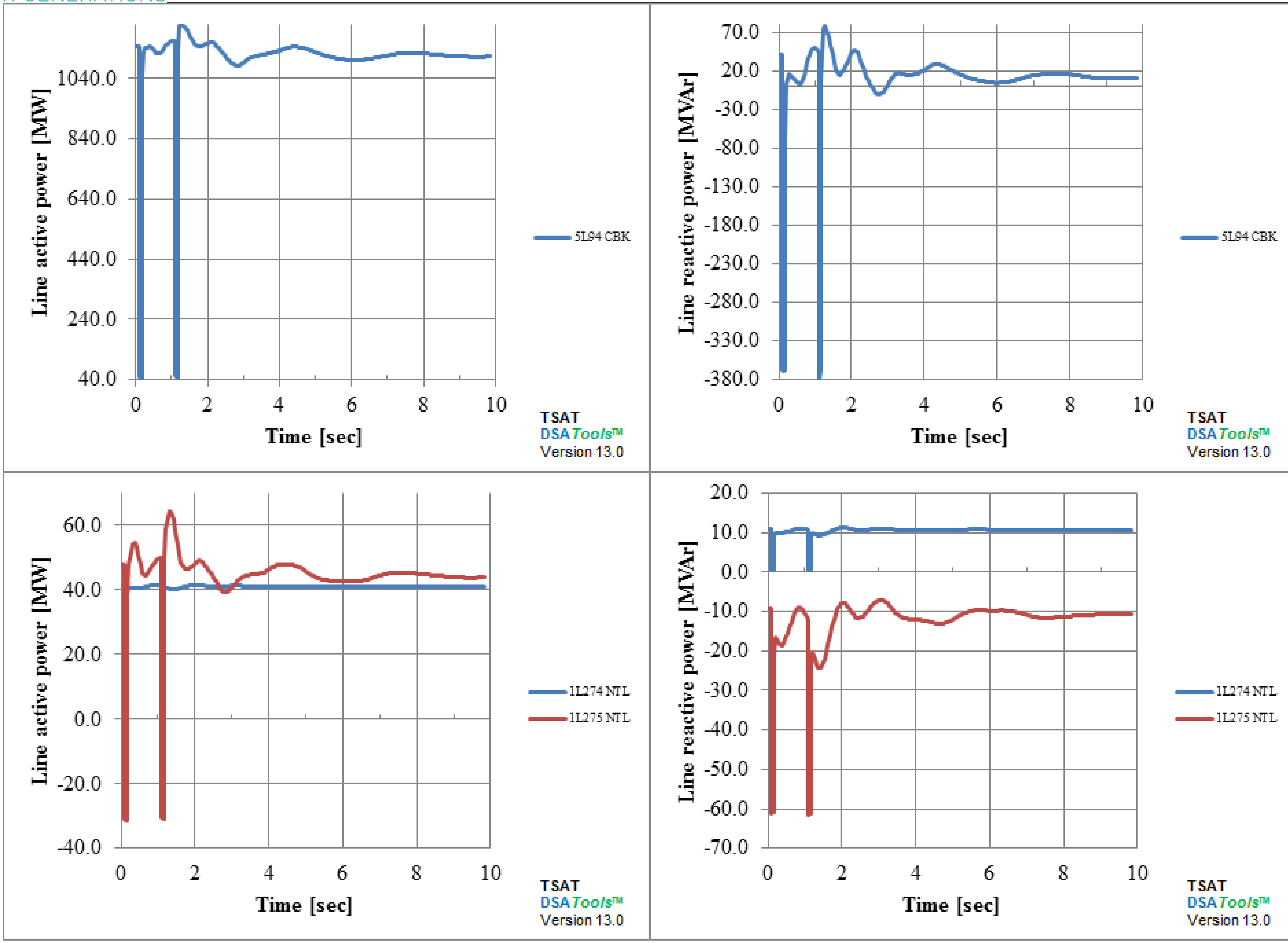




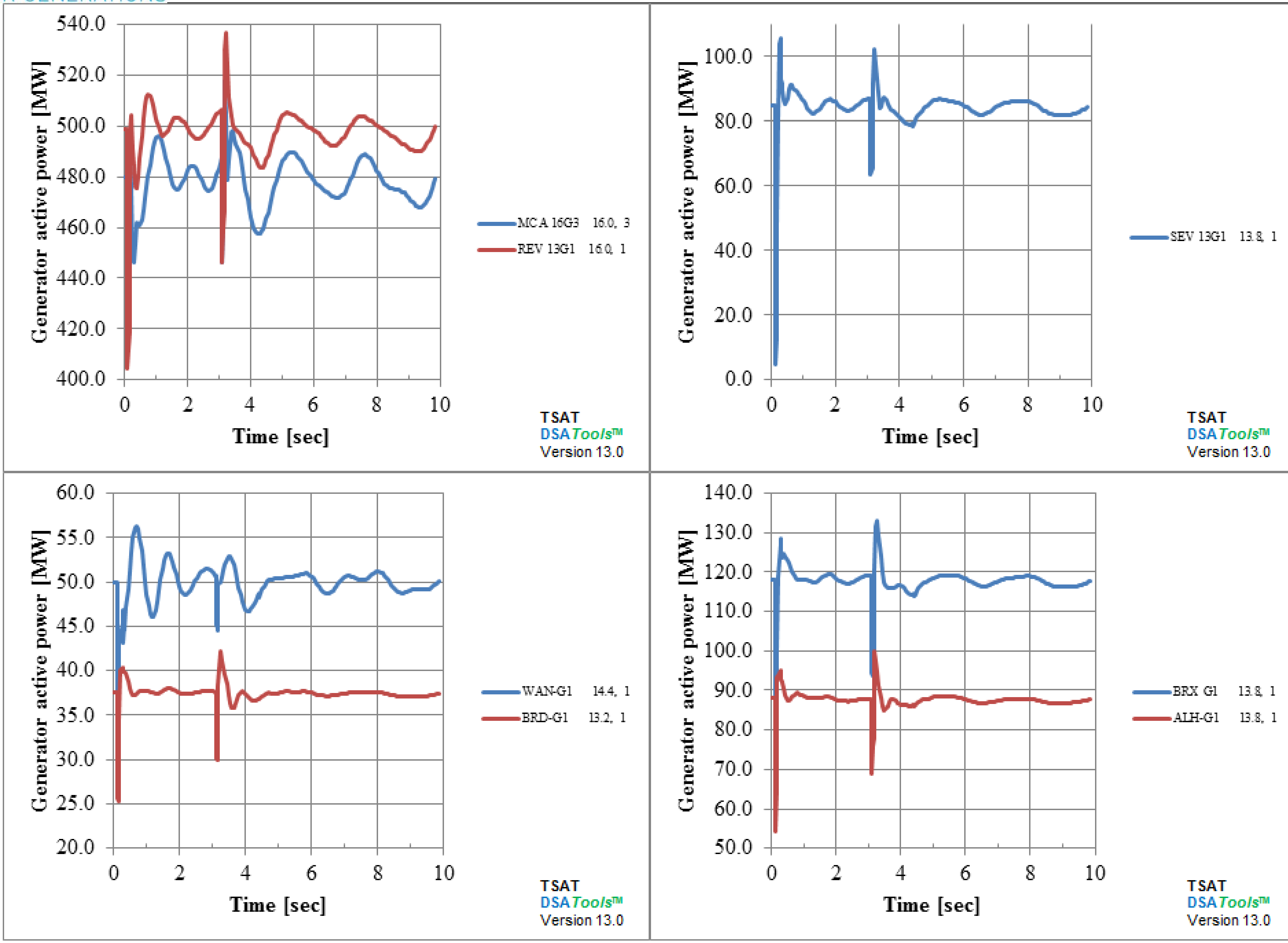




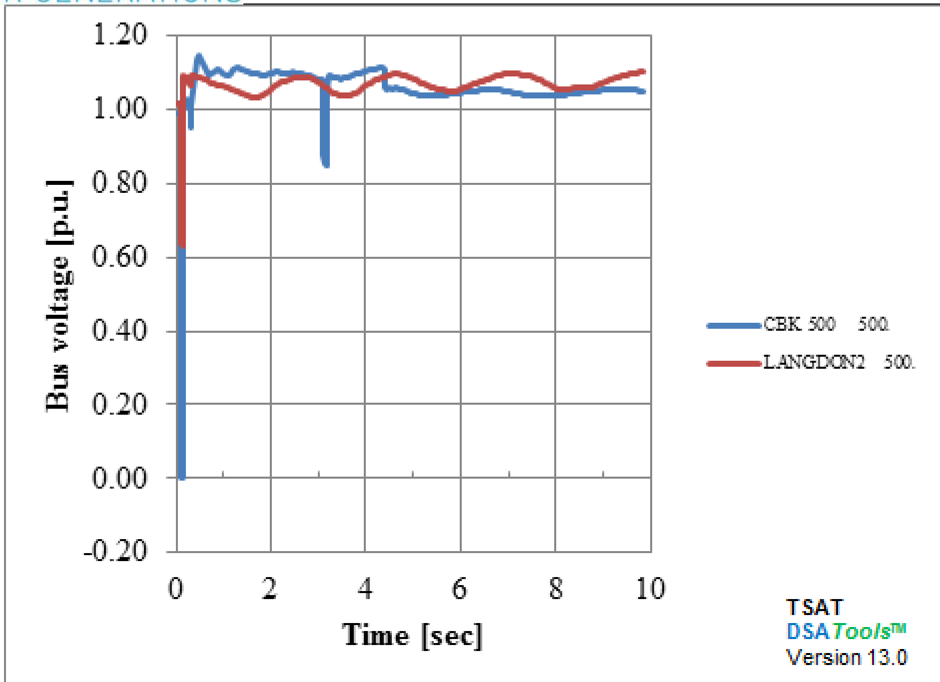
Line Power Flows **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hs_case3a (BC-AB = 1200MW)**

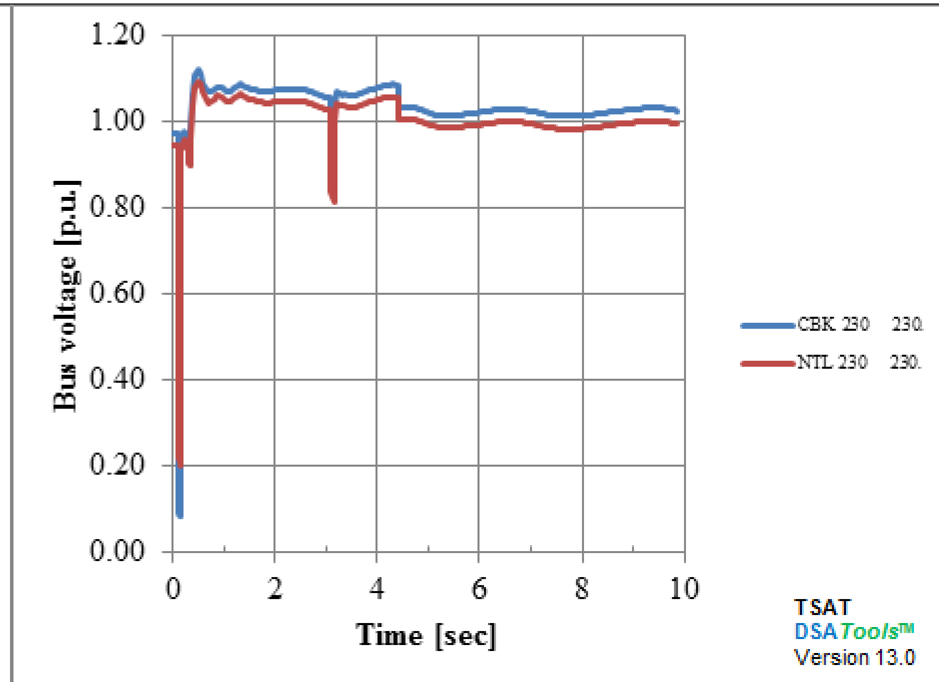


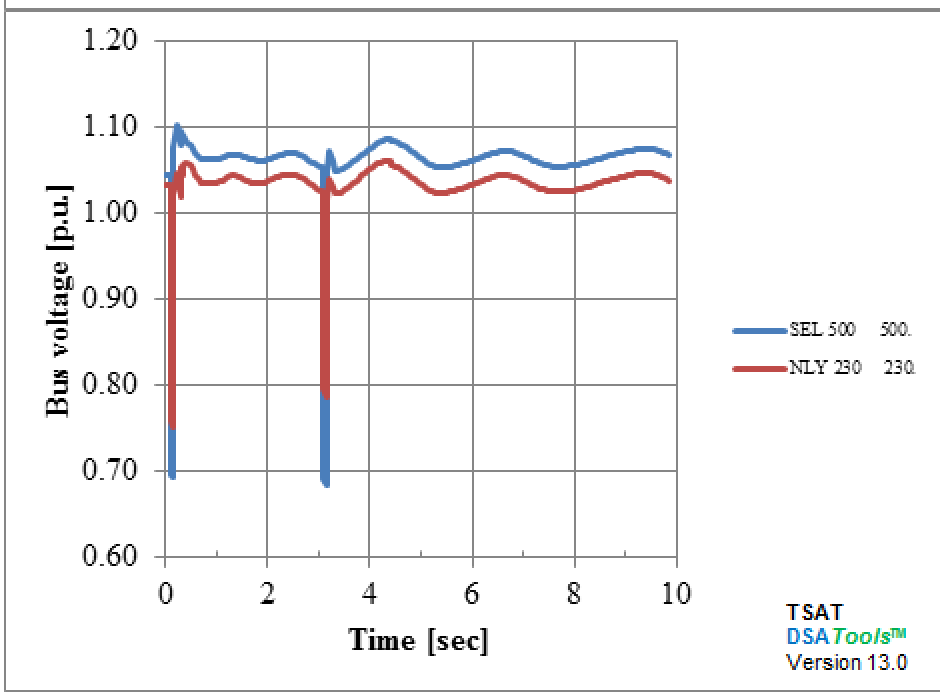
Generator MW Outputs **13 -- 5L92 CBK-SEL 3PH@CBK 500KV** **13hs_case3a (BC-AB = 1200MW)**

