Path 1 Transfer Capability Restoration Study

Report No. Transmission & Stations Planning 2014-070

December 19th, 2014

Transmission and Stations Planning

This page left blank intentionally

ACKNOWLEDGEMENTS

The power flow, stability study and report are prepared by BC Hydro Transmission & Stations Planning in conjunction with Powertech Labs Inc. The establishment of BC Hydro system cases and the reviews of combined base cases are assisted by BC Hydro System Data and Modeling group and Performance Planning group. The combined system base cases are prepared by AESO and reviewed by BC Hydro. The new shunt reactor compensation requirement for 5L94 to accommodate the reduction of line length due to the establishment of a new Chapel Rock substation is performed by BC Hydro Stations Planning Analytical Studies. The planning cost estimate for the new equipment at BC Hydro Cranbrook substation is provided by BC Hydro Stations Planning.

BC Hydro:

Transmission & Stations Planning:	Steven Pai
System Data and Modeling:	Tito Inga-Rojas
	Jim Li
Performance Planning:	Guihua Wang
	Charlie Zuo
	Hamid Atighechi
Stations Planning:	Jack Sawada
	Dr. Anthony Ho

Powertech Labs Inc.: Dr. Khosro Kabiri
Dr. Akshaya Kumar Moharana

CONTENTS

DISCLAIMER

This Report was prepared solely for BC Hydro's internal purposes. All parties other than BC Hydro are third parties.

BC Hydro does not represent, guarantee or warrant to any third party, either expressly or by implication:

(a) the accuracy, completeness or usefulness of,

(b) the intellectual or other property rights of any person or party in, or

(c) the merchantability, safety or fitness for purpose of,

any information, product or process disclosed, described or recommended in this Report.

Nothing in this Report obligates BC Hydro to take any action with respect to the recommendations contemplated herein. BC Hydro does not accept any liability of any kind arising in any way out of the use by a third party of any information, product or process disclosed, described or recommended in this Report, nor does BC Hydro accept any liability arising out of reliance by a third party upon any information, statements or recommendations contained in this Report. Should third parties use or rely on any information, product or process disclosed, described or recommended in this Report, they do so entirely at their own risk.

COPYRIGHT NOTICE

EXECUTIVE SUMMARY

Further to the earlier separate studies on Path 1 by Alberta Electric System Operator (AESO) and BC Hydro (BCH) [1], a joint study is carried out in a coordinated manner by the two entities. This report documents the BCH portion of the joint study for restoring the Path 1 (BC to Alberta transmission intertie) transfer capability to its path rating of 1200 MW from BC to Alberta and 1000 MW from Alberta to BC [2]. This report covers the BC system constraints and mitigating measure options in BC. Issues and constraints in Alberta are not covered in this report. A separate report prepared by AESO covers the Alberta system study results.

The BCH study results and conclusions are based on studying the 48 base cases jointly established with AESO covering three years, 2014, 2017 and 2022. The base cases were established by each entity first preparing the base cases of their respective systems, which include their respective planned projects and anticipated loads up to and including 2022. Then the separate cases were combined to form the base cases for the joint study. Two network configurations were studied for 2017, one before the completion of the new Alberta 500/240kV Chapel Rock project and one after the Chapel Rock. For each year and its corresponding network configuration, 12 base cases have been established, covering winter peak load, summer peak load and summer light load conditions with corresponding potential tie line flows on Path 1 (BC to Alberta), Path 3 (BC to US), and MATL (Montana to Alberta 230kV tie). BC Kootenay area generations near Selkirk substation and Alberta wind generation levels are additional variables incorporated in the base cases for assessing their effect on Path 1 capability.

For the purposes of focusing on restoring the 500kV tie transmission capability to path rating as the key issues of this study, it was agreed by both parties that the 138kV BC to AB ties are to be opened to avoid overloading during high transfers. The approach is considered adequate for the purpose of this study as the measure is consistent with the present operating practice.

Changes to the study conditions and assumptions of either system could affect the outcome of the conclusions.

Power flows and stability analyses have been employed to assess the pre and post disturbance performance of BC system with high Path 1 transfers. Credible contingencies in BC including single and double contingencies have been applied. Contingencies in Alberta and their impact to Path 1 are to be covered in the AESO study and report.

The BC Hydro study results can be summarized below:

<u>For BC to AB 1200 MW transfer</u>

1. For the system prior to Chapel Rock under favorable conditions and with the 138kV ties opened, 1200 MW transfer to AB could be achieved provided that the risk of tie tripping from temporary single line to ground fault on 5L92 or 5L94 is acceptable. The favorable

opportunities diminish as system load increases with lowered system voltages. The impact of double contingencies is manageable with the existing RAS functions.

2. Under most circumstances prior to Chapel Rock, 1200 MW transfer could not be realized. CBK and NTL area system voltages are generally very low which could lead to the following issues.

    a. The 500kV tie to Alberta will be tripped by single line to ground fault on 5L92 or 5L94.
    b. Loss of 2L294 or 5L91 could cause very low voltages and perhaps voltage instability.

    The above limitations would become worse as area system load increases from 2014 to 2017. To mitigate the unacceptable system performance, BC to AB transfer limit needs to be reduced and/or Kootenay area reliability must run generation needs to be raised to avoid potential under voltage conditions or voltage collapse after a single contingency.

3. High generation from wind farms in AB further degrade the system performance due to lower Langdon voltages compared to no wind cases.
4. Operation instructions to account for the AB wind generation effect, Kootenay area generation dispatch and some generation shedding rules may need adjustment based on 1200 MW transfer.
5. Potentially large voltage variations occur at CBK and NTL as tie line flow changes. In addition, loss of 5L92 or 5L94 would cause temporary high voltages at these buses although the long term steady state voltages after regulation are acceptable. Having a dynamic device capable of responding to fast voltage variations would be desirable.
6. If the 1200 MW BC to AB transfer is to be achieved for all studied scenarios prior to Chapel Rock from a purely BC system perspective without considering the more limiting constraints in AB, one option is to reinforce the system by providing var support at CBK. For understanding purposes, a cursory assessment shows that adding a 100 Mvar shunt capacitor and a +/-250 Mvar SVC or STATCOM at CBK would provide adequate response to various contingencies. In addition, it will also automatically regulate the area voltages while transfers change. The estimated cost for high level planning purposes is about $56 million.
7. Connecting the Chapel Rock to 5L94 at about 110 kM from Cranbrook and keeping the existing 500kV 122.5 Mvar line end reactor at CBK could cause equipment switching concerns. To address this issue and also to provide sufficient compensation for achieving successful single pole reclose in less than one second, the 122.5 Mvar reactor needs to be replaced, possibly with two 500kV 35 Mvar line reactors, one at CBK and the other at Chapel Rock according to the preliminary BCH analytical study results. The estimated cost for replacing the CBK 500kV line end reactor with a 35 Mvar unit is about $6M, for this study purpose. The Chapel Rock substation may be located 150kM from Cranbrook, depending on the outcome of site selection. The line end reactors will need to be properly sized to ensure the resulting single pole reclose time is sufficiently fast for the maximum transfers.
8. After Chapel Rock is in service, 1200 MW BC to AB transfer could be achieved without the risk of 5L94tripout from temporary single line to ground fault on 5L92 or 5L94, and also the unacceptable post outage steady state voltage after loss of 2L294 or 5L91.

For AB to BC 1000 MW transfer

9. During summer, the existing system could carry 1000 MW import from Alberta, however subject to the risk of tie tripping from some single contingencies and double contingencies. The risk could be mitigated by enabling generation shedding in AB to reduce the transmission stress from the source, thereby preserving the tie. A partial solution alternative is curtailing generation in Kootenay area which is less effective and may not prevent tie tripping under certain conditions.
10. With Chapel Rock in service, tie tripping due to some contingencies may be avoided.
11. System operating instructions need to be updated to reflect the increased import.
12. Import from AB needs to be coordinated with import from US and possibly other path flows to prevent the risk of potential inter area oscillation caused by the simultaneous loss of 5L91 and 5L96.

1. INTRODUCTION

Further to the earlier separate studies on Path 1 by Alberta Electric System Operator (AESO) and by BC Hydro (BCH), this is a joint study carried out in a coordinated manner by the two entities to assess their respective internal constraints that limit the Path 1 transfer capabilities between BC and Alberta (AB) and determine means to restore the capabilities for the present and future systems. Jointly prepared base cases with systems modeled by the respective entities that reflect the combined system conditions of Path 1 transfers are used in the study. Means to alleviate the constraints within the respective systems for restoring the transfer capability to the path rating (1200 MW BC to AB and 1000 MW AB to BC) are explored with power flow and transient stability analysis. For this study purpose, Path 1 500kV connection is referring to either the 500kV line from Cranbrook to Bennett/Langdon or the line from Cranbrook to Chapel Rock substation when the new Alberta 500/240kV substation is looped through the 500kV tie line.

This report documents the BCH study of BC system constraints, potential solutions and associated high level planning cost estimates. In parallel with the BCH study, the AESO report will document the Alberta system study results, including system constraints, solutions, and approximate planning level costs. The combined effect of mitigating measures in AB and BC are to be taken into account in developing the final conclusions of the respective reports.

2. STUDY OBJECTIVE

The BC – Alberta intertie has been transferring power below the path rating due to various constraints. The joint study helps BCH to explore with AESO in a coordinated manner the respective limiting constraints and potential means to address these issues so that Path 1 could be fully utilized in an economical manner in the near future as well as for the long term. This study also helps to identify potential interactive effects between BC and AB on Path 1 transfer capability and means to address them.

The principle of the study is to enable the system to carry the path rating flows and be able to preserve the tie in service after single contingencies, except loss of the tie or other serial component, e.g. 5L92. The study does not address the constraints on the parallel 138kV ties between BC and AB; rather the focus is on the 500kV transmission system capability.

3. STUDY SCOPE

Three bench mark years, 2014, 2017 and 2022 are studied using jointly prepared base cases which cover scenarios of interest to both parties. System seasonal loadings, Path 1 flows, Path 3 flows, MATL flows, AB wind generations, Kootenay area generations in BC and planned system development in both systems including Chapel Rock are all taken into account in developing the 48 base cases for the study. The 138kV ties between BC and AB are opened in the base cases so to

focus on the transfer capability of the 500kV tie. The assumption is considered adequate as it is consistent with the present operating procedure.

The study identifies the respective system constraints, potential technical solutions and high level planning cost estimates. Solutions of each entity are to be integrated into the original base cases to test the combined effect and for determining the combined set of solution options.

4. STUDY METHODOLOGY AND CRITERIA

BCH and AESO study their respective system using the jointly established set of 48 common base cases. Findings on constraints are coordinated during regular conference calls and meetings. Solutions of each entity will be integrated into the original base cases to test the combined effect and for determining the combined set of solution options.

All pre-contingency base cases (N-0) are set up with Path 1 transfers at the path rating, i.e. 1200 MW BC to AB and 1000 MW AB to BC. Where constraints are identified for the N-0 conditions, mitigation measures including system reinforcements are incorporated in building the base cases to alleviate the constraints. The BCH post Chapel Rock base cases have been adjusted with 5L94 compensated with two 35 Mvar reactors, one at CBK and one at Chapel Rock rather than a single 122.5 Mvar reactor at CBK.

The BCH system has been studied with power flow and transient stability analysis. The pre-outage conditions and the impact of major contingencies in BC, including Category B and Category C, are studied from both steady state and dynamic performance perspectives. 5L92 and 5L94 Single pole reclose performance and the system capability to carry the full transfers is studied. In addition, studies are also carried out to test out the effect of major variables and solution options.

4.1 Power Flow Analysis

The pre-outage power flows were solved with all control devices (automatic and manual) turned on to emulate well-tuned pre-outage base case conditions.

Post-contingency power flows were solved in two different ways to simulate system response at different stages, one for the short-term and another one for the long-term. In short-term only the fast automatic control actions like Remedial Action Schemes (RAS) actions (e.g. generation shedding, direct transfer tripping) and SVC were allowed to operate. The governor response option was used to solve the short-term power flows. The extreme results imply potential issues to be further examined in detail with transient stability simulation studies. In the long-term post-contingency solution, only automatically controlled devices were allowed to move. Manually controlled devices were locked. The results depict the system long term steady state response prior to manual operator actions. Table 4-1 summarizes the parameters used for solving different stages of power flows.

Table 4-1: Power flow solution parameters

	Pre-outage	Post-outage short-term	Post-outage long-term
Area Interchange Flow Control (AGC)	On	Off	On/Off†
Governor Response	Off	On	Off
Continuous Shunt Adjustment	On	On	On
Automatic Discrete Shunt Adjustment	On	Off	On
Manual Discrete Shunt Adjustment	On	Off	Off
Automatic Transformer Tap Changer Adjustment	On	Off	On
Manual Transformer Tap Changer Adjustment	On	Off	Off
Phase Shifter Adjustment	On	Off	On
Limit Generator VArs	On	On	On
Limit Swing Bus Generator VArs	On	On	On
Remote Control By Generators	On	On	On

† For some contingencies AGC is turned off.

The responses in BC Hydro system including voltages and thermal limits were monitored using existing BCH operation practices.

4.2 Contingencies

Credible major BCH contingencies that could impact Path 1 performance, are identified and studied as listed in Appendix B Table B-1(single contingencies) and Appendix B Table B-2(double contingencies). Multiple devices in the same protection zone are regarded as a single contingency which are tripped with timings according to the protection settings.

Transient stability simulations and post contingency power flows from both short and long term perspectives are conducted to assess the system response. The transient stability simulation switching sequence consists of a 3-phase fault applied at either side of the line, followed by its subsequent trip out, appropriate RAS actions, and then unsuccessful reclose of the line if applicable. The same set of actions are applied without the timing sequence for solving post contingency power flows. The single pole reclose capability is also tested by applying a single line to ground fault at CBK end of 5L94 to test the system capability of sustaining the high transfers duing two phase operation. The same study was performed for 5L92 for fault on either side of the line.

The exisiting BCH Remedial Action Schemes (RAS) are employed to mitigate the impact of disturbances. For a given base case, appropriate RAS actions such as generation shedding, line tripping, and reactive equipment switching, etc. are applied based on existing BCH system operating order instructions plus any modifications necessary to test the system response during the course of the study.

4.3 Transient Stability Analysis

The same set of single and double contingencies applied to study the BCH system post contingency steady state performance with power flows were also run with TSAT to study the

system transient stability and dynamic performance. Separate runs were made with three phase faults applied at either end of the line to determine the worst response. In addition, critical lines that are equipped with single pole reclose capability are also studied to assess their ability to withstand temporary single line to ground fault based on the high transfers.

4.3.1 Single-pole reclose

5L92 (CBK – SEL) and 5L94 (CBK to Langdon) make up the radial connection in series between BC and Alberta major grids. The reliability of these circuits has immediate impact on the tie. Consequently, both lines are equipped with Single Pole Reclose (SPR) function to prevent the tie tripping from common temporary single line to ground faults. Transient stability studies are conducted to assess if the tie could carry the full path rating load during temporary fault and single pole reclose operation.

The 5L92 single pole reclose operation is simulated with reclosing the faulted phase 56 cycles after fault is cleared. 5L94 reclosing is based on 36 cycles after fault clearing for the system before Chapel Rock is in service. With Chapel Rock, the reclosing time is 60 cycles after fault clearing, assuming the CBK-Chapel Rock line is compensated with at least one 35 Mvar line end reactor. While reclosing time could be shortened to 48 cycles when two 35 Mvar line end reactors are in service, for this study purpose it is deemed reasonable to apply 60 cycles reclosing time for both cases.

4.4 Study Criteria

Studies are conducted in accordance with the principles of BC Hydro System Operating Limits Methodology for Planning Horizon. System voltage limits stipulated in the BCH system operating orders are observed.

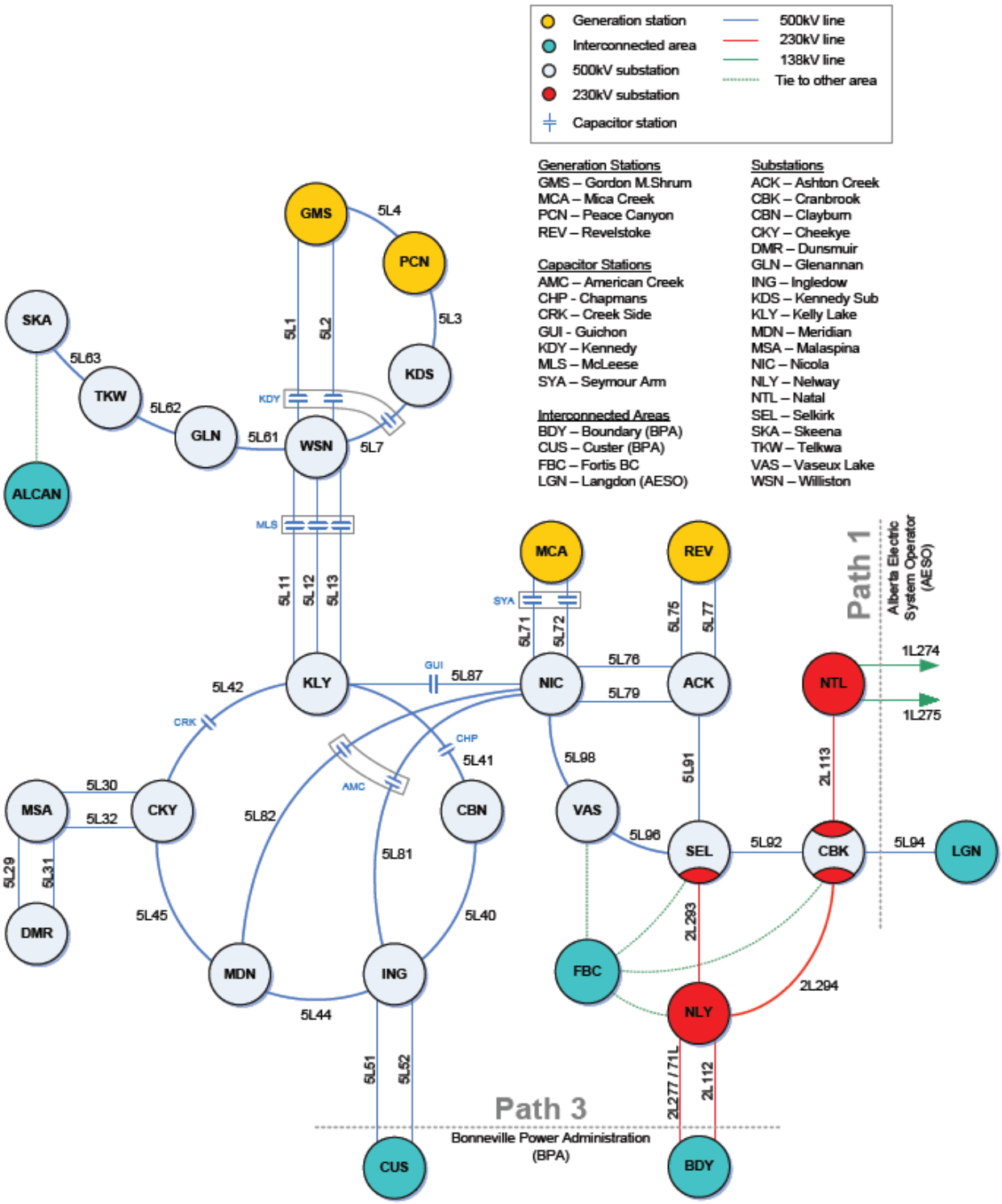
5. STUDY DATA AND CONDITIONS

The study is performed on a set of base cases jointly prepared by BCH and AESO with each party having developed power flow and stability models of their respective power systems. Various system scenarios are developed to model high transfer conditions between AIES and BCH. Three years are selected as benchmarks; 2014, 2017 and 2022. For each year, one network configuration is used to develop the base cases except for 2017 when AB plans to add a new Chapel Rock substation. For this year, two sets of base cases are prepared, one without Chapel Rock and one including Chapel Rock. The new AB 500/240 kV substation is assumed located about 110 kM from BC Hydro Cranbrook (CBK) substation. Chapel Rock is connected to the system by looping through the 500kV BC-AB tie line. The 2022 base cases include the new Chapel Rock substation.