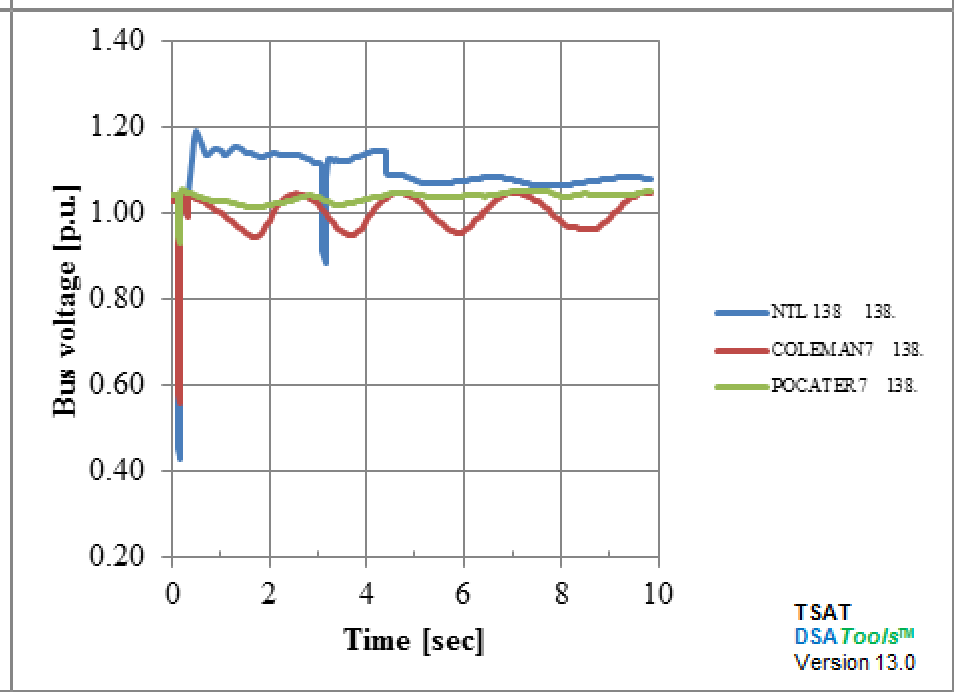


Bus Variables **13 -- 5L92 CBK-SEL 3PH@CBK 500KV** **13hs_case3a (BC-AB = 1200MW)**

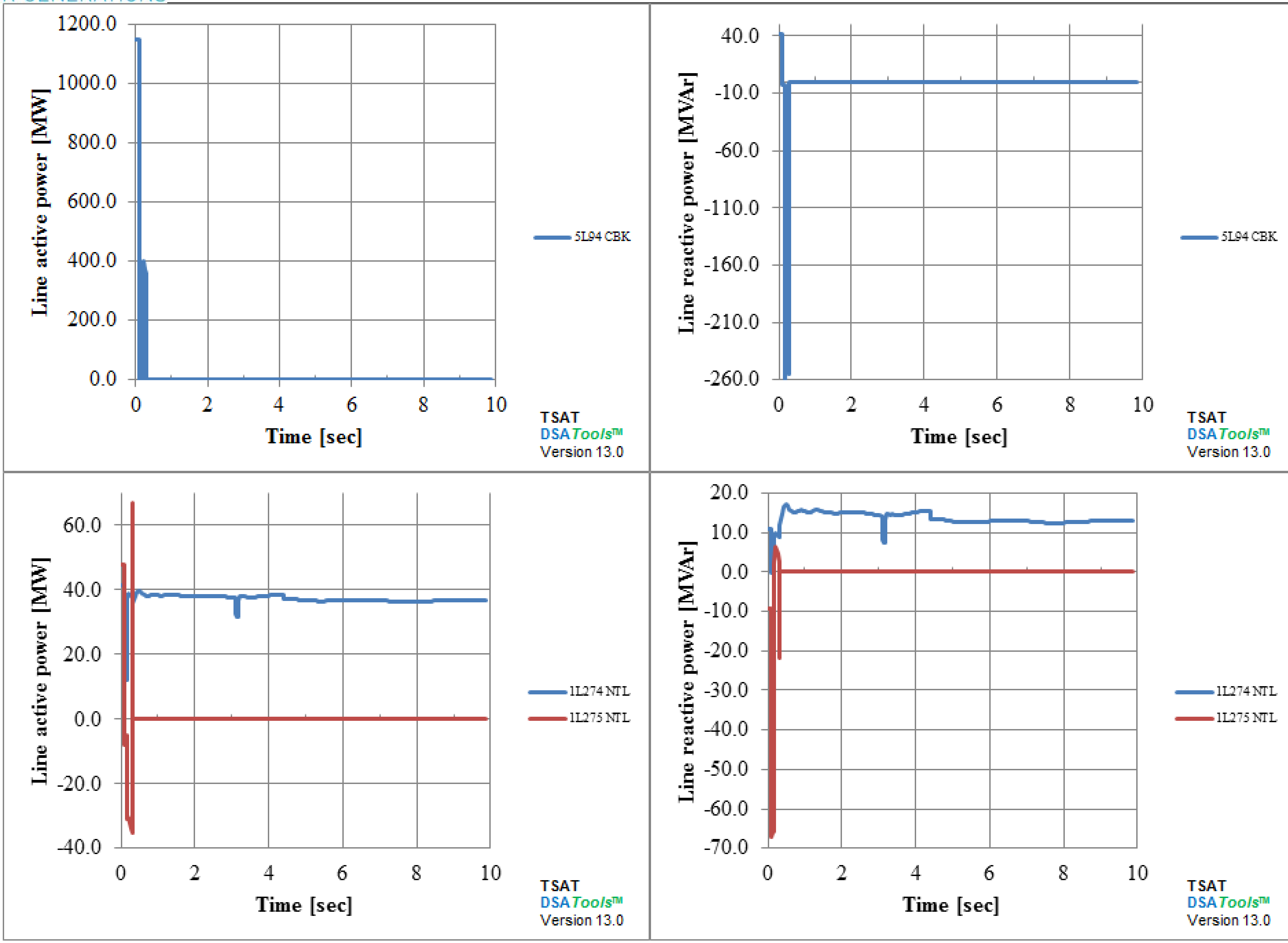




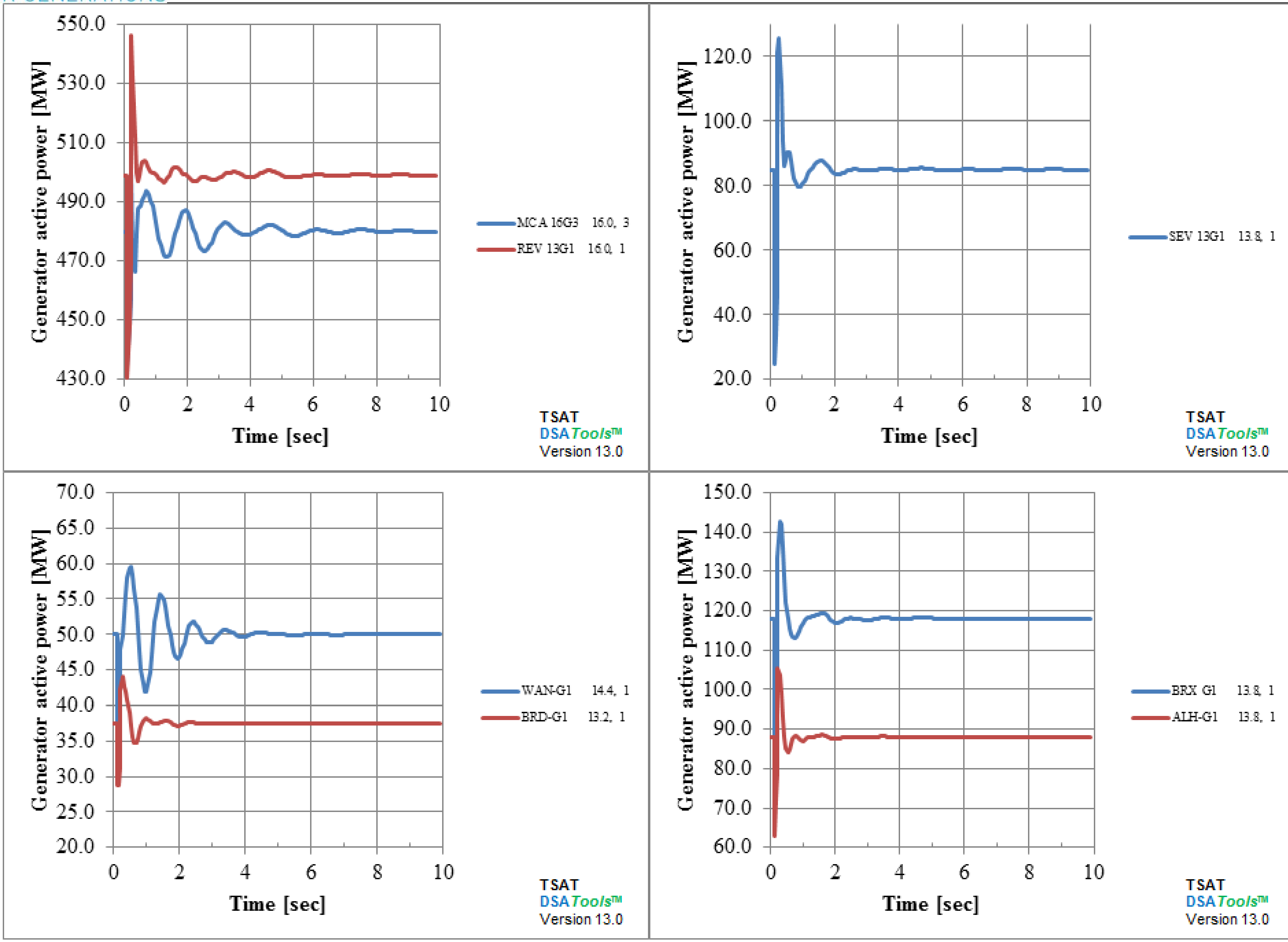




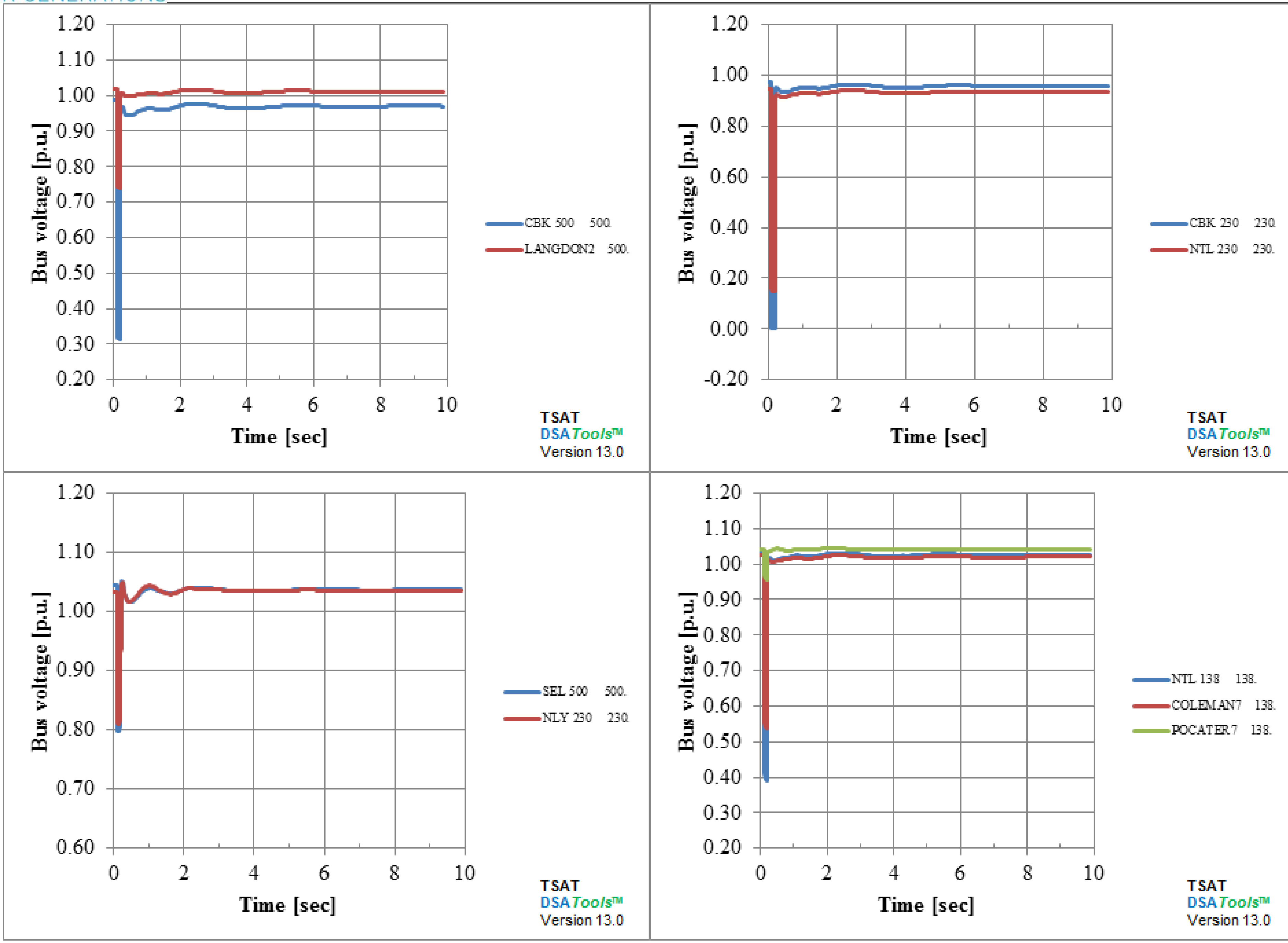
Line Power Flows **13 -- 5L92 CBK-SEL 3PH@CBK 500KV** **13hs_case3a (BC-AB = 1200MW)**