The network configurations and system data used in the analysis are described in this section.

5.1 BC Network, Major Projects and Acronyms

The existing major transmission system in BC is displayed below:



Projects planned in BC have been incorporated in the base cases including the following major ones of BCH and FortisBC that may be significant to Path 1 performance. These projects are listed below for easy reference. Projects incorporated in the AB system base cases are referenced in the AB study report. Changes to the plan and/or and their associated in service dates could significantly affect the study results and the conclusions stated in this report.

ISD	Project Name	Size
2014-10-31	BCH addition of G5 at Mica generating station	500 MW
2015-04	BCH addition of G6 at Mica generating station	500 MW
2018-04	BCH addition of G6 at Revelstoke generating station	532 MW
2018-04	BCH addition of 250 MVAr - 500 kV Switchable Shunt Capacitor at Nicola substation	250 MVAR
2018-10	BCH Series Capacitor addition on 5L98 (50%)	
2019 winter	FortisBC addition of a third 230/138 KV Transformer at LEE substation	168 MVA
2021 winter	FortsiBC addition of a SVC at DG BELL Substation	+150/-50 MVAR

The BCH key acronyms used in this report are listed below for easy reference:

ACK: Ashton Creek Substation
CBK: Cranbrook Substation
ING: Ingledow Substation
KCL: Kootenay Canal GS
KLY: Kelly Lake Substation
MCA: Mica GS
MDN: Meridian Substation
NIC: Nicola Substation
NTL: Natal Substation
REV: Revelstoke GS
SEL: Selkirk Substation
SEV: Seven Mile GS
VAS: Vaseau Lake Substation
5L51: 500kV transmission line # 1 from ING to CUS (US)
5L52: 500kV transmission line # 2 from ING to CUS (US)
5L71: 500kV transmission line # 1 from Mica GS to NIC
5L75: 500kV transmission line # 1 from REV GS to ACK
5L76: 500kV transmission line # 1 from ACK to NIC
5L79: 500kV transmission line # 2 from ACK to NIC
5L81: 500kV transmission line from NIC to ING
5L82: 500kV transmission line from NIC to MDN
5L87: 500kV transmission line from NIC to KLY
5L91: 500kV transmission line from ACK to SEL
5L92: 500kV transmission line from CBK to SEL
5L94: 500kV transmission line from CBK to Bennett/Langdon, or

CBK to Chapel Rock after development of the new substation
5L96: 500kV transmission line from VAS to SEL
5L98: 500kV transmission line from NIC to VAS
2L112: 230kV transmission line from NLY to BDY (US)
2L293: 230kV transmission line from SEL to NLY
2L294: 230kV transmission line from NLY to CBK
2L288: 230kV transmission line from KCL to BTS (Fortis BC)
2L289: 230kV transmission line from SEL to BTS (Fortis BC)
2L295: 230kV transmission line from SEL to KCL

5.2 138 kV Ties Between BCH and AB

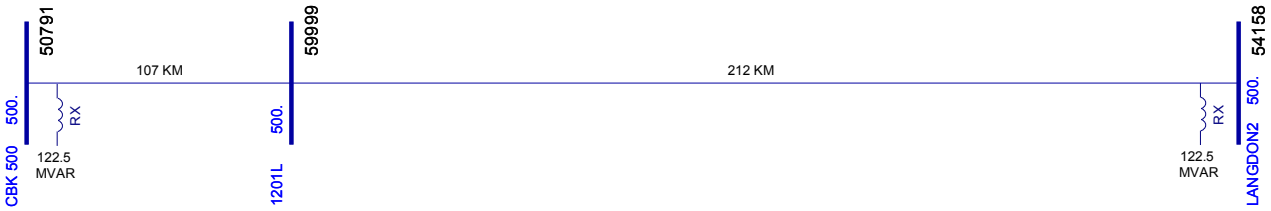
Under high transfers, the elements in the 138kV tie system to AB may overload. In order to focus on the study of restoring the 500kV tie transfer capability, it was agreed by both AESO and BCH that the 138kV ties are opened for establishing the study base cases. This approach is deemed acceptable as it is consistent with the BC Hydro present operating procedures.

5.3 5L94/1201L 500 kV Tie

A 500kV Bennett substation has been built adjacent to Langdon substation. Due to their close proximity and the electrical connection arrangement, reference to Langdon is considered equivalent to Bennett/Langdon throughout the document unless otherwise noted.

In the 2014 and 2017 base cases before the establishment of Chapel Rock substation, the existing BC and Alberta 500 kV tieline between CBK and Langdon substation is modelled with two line segments, CBK to the BC_AB border and from the border to Langdon substation as depicted in Figure 1 (a). During the course of the study it was found that modeling a fictitious bus on AB side of the border has effectively redefined the 500kV connection metered point to the border rather than at Langdon (or Chapel Rock after its development) in power flow solutions. To be consistent with the WECC Path 1 definition, our study has been carried out with the base cases updated to exclude the fictitious bus at the border as shown in Figure 1(b) for cases without Chapel Rock, and Figure 1(c) for cases with Chapel Rock. It should be noted that with a metered point at Langdon, the required BC to AB flow would be increased by the amount of losses between the border and Langdon, which is about 30 MW based on 1200 MW BC to AB transfer. It is assumed in the power flows that the metering point is moved to Chapel Rock after it is placed in service.

The new Chapel Rock connection to the 500kV tie makes the existing CBK 500kV 122.5 Mvar line end shunt reactor incompatible with the new tie configuration due to potential resonance. Replacing the reactor with two 35 Mvar line end reactors, one at CBK and one at Chapel Rock is considered appropriate for the purpose of this study. Consequently the 2017 and 2022 post Chapel Rock base cases are updated accordingly. Further information is provided in Section 6.3.



(a) Without Chapel Rock (with a fictitious border bus)

(b) Without Chapel Rock (w/o fictitious border bus)

(c) With Chapel Rock and two 500 kV 35 Mvar line end RXs (w/o fictitious border bus)

Figure 1: Modeling of 5L94/1201L before and after the development of Chapel Rock substation

5.4 Power flow base cases

Three benchmark years are studied, 2014, 2017 and 2022. For each year, 12 base cases have been prepared except for 2017 which has two sets of 12 cases, one before the development of Chapel Rock substation and another one after the new substation development. The 12 cases in each set model the different system conditions that are of interest. 10 are for BC to AB transfer scenarios and 2 for AB to BC transfer scenarios. The base cases cover all system loading conditions; heavy winter (HW), heavy summer (HS), and light summer (LS). In addition, the BCH cases also have taken Path 3 (BC – US) flow variations and Kootenay area generation dispatches into consideration. Similarly the AB system base case conditions have included three levels of AIES wind generations and the Alberta – Montana (MATL) tie line transfer as variables. All 48 base cases are listed in Appendix A, Table A-1 and the naming convention of each case is described with an example below:

Case full name: y14c01_Rev3
Case short name: y14c01
where: y14 denotes year 2014
c01 denotes case number c01
Rev_3 denotes version number of jointly prepared base cases used in the study

Table 5-1 shows the case numbers corresponding to the year, load level and Chapel Rock connection status for BC to AB transfers.

Table **5-2** displays the same for AB to BC transfers.

Table 5-1: Overview of BC to Alberta transfer base cases (Transfer Level 1200 MW)

	Before Chapel Rock		After Chapel Rock	
2014	HW y14c01 to y14c03	HS y14c04 to y14c10		
2017	HW y17c01 to y17c03	HS y17c04 to y17c10	HW y17c21 to y17c23	HS y17c24 to y17c30
2022			HW y22c21 to y22c23	HS y22c24 to y22c30

HW: Heavy Winter
HS: Heavy Summer
LS: Light Summer

Table 5-2: Overview of Alberta to BC transfer base cases (Transfer Level 1000 MW)

	Before Chapel Rock		After Chapel Rock	
2014	HS y14c11	LS y14c12		
2017	HS y17c11	LS y17c12	HS y17c31	LS y17c32
2022			HS y22c31	LS y22c32

HS: Heavy Summer
LS: Light Summer

5.5 Dynamic Data

The BC and AB system dynamic data have been prepared by the respective entities. Dynamic data of other areas are from WECC base cases. Each of the power flow cases has a corresponding dynamic file in PSS/E format. This file can be directly read in Powertech DSA*Tools*. There are also gnet.idv file and remove_Governor.idv files associated with each case. The gnet file is directly usable. The remote_Governor.idv file was translated to DSA*Tools* format. In addition, for studying the BCH system transient stability performance dynamic models listed below have been developed for this study.

5.5.1 MATL RAS

A user-defined model was developed for TSAT to simulate the functional performance of MATL RAS based on the functional description given in [3] and [4].

5.5.2 5L94 Under-voltage protection

A user-defined model was developed for TSAT to simulate the under voltage tripping of 5L94, as described in Appendix C.1System Equipment Data.

5.5.3 5L92 & 5L94 CBK RX/CX RAS

A user-defined model was developed for TSAT to simulate the shunt reactive equipment switching after the loss of 5L92 and subsequent tripping of 5L94, as described in Appendix C.2System Equipment Data.

6. STUDY RESULTS

The results are discussed below based on the direction of transfer between BC and Alberta. The associated power flow results, transient stability simulation plots, and mitigating measure effect results and plots are in Appendices D, E, F and G.

6.1 BC to AB Transfer

For these cases the transfer level is set to 1200 MW. Alberta also imports 300 MW from Montana through MATL.

6.1.1 2014 Cases

Cases y14c01 to y14c03 are heavy winter cases and cases y14c04 to y14c10 are heavy summer cases. The assumed BC Hydro load is 10351 MW in heavy winter cases, and 7239 MW in heavy summer cases. List of the cases and their associated system conditions are displayed in Appendix A, Table A–2.

N-0 Results

Some voltages are marginal, e.g. CBK500 at about 0.95 pu and NTL230 at 0.92 pu under winter peak loading condition (Cases y14c01 to y14c03). In summer the CBK500 may vary between 0.94pu and 0.99 pu and NTL230 may vary between 0.93 pu and 0.96 pu (Cases y14c04 to y14c10). NTL138 can be maintained at 1.03pu by the voltage regulator.

High AIES wind generations would significantly lower the Langdon and CBK system voltages in summer cases, e.g. the Langdon voltage would be dropped by about 9% and CBK500 voltage dropped by about 5% (Cases y14c06, y14c04) from no wind to full wind condition. The voltage drop due to wind increase is less significant in winter cases.

Bus voltages and power flows of the cases based on Path 1 metered at Langdon are displayed in Appendix A–2. The same cases with Path 1 metered at the border are displayed in Appendix A-3 for comparison of impact on flows and bus voltages. Tie flow metered at the border results in flows about 30 MW less than the ones metered at Langdon due to reduction in losses.

Path 1 flow changes significantly affect the CBK area system voltage which could be about 10% for a flow change of 1200 MW. Section 6.8 shows sensitivity analyses of some base case scenarios.

N-1 Results

The post contingency power flows are marginally acceptable in some selected scenarios (cases y14c05, y14c06 and y14c09). However the remaining cases have low voltages. The post contingency power flow results show that loss of 5L91 or 2L294 would cause large voltage drops and result in low voltages; CBK500 below 0.93 pu and NTL230 below 0.90pu in several cases (Cases y14c01 to y14c04, and y14c10) or un-converged power flows (y14c07, y14c08). For details refer to Appendix D.

Transient stability simulation results indicate that several single contingencies would cause low dynamic voltage at CBK, resulting in tripping of the 500kV tie, 5L94, under AB high wind summer conditions. In addition, a temporary single line to ground fault on 5L92 or 5L94 would result in tripping the 500kV tie in most cases since the two transmission phases during single pole reclose operation would not be able to carry the 1200 MW BC to AB transfer. For details on bus voltages and 5L94 dynamic flows in response to the contingencies, refer to Appendices E and F respectively.

Impact of significant contingencies is discussed below.

Loss of 5L81 or 5L82 caused by a three phase fault on the line near NIC could result in significant voltage drop at CBK and subsequent tripping of 5L94 under AB high wind conditions (Case y14c04). By shedding an additional amount of generation at MCA, the 5L94 tripping could be avoided (Appendix G.4).

Loss of 5L91 results in non-convergence in post outage power flows, i.e. potential voltage collapse of cases with low Kootenay area generations and high AB wind (Cases y14c07 & y14c08) due to low system voltages at Langdon and CBK500. The voltage instability could be mitigated by increasing the Kootenay area generations as a Reliability Must Run (RMR) requirement during high wind periods as shown in Table 6-1 below (Appendix G.9). Alternatively curtailing wind generation would raise the system voltages, thereby preventing voltage collapse from loss of 5L91 (Case y14c09).

Table 6-1: Kootenay area generation adjustments to base cases y14c07 and y14c08

		Kootenay AREA GEN	5L91+5L96 SEL	CBK 230	CBK 500	NTL 138	NTL 230
Base case: y14c07		MW	MW	pu	pu	pu	pu
N-0	Pre Contingency	555.00	-1163.09	0.95	0.95	1.03	0.94
N-1	5L91 ACK-SEL	no post contingency power flow solution					
N-0	Adjusted Pre Contingency	1040.05	-732.85	0.94	0.94	1.03	0.93
N-1	5L91 ACK-SEL			0.91	0.92	1.04	0.90

Base case: y14c08							
N-0	Pre Contingency	555.00	-1163.62				
N-1	5L91 ACK-SEL	no post contingency power flow solution					
N-0	Adjusted Pre Contingency	840.00	-929.20	0.94	0.95	1.04	0.94
N-1	5L91 ACK-SEL			0.90	0.91	1.04	0.89

Loss of 5L92 would result in subsequent transfer tripping of 5L94 and automatic switching of shunt reactive equipment to reduce the area voltages. Results indicate that while the CBK and NTL temporary voltages could be high due to large load rejection caused by the loss of 1200 MW transfer to AB as shown in the transient stability simulation and short term post contingency power flows, the long term steady state voltages are acceptable after automatic equipment adjustments.

Loss of 5L94 is similar to the loss of 5L92, although somewhat less severe, it still could result in temporary high voltages at CBK and NTL in summer cases. However the voltages would be brought down to acceptable level by the automatic actions of on-load tap changing transformers and NTL voltage regulator.

Loss of 5L96 causes similar issue as loss of 5L91, although to a lesser extent. Dispatching the Kootenay area generation to a high level would help to alleviate the post contingency steady state low voltage issue (Appendix G.9).

Loss of 2L289 caused by a three phase fault near SEL230 could result in significant voltage drop at CBK and subsequent tripping of 5L94 as shown in transient stability simulation results (Case y14c04). By shedding 160 MW of generation at Kootenay area 5L94 tripping could be avoided (Appendix G.5).

Loss of 2L293 caused by a three phase fault near SEL230 could result in significant voltage drop at CBK and subsequent tripping of 5L94 as demonstrated in transient stability simulation result (Case y14c04). By shedding 125 MW generation in the area the 5L94 tripping could be avoided (Appendix G.6). Alternatively, reducing the pre-outage transfer to 1100 MW could prevent 5L94 tripping (Appendix G.8). A 3rd option is providing additional shunt capacitive var support to maintain area voltage at a higher level (Appendix G.14). No issue has been found for fault at NLY end of the line.

Loss of 2L294 could cause NTL230 steady state voltage to drop below 0.9 pu in winter (Cases y14c01 to y14c03) and summer (Cases y14c04, y14c07, y14c08). To address this issue, either reducing the transfer to a lower level or adding shunt capacitive var support at CBK would be effective. No transient stability issue has been identified for this outage. Dispatching the Kootenay area generation to a high level would help to alleviate the post contingency steady state low voltage issue (Appendix G.9).

Loss of 2L295 caused by a three phase fault on the line near SEL could result in significant voltage drop at CBK and subsequent tripping of 5L94 under AB high wind conditions (Case

y14c04). By shedding 250 MW generation at KCL, the 5L94 tripping could be avoided (Appendix G.7).

Single-Pole Reclose Results

The system cannot sustain a temporary single line to ground fault on 5L92 with single pole reclose based on a BC to AB transfer of 1200 MW in most cases (y14c01 to y14c05, y14c07 to y14c10) due to low dynamic voltages during 5L92 two phase operation, which results in subsequent tripping of 5L94. Limit the pre-outage transfer to a lower level could prevent 5L94 from tripping as demonstrated in one sensitivity study based on a 1100 MW transfer (Appendix G.1). Other system conditions may have different limits to avoid 5L94 tripping. Applying generation shedding in BC is not effective to address this issue.

Similarly, the system also could not sustain a BC to AB 1200 MW transfer with 5L94 single pole reclose in some cases (y14c04, y14c07, & y14c08) due to low dynamic voltages during its two phase operation, which results in its subsequent trip out. Limit the pre-outage transfer to a lower level is expected to prevent 5L94 tripping as shown in a 2017 case study (Appendix G.14).

N-2 Results

Generally the impact of double outages is manageable with existing RAS.

The 5L51/5L52 double outages would result in separating BC from the WECC grid. In order to minimize the impact in a controlled manner, 5L94 is directly transfer tripped by RAS actions.

5L76/5L79 double outage could cause large voltage dip at CBK, subsequent trip out of 5L94 and no solution to post outage power flows (Cases y14c01 to y14c03, y14c10) based on applying the existing generation shedding rules which are established for existing BC to AB transfer limits. The issue may be addressed by revising the operation rules to shed additional generations for 1200 MW transfer (Appendix G.3).

The 5L81/5L82 double outage could cause large voltage dip at CBK and subsequent trip out of 5L94 (Cases y14c01 to y14c05) based on the existing generation shedding rules which were established for existing BC to AB transfer limits. The issue may be addressed by revising the operation rules to shed additional generations for 1200 MW transfer (Appendix G.2).

The 5L91/5L96 double outage effectively separates the BCH Kootenay area system from the BC grid and keeps the system east of Selkirk with the AB system. The impact to BC is managed by applying appropriate generation shedding if required. The impact to the system east of SEL is managed by preserving the tie while continually sending power to AB (Cases y14c02, y14c03, y14c05 to y14c10). The current generation shedding rule is established based on the existing transfer limit which may not be suitable for the 1200 MW BC to AB transfer and cause the tie tripped (Cases y14c01, y14c04). Adjusting the rule will keep the tie connected and improve the East Kootenay / AB island system performance (similar to a 2017 case y17c01 in Appendix G.12).

No significant issue has been found with other double outages.

Overall Observations

The present system could marginally carry the 1200 MW BC to AB transfer but only under favorable conditions, including summer loading, high Kootenay area generations and low AB wind, however still subject to accepting the risk of tie tripping from single line to ground fault on 5L92 or 5L94. The impact of double contingencies is manageable with the existing RAS functions. Some generation shedding rules may need adjustment based on 1200 MW transfer.

The study has identified some major concerns; unacceptable low post contingency steady state voltages, increased stress from AB high wind generations, Kootenay area minimum generation dispatch requirements, tie tripping from single line to ground fault on 5L92 or 5L94, and tie tripping by other contingencies in BC. The last issue could be addressed by applying revised shedding rules based on the high transfers. Other issues could be addressed by either reducing the BC to AB transfer to below 1200 MW for the present system or reinforcing the system with additional equipment.