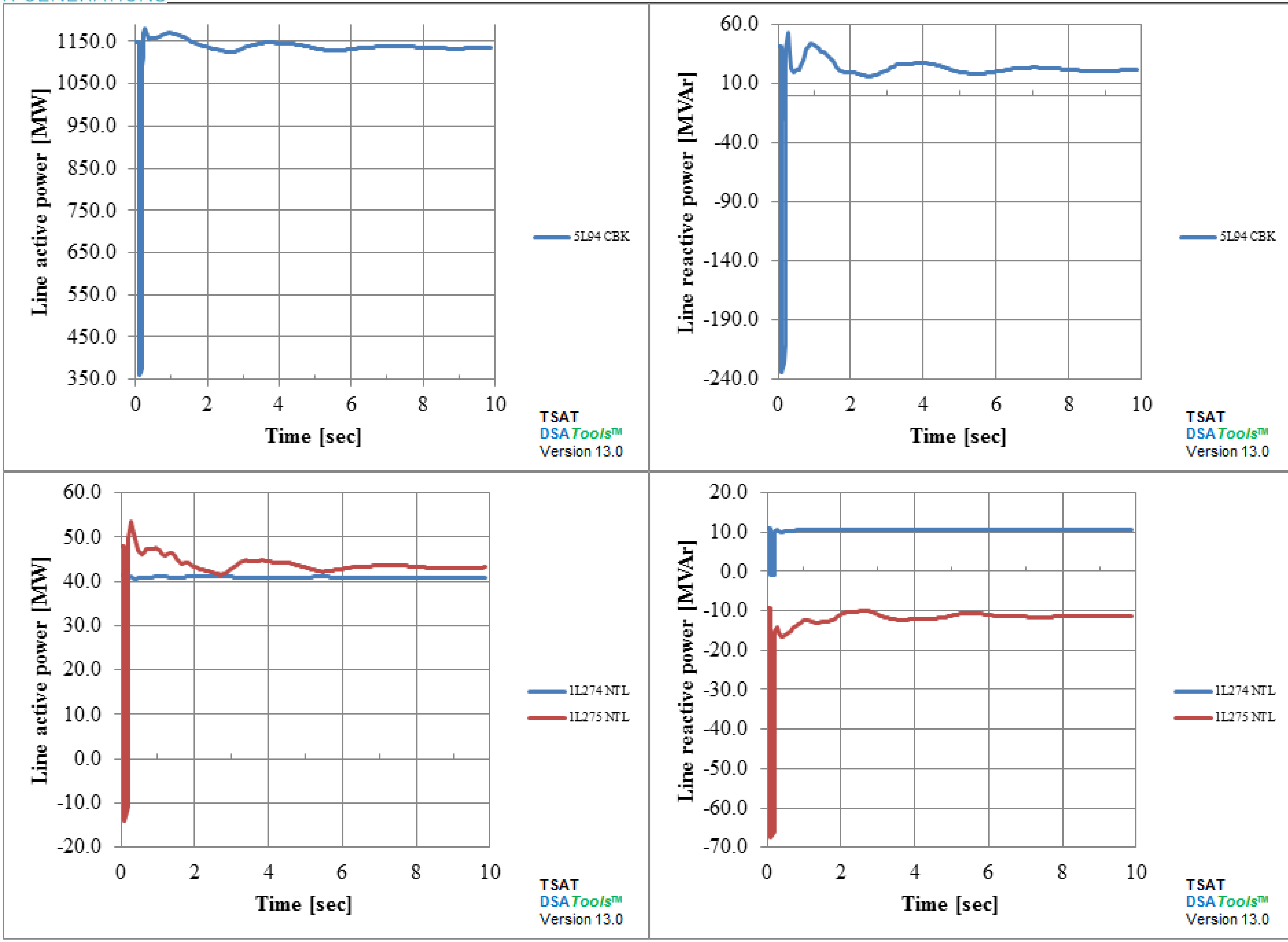
Generator MW Outputs **33 -- 2L294 CBK-NLY 3PH@CBK 230KV** **13hs_case3a (BC-AB = 1200MW)**



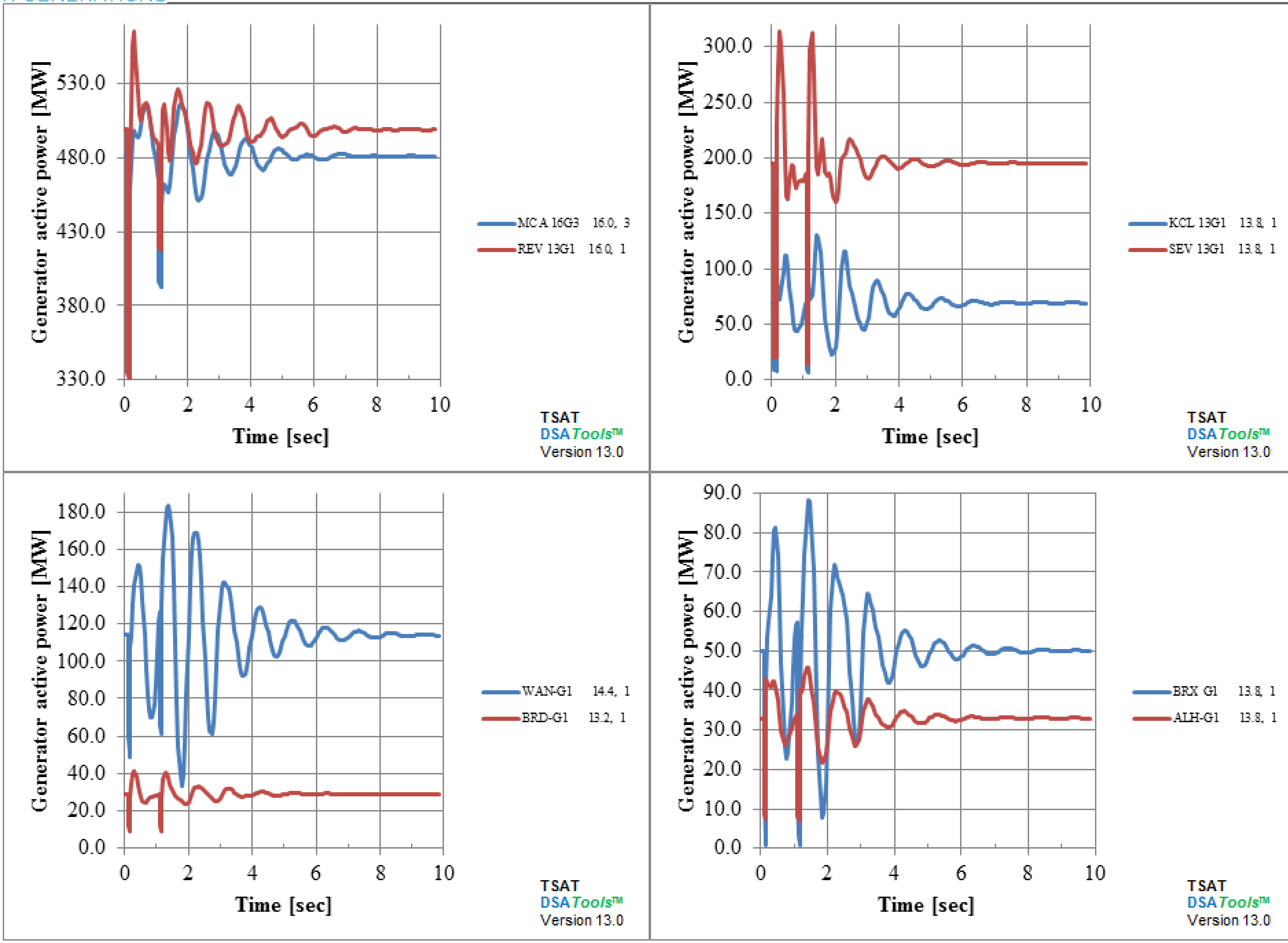
Bus Variables **33 -- 2L294 CBK-NLY 3PH@CBK 230KV** **13hs_case3a (BC-AB = 1200MW)**



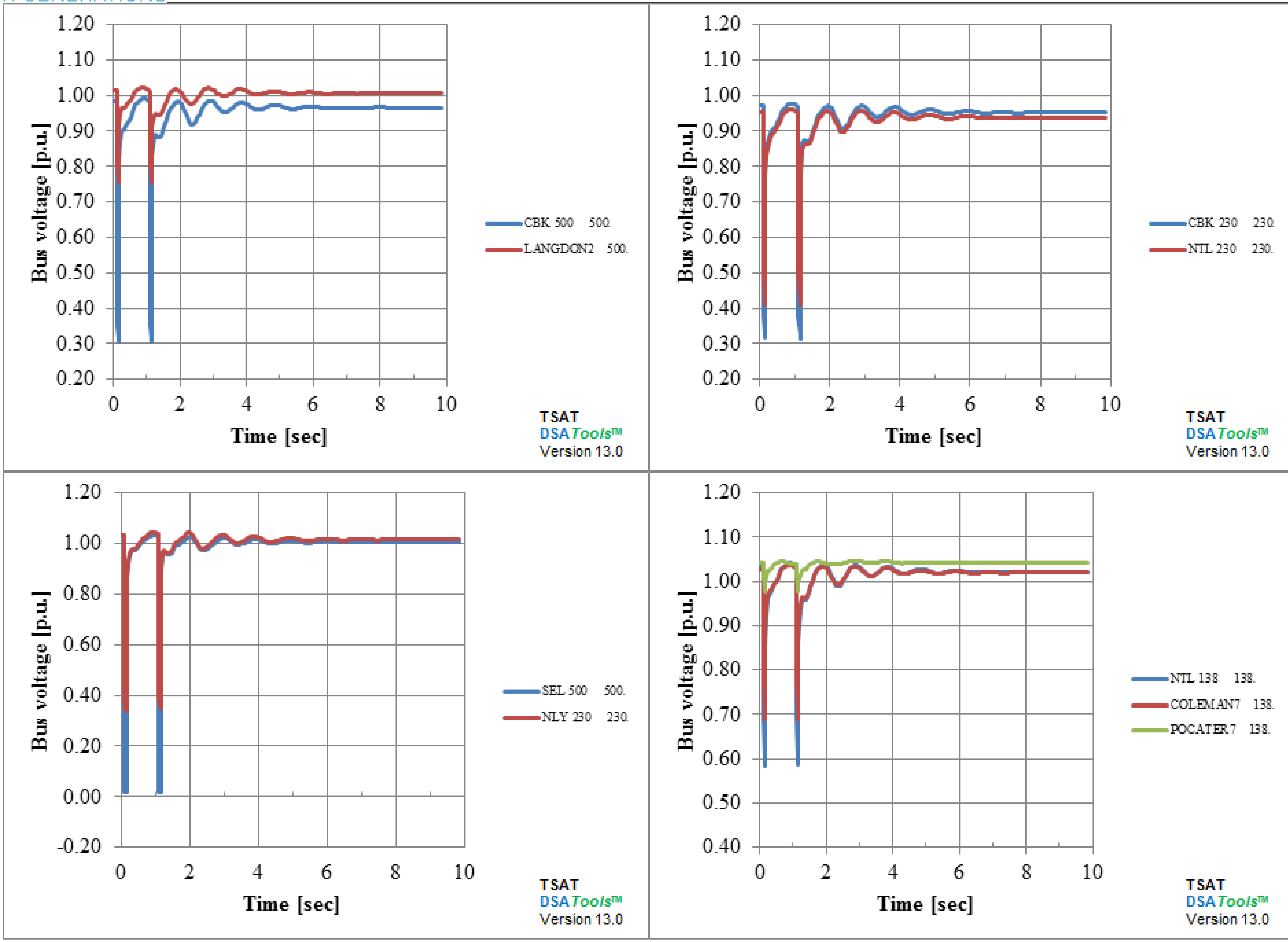
Line Power Flows **33 -- 2L294 CBK-NLY 3PH@CBK 230KV** **13hs_case3a (BC-AB = 1200MW)**



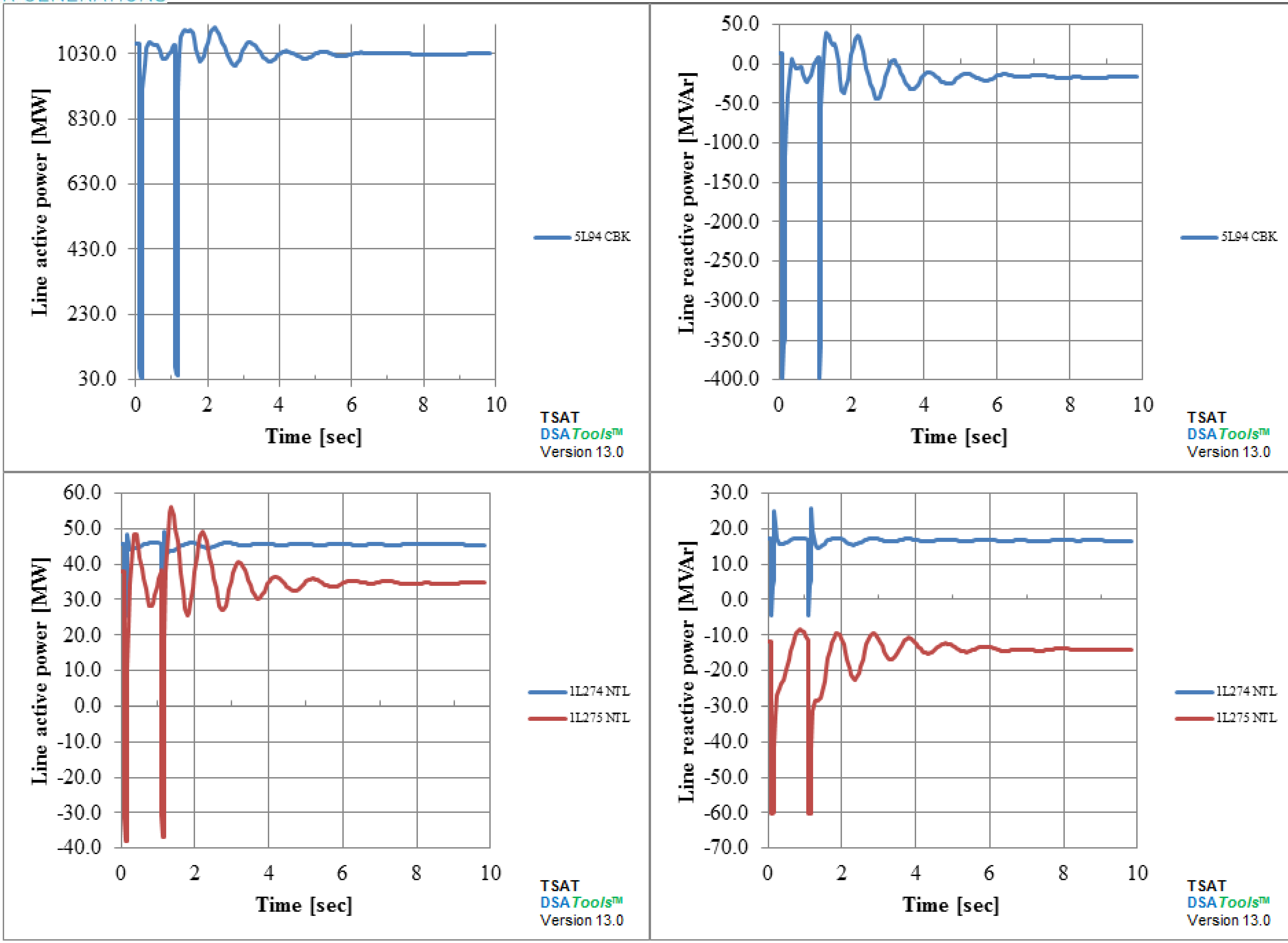
Generator MW Outputs **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hw2ae_case2a(BC-AB = 1100MW)**