If 1200 MW transfer is to be realized under all study conditions from a purely BC system perspective without considering the more limiting constraints in AB, one option is to reinforce the system by providing var support at CBK. For understanding purposes a cursory assessment shows that adding a 100 Mvar shunt capacitor and a +/-250 Mvar SVC or STATCOM would provide adequate static and dynamic var support and voltage regulation capability. Appendix G.14 illustrates the benefit of adding var support in improving single pole reclose capability and post disturbance steady state voltage using a stressed 2017 pre Chapel Rock case.

6.1.2 2017 Cases without Chapel Rock

Cases y17c01 to y17c03 are heavy winter cases and cases y17c04 to y17c10 are heavy summer cases. The BC Hydro load in heavy winter cases is 10863 MW, and in heavy summer cases is 8034 MW. Appendix A Table A – 2 displays the cases and their associated system conditions.

N-0 Results

Generally the CBK area voltages are lower than the 2014 cases. CBK500 is at about 0.94 pu and NTL230 is at about 0.90 pu in winter cases (Cases y17c01 to y17c03). In summer CBK500 may be between 0.91pu and 0.96 pu and NTL230 between 0.86 pu and 0.95 pu (Cases y17c04 to y17c10). NTL138 still can be maintained at 1.03pu by the voltage regulator.

High AIES wind generations would lower the Langdon, CBK and NTL system voltages in summer cases, e.g. Langdon drop by about 5% and CBK500 voltage drop by about 4% from no wind to full wind (Cases y17c09, y17c07). Correspondingly NTL230 would drop from 0.94 pu to 0.88pu. The voltage drop is less significant in winter cases.

N-1 Results

Similar to the 2014 cases, the same issues have been identified but the study results are generally worse due to deteriorating N-0 system conditions as load increases. Furthermore, additional contingencies could cause 5L94 tripping. The post contingency power flows are marginally acceptable only in one scenario (cases y17c06). The remaining cases have low voltages or even

power flow non-convergence, i.e. potential voltage collapse. The long term post contingency power flow results show that loss of 5L91 or 2L294 would cause large voltage drops and result in voltage collapse (Cases y17c07, y17c08) or low voltages; CBK500 below 0.93 pu and NTL230 below 0.88pu in most case (Cases y17c01 to y17c5, y17c09 and y17c10). For detailed results refer to Appendix D. Impacts of individual major contingencies are described below.

Loss of 5L81 or 5L82 caused by a fault on the line near NIC could result in tripping of 5L94 due to low voltage at CBK during summer and AIES high wind period (Case y17c07).

Loss of 5L87 caused by a fault on the line near NIC could result in tripping of 5L94 due to low voltage at CBK during winter and AIES high wind period (Cases y17c01, y17c07).

Fault at SEL and subsequent loss of 5L91 or 5L96 could result in tripping of 5L94 due to low initial voltages at Langdon and CBK during AIES high wind period (Case y17c07). Either limiting the wind generation and/or increasing the Kootenay area generations as a pre-disturbance requirement could prevent the tripping of 5L94 for these contingencies.

Similar to the 2014 cases, loss of 5L91 or 5L96 results in non-convergence in post outage power flows, i.e. potential voltage collapse of cases with low Kootenay area generations and high AB wind (Cases y17c07 & y17c08) due to low system voltages at Langdon and CBK500. The voltage instability could be mitigated by increasing the Kootenay area generations as a Reliability Must Run (RMR) requirement during high wind periods as shown in Table 6-2 below. Results indicate larger RMR should be applied to obtain acceptable post contingency steady state voltages (Appendix G.13). Alternatively curtailing wind generation would raise the system voltages, thereby preventing voltage collapse from loss of 5L91 or 5L96.

Table 6-2: Kootenay area generation adjustments for base case y17c07

		Kootenay AREA GEN	5L91+5L96 SEL	CBK 230	CBK 500	NTL 138	NTL 230
Base case: y17c07		MW	MW	pu	pu	pu	pu
N-0	Pre Contingency	550	-1163	0.92	0.93	1.04	0.90
N-1	5L91 ACK-SEL	no post contingency power flow solution					
N-0	Adjusted Pre-Contingency	1016	-757	0.90	0.91	1.03	0.86
N-1	5L91 ACK-SEL			0.84	0.85	1.02	0.80

Fault at NIC and subsequent loss of 5L98 could result in tripping of 5L94 due to low initial voltages at Langdon and CBK during AIES high wind period (Cases y17c07, y17c08). Either limiting the wind generation and/or increasing the Kootenay area generations as a pre-disturbance requirement could prevent the tripping of 5L94.

Similar to the 2014 cases, while loss of 5L92 or 5L94 would result in temporary high voltages but the voltages will be automatically brought down to acceptable levels by the automatic control actions of on load tap changers and voltage regulator.

Loss of 2L289, 2L293 or 2L295 caused by a line fault near SEL230 could result in tripping of 5L94 due to low dynamic voltages at CBK during AIES high wind period (Cases y17c01, y17c07).

Loss of 2L294 could cause power flow non-convergence (Case y17c07). In other scenarios NTL230 steady state voltage could drop to about 0.84 pu in winter (Cases y14c01 to y14c03) and to 0.88 pu in summer (Cases y14c04 to y14c06, y14c08 to y17c10). Dispatching the Kootenay area generation to a high level would help in some cases to alleviate the post contingency steady state low voltage issue (Appendix G.13). Other option could be reducing the transfer to a lower level (Appendix G.14).

Single-Pole Reclose Results

5L92 cannot sustain a BC to AB transfer of 1200 MW with single pole reclose operation in all cases (y17c01 to y17c10) due to low dynamic voltages during the two phase operation, resulting in subsequent trip out of 5L94. Similar to the 2014 cases, reducing the pre-outage transfers is expected an effective means to prevent 5L94 tripping and for each case the reduction amount may be different (Appendix G.14).

Similarly, 5L94 also could not sustain a BC to AB 1200 MW transfer with single pole reclose operation in some cases (y17c07, y17c08) due to low dynamic voltages during the two phase operation, resulting in its subsequent trip out. Reducing the pre-outage transfer is expected to prevent 5L94 tripping (Appendix G.14).

N-2 Results

The 5L51/5L52 double outages would result in separation of BC from the WECC grid. In order to minimize the impact in a controlled manner, 5L94 is tripped.

5L76/5L79 double outage could cause large voltage dip at CBK and subsequent trip out of 5L94 and no solution to post outage power flows (Cases y17c01, y17c02) based on applying the existing generation shedding rules which were established for existing BC to AB transfer limits. The issue may be addressed by revising the operation rules to shed additional generations for 1200 MW transfer as shown in a 2014 case study (Appendix G.3).

The 5L81/5L82 double outage could cause large voltage dip at CBK and subsequent trip out of 5L94 (Cases y17c01 to y17c07) based on the existing generation shedding rules which were established for existing BC to AB transfers. The issue may be addressed by revising the operation rules to shed additional generations for 1200 MW transfer as shown in a 2014 case study (Appendix G.2).

The 5L91/5L96 double outage effectively separates the BCH Kootenay area system from the BC gird and keeps the system east of Selkirk with the AB system. The impact to BC is managed by applying appropriate generation shedding if required. The impact to the system east of SEL is managed by preserving the tie while continually sending power to AB (Cases y17c07 to y17c10). The current generation shedding rule is established based on existing BC to AB transfers which may not be suitable for the 1200 MW BC to AB transfer and cause the tie tripped (Cases y17c01 to y17c06). Adjusting the rule will keep the tie connected and improve the East Kootenay / AB island system performance (Appendix G.12).

No significant issue has been found with other double outages.

Overall Observations

The 2017 system prior to Chapel Rock could marginally carry the 1200 MW BC to AB transfer only under one favorable condition (Case y17c06) which is summer loading, high Kootenay area generations and no AB wind generation, and still subject to accepting the risk of tie tripping from single line to ground fault on 5L92 or 5L94. For the most part, the system cannot carry 1200 MW transfer from BC to AB. The impact of double contingencies is manageable with the existing RAS functions. Some generation shedding rules may need adjustment based on 1200 MW transfer.

Like the 2014 cases, the study has identified same major concerns; unacceptable low post contingency steady state voltages, increased stress from AB high wind generations, Kootenay area minimum generation dispatch requirements, tie tripping from single line to ground fault on 5L92 or 5L94, and tie tripping by other contingencies in BC. The last issue could be addressed by applying revised shedding rules based on the high transfers. Other issues could be addressed by either reducing the BC to AB transfer to below 1200 MW for the present system or reinforcing the system with additional equipment.

If 1200 MW transfer is to be realized under all study conditions from a purely BC system perspective without considering the more limiting constraints in AB, one option is to reinforce the system by providing var support at CBK. For understanding purposes a cursory assessment shows that adding a 100 Mvar shunt capacitor and a +/-250 Mvar SVC or STATCOM would provide adequate static and dynamic var support and voltage regulation capability. Appendix G.14 illustrates the benefit of adding var support in improving single pole reclose capability and post disturbance steady state voltage.

6.1.3 2017 Cases with Chapel Rock

Cases y17c21 to y17c23 are heavy winter cases and cases y17c24 to y17c30 are heavy summer cases. The BC Hydro load in heavy winter cases is 10863 MW, and in heavy summer cases is 8034 MW. Appendix A Table A – 4 displays the cases and their associated system conditions.

5L94 500kV Line End RX at CBK

For the purposes of this study, the base cases are updated by replacing the 122.5 MVAr line reactor at CBK end with two 500kV 35 MVAr line end reactors, one at CBK and one at Chapel Rock, based on a 110 kM line from CBK to Chapel Rock.

N-0 Results

Overall the area system voltages are significantly improved compared with the cases before Chapel Rock. The replacement of CBK 122.5 Mvar shunt reactor with 2 x 35 Mvar units also effectively provides 52 Mvar support to system voltage.

CBK500 is at about 0.99 to 1.0 pu for both winter and summer conditions with 1200 MW transfer to AB (Cases y17c21 to y17c29). Correspondingly NTL230 could be at about 0.94 to 0.96 pu in winter and at 0.96 pu to 0.97 pu in summer. NTL138 can be maintained at 1.03pu by the voltage regulator.

High AIES wind generations would lower the Chapel Rock and CBK 500kV system voltages, generally less than 3% and 2% respectively from no wind to full wind (Cases y17c21 to y17c29).

N-1 Results

The post contingency power flow voltages are acceptable as shown in Appendix D. the lowest CBK 500 is about 0.98 pu after a 5L91 or 2L294 contingency. The voltages are generally higher than the cases without Chapel Rock.

No transient stability issue has been identified based on two 35 Mvar reactors on 5L94.

The loss of 5L92 or 5L94 will cause similar impact to the system as in the earlier year cases.

Single-Pole Reclose Results

No issue has been found for all cases with the tie except 5L94 temporary single line to ground fault with successful reclose caused MATL tripping in some cases and the tie transfer increased to 1500 MW (Cases y17c21 to y17c30 except y17c23). With Chapel Rock substation in service, 1200 MW BC to AB transfer can be maintained during single pole reclose operation on 5L92 or 5L94.

N-2 Results

5L51/5L52 double outages would result in separation of BC from the WECC grid and in order to minimize the impact in a controlled manner, 5L94 is tripped.

5L76/5L79 double outage could cause large voltage dip at CBK and subsequent trip out of 5L94 in peak load cases (Cases y17c21 to y17c23) based on the existing generation shedding rules which are established for existing BC to AB transfers. The issue may be addressed by revising the operation rules to shed additional generations for 1200 MW transfer (Appendix G.15).

The 5L91/5L96 double outage effectively separates the BCH Kootenay area system from the BC gird and keeps the system east of Selkirk with the AB system. The impact to BC main grid is managed by applying generation shedding to reduce the excess generation if required. The system east of SEL remains tied with AB based on the present rule established for existing BC to AB transfers (Cases y17c21 to y17c30). Adjusting the rule based on 1200 MW could produce improved performance for some cases (y17c27 to y17c30).

No significant issue has been found with other double outages.

Overall Observations

The 2017 system with Chapel Rock 500/240kV substation as modeled in the base cases could carry the 1200 MW BC to AB transfer for all scenarios (Cases y17c21 to y17c30), i.e. for all seasonal loads and with full wind output. Temporary single line to ground fault on 5L92 or 5L94 would not result in tripping the tie. MATL could be tripped under some conditions (Cases y17c21 to y17c30 except y17c23) resulting in BC to AB flow increase to 1500 MW. Loss of 5L51 and 5L52 would result in tripping the BC to AB tie as before Chapel Rock. Voltage variation at CBK in response to tie line flow change would be much reduced, 5% based on flow variation of 1200 MW.

6.1.4 2022 Cases with Chapel Rock

Cases y22c21 to y22c23 are heavy winter cases and cases y22c24 to y22c30 are heavy summer cases. The BC Hydro load in heavy winter cases is 11182 MW, and in heavy summer cases is 8246 MW. Appendix A Table A – 4 displays the cases and their associated system conditions based on 2 x 35 Mvar line end reactors on the 110 kM CBK to Chapel Rock line.

N-0 Results

The voltages are generally lower than the 2017 Chapel Rock cases. The lowest CBK 500 voltage is at 0.96 pu and NTL 230 voltage at 0.92 pu (Case y22c21).

CBK500 is between 0.96 and 1.0 pu for both winter and summer conditions with 1200 MW transfer to AB (Cases y22c21 to y22c30). Correspondingly NTL230 could be between 0.92 and 0.97 pu in winter and between 0.94 pu and 0.97 pu in summer. NTL138 can be maintained at 1.03pu by the voltage regulator.

High AIES wind generations would lower the Chapel Rock and CBK 500kV system voltages, about 7% and 4% respectively from no wind to full wind (Cases y22c21 to y22c29). The wind effect is more pronounced than the 2017 post Chapel Rock cases.

N-1 Results

The post contingency power flow voltages are acceptable as shown in Appendix C. The lowest CBK 500 is about 0.95 pu after a 5L91 or 2L294 contingency. The voltages are generally worse than the 2017 cases with Chapel Rock, but still acceptable.

No transient stability issue has been identified based on two 35 Mvar reactors on 5L94.

The loss of 5L92 or 5L94 will cause similar impact to the system as in the earlier year cases.

Single-Pole Reclose Results

No issue has been found. With Chapel Rock substation in service, 1200 MW BC to AB transfer can be maintained during single pole reclose operation on 5L92 or 5L94.

N-2 Results

5L51/5L52 double outages would result in separation of BC from the WECC grid and in order to minimize the impact in a controlled manner, 5L94 is tripped.

5L76/5L79 double outage could cause large voltage dip at CBK and subsequent trip-out of 5L94 in some peak load cases (Cases y22c22 and y22c23) based on the existing generation shedding rules which are established for existing BC to AB transfers. The issue may be addressed by revising the operation rules to shed additional generations for 1200 MW transfer, similar to 2017 Chapel Rock cases (Appendix G.15).

The 5L91/5L96 double outage effectively separates the BCH Kootenay area system from the BC gird and keeps the system east of Selkirk with the AB system. The impact to BC main grid is managed by applying generation shedding to reduce the excess generation if required. The system

east of SEL remains tied with AB based on the present rule established for existing BC to AB transfers (Cases y22c21 to y22c30). Adjusting the rule based on 1200 MW could produce improved performance for some cases (y22c27 to y22c30).

No significant issue has been found with other double outages.

Overall Observations

Like the 2017 cases, the 2022 system with Chapel Rock 500/240kV substation and AB system modeled as in the base cases could carry the 1200 MW BC to AB transfer for all scenarios (Cases y22c21 to y22c30), i.e. for all seasonal loads and with full wind output. Temporary single line to ground fault on 5L92 or 5L94 would not result in tripping the tie. Loss of 5L51/5L52 would result in tripping the BC to AB tie. Voltage variation at CBK in response to tie line flow change is expected similar to the 2017 post Chapel Rock cases, i.e. about 5% for a flow variation of 1200 MW.

6.2 AB to BC Transfer

For these cases the transfer level is set to 1000 MW. Alberta also exports 325 MW to Montana through MATL.

6.2.1 2014 Cases

Two cases have been prepared to study the transfer capability, one for heavy summer condition (Case y14c11) and one for light summer (Case y14c12). The BC Hydro load in the heavy summer case is 7239 MW, and in light summer case is 4469 MW. Appendix A Table A – 2 displays the values of key parameters.

N-0 Results

No issue has been identified for the pre-outage voltages.

N-1 Results

Loss of 5L91 could result in power flow non-convergence after shedding the required amount of generations at Kootenay area according to the existing generation rules (Case y14c11). This could be due to lack of var capability from the few remaining units in the area after shedding. In addition, the contingency causes 5L94 tripped. To address this issue, the effective option is to shed some generation in AB (Appendix G.11). Another option is to curtail the Kootenay area generations and run some units with low MW output or as synchronous condensers (Appendix G.10).

Loss of 5L96 for a fault near SEL causes 5L94 tie tripped (Case y14c11). Similar to the 5L91 contingency, it is expected shedding some AB generation or curtailing Kootenay area generation would resolve the issue (Appendix G.10).

Loss of 5L92 would result in subsequent transfer tripping of 5L94 and automatic switching of shunt reactive equipment to reduce the area voltages. Results indicate that while the CBK and NTL temporary voltages could be high due to the loss of 1000 MW transfer to BC as shown in the transient stability simulation and short term post contingency power flows, the long term steady state voltages are acceptable after automatic equipment adjustments.

Similar to the loss of 5L92, loss of 5L94 could result in temporary high voltages at CBK and NTL. However the voltages would be brought down to acceptable level by the automatic actions of on-load tap changing transformers and NTL voltage regulator.

Single-Pole Reclose Results

No issue has been found based on 1000 MW transfer from AB to BC. A temporary single line to ground fault on 5L92 or 5L94 with single pole reclose would not result in tripping the tie.

N-2 Results

The 5L51/5L52 double outages would result in separation of BC from the WECC grid and in order to minimize the impact in a controlled manner, 5L94 is tripped (Case y14c12).

5L76/5L79 double outages could cause low voltage at CBK and subsequent trip-out of 5L94. To prevent unacceptable voltage performance, 5L94 will be directly transfer tripped for the double contingency (Case y14c11). Similar to the 5L91 or 5L96 single contingencies shedding some generation in AB would provide direct help to preserve the tie. However, curtailing Kootenay area generation is not effective in keeping the tie intact (Appendix G.10).

The 5L81/5L82 double outages could cause low voltage at CBK and subsequent trip-out of 5L94 (Cases y14c11). To prevent unacceptable voltage performance, 5L94 will be directly transfer tripped for the double contingency. Similar to 5L76/5L79 double outages, shedding some generation in AB would provide direct help to preserve the tie.Curtailing Kootenay area generation is not effective in keeping the tie intact (Appendix G.10).

Loss of 5L91/5L96 could cause relatively high voltage in Kootenay area due to reduced var absorbing capability after shedding large number of generators in the area (Case y14c12). Allocating some generation shedding in AB may be necessary to prevent the over voltages. Alternatively, Kootenay area generations or import from AB need to be curtailed. Furthermore, loss of 5L91/5L96 while importing heavily from both AB and US could cause low frequency inter area oscillation and even possibly lead to voltage collapse in BCH (Case y14c12). To address this issue, Path 1 and Path 3 imports need to be coordinated with other factors. For further discussion, refer to Section 6.11 (6.11 Low Frequency Inter-Area Oscillation During High Imports).

No significant issue has been found with other double outages.

Overall Observations

Study results indicate that during summer, the existing system could carry 1000 MW import from Alberta, however subject to the risk of tie tripping from some single contingencies and double contingencies. The risk could be mitigated by enabling some generation shedding in AB to reduce the stress, thereby preserving the tie. A partial solution alternative is curtailing generation in

Kootenay area. However this option does not necessarily address double contingencies that might trip the tie. In addition, import from AB needs to be coordinated with import from US and some other path flows to prevent the risk of potential inter area oscillation.