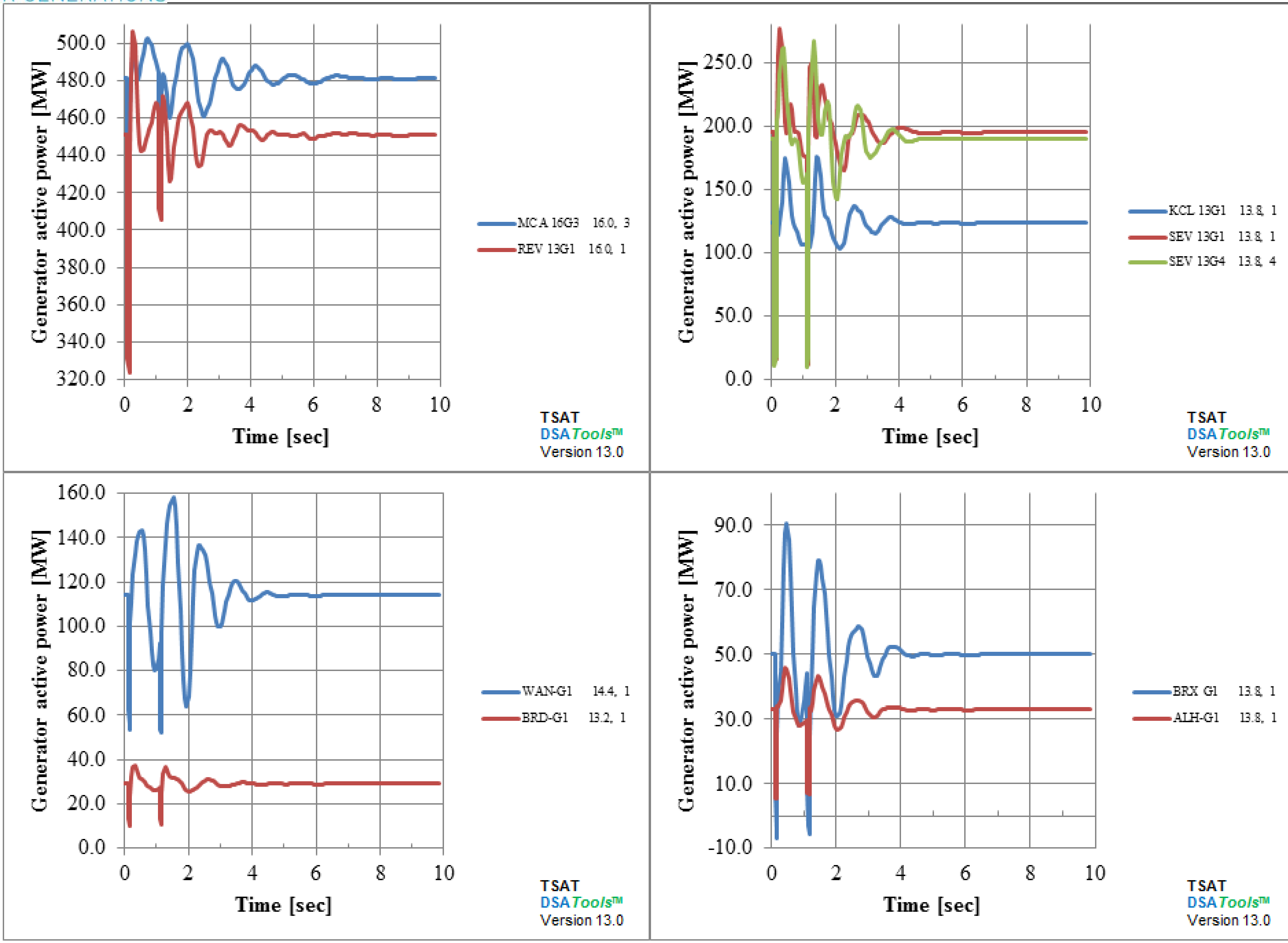
Bus Variables **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hw2ae_case2a(BC-AB = 1100MW)**



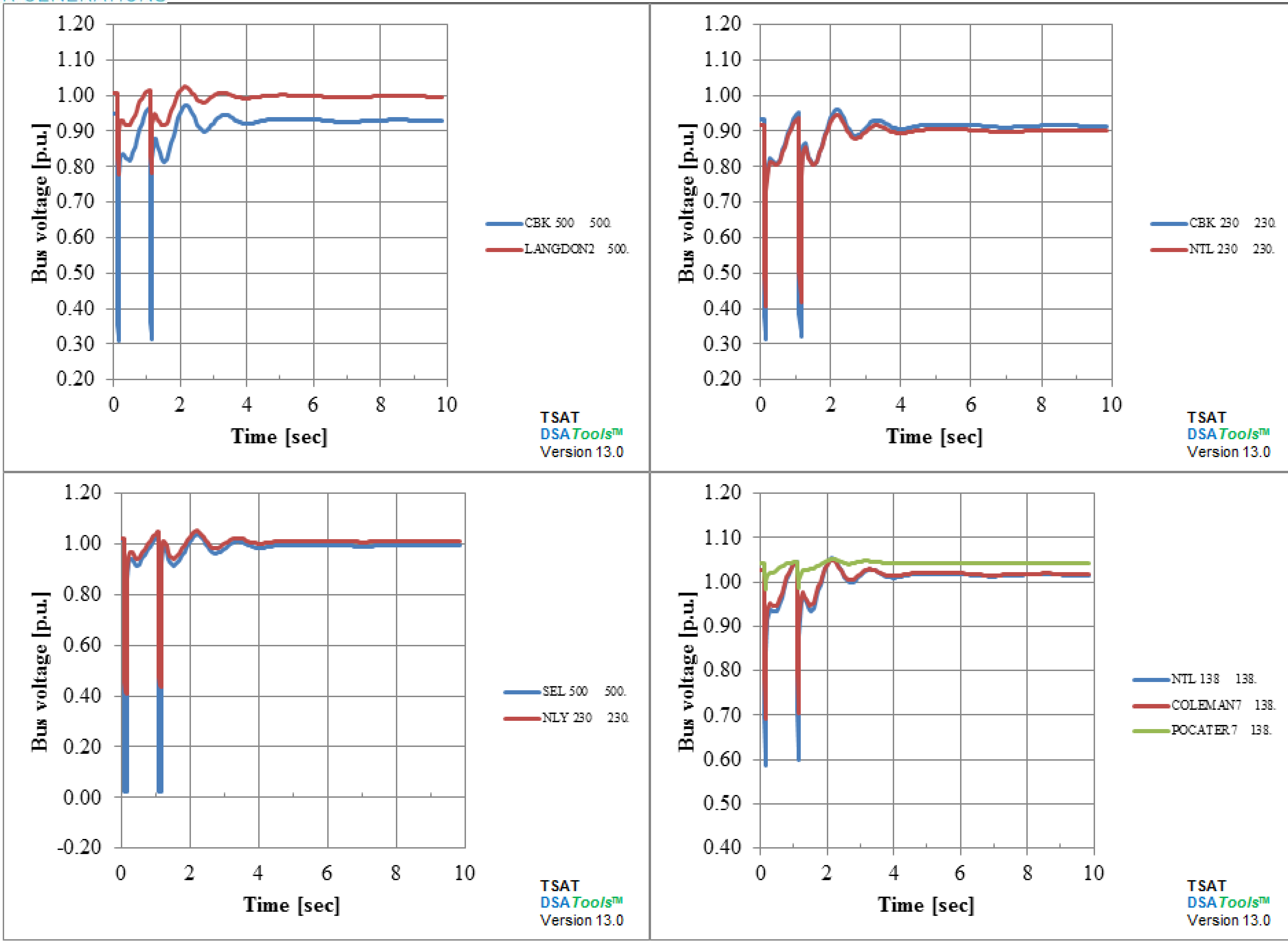
Line Power Flows **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hw2ae_case2a(BC-AB = 1100MW)**



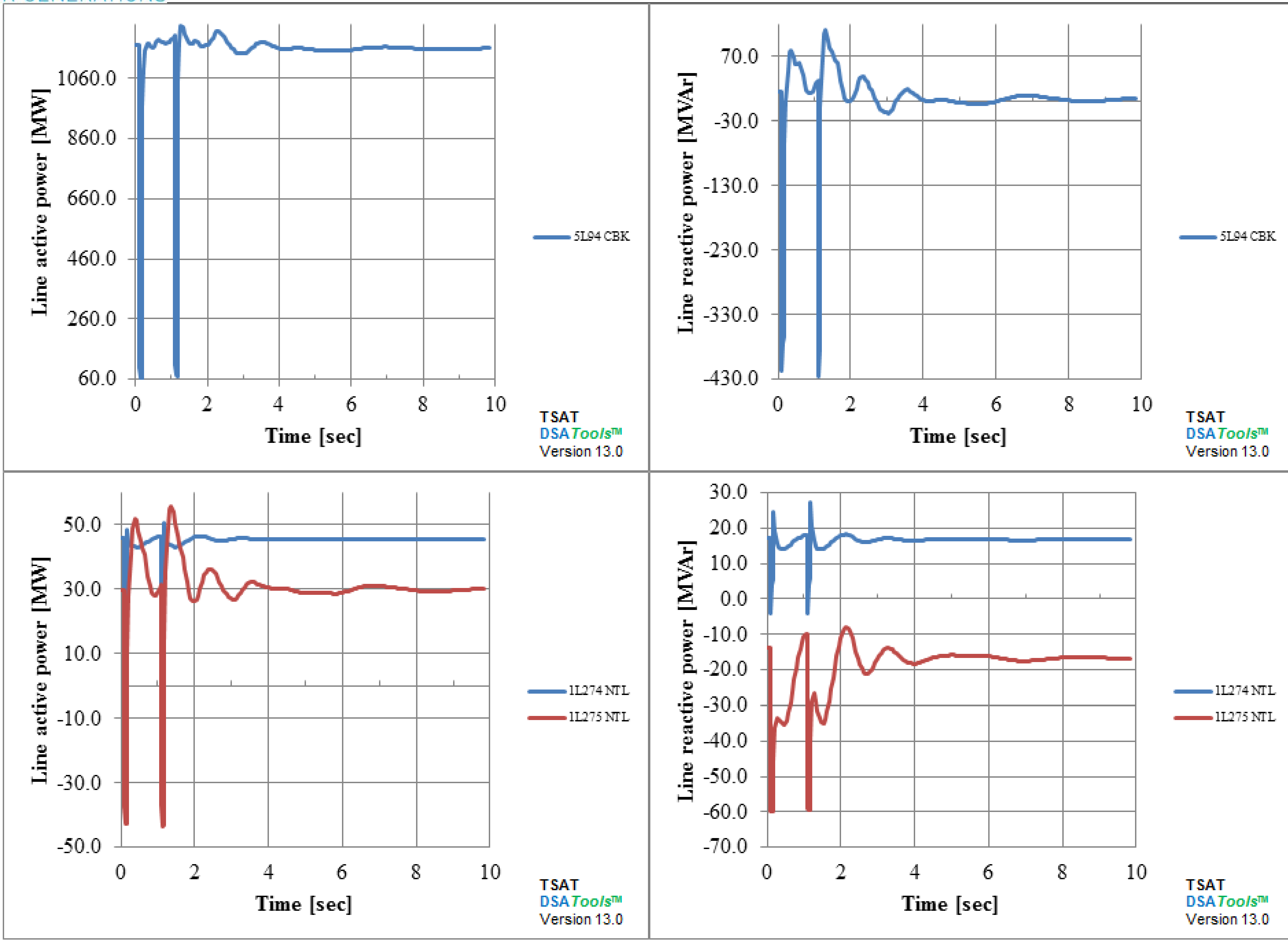
Generator MW Outputs **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hw2ae_case3(BC-AB = 1200MW)**



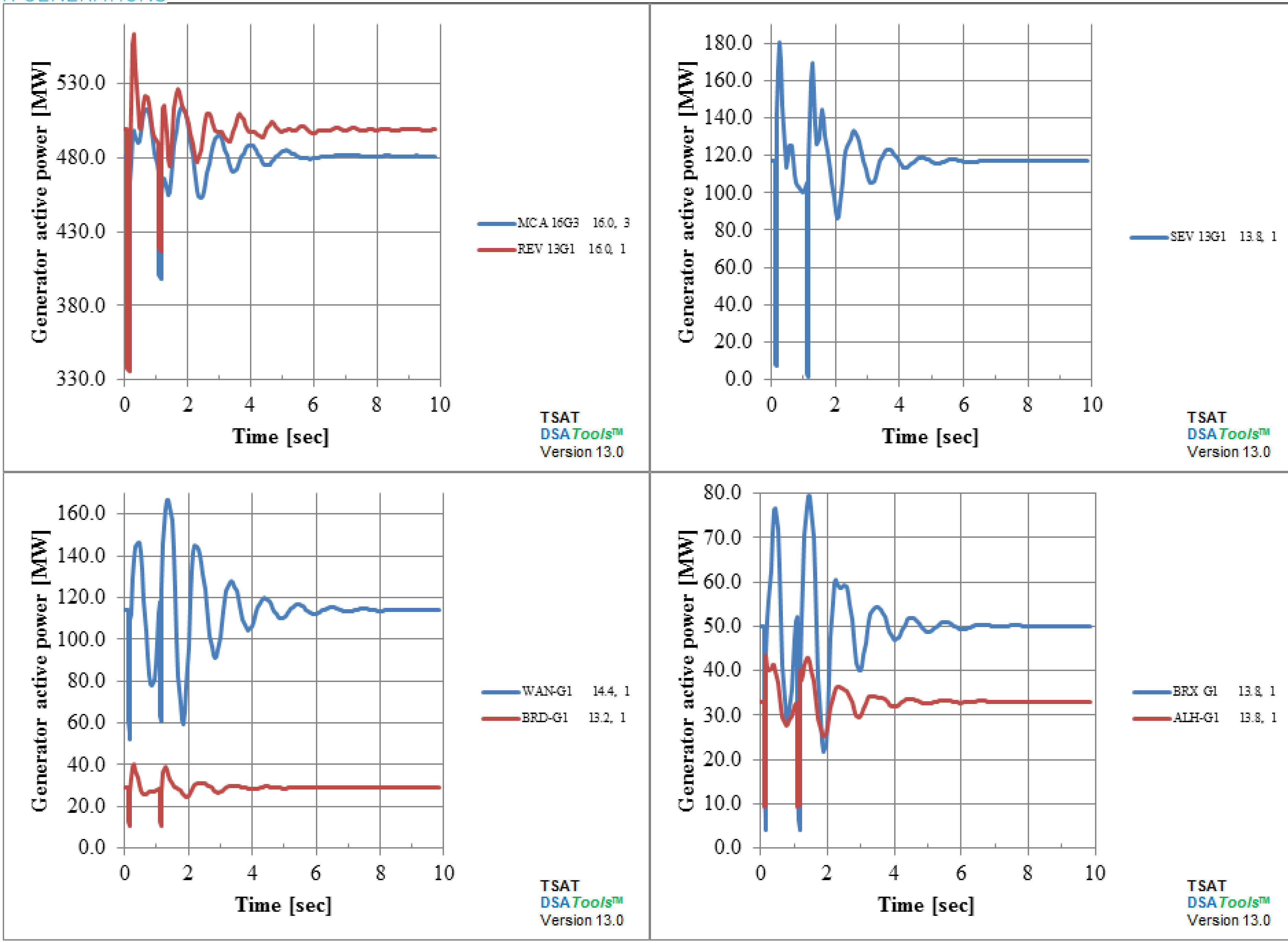
Bus Variables **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hw2ae_case3(BC-AB = 1200MW)**