6.2.2 2017 Cases without Chapel Rock

Case 11 is a heavy summer case and case 12 is a light summer case. The BC Hydro load in the heavy summer case is 8034 MW, and in light summer case is 5120 MW.

N-0 Results

No issue has been identified for the pre-outage voltages.

N-1 Results

Similar to 2014 cases, loss of 5L91 could result in power flow non-convergence after shedding the required amount of generations at Kootenay area according to the existing generation rules (Case y17c11). This could be due to lack of var capability from the few remaining units in the area after shedding. To address this issue, the effective option is to shed some generation in AB. Another option is to curtail the Kootenay area generations and run some units with low MW output or as synchronous condensers.

Similar to the 2014 cases, while loss of 5L92 or 5L94 would result in temporary high voltages but the voltages will be automatically brought down to acceptable levels by the automatic control actions of on load tap changers and voltage regulator.

Single-Pole Reclose Results

No issue has been found based on 1000 MW transfer from AB to BC. A temporary single line to ground fault on 5L92 or 5L94 with single pole reclose would not result in tripping the tie.

N-2 Results

Similar to 2014 cases, the 5L51/5L52 double outages would result in separation of BC from the WECC grid and in order to minimize the impact in a controlled manner, 5L94 should be tripped (Case y17c12).

Similar to 2014, 5L76/5L79 double outages could cause low voltage at CBK and subsequent trip-out of 5L94 (Case y17c11). To prevent tie tripping one option is to shed some generation in AB.

Similar to 2014 cases, loss of 5L91/5L96 could cause high voltage in Kootenay area but less pronounced (Case y17c12). Low frequency oscillation caused by the double contingencies may still exist during high imports from AB and US as discussed in 2014 case.

No significant issue has been found with other double outages.

Overall Observations

Results are similar to the 2014 observations.

6.2.3 2017 Cases with Chapel Rock

Case 31 is a heavy summer case and case 32 is a light summer case. The BC Hydro load in the heavy summer case is 8034 MW, and in light summer case is 5120 MW.

N-0 Results

No issue has been identified for the pre-outage voltages.

N-1 Results

Loss of 5L91 could result in power flow non-convergence after shedding the required amount of generations at Kootenay area according to the existing generation rules (Case y17c31). This could be due to lack of var from the few remaining units in the area after shedding. To address this issue, the effective option is to shed some generation in AB. Another option is to curtail the Kootenay area generations and run some units with low MW output or as synchronous condensers.

Similar to the 2014 cases, while loss of 5L92 or 5L94 would result in temporary high voltages but the voltages will be automatically brought down to acceptable levels by the automatic control actions of on load tap changers and voltage regulator.

Single-Pole Reclose Results

No issue has been found based on 1000 MW transfer from AB to BC. A temporary single line to ground fault on 5L92 or 5L94 with single pole reclose would not result in tripping the tie.

N-2 Results

The 5L51/5L52 double outages would result in separation of BC from the WECC grid and in order to minimize the impact in a controlled manner, 5L94 is tripped (Case y17c32).

The post disturbance performance of 5L76/5L79 double outage has improved and the tie could be maintained (Appendix G.16).

Similar to 2014 cases, loss of 5L91/5L96 could cause high voltage in Kootenay area but less pronounced (Case y17c32). Low frequency oscillation caused by the double contingencies may still exist during high imports from AB and US as discussed in 2014 case.

No significant issue has been found with other double outages.

Overall Observations

Results are similar to the 2014 observations except that the tie tripping from some contingencies may be avoided.

6.2.4 2022 Cases with Chapel Rock

In these cases, the Chapel Rock station is in service. Case 31 is a heavy summer case and case 32 is a light summer case. The BC Hydro load in the heavy summer case is 8246 MW, and in light summer case is 5216 MW.

N-0 Results

No issue has been identified for the pre-outage voltages.

N-1 Results

Loss of 5L91 could result in power flow non-convergence after shedding the required amount of generations at Kootenay area according to the existing generation rules (Case y22c31). This could be due to lack of var from the few remaining units in the area after shedding. To address this issue, the effective option is to shed some generation in AB. Another option is to curtail the Kootenay area generations and run some units with low MW output or as synchronous condensers.

Similar to the 2014 cases, while loss of 5L92 or 5L94 would result in temporary high voltages but the voltages will be automatically brought down to acceptable levels by the automatic control actions of on load tap changers and voltage regulator.

Single-Pole Reclose Results

No issue has been found based on 1000 MW transfer from AB to BC. A temporary single line to ground fault on 5L92 or 5L94 with single pole reclose would not result in tripping the tie.

N-2 Results

The 5L51/5L52 double outages would result in separation of BC from the WECC grid and in order to minimize the impact in a controlled manner, 5L94 is tripped (Case y22c32).

The post disturbance performance of 5L76/5L79 double outage has improved and the tie could be maintained (Appendix G.16).

Similar to 2014 cases, loss of 5L91/5L96 could cause high voltage in Kootenay area but less pronounced (Case y22c32). Low frequency oscillation caused by the double contingencies may still exist during high imports from AB and US as discussed in 2014 case.

No significant issue has been found with other double outages.

Overall Observations

Results are similar to the 2014 observations except that the tie tripping from some contingencies may be avoided.

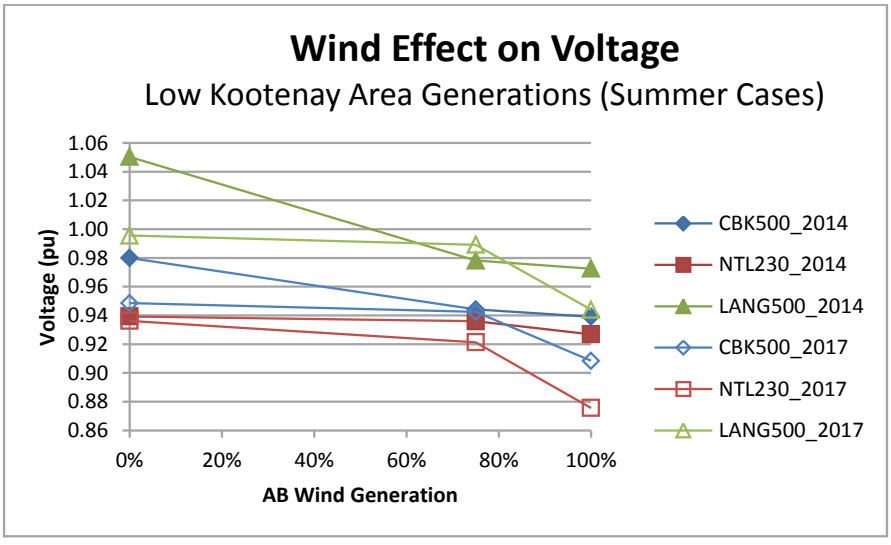
6.3 5L94 Cranbrook – Chapel Rock Reactive Compensation

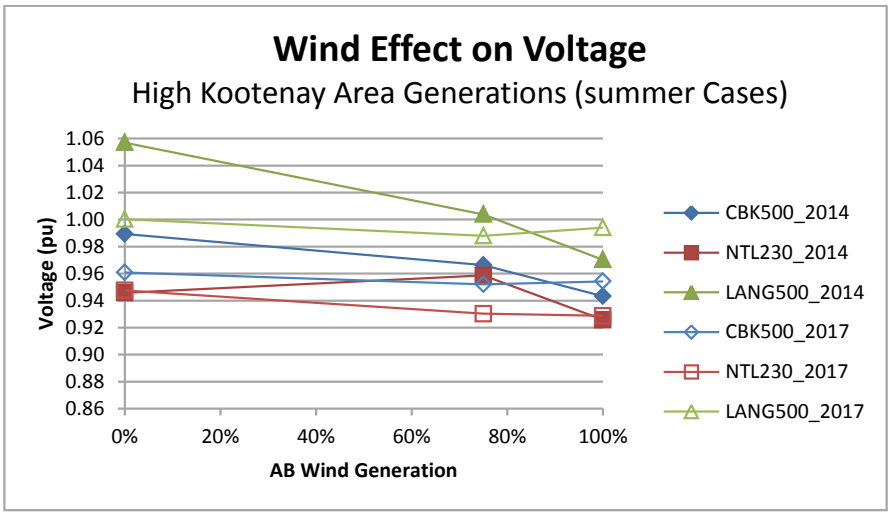
The development of Chapel Rock substation and looping it through Path 1 500kV circuit between CBK and Bennett substations effectively reduces the Path 1 distance from 330 km to about 110 km which renders the existing line end RX at CBK (122.5 MVAr) inappropriate and may cause resonance. Based on a quick assessment performed by BC Hydro Analytical Study group of Stations Planning Department, in order to provide the shortened 5L94 with a single pole reclose capability in less than one second, 2 x 35 MVAr line end RXs may be required, one at CBK and one at Chapel Rock. For this study purpose, it is assumed reasonable to model the 5L94 with two 35 Mvar line end reactors. Consequently the 2017 and 2022 post Chapel Rock base cases are updated accordingly for BCH study purposes.

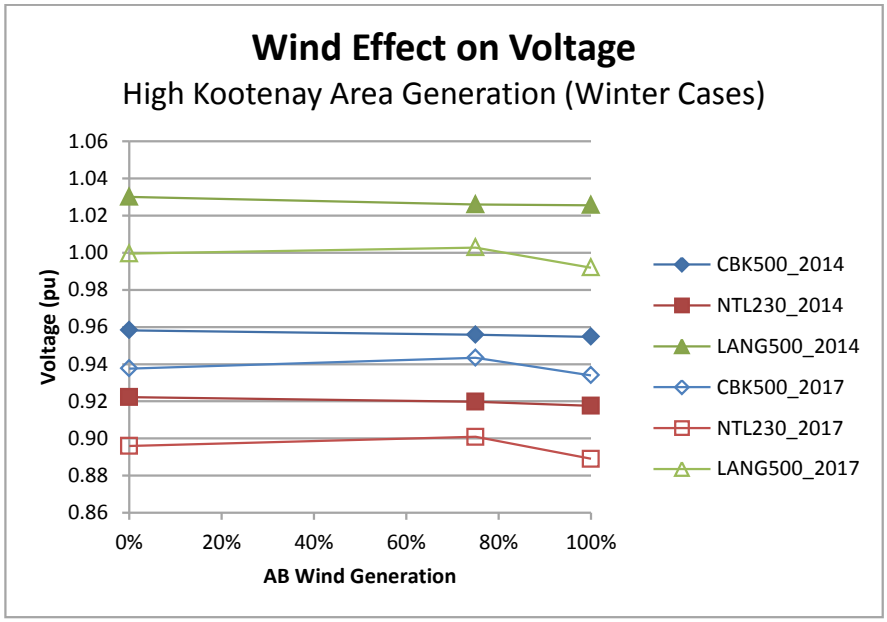
The cost of replacing the CBK 500kV 122.5 Mvar line end reactor with a 500 kV 35 Mvar unit is estimated $6M for this study purpose. The cost of adding a 35 Mvar line end reactor at Chapel Rock is not estimated.

6.4 Alberta Wind Generation Effect

The amount of AIES wind generation significantly affects Path 1 BC to AB transfer capability due to their impact on the voltages. Prior to the establishment of Chapel Rock, AB high wind generations would significantly lower the Path 1 area system voltages particularly during summer. Compounded with increased area load, with low Kootenay area generations the 2017 system voltages could drop below acceptable level for the pre-outage conditions. The voltages would drop much more so after a first contingency. To prevent voltage instability the transfer level would need to be reduced and/or Kootenay area generations must be raised when there are AB high wind generations. Figures below show the AB wind generation effect on voltages of winter and summer base cases with varying Kootenay area generations. After Chapel Rock is in place the wind effect on voltage is much reduced.







6.5 5L92 and 5L94 Single Pole Reclose

Prior to Chapel Rock, the existing system is so weak that single line to ground fault on 5L92 would result in tripping the tie for majority of the ten scenarios in 2014 and 2017 based on 1200 MW BC to AB pre-outage flow. While the impact of temporary single line to ground fault on 5L94 is less severe than 5L92, however the tie still would be tripped for some scenarios. After Chapel Rock is operational, the circuits can carry the full 1200 MW BC to AB flow during temporary single line to ground fault with successful reclose.

For AB to BC flow at 1000 MW, both 5L92 and 5L94 would be able to ride through the temporary single line to ground faults, before and after the Chapel Rock is in service.

The reduction of transfers or addition of shunt var support at CBK would improve system performance during temporary single line to ground faults on 5L92 and 5L94 for the scenarios prior to Chapel Rock, as demonstrated in Appendix G.14.

6.6 Impact on Kootenay Area Generation Dispatch

Kootenay area generation dispatch affects Path 1 import and export transfer limits.

When BC to AB transfer is high, the Kootenay area generation must be kept above a minimum level so that loss of 5L91 would not result in voltage collapse due to power flowing through the increased impedance between NIC and SEL via VAS. With 1200 MW flows from BC to AB, loss of 5L91 could result in post outage power flow non-convergence, i.e. a potential voltage collapse, if the Kootenay area generations are relatively low (Cases y14c07, y14c08). A certain minimum amount of generation is required to prevent voltage instability, as shown in Table 6-1.

However during high AB to BC transfers, the Kootenay area generations must be kept below a certain amount so that there will be sufficient lightly loaded generating units remaining on line to support the system voltages after fully loaded generators are shed to mitigate the impact from loss of 5L91. In the cases studied (Cases y14c11, y17c11, y17c31 and y22c31) with 1000 MW flow from AB to BC, loss of 5L91 could result in post outage power flow non-convergence after generation shedding in Kootenay area due to lack of var support. Shedding some generations in AB (e.g. one Genesee unit) together with some units in the Kootenay area would resolve this issue. An alternate solution would be curtailing Kootenay area generations with some units running at low MW output which will then be used to sustain the system voltage after shedding high MW units.

6.7 Impact on BCH Generation Shedding Requirements

The study is carried out with RAS actions and generation shedding applied in accordance with the present BCH system operating order instructions which are developed based on the current transfer limit of 850 MW for BC to AB and 800 MW for AB to BC. Adjustment to the rules is required when the transfer limit is raised to 1200 MW (BC to AB) and 1000 MW (AB to BC). Studies have identified potential need to review and adjust the operation and RAS arming rules of various contingencies, including but not limited to the following: 5L81, 5L82, 5L91, 5L96, 5L76 & 5L79, 5L91 & 5L96.

6.8 Voltage Variation from Path 1 Flow Changes

The CBK and NTL area voltages vary significantly with the amount of power transfer on Path 1. Table 6-3 below shows the amount of voltage variations of some representative cases as transfers change, before and after Chapel Rock is in service.

Before Chapel Rock, 2014 winter and summer cases show that CBK500 bus voltage could rise by 10% as flow drops from 1200 MW to zero or vice versa. After Chapel Rock, the voltage change is about 5%.

During light load hours in 2014, CBK500 voltage could rise to 109% as import from Alberta drops from 1000 MW to zero.

Table 6-3: Voltage sensitivity analysis to Path 1 flow

CASE	BCH Load	BC to AB flow	CBK 500	CBK 230	SEL 500	SEL 230	NTL 230	NTL 138	NLY 230
y14c01_Rev3	10351	1200	0.9547	0.9390	1.0202	1.0247	0.9176	1.0265	1.0218
y14c01_Rev3_P1_0	10351	0	1.0584	1.0219	1.0414	1.0381	0.9806	1.0290	1.0387
y14c04_Rev3	7239	1200	0.9432	0.9350	1.0200	1.0219	0.9257	1.0361	1.0223
y14c04_Rev3_P1_0	7239	0	1.0422	1.0112	1.0404	1.0345	0.9815	1.0296	1.0370
y14c10_Rev3	7239	1200	0.9550	0.9467	1.0176	1.0234	0.9452	1.0320	1.0221
y14c10_Rev3_P1_0	7239	0	1.0634	1.0308	1.0632	1.0546	1.0074	1.0271	1.0481
y14c12_Rev3	4469	-1000	1.0374	1.0262	1.0452	1.0413	1.0292	1.0360	1.0398
y14c12_Rev3_P1_0	4469	0	1.0910	1.0620	1.0749	1.0622	1.0542	1.0309	1.0555
y17c28_Rev3	8034	1200	0.9943	0.9782	1.0297	1.0309	0.9659	1.0397	1.0301
y17c28_Rev3_P1_0	8034	0	1.0467	1.0176	1.0522	1.0456	0.9885	1.0309	1.0425
y17c30_Rev3	8034	1200	0.9886	0.9716	1.0275	1.0303	0.9595	1.0335	1.0276
y17c30_Rev3_P1_0	8034	0	1.0412	1.0101	1.0500	1.0448	0.9779	1.0408	1.0409
y17c32_Rev3	5216	-1000	1.0353	1.0185	1.0416	1.0392	0.9965	1.0329	1.0387
y17c32_Rev3_P1_0	5216	0	1.0638	1.0354	1.0720	1.0618	1.0184	1.0409	1.0530

6.9 Additional VAr Support at Cranbrook (Prior to Chapel Rock)

Prior to the completion of Chapel Rock project, when transferring 1200 MW from BC to AB the Langdon – Cranbrook 500 kV system voltages are generally low which could lead to tripping from single line to ground fault on 5L92 and/or 5L94 and also voltage instability after loss of 2L294 or 5L91. The above issue has been identified in previous sections of the report. For this study purpose, means of improving the system voltages are explored with power flow and stability analyses, including adding static or dynamic shunt var devices at CBK. The system benefits of these devices are displayed below.

Table 6-4 shows the results of transient simulations done to find what size is adequate to mitigate the problem. With a 300 MVAr fixed shunt capacitor addition at CBK 500, the voltage of this bus during high transfer of 1200 MW stays close to 1 p.u., and the tie line low-voltage protection does not trigger for single-phase-to-ground faults on 5L92. On the other hand, an extra 250 MVAr SVC can also mitigate the tripping problem. A few other options are also listed in the table.

Table 6-4: Mitigation for 5L92 single pole reclose

Case	BC → AB	V0†	Contingency	Reclose	Mitigation	Results
y14c01_Rev3	1200 MW	0.955	5L92 @ CBK	56 cyc	no	5L94 tripped.
Y14c01_Rev3_1100	1100 MW	0.976	5L92 @ CBK	56 cyc	no	Ok
y14c01_Rev3_bch4	1200 MW	0.955	5L92 @ CBK	56 cyc	200 MVAr SVC at CBK 500	Ok
y17c01_Rev3	1200 MW	0.934	5L92 @ CBK	56 cyc	no	5L94 tripped.
Y17c01_Rev3_1100	1100 MW	0.956	5L92 @ CBK	56 cyc	no	Ok
y17c01_Rev3_bch4	1200 MW	0.934	5L92 @ CBK	56 cyc	0 FC + 250 SVC at CBK 500	Ok
		0.996			300 FC + 0 SVC at CBK 500	Ok
		0.966			150 FC + 50 SVC at CBK 500	Ok
		0.955			75 FC + 100 SVC at CBK 500	Ok
y17c01_Rev3	1200 MW	0.934	5L92 @ CBK	56 cyc	520 MW Load Shed‡ in AB	Ok

† Pre-contingency voltage at CBK 500 bus in per unit.

‡ Load is shed 18 cycles after fault occurrence.

Note 1: 5L94 line reactor is 135 MVAr at CBK.

Note 2: The voltages are more depressed when the SLG fault on 5L92 is applied at CBK end versus SEL end.