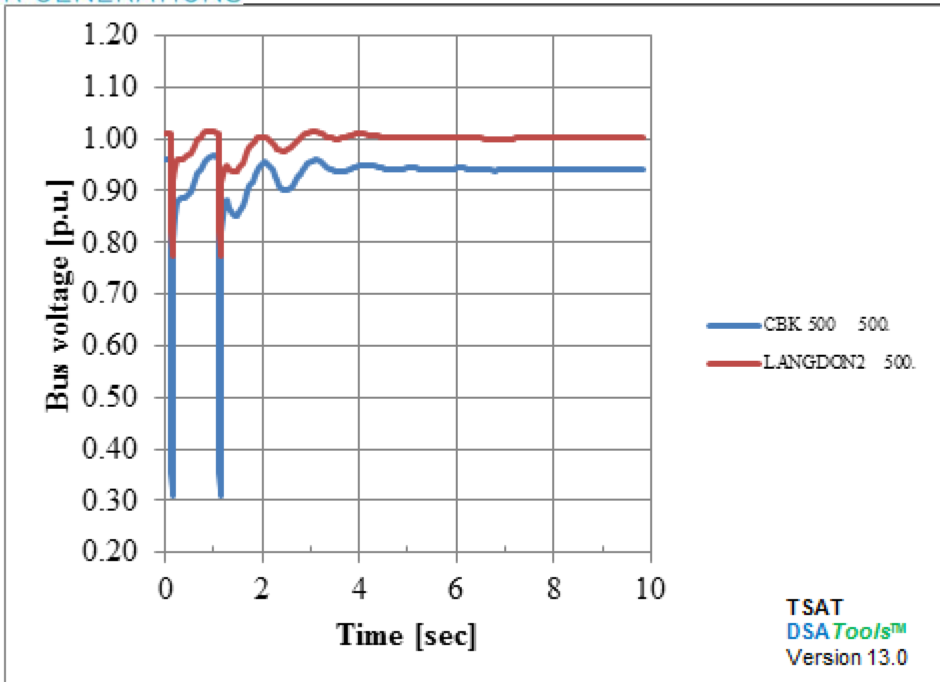
Line Power Flows **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hw2ae_case3(BC-AB = 1200MW)**

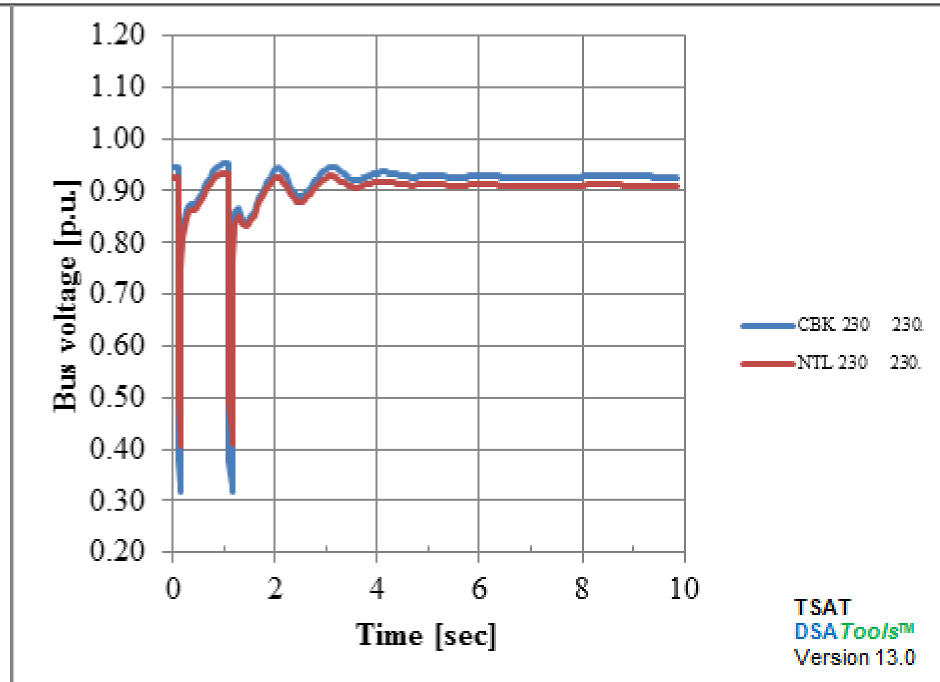


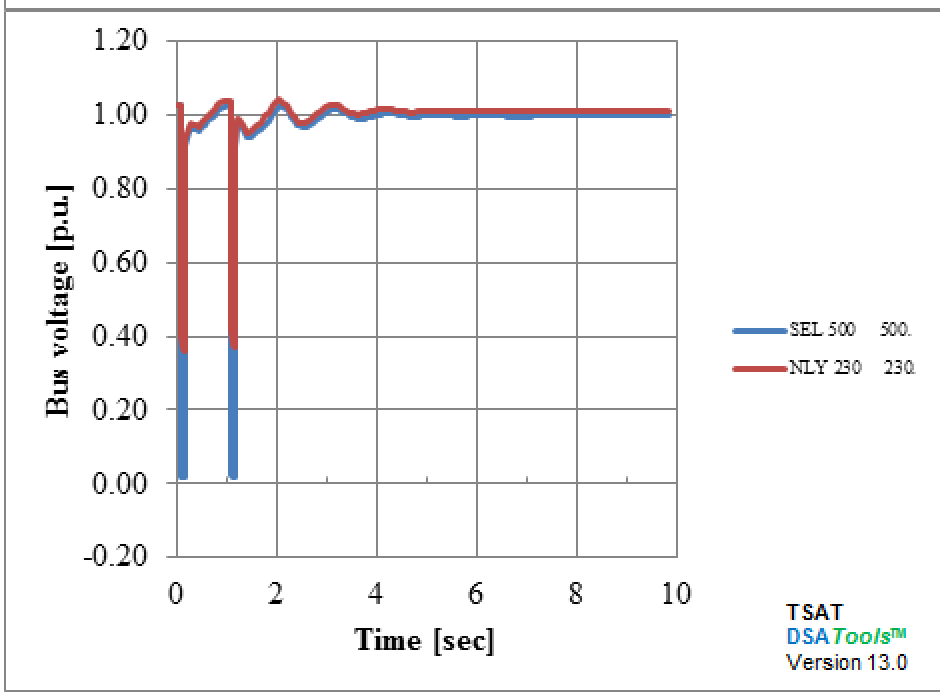
Generator MW Outputs **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hw2ae_case3b(BC-AB = 1200MW)**

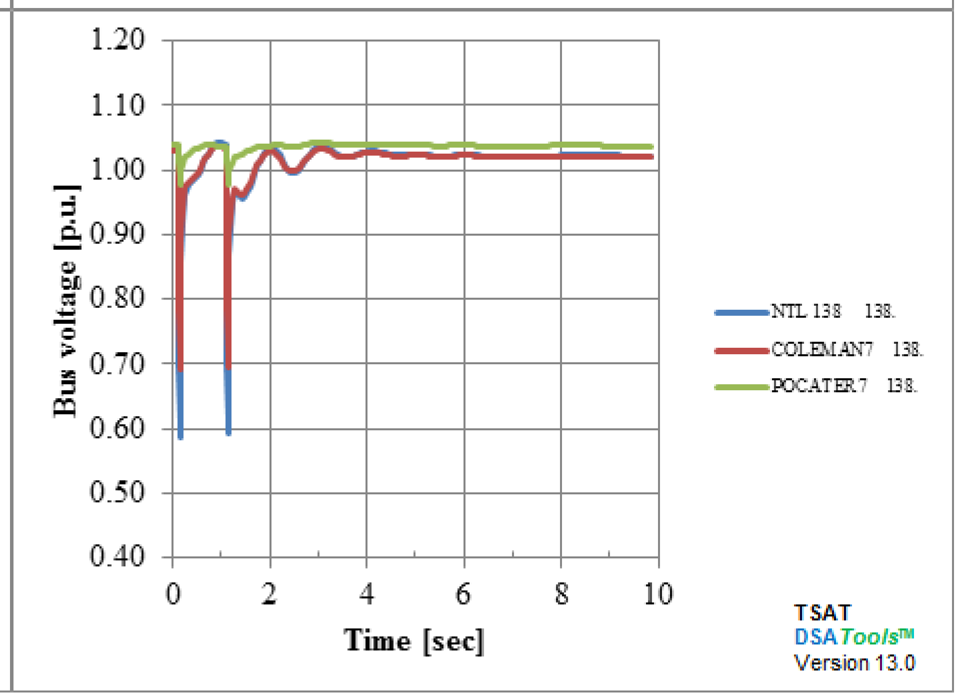


Bus Variables **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hw2ae_case3b(BC-AB = 1200MW)**

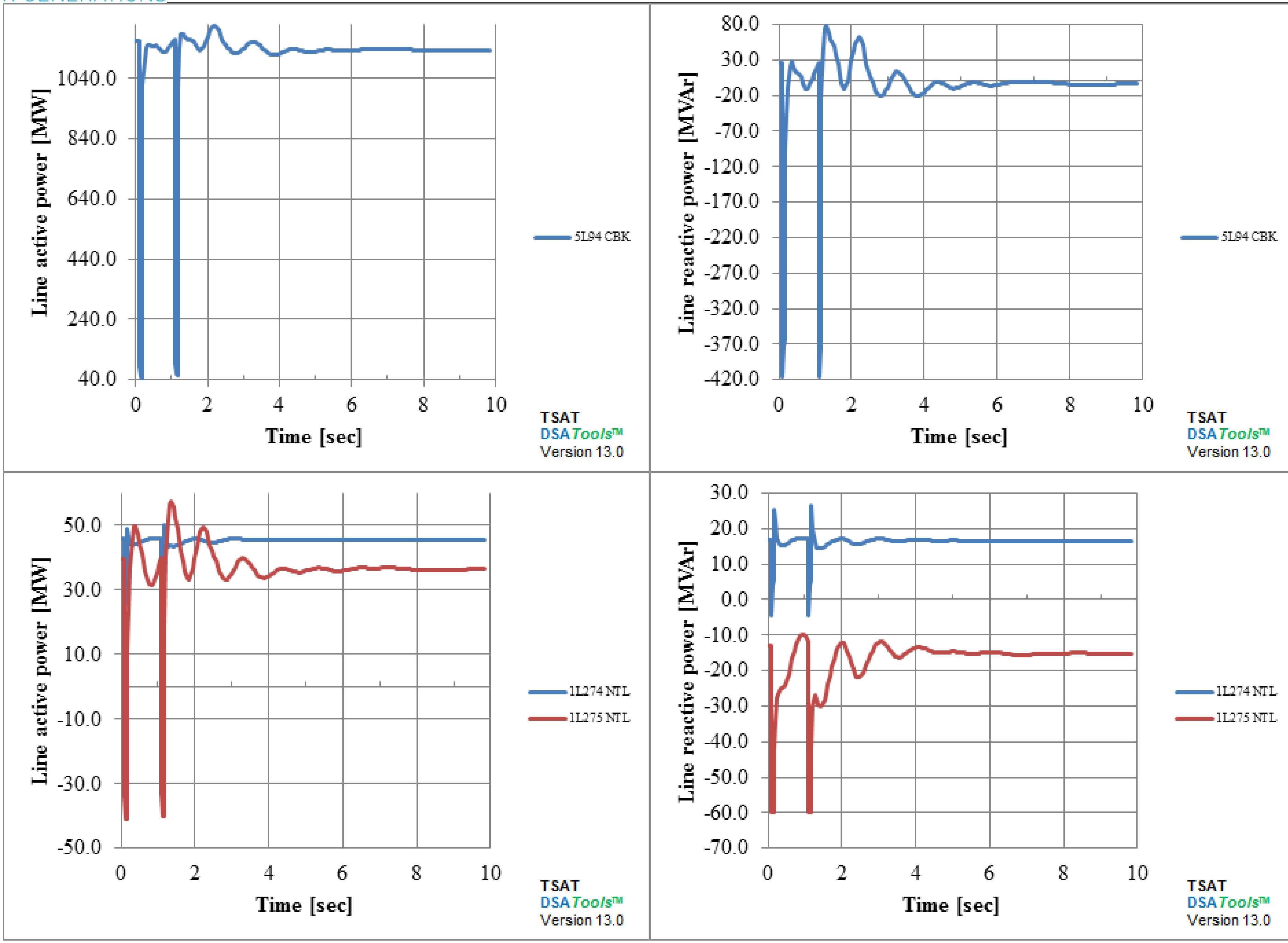




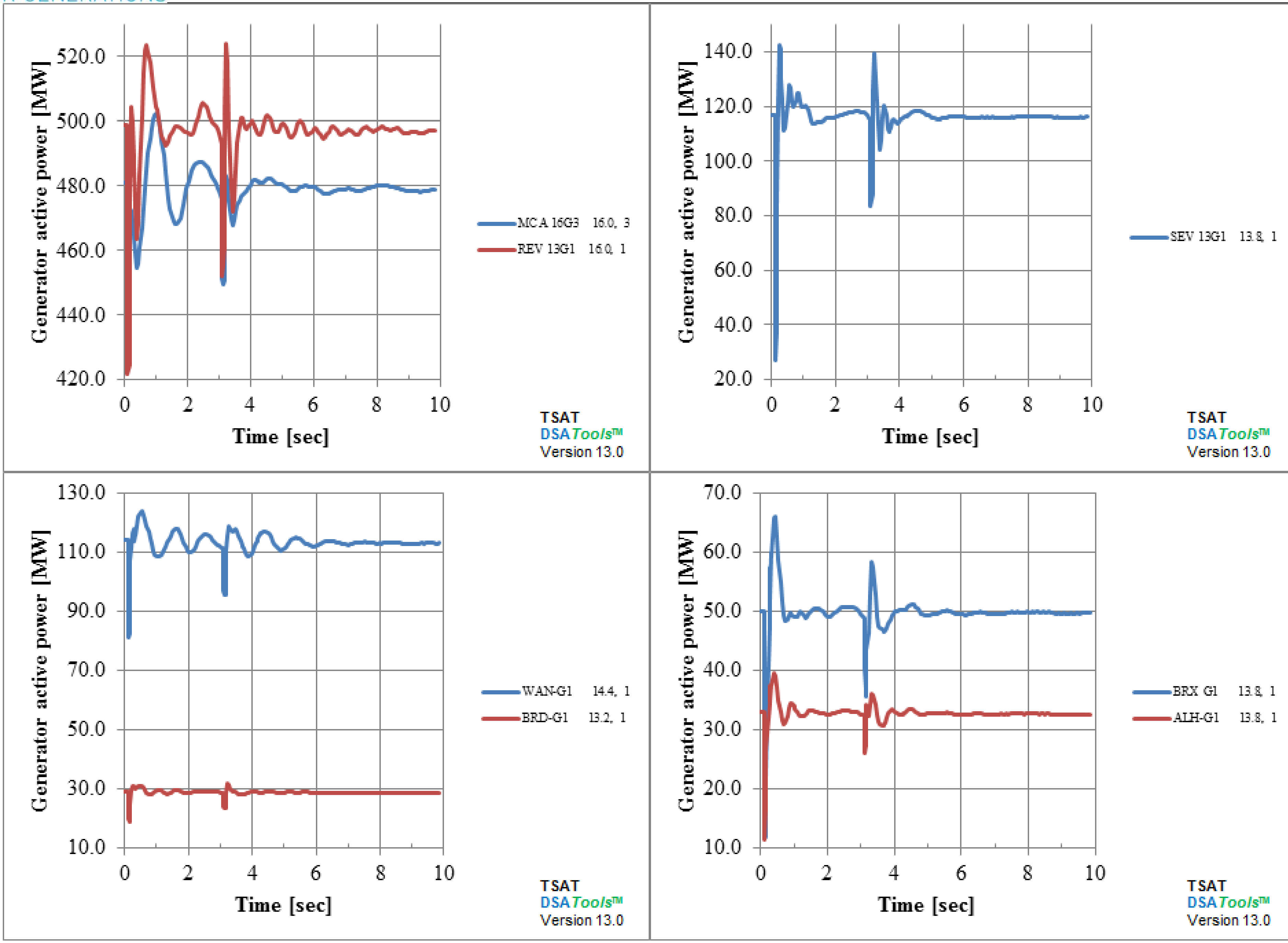




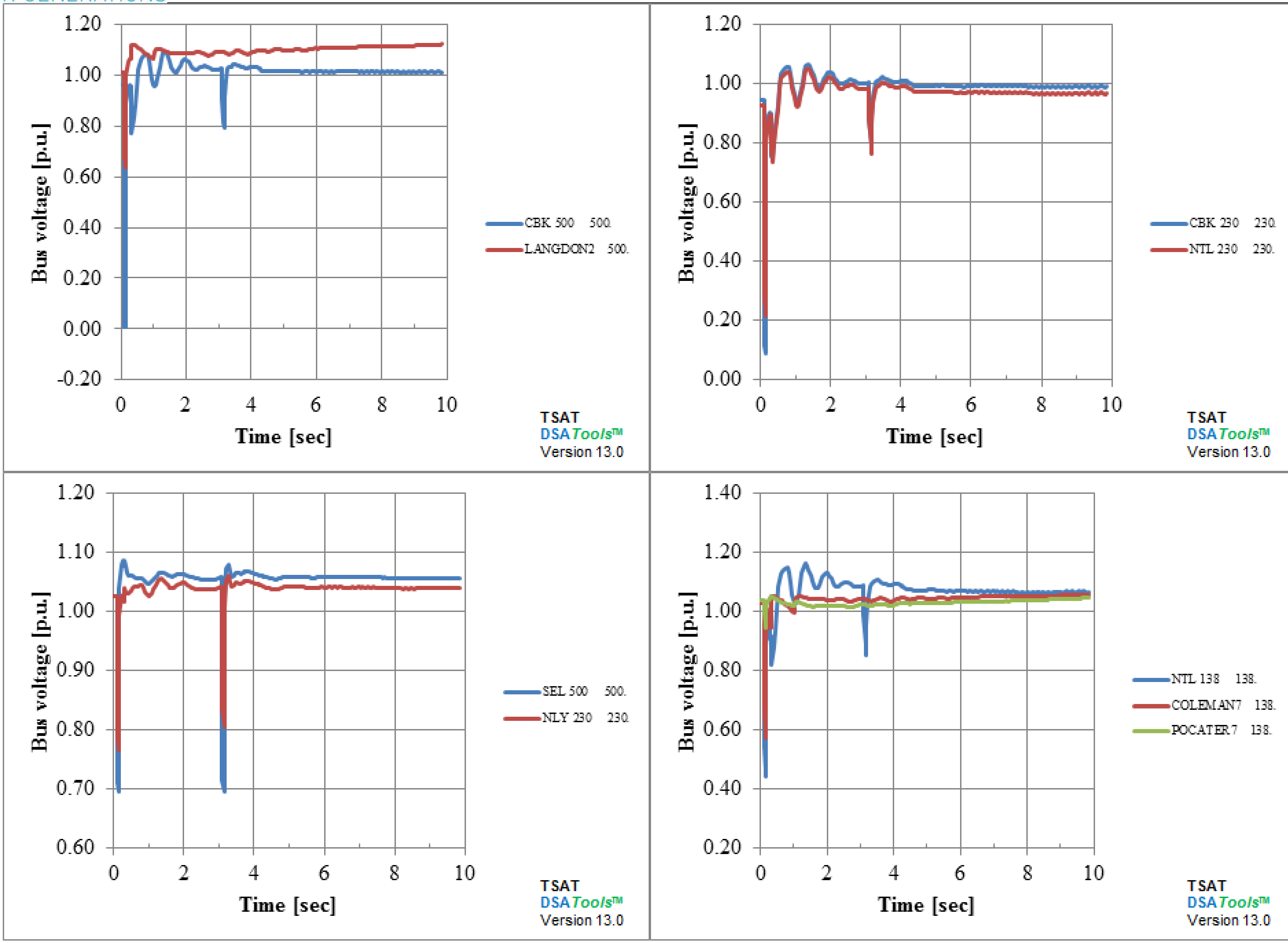
Line Power Flows **12 -- 5L91 ACK-SEL_2 3PH@SEL 500KV** **13hw2ae_case3b(BC-AB = 1200MW)**



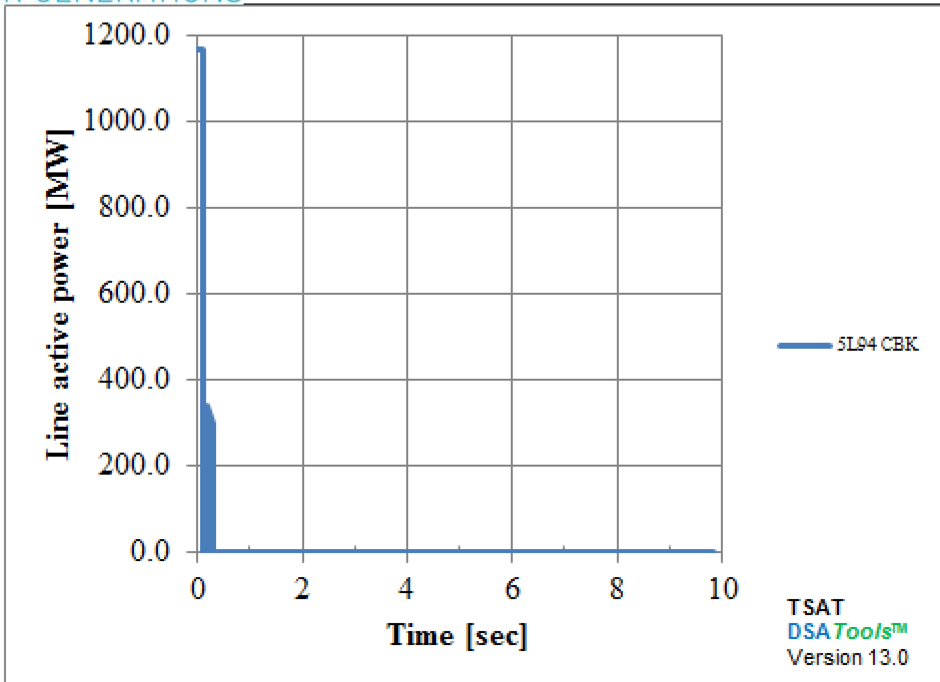
Generator MW Outputs **13 -- 5L92 CBK-SEL 3PH@CBK 500KV** **13hw2ae_case3b(BC-AB = 1200MW)**

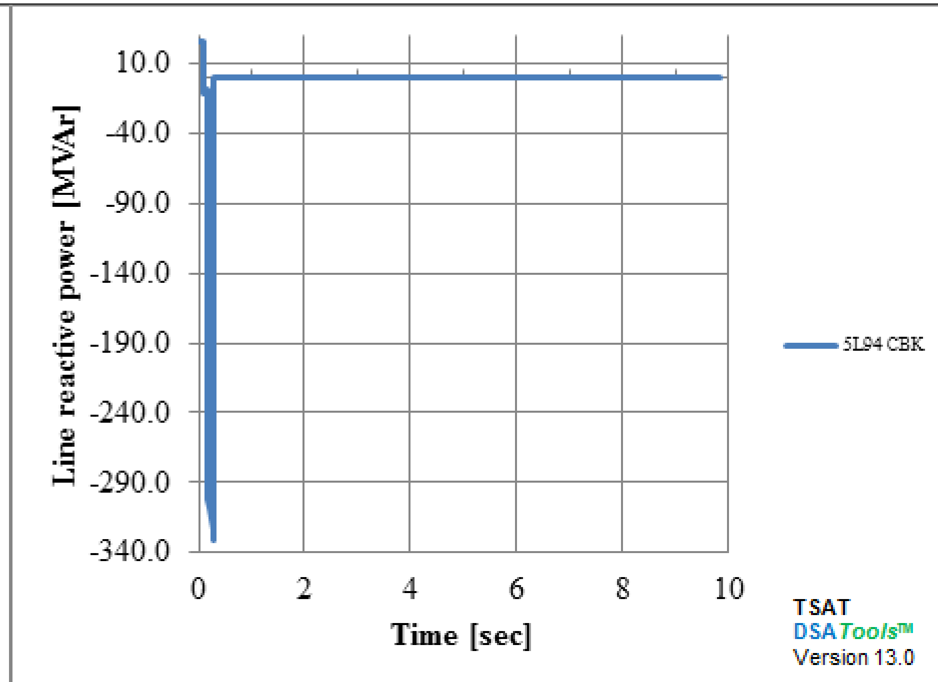


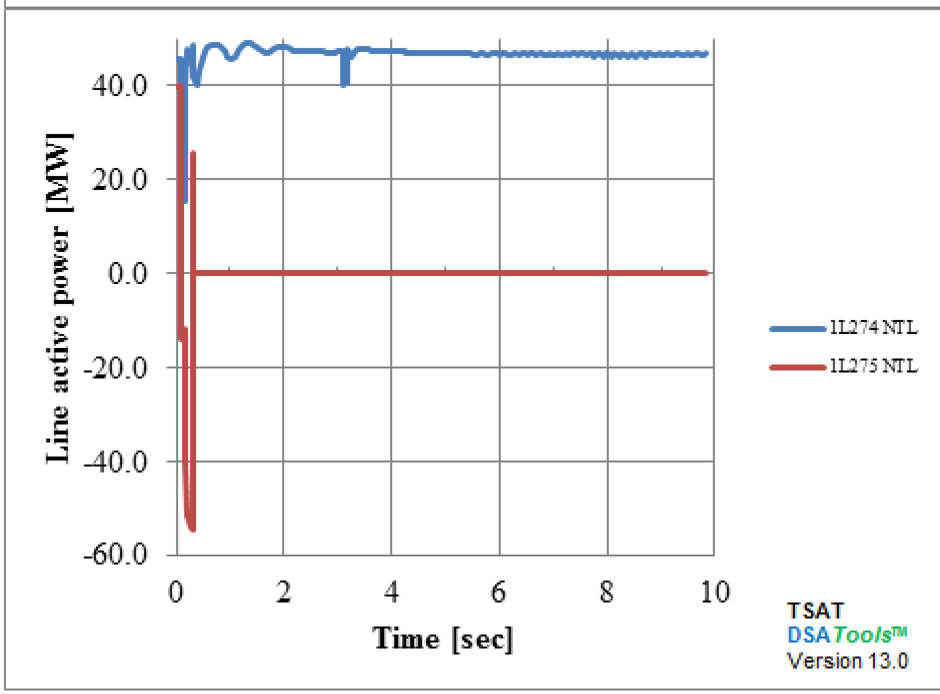
Bus Variables **13 -- 5L92 CBK-SEL 3PH@CBK 500KV** **13hw2ae_case3b(BC-AB = 1200MW)**

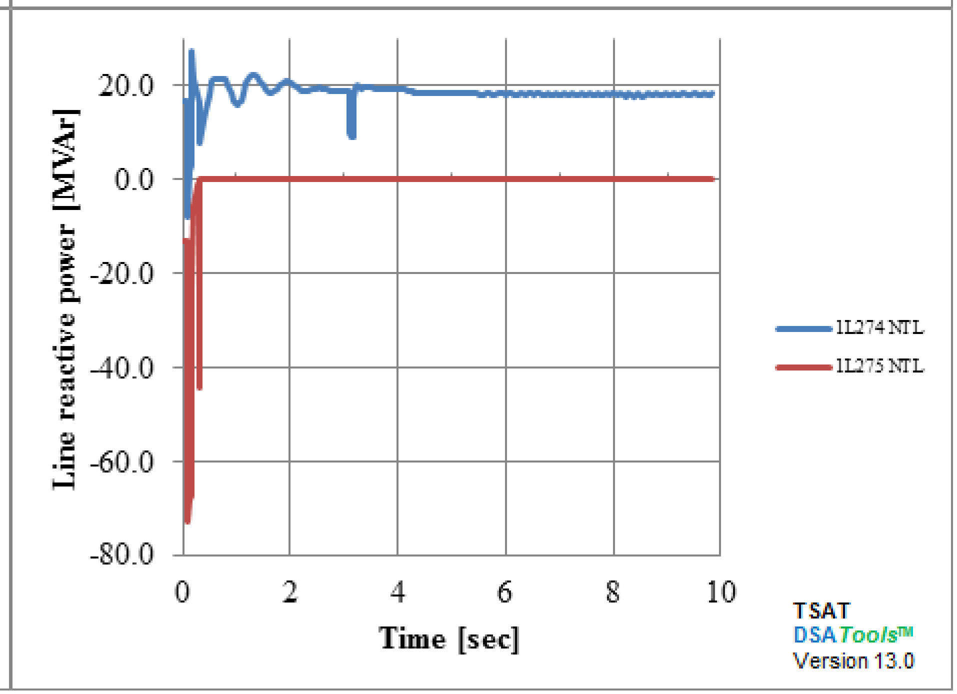


Line Power Flows **13 -- 5L92 CBK-SEL 3PH@CBK 500KV** **13hw2ae_case3b(BC-AB = 1200MW)**