6.10 Generation Shedding in Alberta during High Import

High transfer from AB to BC could cause issues when the power receiving system (BCH) experiences contingencies that result in a transmission constraint condition. The effective solution would be shedding the excess generation at the source. Some examples are discussed below.

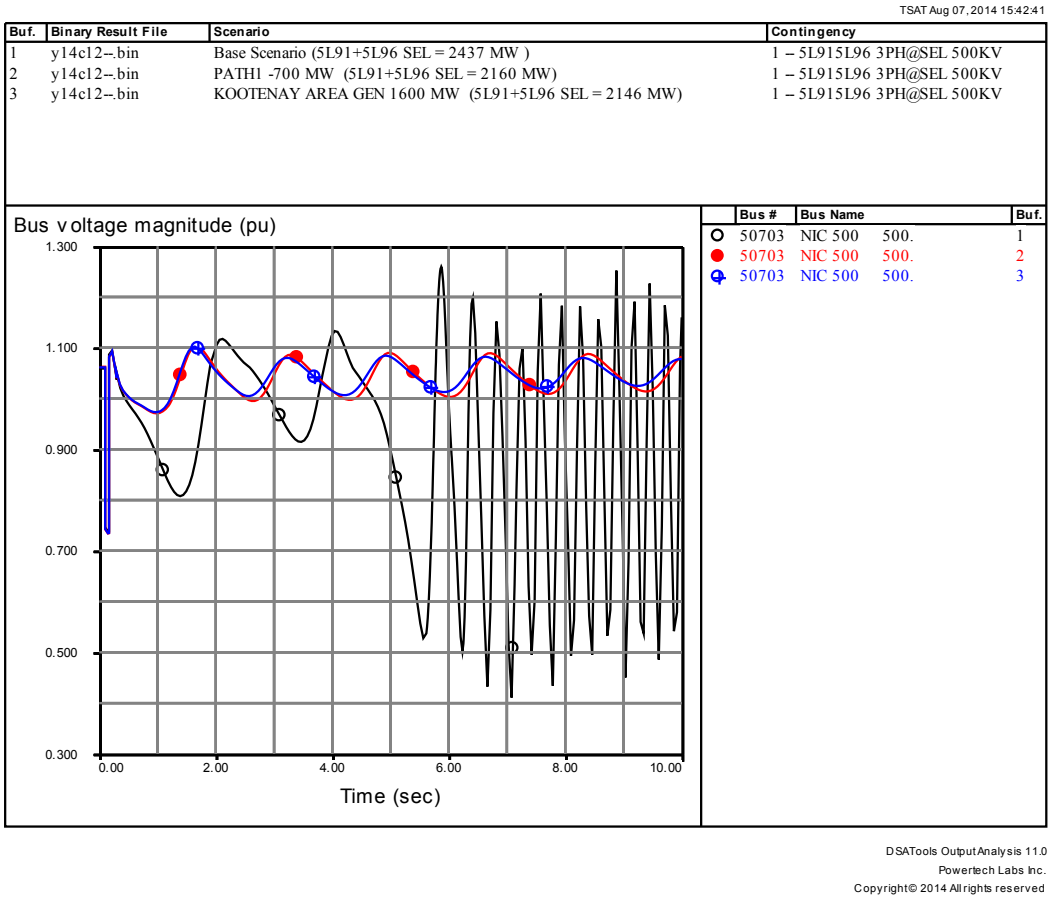
Loss of 5L91 could result in tripping Path 1 and/or voltage collapse unless the excess generation is shed. The present approach is to shed some generation in the Kootenay area which helps to alleviate the system stress, however not very effectively. Furthermore shedding large generations may result in lack of var support and lead to voltage collapse. Shedding some generation in AB would resolve this issue. Similar situation exists for 5L96 contingency, 5L76&5L79 or 5L81&5L82 double contingencies.

Loss of 5L91/5L96 would sever the BCH East Kootenay system from the main grid and leave the system east of SEL tied with the AB system to form a big island, assuming MATL is tripped from protection. To ensure that the island system will not exceed the frequency requirement, some excess generation must be shed quickly, including some units in AB to produce acceptable voltages.

6.11 Low Frequency Inter-Area Oscillation During High Imports

During high imports from US and AB, loss of 5L91/5L96 could cause low frequency inter area oscillation in the BCH and WECC system which may lead to collapse (Case y14c12). This is a known issue that could be related to Path 8 (Montana to Northwest) and Path 6 (West of Hatwai)

transfers. However this inter-regional issue may not have been fully investigated yet to develop a coordinated solution amongst the affected entities. For now, from a purely BC and Alberta perspective, reducing AB import or curtailing the Kootenay area total generation might be an effective means to prevent the risk. The effect of changing these variables are shown in the diagram below where inter area oscillation is reduced by reducing the 5L91 & 5L96 pre-outage flow from SEL to Lower Mainland to less than 2160 MW, which is achieved through lowering AB import or Kootenay area generations.



6.12 Effect of Chapel Rock on Path 1

The development of 500/240kV Chapel Rock substation and its associated connections to the 500kV line compensated with two 35 Mvar reactors and the integration to the AB regional transmission network as modeled in the base cases have produced favorable results for increased Path 1 BC to AB transfer based on the scenarios studied. The system voltages have generally been raised up to desirable levels hence more capable to allow higher BC to AB transfers without the risk of the tie being tripped due to various contingencies in BC. For AB to BC transfer, the effect is less significant as the key issue of excess generation from AB after certain BC contingencies remain unchanged.

6.13 Effect of Deferring REV 6 Associated Projects Beyond 2022

The Revelstoke G6 and its associated projects including the addition of a 250 Mvar shunt capacitor at NIC and 50% series compensation of 5L98 are now in the plan for service in 2029 rather than 2018. To understand the effect of this deferral on Path 1 transfer capability, a sensitivity analysis has been conducted based on updated 2022 base cases with the above projects excluded in the system model.

A base case has been established for 1200 MW BC to AB transfer for summer under high wind conditions (y22c24). Same set of contingencies of N-1, N-2 and temporary single line to ground fault on 5L92 and 5L94 are applied. Power flow and transient stability study results did not identify any issue. Detailed results are reported in Appendix G.17.

For the 1000 MW transfer from AB to BC, this deferral is not expected to cause material difference in results as the system is similar to the 2017 Chapel Rock cases which have no significant issues.

6.14 Chapel Rock 500/240kV Fixed Tap Transformer Model

The AB base cases have Chapel Rock 500/240kV transformers modeled with an automatic on load tap changer and a range of 500kV+/-10%/240kV. However the latest design information indicates that the new transformers would be two 525/246 kV autotransformers with De-Energized Tap Changer ("DETC") on the 500 kV side and range of +/- 2×2.5% (500-550 kV). To assess the effect of modeling difference a sensitivity analysis has been conducted.

Review of the 24 Chapel Rock base cases shows that the taps in the pre-outage base cases vary between 0.9625 (case y22c27) and 1.025 (y22c31) covering full Path 1 flows in either direction (+1200 MW, -1000 MW). To ensure acceptable performance for the full transfer range with a fixed tap position, two extreme cases (y22c27 and y22c31) are studied with two fixed tap positions (512.5/246kV, 500/246kV). While both results are acceptable for the studied cases, 512.5/246kV is preferred as it would produce slightly better voltage profile for the 500kV system (Appendix G.18).

6.15 Chapel Rock Location and 500/240kV Fixed Tap Transformer Model

Similar to the issues addressed in Section 6.14, the assumed distance of Cranbrook to Chapel Rock (110kM) used in the study base cases appears too short based on the potential locations currently under consideration. The distance could be around 140kM to 150kM. This could lead to a change to the size of line end reactors from 2 x 35 Mvars to 2 x 40 Mvars (for the 140kM line), or to 2 x 45 Mvars (for the 150kM line). To assess the combined effect of longer transmission line between Cranbrook and Chapel Rock and the fixed tap transformers, a cursory assessment is performed with modified extreme cases of y22c27 and y22c31 based on a 150kM line, 2 x 45 Mvar line end

reactors and a fixed tap position of 512.5/246kV. Results are acceptable for the studied cases (Appendix G.19).

7. CONCLUSION

The above study results can be summarized below:

For BC to AB 1200 MW transfer

1. For the system prior to Chapel Rock under favorable conditions and with the 138kV ties opened, 1200 MW transfer to AB could be achieved provided that the risk of tie tripping from temporary single line to ground fault on 5L92 or 5L94 is acceptable. The favorable opportunities diminish as system load increases with lowered system voltages. The impact of double contingencies is manageable with the existing RAS functions.
2. Under most circumstances prior to Chapel Rock, 1200 MW transfer could not be realized. CBK and NTL area system voltages are generally very low which could lead to the following issues.
    a. The 500kV tie to Alberta will be tripped by single line to ground fault on 5L92 or 5L94.
    b. Loss of 2L294 or 5L91 could cause very low voltages and perhaps voltage instability.

    The above limitations would become worse as area system load increases from 2014 to 2017. To mitigate the unacceptable system performance, BC to AB transfer limit needs to be reduced and/or Kootenay area reliability must run generation needs to be raised to avoid potential under voltage conditions or voltage collapse after a single contingency.

3. High generation from wind farms in AB further degrade the system performance due to lower Langdon voltages compared to no wind cases.
4. Operation instructions to account for the AB wind generation effect, Kootenay area generation dispatch and some generation shedding rules may need adjustment based on 1200 MW transfer.
5. Potentially large voltage variations occur at CBK and NTL as tie line flow changes. In addition, loss of 5L92 or 5L94 would cause temporary high voltages at these buses although the long term steady state voltages after regulation are acceptable. Having a dynamic device capable of responding to fast voltage variations would be desirable.
6. If the 1200 MW BC to AB transfer is to be achieved for all studied scenarios prior to Chapel Rock from a purely BC system perspective without considering the more limiting constraints in AB, one option is to reinforce the system by providing var support at CBK. For understanding purposes, a cursory assessment shows that adding a 100 Mvar shunt capacitor and a +/-250 Mvar SVC or STATCOM at CBK would provide adequate response to various contingencies. In addition, it will also automatically regulate the area voltages while transfers change.

7. Connecting the Chapel Rock to 5L94 at about 110 kM from Cranbrook and keeping the existing 500kV 122.5 Mvar line end reactor at CBK could cause equipment switching concerns. To address this issue and also providing sufficient compensation for achieving successful single pole reclose in less than one second, the 122.5 Mvar reacotr needs to be replaced, possibly with two 500kV 35 Mvar line reactors, one at CBK and the other at Chapel Rock according to the preliminary BCH analytical study results. The estimated cost for replacing the CBK 500kV line end reactor with a 35 Mvar unit is about $6M, for this study purpose. The Chapel Rock substation may be located 150kM from Cranbrook, depending on the outcome of site selection. The line end reactors will need to be properly sized to ensure the resulting single pole reclose time is sufficiently fast for the maximum transfers.
8. After Chapel Rock is in service, 1200 MW BC to AB transfer could be achieved without the risk of 5L94 tripout from temporary single line to ground fault on 5L92 or 5L94, and also the unacceptable post outage steady state voltage after loss of 2L294 or 5L91.

<u>For AB to BC 1000 MW transfer</u>

9. During summer, the existing system could carry 1000 MW import from Alberta, however subject to the risk of tie tripping from some single contingencies and double contingencies. The risk could be mitigated by enabling generation shedding in AB to reduce the transmission stress from the source, thereby preserving the tie. A partial solution alternative is curtailing generation in Kootenay area which is less effective and may not prevent tie tripping under certain conditions.
10. With Chapel Rock in service, tie tripping due to some contingencies may be avoided.
11. System operating instructions need to be updated to reflect the increased import.
12. Import from AB needs to be coordinated with import from US and possibly other path flows to prevent the risk of potential inter area oscillation caused by the simultaneous loss of 5L91 and 5L96.

8. REFERENCES

[1] "Planning Assessment of BC to Alberta Transfer Capability of the Existing System", BC Hydro, Report No. T&S Planning 2013-058, October, 2013.
[2] "WECC 2014 Path Rating Catalog", Western Electricity Coordinating Council, March 31 2014.
[3] "Enbridge Inc. Montana Alberta Tie Line Functional Description and Specifications for MATL RAS", Technical Memorandum 6013-001-100-Rev03, Teshmont Consultants LP, 27 January 2014.
[4] "Enbridge Inc. Montana Alberta Tie Line MATL RAS PSS/E User Model Documentation", Technical Memorandum 6013-001-200-Rev03, Teshmont Consultants LP, 27 January 2014.

For appendices please refer to two separate documents accompanying this document.

END OF REPORT

Path 1 Transfer Capability Restoration Study

(APPENDICES)

Report No. Transmission & Stations Planning 2014-070

19th December 2014

Transmission and Stations Planning

CONTENTS

LIST OF FIGURES

DISCLAIMER

This Report was prepared solely for BC Hydro's internal purposes. All parties other than BC Hydro are third parties.

BC Hydro does not represent, guarantee or warrant to any third party, either expressly or by implication:

(a) the accuracy, completeness or usefulness of,

(b) the intellectual or other property rights of any person or party in, or

(c) the merchantability, safety or fitness for purpose of,

any information, product or process disclosed, described or recommended in this Report.

Nothing in this Report obligates BC Hydro to take any action with respect to the recommendations contemplated herein. BC Hydro does not accept any liability of any kind arising in any way out of the use by a third party of any information, product or process disclosed, described or recommended in this Report, nor does BC Hydro accept any liability arising out of reliance by a third party upon any information, statements or recommendations contained in this Report. Should third parties use or rely on any information, product or process disclosed, described or recommended in this Report, they do so entirely at their own risk.

COPYRIGHT NOTICE

A. PRE-OUTAGE POWER FLOWS

Names of study base cases and their associated system conditions including load levels, tie line flows, BCH system conditions and AIES wind levels are displayed below.

Table A – 1: List of 48 base cases and their system conditions

Case	Load	BC-to-AB (MW)	BC-to-US (MW)	BCH case names	AIES wind	MT-to-AB (MW)	WECC reference case
2014 (w/o Chapel Rock)							
y14c01_Rev3	HW	1200	-1200	b14hw_p50d_HSI1_wecc	100%	300	14hw2ap
y14c02_Rev3	HW	1200	-1200	b14hw_p50d_HSI1_wecc	75%	300	14hw2ap
y14c03_Rev3	HW	1200	-1200	b14hw_p50d_HSI1_wecc	0	300	14hw2ap
y14c04_Rev3	HS	1200	1200	b14hs_p50d_HSI2a_wecc	100%	300	14hsp1ap
y14c05_Rev3	HS	1200	1200	b14hs_p50d_HSI2a_wecc	75%	300	14hsp1ap
y14c06_Rev3	HS	1200	1200	b14hs_p50d_HSI2a_wecc	0	300	14hsp1ap
y14c07_Rev3	HS	1200	1200	b14hs_p50d_MSI2a_wecc	100%	300	14hsp1ap
y14c08_Rev3	HS	1200	1200	b14hs_p50d_MSI2a_wecc	75%	300	14hsp1ap
y14c09_Rev3	HS	1200	1200	b14hs_p50d_MSI2a_wecc	0%	300	14hsp1ap
y14c10_Rev3	HS	1200	-2400	b14hs_p50d_MSI3_wecc	75%	300	14hsp1ap
y14c11_Rev3	HS	-1000	2000	b14hs_p50d_HSI4_wecc	100%	-325	14hsp1ap
y14c12_Rev3	LS	-1000	-1000	b14ls_p50d_MSI5_wecc	100%	-325	14lw1ap
2017 (w/o Chapel Rock)							
y17c01_Rev3	HW	1200	-1200	b17hw_p50d_HSI1_wecc	100%	300	17hw2ap
y17c02_Rev3	HW	1200	-1200	b17hw_p50d_HSI1_wecc	75%	300	17hw2ap
y17c03_Rev3	HW	1200	-1200	b17hw_p50d_HSI1_wecc	0	300	17hw2ap
y17c04_Rev3	HS	1200	2000	b17hs_p50d_HSI2b_wecc	100%	300	17hs1ap
y17c05_Rev3	HS	1200	2000	b17hs_p50d_HSI2b_wecc	75%	300	17hs1ap
y17c06_Rev3	HS	1200	2000	b17hs_p50d_HSI2b_wecc	0	300	17hs1ap
y17c07_Rev3	HS	1200	2000	b17hs_p50d_MSI2b_wecc	100%	300	17hs1ap
y17c08_Rev3	HS	1200	2000	b17hs_p50d_MSI2b_wecc	75%	300	17hs1ap
y17c09_Rev3	HS	1200	2000	b17hs_p50d_MSI2b_wecc	0%	300	17hs1ap
y17c10_Rev3	HS	1200	-2400	b17hs_p50d_MSI3_wecc	75%	300	17hs1ap
y17c11_Rev3	HS	-1000	2000	b17hs_p50d_HSI4_wecc	100%	-325	17hs1ap
y17c12_Rev3	LS	-1000	-1000	b17ls_p50d_MSI5_wecc	100%	-325	17lw1asp
2017 (with Chapel Rock)							
y17c21_Rev3	HW	1200	-1200	b17hw_p50d_HSI1_wecc	100%	300	17hw2ap
y17c22_Rev3	HW	1200	-1200	b17hw_p50d_HSI1_wecc	75%	300	17hw2ap
y17c23_Rev3	HW	1200	-1200	b17hw_p50d_HSI1_wecc	0	300	17hw2ap
y17c24_Rev3	HS	1200	2000	b17hs_p50d_HSI2b_wecc	100%	300	17hs1ap
y17c25_Rev3	HS	1200	2000	b17hs_p50d_HSI2b_wecc	75%	300	17hs1ap
y17c26_Rev3	HS	1200	2000	b17hs_p50d_HSI2b_wecc	0	300	17hs1ap
y17c27_Rev3	HS	1200	2000	b17hs_p50d_MSI2b_wecc	100%	300	17hs1ap
y17c28_Rev3	HS	1200	2000	b17hs_p50d_MSI2b_wecc	75%	300	17hs1ap
y17c29_Rev3	HS	1200	2000	b17hs_p50d_MSI2b_wecc	0%	300	17hs1ap
y17c30_Rev3	HS	1200	-2400	b17hs_p50d_MSI3_wecc	75%	300	17hs1ap
y17c31_Rev3	HS	-1000	2000	b17hs_p50d_HSI4_wecc	100%	-325	17hs1ap
y17c32_Rev3	LS	-1000	-1000	b17ls_p50d_MSI5_wecc	100%	-325	17lw1asp

Case	Load	BC-to-AB (MW)	BC-to-US (MW)	BCH case names	AIES wind	MT-to-AB (MW)	WECC reference case
2022 (with Chapel Rock)							
y22c21_Rev3	HW	1200	-1200	b22hw_p50d_HSI1_wecc	100%	300	22hw1a1p
y22c22_Rev3	HW	1200	-1200	b22hw_p50d_HSI1_wecc	75%	300	22hw1a1p
y22c23_Rev3	HW	1200	-1200	b22hw_p50d_HSI1_wecc	0	300	22hw1a1p
y22c24_Rev3	HS	1200	2000	b22hs_p50d_HSI2b_wecc	100%	300	23hs1ap
y22c25_Rev3	HS	1200	2000	b22hs_p50d_HSI2b_wecc	75%	300	23hs1ap
y22c26_Rev3	HS	1200	2000	b22hs_p50d_HSI2b_wecc	0	300	23hs1ap
y22c27_Rev3	HS	1200	2000	b22hs_p50d_MSI2b_wecc	100%	300	23hs1ap
y22c28_Rev3	HS	1200	2000	b22hs_p50d_MSI2b_wecc	75%	300	23hs1ap
y22c29_Rev3	HS	1200	2000	b22hs_p50d_MSI2b_wecc	0%	300	23hs1ap
y22c30_Rev3	HS	1200	-2400	b22hs_p50d_MSI3_wecc	75%	300	23hs1ap
y22c31_Rev3	HS	-1000	2000	b22hs_p50d_HSI4_wecc	100%	-325	23hs1ap
y22c32_Rev3	LS	-1000	-1000	b22ls_p50d_MSI5_wecc	100%	-325	22lsp1sbp