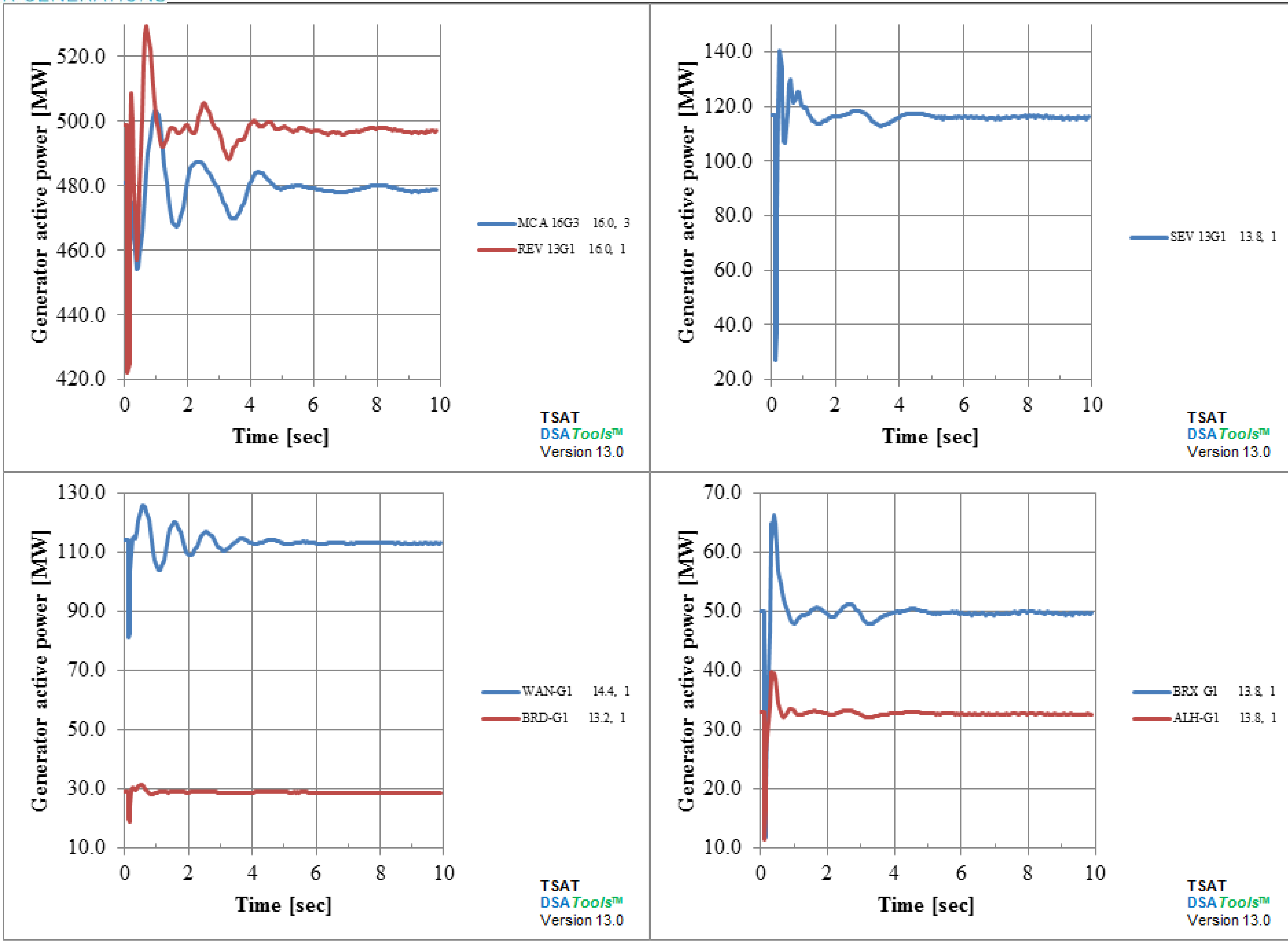




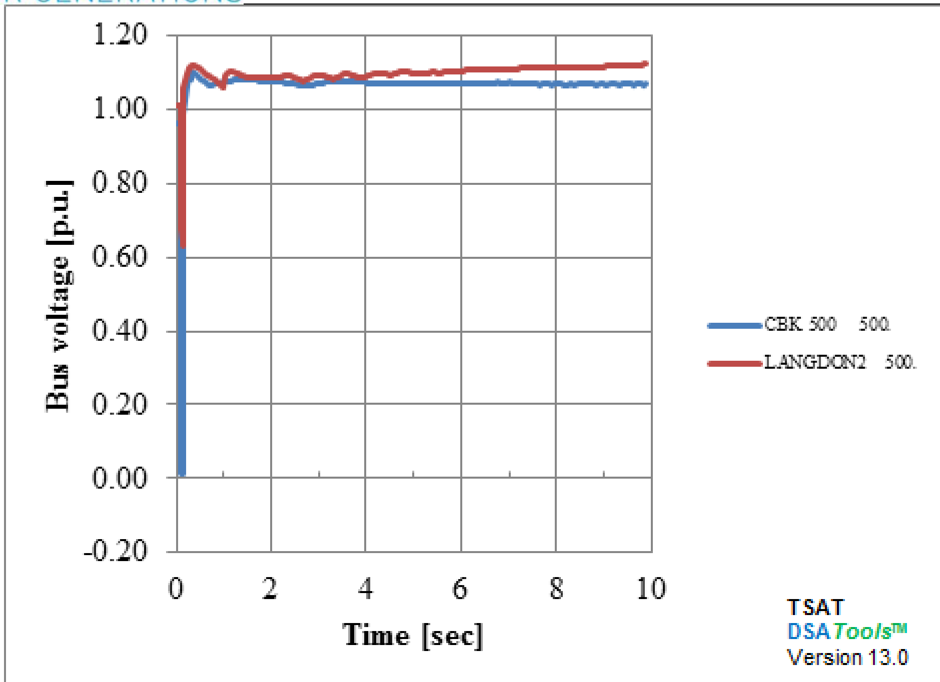


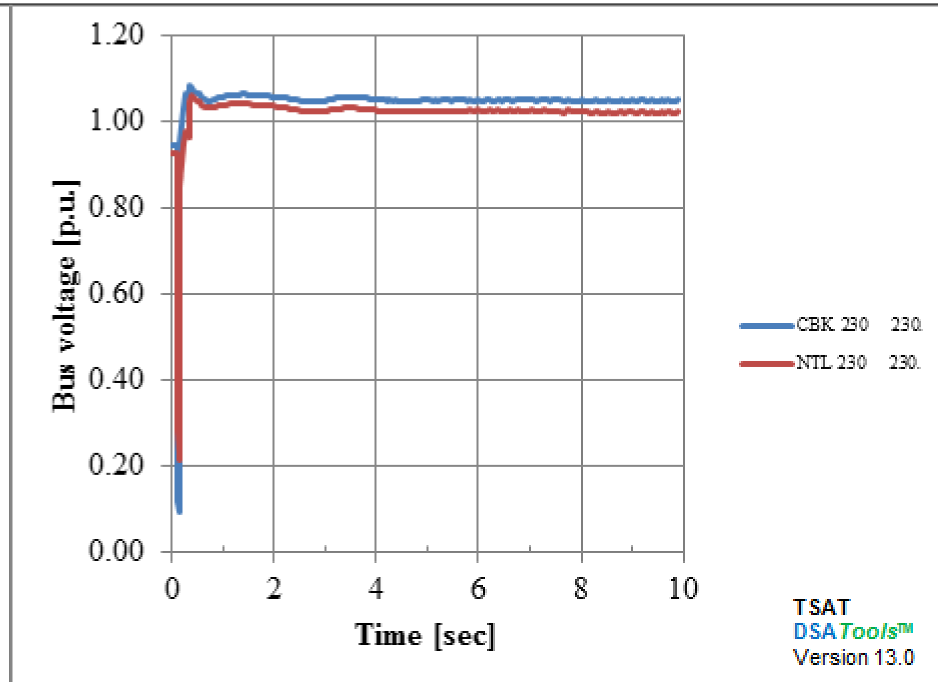


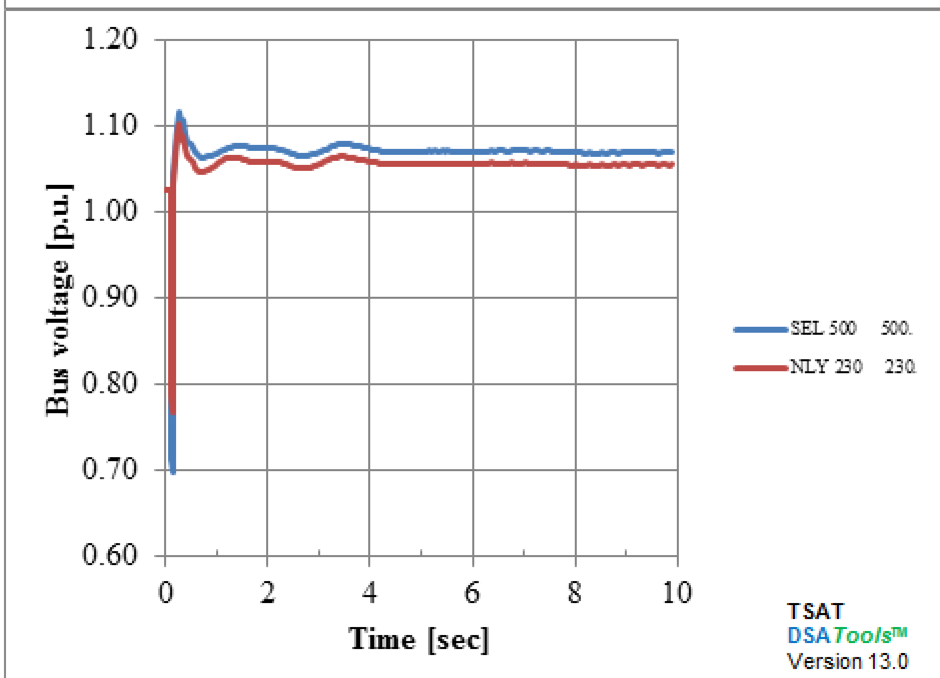
Generator MW Outputs **15 -- 5L94 CBK-LGN 3PH@CBK 500KV** **13hw2ae_case3b(BC-AB = 1200MW)**

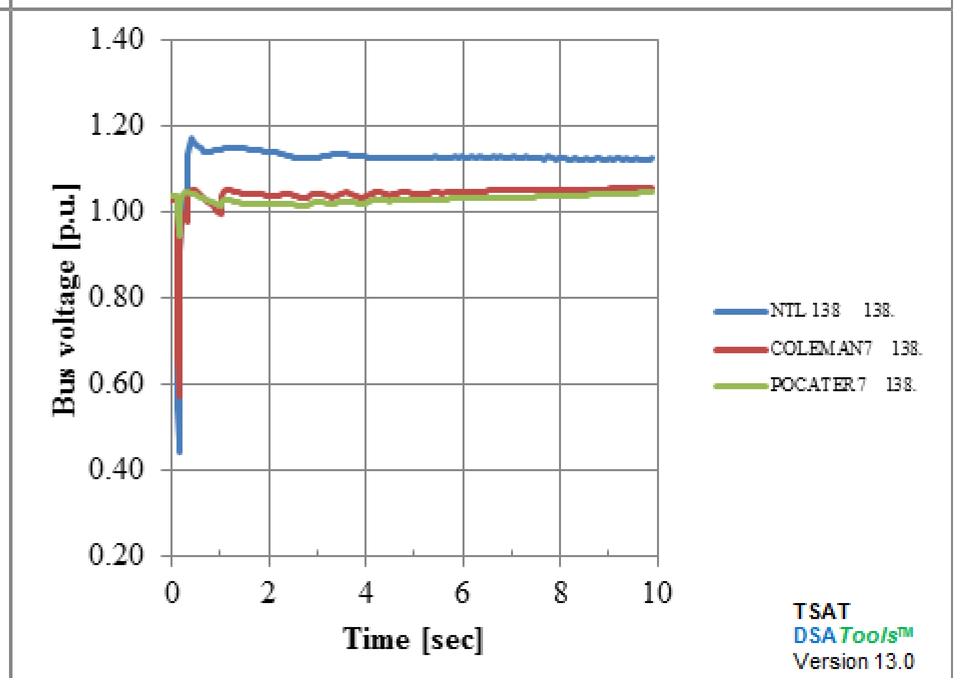


Bus Variables **15 -- 5L94 CBK-LGN 3PH@CBK 500KV** **13hw2ae_case3b(BC-AB = 1200MW)**

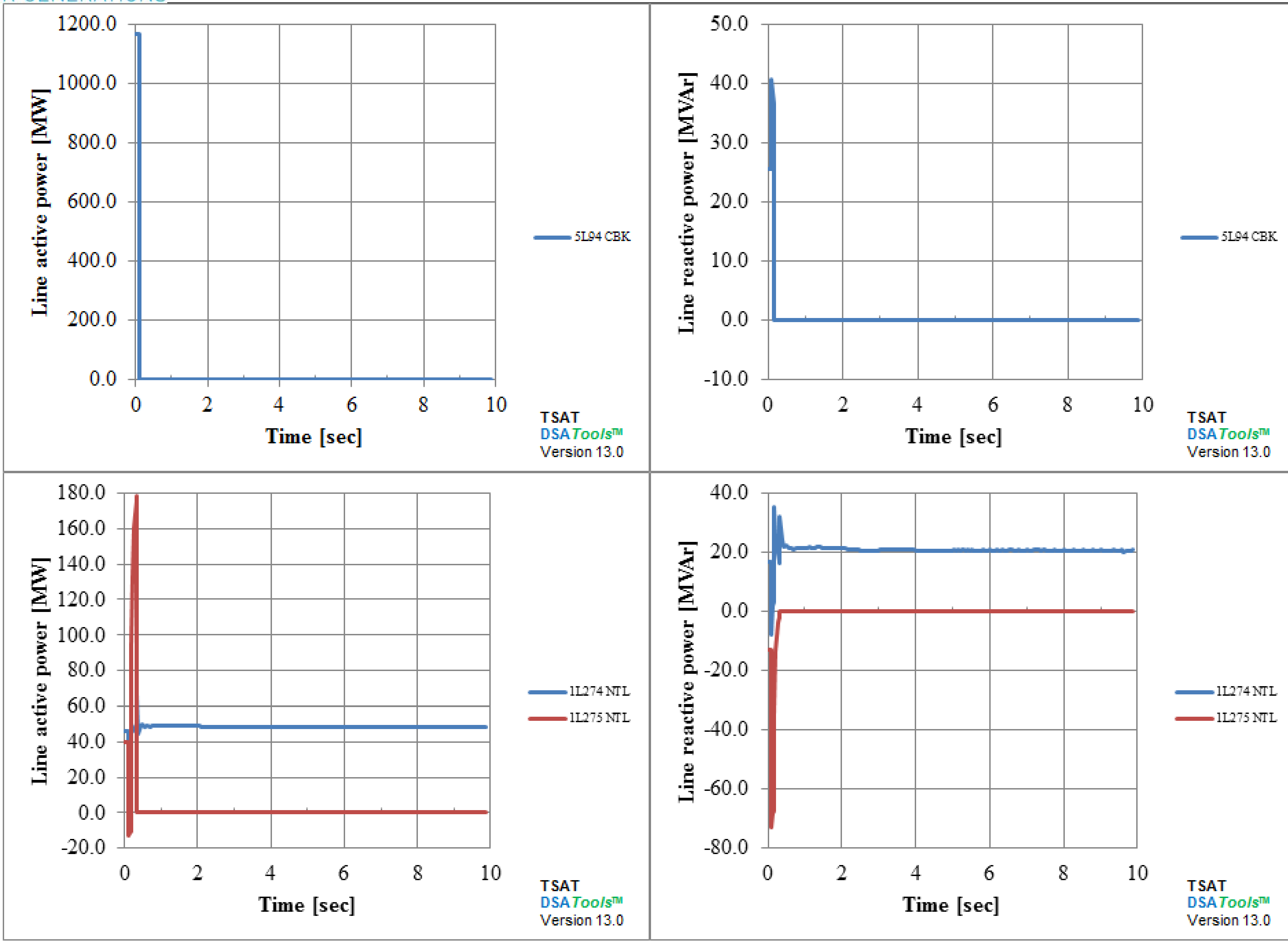




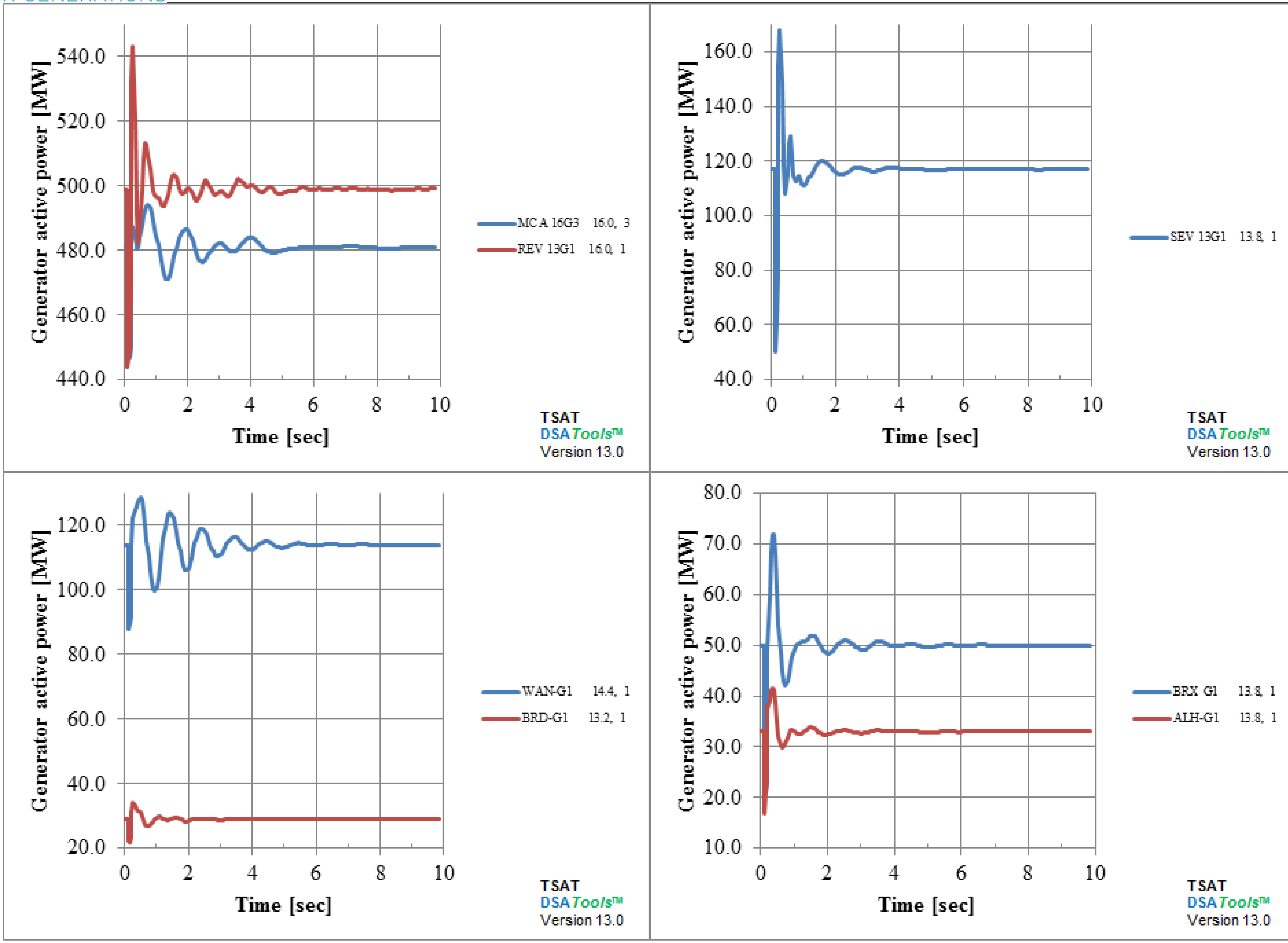




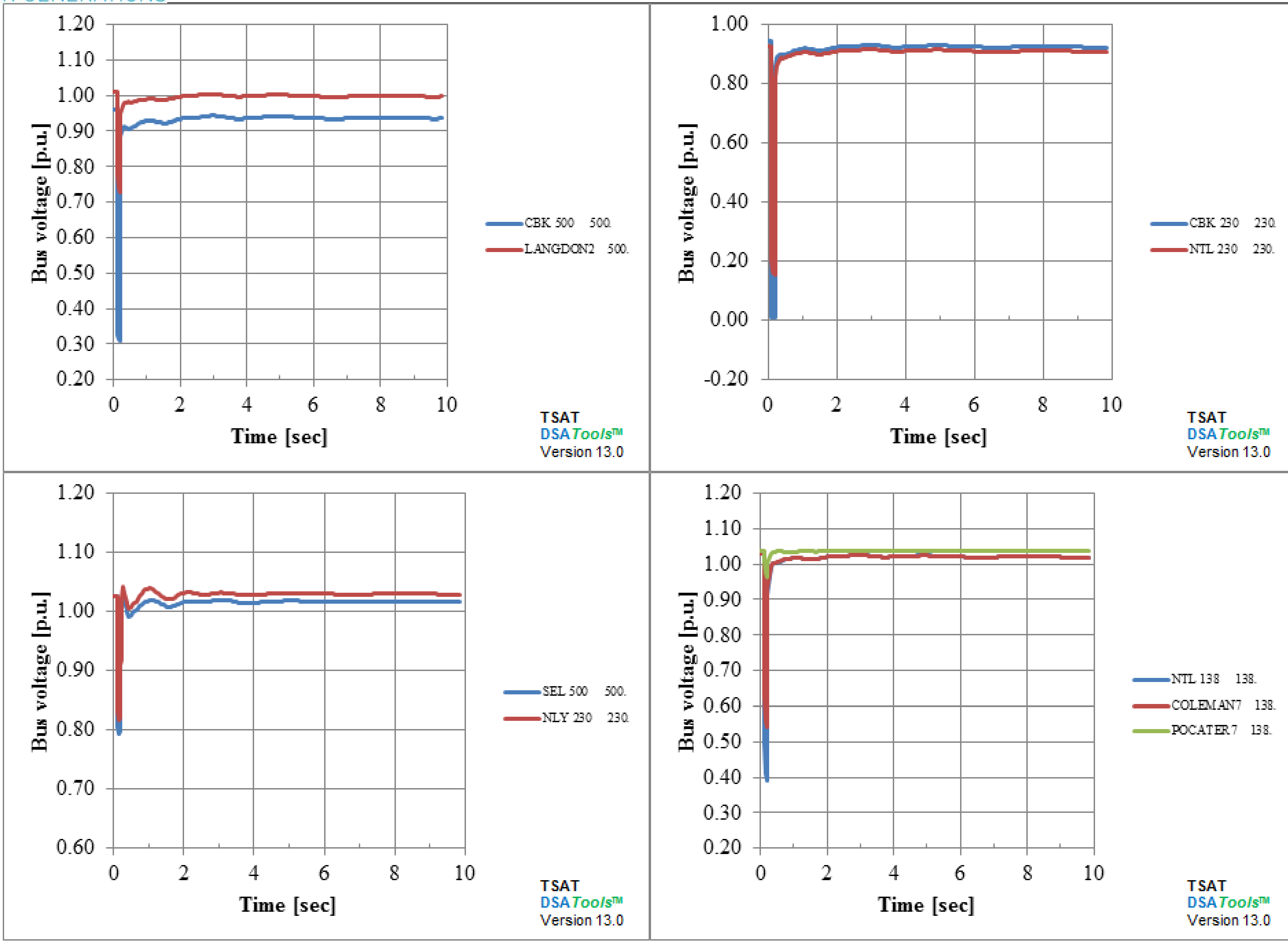
Line Power Flows **15 -- 5L94 CBK-LGN 3PH@CBK 500KV** **13hw2ae_case3b(BC-AB = 1200MW)**



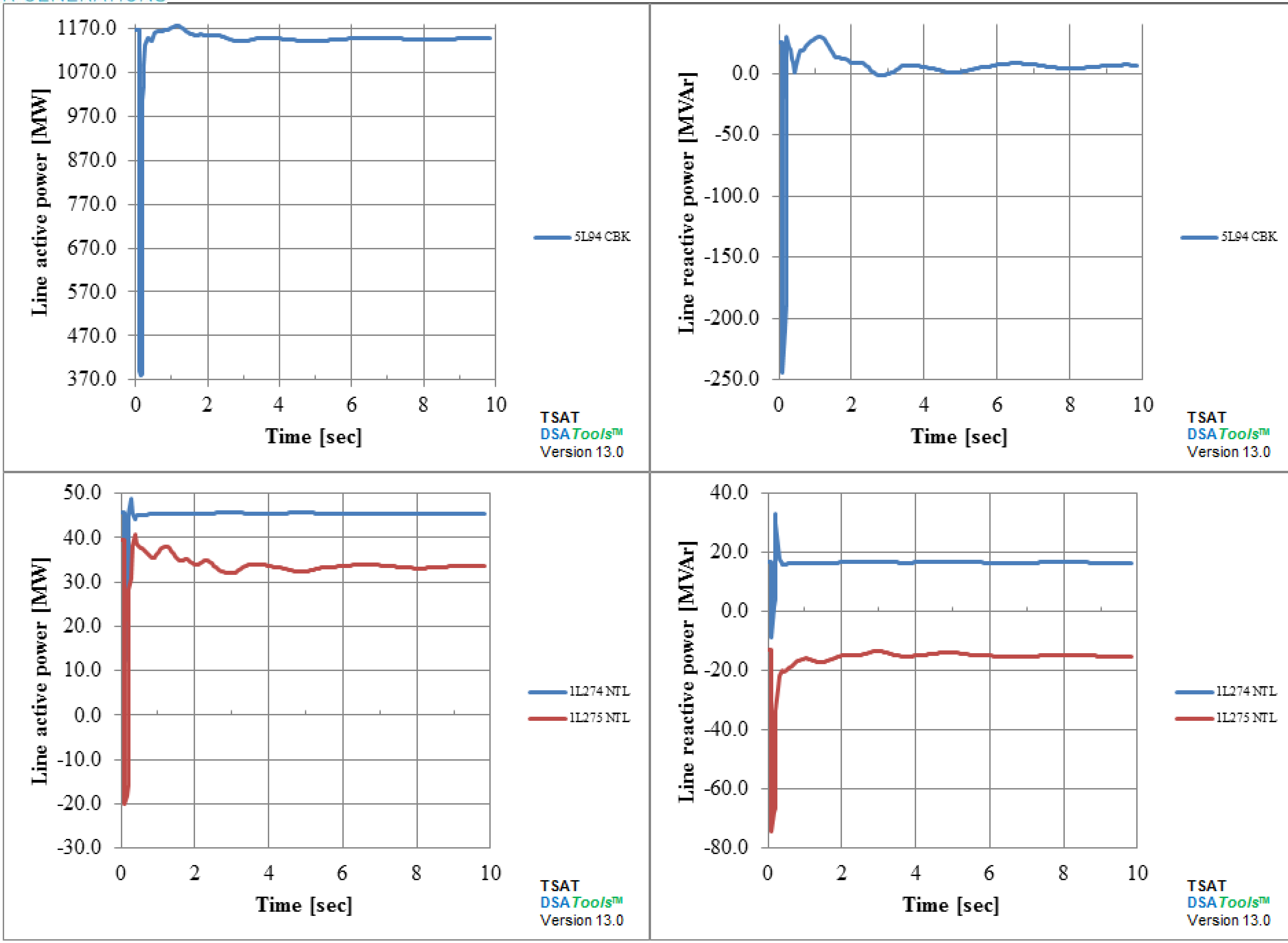
Generator MW Outputs **33 -- 2L294 CBK-NLY 3PH@CBK 230KV** **13hw2ae_case3b(BC-AB = 1200MW)**



Bus Variables **33 -- 2L294 CBK-NLY 3PH@CBK 230KV** **13hw2ae_case3b(BC-AB = 1200MW)**



Line Power Flows **33 -- 2L294 CBK-NLY 3PH@CBK 230KV** **13hw2ae_case3b(BC-AB = 1200MW)**


Line active power [MW]
Time [sec]
5L94 CBK
Line reactive power [MVAr]
Time [sec]
5L94 CBK
Line active power [MW]
Time [sec]
1L274 NTL
1L275 NTL
Line reactive power [MVAr]
Time [sec]
1L274 NTL
1L275 NTL
TSAT
DSATools™
Version 13.0

END OF REPORT