Case: case names used in the study. Developed using respective BCH, AESO cases and WECC reference cases
BCH case names: reference names of BCH base cases used in developing the combined WECC cases
WECC reference case: WECC cases used to model the systems external to BCH and AESO

Table A – 2: 2014 and 2017 N-0 base cases (w/o Chapel Rock) – 500kV Tie Line Flow Metered at Langdon

	SEL AREA GEN	SEL 500/230	5L98 VAS	5L96 SEL	5L91 SEL	5L91 & 5L96	5L92 SEL	SEL 500	SEL 230	NTL 230	NTL 138	NLY 230	CBK 500	CBK 230	LANG 500	AIES WIND
PFB CASE	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**% max wind**
y14c01_Rev3_bch1	1836	1275	-29	209	-262	-53	1327	1.0202	1.0247	0.9176	1.0265	1.0218	0.9547	0.9390	1.0256	100
y14c02_Rev3_bch1	1836	1277	-27	211	-261	-50	1326	1.0206	1.0249	0.9198	1.0310	1.0221	0.9558	0.9403	1.0259	75
y14c03_Rev3_bch1	1836	1278	-26	212	-260	-48	1326	1.0212	1.0253	0.9223	1.0329	1.0225	0.9583	0.9427	1.0301	0
y14c04_Rev3_bch1	1754	1226	104	211	-243	-31	1256	1.0200	1.0219	0.9257	1.0361	1.0223	0.9432	0.9350	0.9702	100
y14c05_Rev3_bch1	1754	1228	108	216	-240	-24	1252	1.0262	1.0258	0.9586	1.0240	1.0258	0.9662	0.9579	1.0038	75
y14c06_Rev3_bch1	1753	1234	114	223	-235	-12	1245	1.0322	1.0294	0.9459	1.0311	1.0289	0.9893	0.9748	1.0570	0
y14c07_Rev3_bch1*	1040*	549	-332	-209	-524	-733	1281	1.0192	1.0215	0.9312	1.0349	1.0216	0.9444	0.9374	0.9740	100
y14c08_Rev3_bch1*	840*	355	-394	-280	-649	-929	1284	1.0203	1.0234	0.9402	1.0353	1.0230	0.9498	0.9437	0.9799	75
y14c09_Rev3_bch1	555	94	-521	-408	-784	-1192	1286	1.0255	1.0280	0.9393	1.0257	1.0273	0.9800	0.9672	1.0504	0
y14c10_Rev3_bch1	555	417	-356	-239	-604	-843	1260	1.0176	1.0234	0.9452	1.0320	1.0221	0.9550	0.9467	0.9969	75
y14c11_Rev3_bch1	1952	1670	1127	1319	1092	2411	-743	1.0070	1.0142	0.9569	1.0300	1.0216	0.9753	0.9679	0.9606	100
y14c12_Rev3_bch1	818	724	666	791	728	1519	-795	1.0452	1.0413	1.0292	1.0360	1.0398	1.0374	1.0262	1.0526	100
y17c01_Rev3_bch1	1862	1291	-24	223	-258	-35	1325	1.0160	1.0219	0.8891	1.0330	1.0192	0.9339	0.9189	0.9920	100
y17c02_Rev3_bch1	1862	1291	-24	224	-258	-34	1324	1.0184	1.0234	0.9009	1.0346	1.0207	0.9434	0.9291	1.0028	75
y17c03_Rev3_bch1	1862	1286	-27	220	-261	-41	1326	1.0168	1.0224	0.8960	1.0323	1.0195	0.9376	0.9220	0.9995	0
y17c04_Rev3_bch1	1750	1227	114	220	-239	-20	1245	1.0226	1.0233	0.9287	1.0349	1.0237	0.9542	0.9435	0.9940	100
y17c05_Rev3_bch1	1750	1228	115	221	-238	-17	1244	1.0221	1.0229	0.9303	1.0311	1.0234	0.9519	0.9419	0.9879	75
y17c06_Rev3_bch1	1750	1224	113	219	-241	-22	1244	1.0244	1.0244	0.9476	1.0255	1.0247	0.9607	0.9510	1.0002	0
y17c07_Rev3_bch1*	1016*	527	-296	-184	-573	-757	1284	1.0099	1.0160	0.8635	1.0321	1.0175	0.9127	0.9023	0.9450	100
y17c08_Rev3_bch1	551	87	-508	-400	-800	-1199	1286	1.0145	1.0209	0.9227	1.0350	1.0219	0.9443	0.9351	0.9898	75
y17c09_Rev3_bch1	550	83	-510	-401	-802	-1203	1286	1.0149	1.0206	0.9362	1.0246	1.0221	0.9486	0.9400	0.9956	0
y17c10_Rev3_bch1	551	418	-374	-253	-588	-841	1259	1.0144	1.0212	0.9258	1.0274	1.0201	0.9464	0.9358	0.9948	75
y17c11_Rev3_bch1	1945	1661	1130	1320	1093	2413	-754	1.0170	1.0203	0.9738	1.0261	1.0264	1.0103	0.9979	1.0366	100
y17c12_Rev3_bch1	716	622	643	760	651	1411	-789	1.0389	1.0365	0.9861	1.0297	1.0349	1.0157	1.0027	1.0177	100

Table A – 3: 2014 and 2017 N-0 base cases (w/o Chapel Rock) – 500kV Tie Line Flow Metered at the BC/AB border

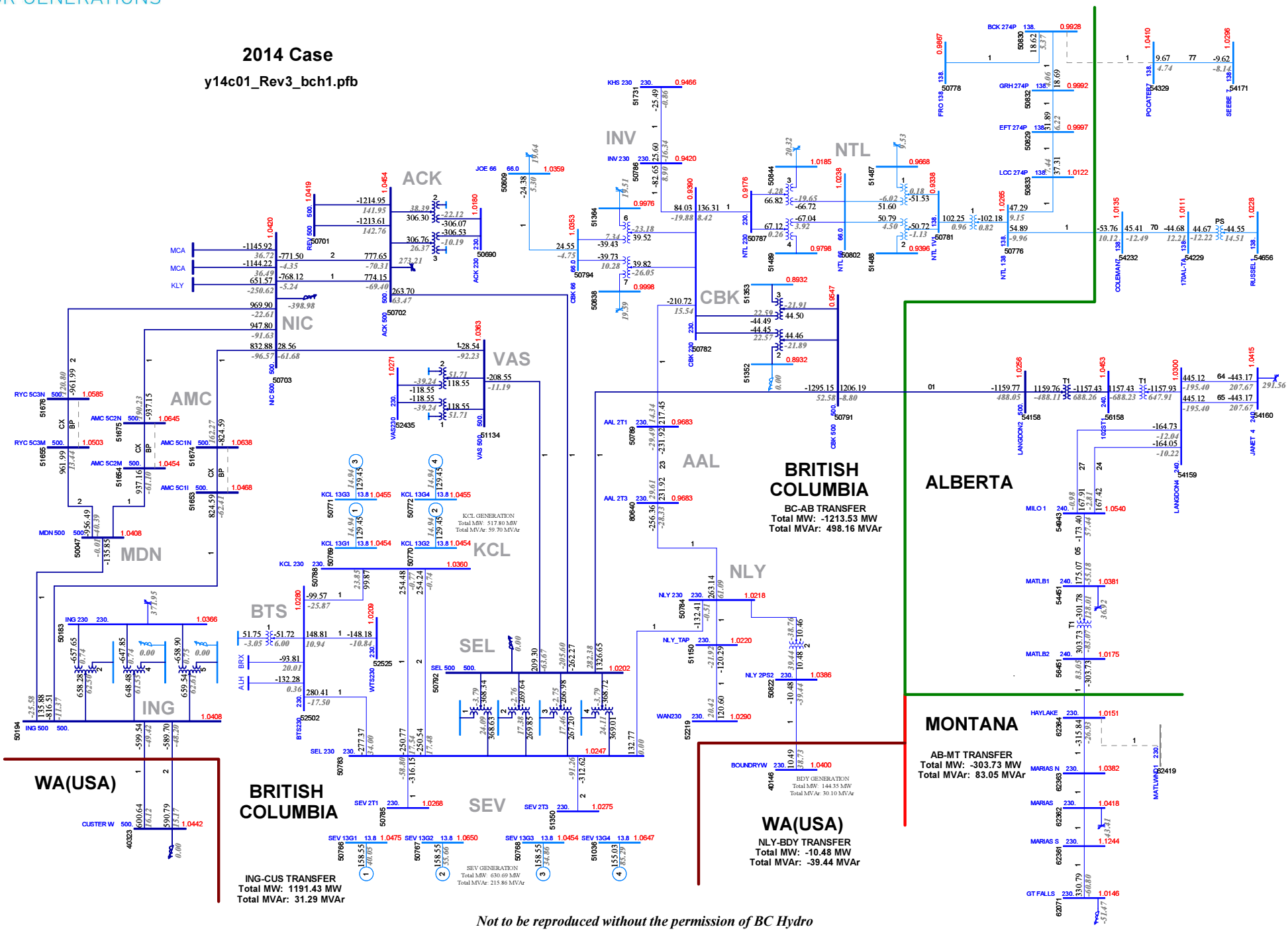
	SEL AREA GEN	SEL 500/230	5L98 VAS	5L96 SEL	5L91 SEL	5L91 & 5L96 SEL	5L92 SEL	SEL 500	SEL 230	NTL 230	NTL 138	NLY 230	CBK 500	CBK 230	LANG 500	AIES WIND
BASE CASE	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**% max wind**
y14c01_Rev3_bch0	1836	1281	-10	229	-243	-13	1293	1.0240	1.0270	0.9267	1.0337	1.0241	0.9668	0.9500	1.0305	100
y14c02_Rev3_bch0	1836	1283	-8	230	-241	-11	1293	1.0243	1.0272	0.9315	1.0305	1.0244	0.9679	0.9517	1.0308	75
y14c03_Rev3_bch0	1836	1285	-8	231	-241	-9	1293	1.0250	1.0276	0.9354	1.0245	1.0247	0.9703	0.9541	1.0347	0
y14c04_Rev3_bch0	1754	1233	125	234	-221	13	1219	1.0246	1.0247	0.9402	1.0381	1.0249	0.9577	0.9489	0.9765	100
y14c05_Rev3_bch0	1754	1234	127	236	-220	15	1218	1.0296	1.0279	0.9680	1.0313	1.0277	0.9772	0.9681	1.0086	75
y14c06_Rev3_bch0	1753	1240	130	240	-218	22	1217	1.0350	1.0311	0.9558	1.0297	1.0304	0.9983	0.9833	1.0603	0
y14c07_Rev3_bch0	555	93	-507	-394	-769	-1163	1256	1.0192	1.0237	0.9413	1.0326	1.0237	0.9541	0.9471	0.9789	100
y14c08_Rev3_bch0	555	91	-507	-394	-769	-1164	1255	1.0210	1.0251	0.9481	1.0413	1.0248	0.9597	0.9532	0.9848	75
y14c09_Rev3_bch0	555	100	-503	-389	-766	-1155	1255	1.0291	1.0304	0.9453	1.0304	1.0293	0.9889	0.9744	1.0540	0
y14c10_Rev3_bch0	555	418	-340	-222	-588	-810	1228	1.0222	1.0267	0.9554	1.0401	1.0249	0.9675	0.9585	1.0021	75
y14c11_Rev3_bch0	1952	1672	1135	1328	1103	2431	-761	1.0055	1.0133	0.9550	1.0285	1.0210	0.9727	0.9657	0.9588	100
y14c12_Rev3_bch0	1775	1624	1041	1205	1246	2451	-828	1.0244	1.0255	1.0220	1.0313	1.0299	1.0255	1.0181	1.0490	100
y17c01_Rev3_bch0	1862	1298	-4	245	-237	8	1289	1.0196	1.0241	0.8956	1.0384	1.0213	0.9455	0.9282	0.9971	100
y17c02_Rev3_bch0	1862	1298	-3	246	-236	10	1287	1.0228	1.0261	0.9139	1.0348	1.0233	0.9577	0.9427	1.0083	75
y17c03_Rev3_bch0	1862	1293	-6	242	-240	3	1289	1.0210	1.0250	0.9053	1.0402	1.0219	0.9510	0.9339	1.0050	0
y17c04_Rev3_bch0	1750	1234	133	240	-220	20	1213	1.0261	1.0254	0.9426	1.0282	1.0256	0.9661	0.9547	0.9991	100
y17c05_Rev3_bch0	1750	1235	134	241	-219	22	1212	1.0255	1.0251	0.9441	1.0243	1.0253	0.9636	0.9530	0.9926	75
y17c06_Rev3_bch0	1750	1231	132	239	-221	18	1212	1.0275	1.0263	0.9557	1.0319	1.0264	0.9710	0.9602	1.0044	0
y17c07_Rev3_bch0	550	90	-491	-382	-781	-1163	1253	1.0105	1.0173	0.9048	1.0356	1.0195	0.9299	0.9212	0.9525	100
y17c08_Rev3_bch0	550	93	-489	-380	-780	-1160	1253	1.0190	1.0237	0.9343	1.0344	1.0243	0.9569	0.9465	0.9952	75
y17c09_Rev3_bch0	550	90	-490	-381	-782	-1163	1252	1.0207	1.0250	0.9488	1.0260	1.0252	0.9622	0.9525	1.0008	0
y17c10_Rev3_bch0	551	424	-355	-233	-568	-801	1225	1.0196	1.0251	0.9386	1.0280	1.0231	0.9598	0.9480	1.0004	75
y17c11_Rev3_bch0	1945	1663	1136	1328	1101	2429	-768	1.0160	1.0197	0.9725	1.0245	1.0259	1.0089	0.9967	1.0352	100
y17c12_Rev3_bch0	1770	1613	1051	1211	1225	2436	-824	1.0187	1.0220	0.9812	1.0265	1.0264	1.0052	0.9967	1.0145	100

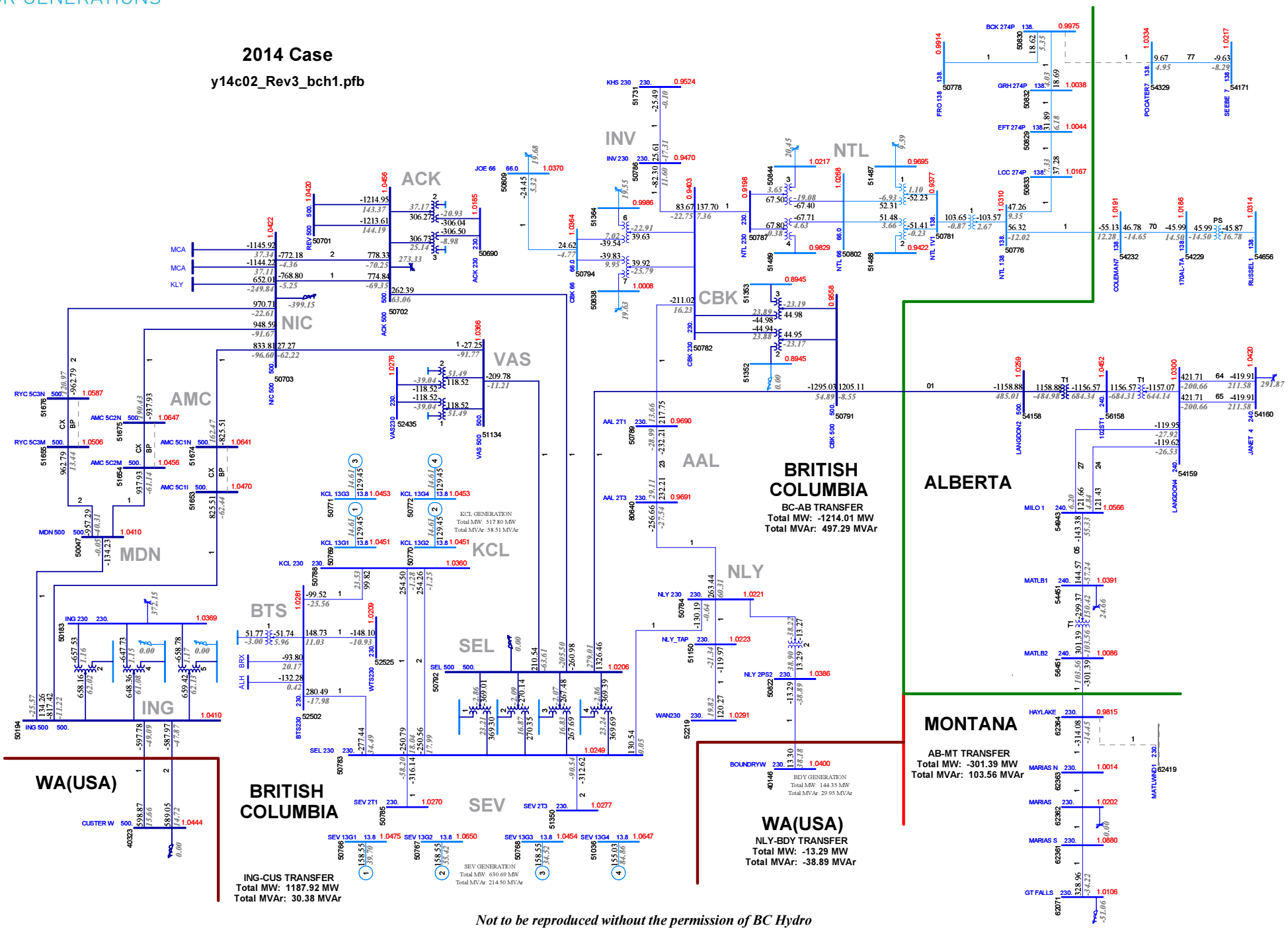
Table A – 4: 2017 & 2022 N-0 base cases (with Chapel Rock) - 2 x 35 Mvar line end RXs on 5L94 (one at CBK, one at Chapel Rock)

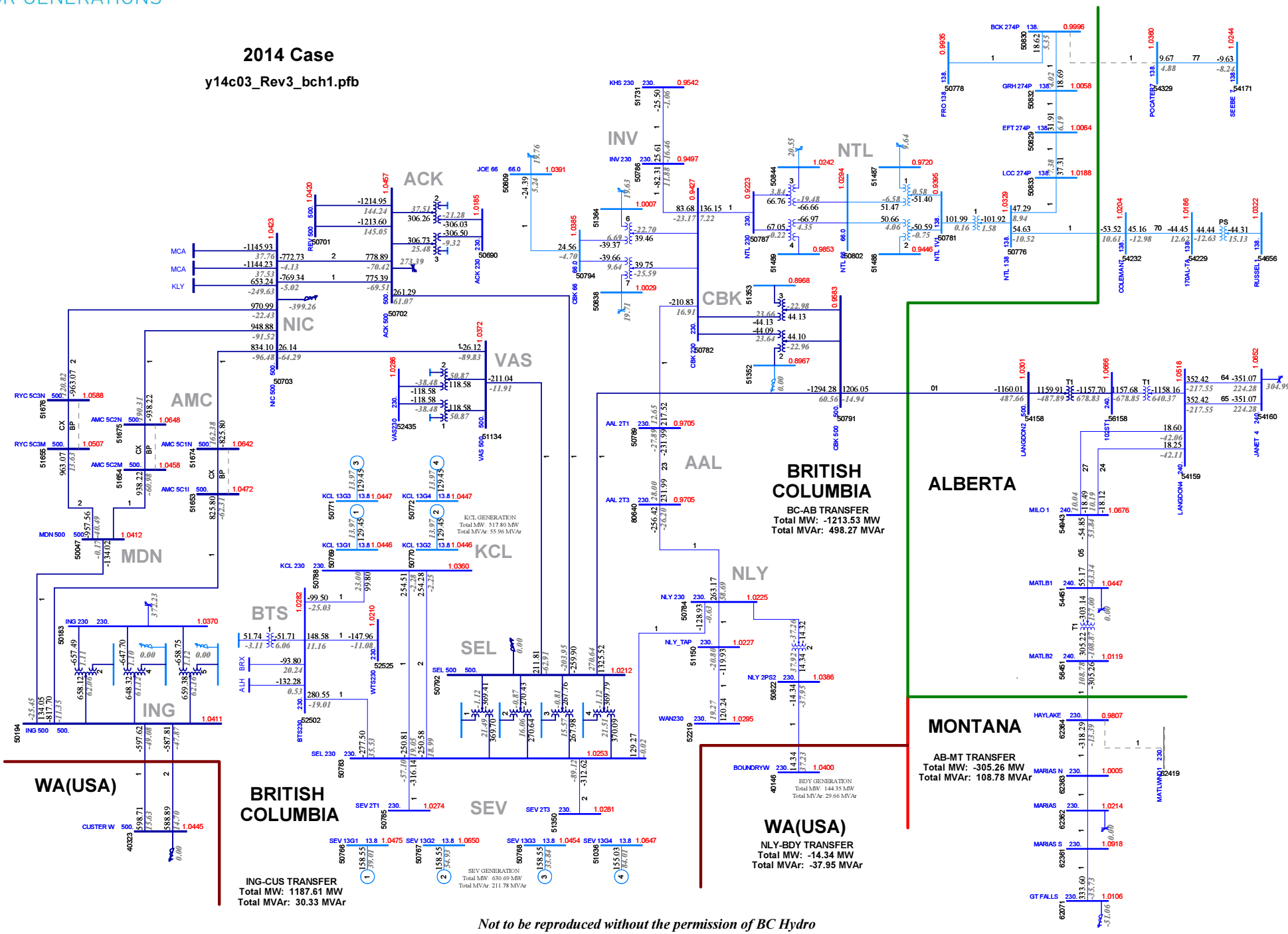
	SEL AREA GEN	SEL 500/230	5L98 VAS	5L96 SEL	5L91 SEL	5L91 & 5L96	5L92 SEL	SEL 500	SEL 230	NTL 230	NTL 138	NLY 230	CBK 500	CBK 230	Chapel Rock	LANG 500	AIES WIND
PFB CASE	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**% max wind**
y17c21_Rev3_st_35_35	1299	1862	-3	247	-238	9	1289	1.0299	1.0305	0.9374	1.0304	1.0271	0.9855	0.9645	0.9979	1.0002	100
y17c22_Rev3_st_35_35	1299	1861	-2	247	-238	9	1289	1.0319	1.0318	0.9500	1.0255	1.0283	0.9938	0.9728	1.0087	1.0098	75
y17c23_Rev3_st_35_35	1301	1862	0	249	-237	12	1288	1.0350	1.0337	0.9607	1.0234	1.0302	1.0057	0.9838	1.0255	1.0242	0
y17c24_Rev3_st_35_35	1234	1750	134	241	-220	21	1212	1.0314	1.0287	0.9618	1.0331	1.0285	0.9869	0.9749	0.9843	0.9888	100
y17c25_Rev3_st_35_35	1235	1750	135	242	-220	22	1212	1.0341	1.0303	0.9712	1.0342	1.0298	0.9977	0.9813	1.0039	1.0089	75
y17c26_Rev3_st_35_35	1237	1750	137	245	-218	27	1209	1.0359	1.0314	0.9607	1.0332	1.0307	1.0048	0.9857	1.0163	1.0066	0
y17c27_Rev3_st_35_35	93	549	-487	-379	-780	-1159	1252	1.0285	1.0301	0.9661	1.0292	1.0295	0.9896	0.9763	0.9937	0.9906	100
y17c28_Rev3_st_35_35	96	550	-487	-379	-780	-1159	1255	1.0296	1.0308	0.9668	1.0405	1.0301	0.9939	0.9789	1.0018	1.0082	75
y17c29_Rev3_st_35_35	97	550	-485	-377	-778	-1155	1251	1.0319	1.0323	0.9596	1.0328	1.0314	1.0018	0.9844	1.0147	1.0068	0
y17c30_Rev3_st_35_35	426	551	-353	-232	-568	-800	1226	1.0271	1.0301	0.9585	1.0330	1.0274	0.9872	0.9702	0.9941	0.9988	75
y17c31_Rev3_st_35_35	1660	1945	1137	1328	1101	2429	-770	1.0183	1.0212	0.9719	1.0407	1.0270	1.0179	1.0004	1.0280	1.0222	100
y17c32_Rev3_st_35_35	623	716	652	770	660	1430	-807	1.0441	1.0401	1.0030	1.0288	1.0379	1.0325	1.0121	1.0371	1.0325	100
y22c21_Rev3_st_35_35	1294	1861	55	289	-286	3	1290	1.0267	1.0282	0.9161	1.0351	1.0236	0.9635	0.9469	0.9620	0.9653	100
y22c22_Rev3_st_35_35	1298	1862	60	294	-284	9	1288	1.0314	1.0311	0.9372	1.0356	1.0264	0.9821	0.9646	0.9876	0.9904	75
y22c23_Rev3_st_35_35	1301	1861	62	296	-285	12	1288	1.0372	1.0348	0.9713	1.0343	1.0298	1.0062	0.9851	1.0240	1.0343	0
y22c24_Rev3_st_35_35	1231	1750	218	307	-285	22	1208	1.0272	1.0270	0.9369	1.0336	1.0270	0.9717	0.9597	0.9640	0.9638	100
y22c25_Rev3_st_35_35	1235	1750	221	310	-284	26	1207	1.0317	1.0298	0.9652	1.0352	1.0295	0.9902	0.9781	0.9890	0.9872	75
y22c26_Rev3_st_35_35	1238	1750	224	313	-284	29	1207	1.0362	1.0324	0.9617	1.0293	1.0317	1.0087	0.9884	1.0233	1.0095	0
y22c27_Rev3_st_35_35	85	545	-447	-347	-818	-1165	1250	1.0217	1.0261	0.9399	1.0393	1.0269	0.9655	0.9567	0.9571	0.9544	100
y22c28_Rev3_st_35_35	90	545	-442	-341	-817	-1158	1248	1.0282	1.0304	0.9647	1.0356	1.0304	0.9902	0.9772	0.9942	0.9957	75
y22c29_Rev3_st_35_35	93	545	-440	-340	-817	-1156	1249	1.0328	1.0334	0.9623	1.0301	1.0327	1.0081	0.9887	1.0256	1.0176	0
y22c30_Rev3_st_35_35	400	545	-372	-246	-575	-822	1222	1.0306	1.0300	0.9644	1.0353	1.0290	0.9895	0.9772	0.9896	0.9943	75
y22c31_Rev3_st_35_35	1656	1942	1378	1517	913	2429	-776	1.0246	1.0255	0.9699	1.0379	1.0300	1.0242	0.9982	1.0423	1.0338	100
y22c32_Rev3_st_35_35	711	812	797	896	627	1523	-812	1.0412	1.0390	0.9955	1.0317	1.0385	1.0340	1.0174	1.0384	1.0301	100

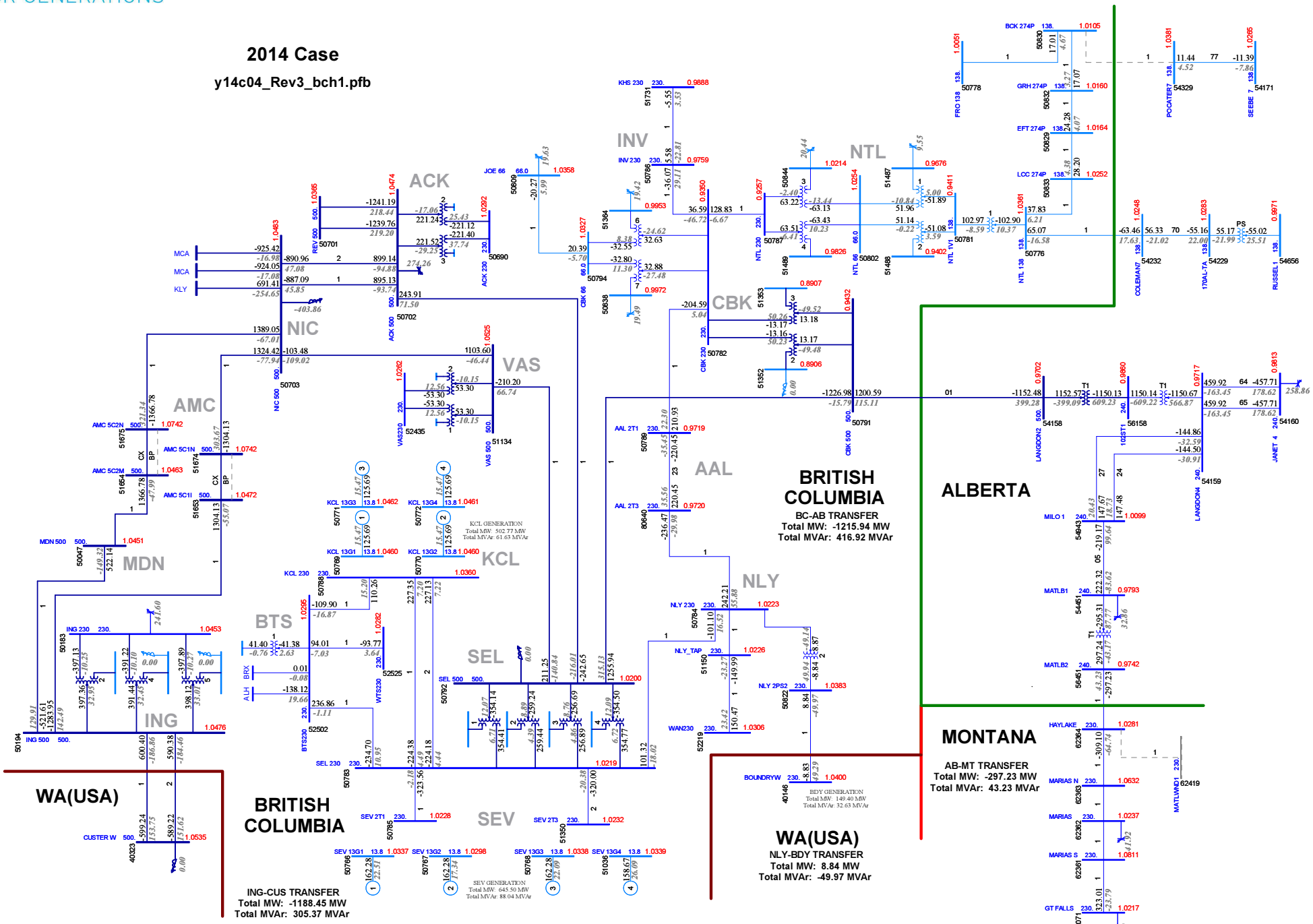
Table A – 5: 2017 & 2022 N-0 base cases (with Chapel Rock) - 1 x 35 Mvar line end RX on 5L94 at CBK

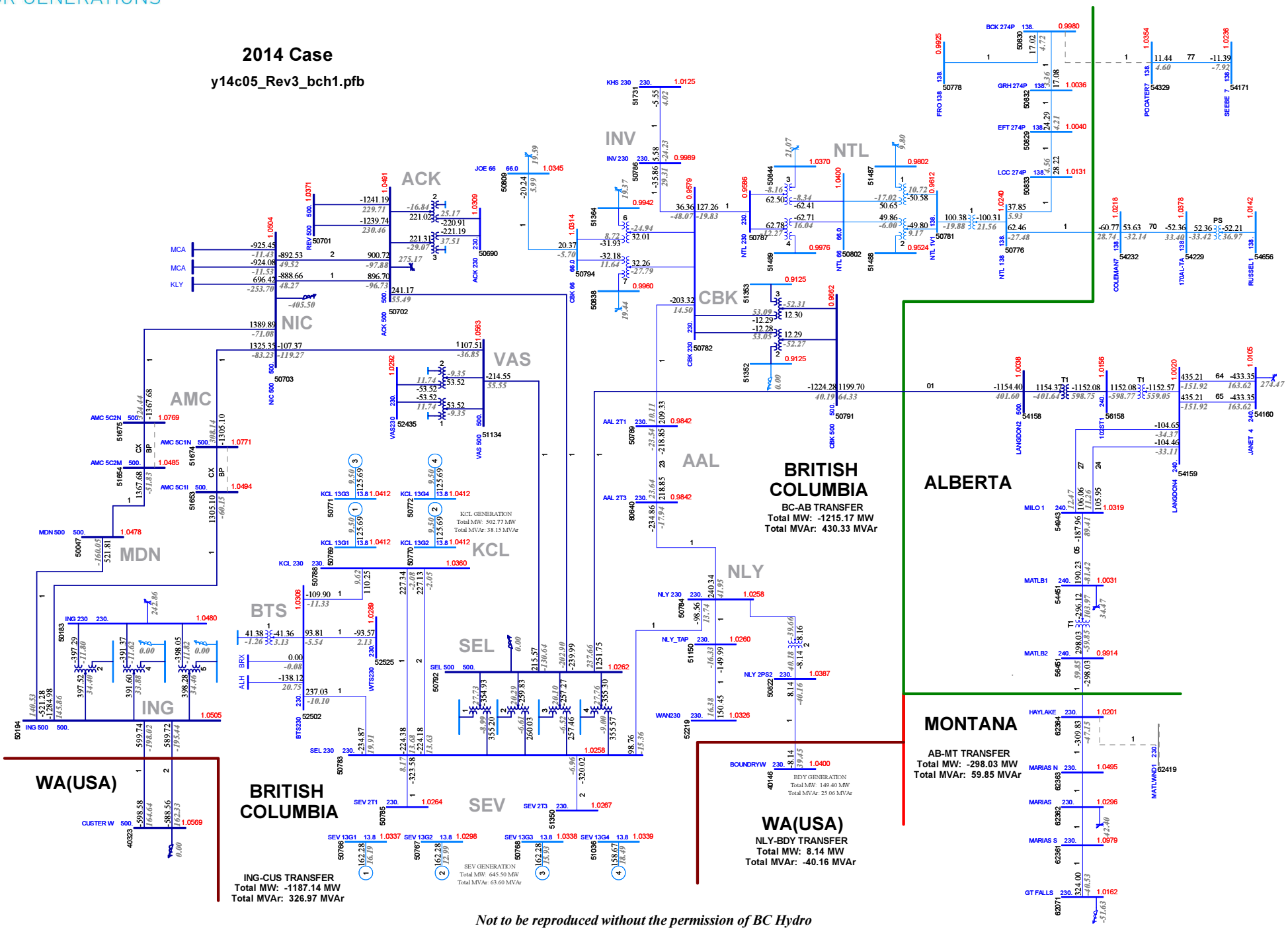
	SEL AREA GEN	SEL 500/230	5L98 VAS	5L96 SEL	5L91 SEL	5L91 & 5L96	5L92 SEL	SEL 500	SEL 230	NTL 230	NTL 138	NLY 230	CBK 500	CBK 230	Chapel Rock	LANG 500	AIES WIND
PFB CASE	**MW**	**MW**	**MW**	**MW**	**MW**		**MW**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**	**p.u.**		**p.u.**	**% max wind**
y17c21_Rev3_bch1	1862	1299	-2	248	-237	11	1287	1.0303	1.0307	0.9391	1.0322	1.0274	0.9871	0.9661	0.9997	1.0008	100
y17c22_Rev3_bch1	1862	1300	0	250	-236	14	1286	1.0334	1.0327	0.9576	1.0320	1.0294	0.9990	0.9812	1.0115	1.0106	75
y17c23_Rev3_bch1	1862	1302	0	250	-236	14	1288	1.0351	1.0337	0.9602	1.0228	1.0302	1.0061	0.9834	1.0270	1.0246	0
y17c24_Rev3_bch1	1750	1233	134	241	-220	21	1211	1.0315	1.0288	0.9560	1.0257	1.0286	0.9873	0.9745	0.9857	0.9892	100
y17c25_Rev3_bch1	1750	1236	135	242	-220	22	1213	1.0342	1.0304	0.9705	1.0338	1.0298	0.9979	0.9805	1.0053	1.0093	75
y17c26_Rev3_bch1	1750	1237	137	244	-218	26	1210	1.0360	1.0315	0.9599	1.0321	1.0307	1.0052	0.9853	1.0178	1.0070	0
y17c27_Rev3_bch1	550	93	-488	-380	-781	-1161	1254	1.0287	1.0303	0.9689	1.0227	1.0297	0.9907	0.9775	0.9953	0.9910	100
y17c28_Rev3_bch1	550	96	-486	-378	-779	-1157	1253	1.0297	1.0309	0.9659	1.0397	1.0301	0.9943	0.9782	1.0033	1.0087	75
y17c29_Rev3_bch1	550	97	-485	-377	-778	-1155	1252	1.0319	1.0323	0.9588	1.0321	1.0313	1.0020	0.9835	1.0161	1.0072	0
y17c30_Rev3_bch1	551	426	-353	-232	-567	-799	1225	1.0275	1.0303	0.9595	1.0335	1.0276	0.9886	0.9716	0.9959	0.9993	75
y17c31_Rev3_bch1	1945	1660	1137	1328	1100	2428	-769	1.0185	1.0212	0.9710	1.0403	1.0269	1.0181	0.9994	1.0294	1.0225	100
y17c32_Rev3_bch1	716	623	652	770	660	1430	-806	1.0440	1.0400	1.0010	1.0270	1.0377	1.0321	1.0101	1.0384	1.0329	100
y22c21_Rev3_bch1	1861	1294	56	290	-285	5	1288	1.0270	1.0284	0.9169	1.0356	1.0238	0.9646	0.9480	0.9636	0.9658	100
y22c22_Rev3_bch1	1862	1298	59	293	-285	8	1289	1.0318	1.0314	0.9489	1.0285	1.0268	0.9842	0.9676	0.9895	0.9909	75
y22c23_Rev3_bch1	1862	1301	62	296	-285	11	1289	1.0372	1.0347	0.9680	1.0417	1.0297	1.0062	0.9839	1.0254	1.0346	0
y22c24_Rev3_bch1	1750	1231	216	305	-286	19	1211	1.0274	1.0271	0.9374	1.0341	1.0270	0.9724	0.9604	0.9654	0.9641	100
y22c25_Rev3_bch1	1750	1235	220	310	-284	25	1209	1.0318	1.0298	0.9594	1.0283	1.0295	0.9904	0.9775	0.9904	0.9876	75
y22c26_Rev3_bch1	1750	1238	223	312	-284	28	1209	1.0364	1.0326	0.9628	1.0304	1.0318	1.0098	0.9893	1.0250	1.0099	0
y22c27_Rev3_bch1	545	85	-447	-346	-818	-1164	1249	1.0218	1.0262	0.9344	1.0324	1.0270	0.9659	0.9564	0.9585	0.9547	100
y22c28_Rev3_bch1	545	90	-442	-341	-817	-1158	1248	1.0285	1.0306	0.9656	1.0365	1.0305	0.9913	0.9781	0.9959	0.9962	75
y22c29_Rev3_bch1	546	94	-439	-339	-816	-1155	1249	1.0328	1.0334	0.9615	1.0297	1.0326	1.0083	0.9878	1.0271	1.0180	0
y22c30_Rev3_bch1	545	401	-372	-246	-576	-822	1223	1.0309	1.0302	0.9652	1.0357	1.0292	0.9906	0.9782	0.9912	0.9947	75
y22c31_Rev3_bch1	1942	1655	1378	1517	913	2429	-776	1.0248	1.0257	0.9706	1.0385	1.0301	1.0252	0.9989	1.0440	1.0343	100
y22c32_Rev3_bch1	812	712	797	896	627	1523	-811	1.0416	1.0392	0.9965	1.0329	1.0387	1.0353	1.0185	1.0401	1.0306	100

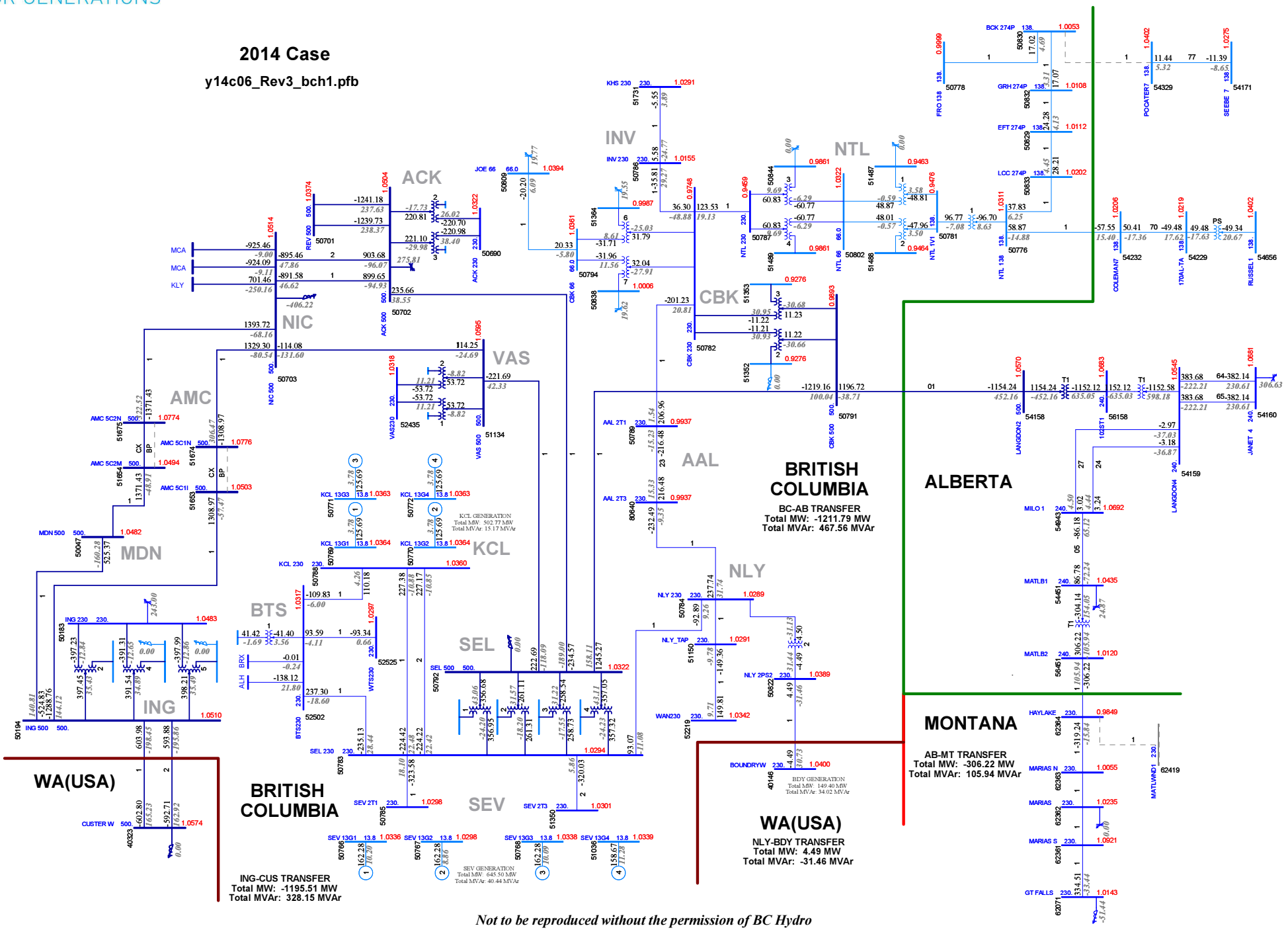


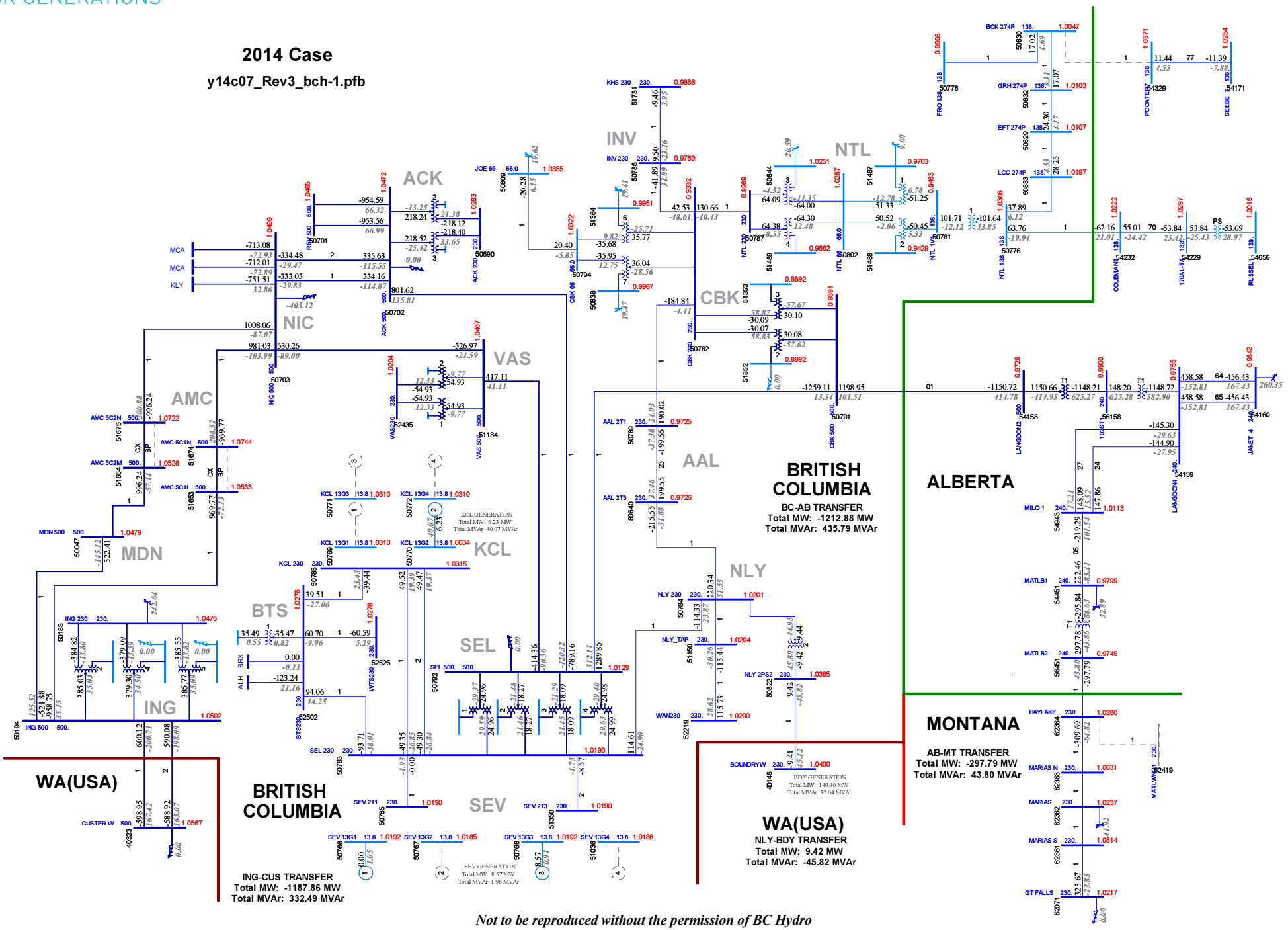


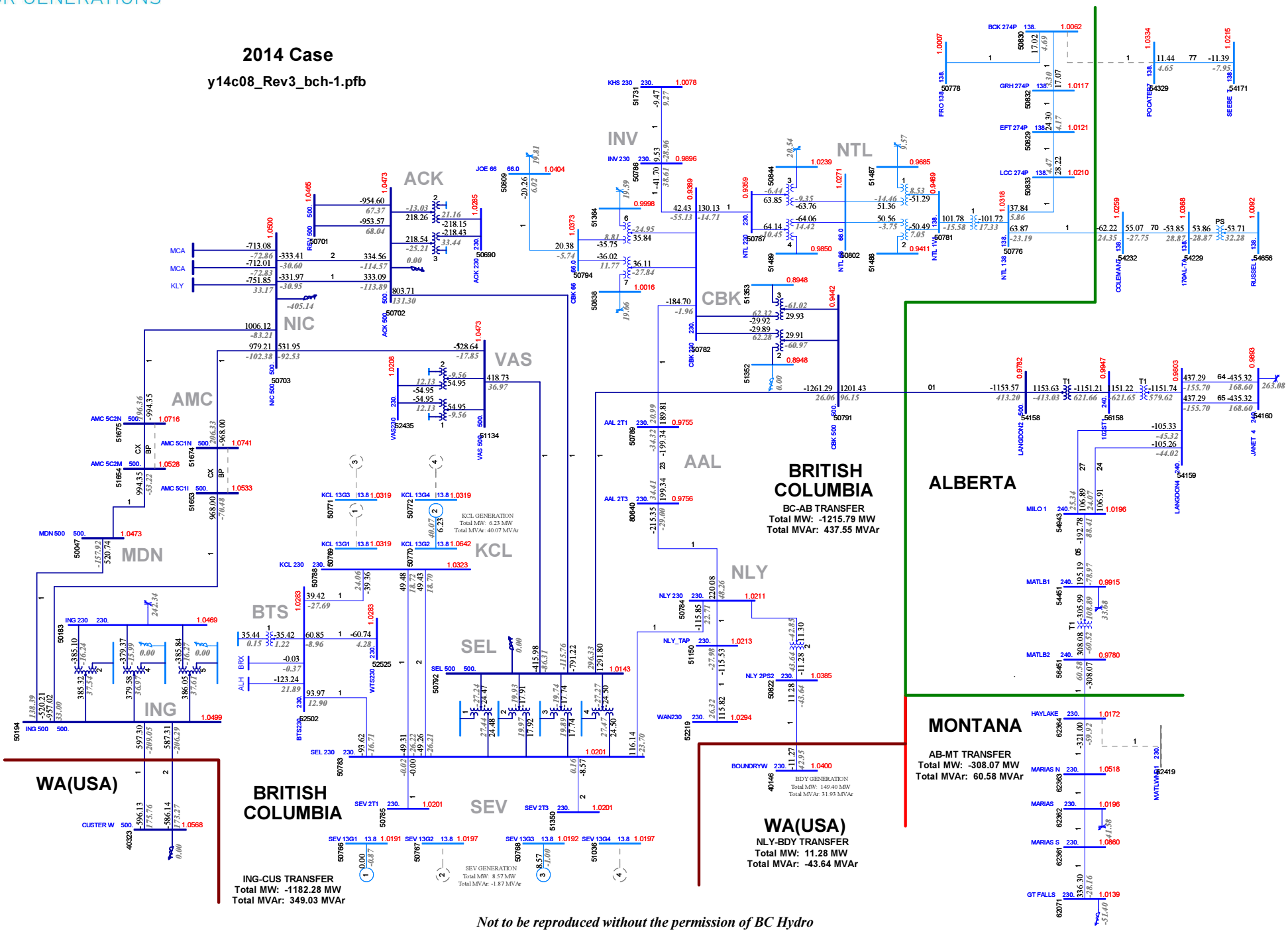


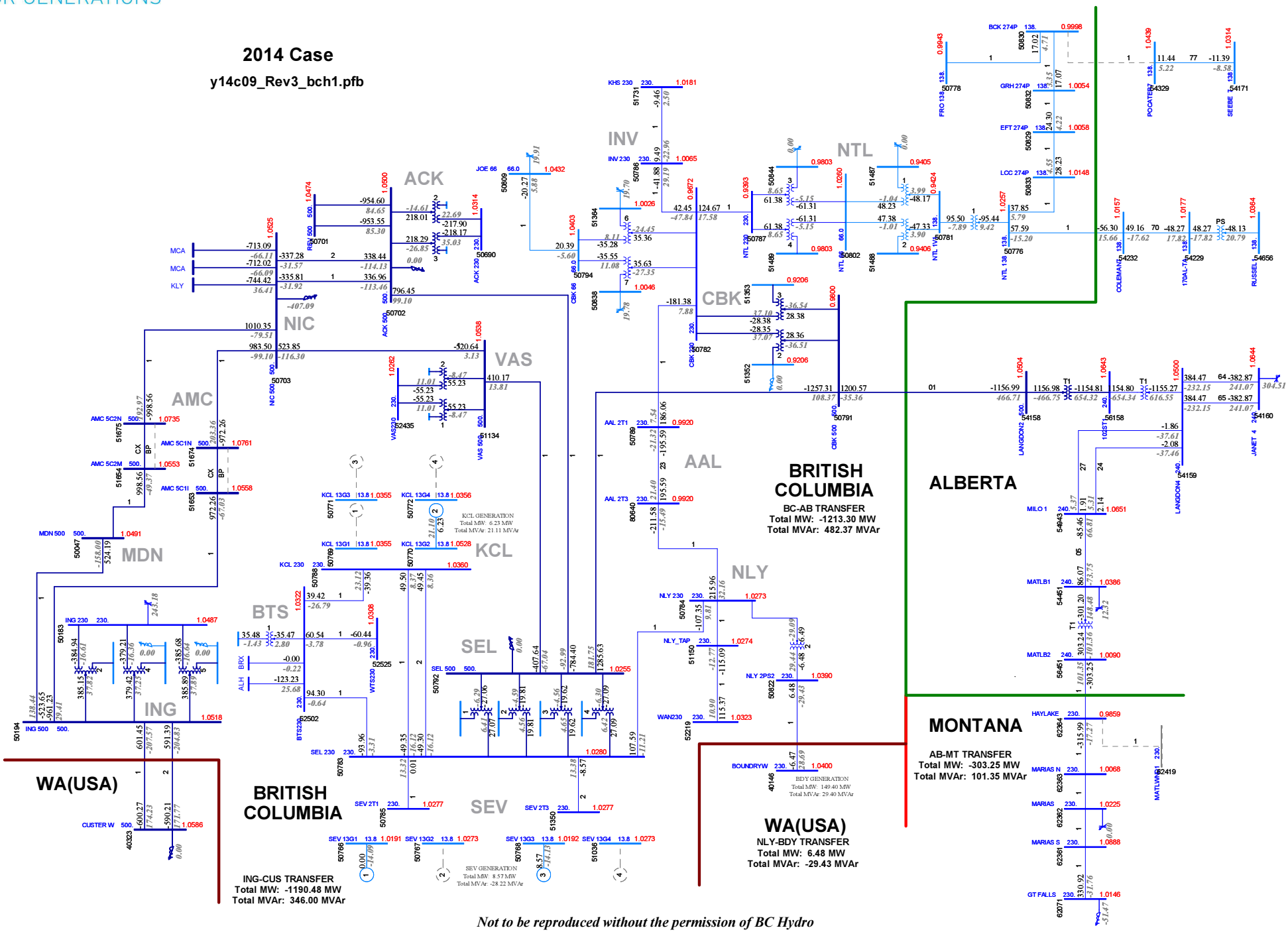


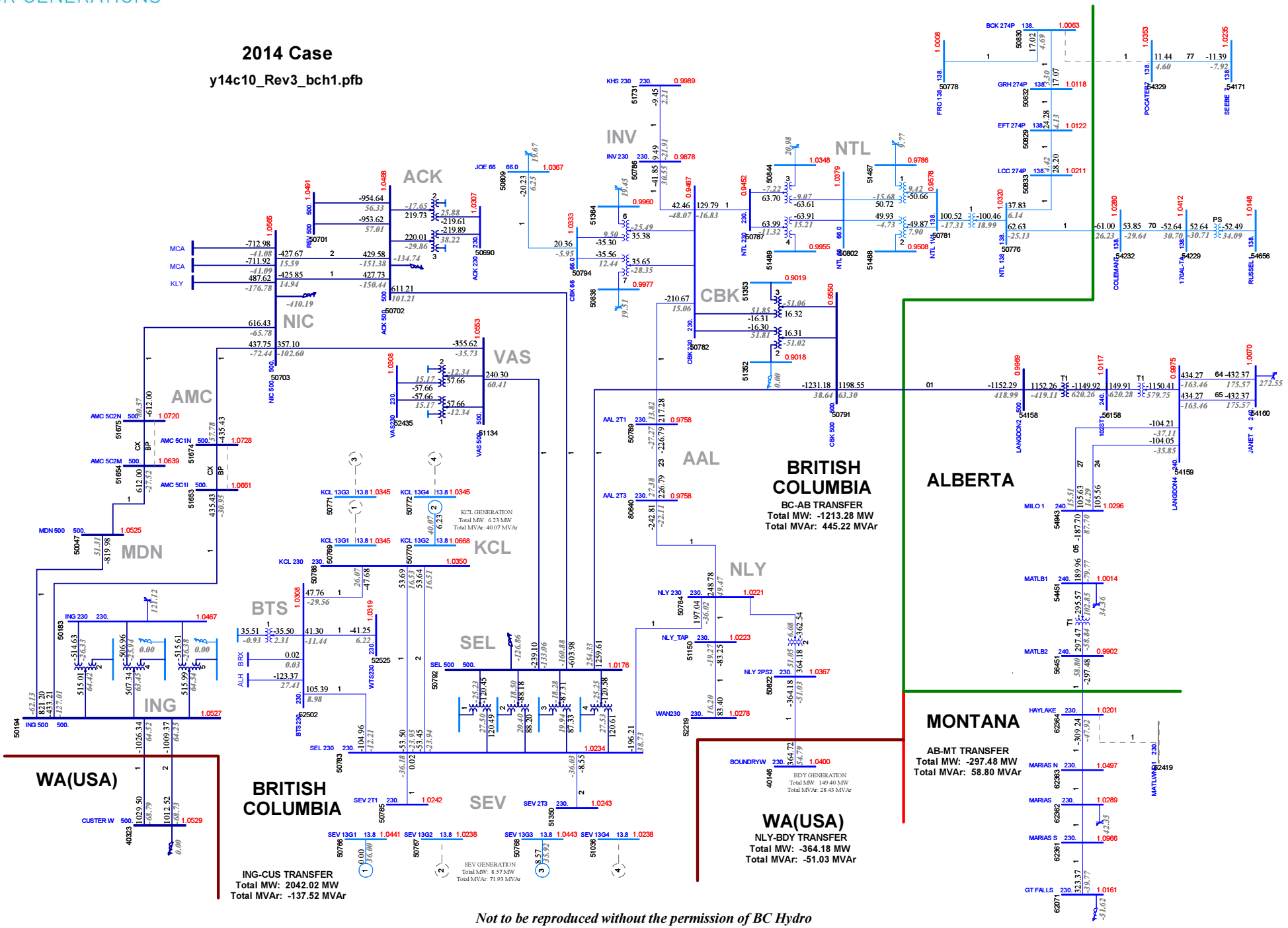


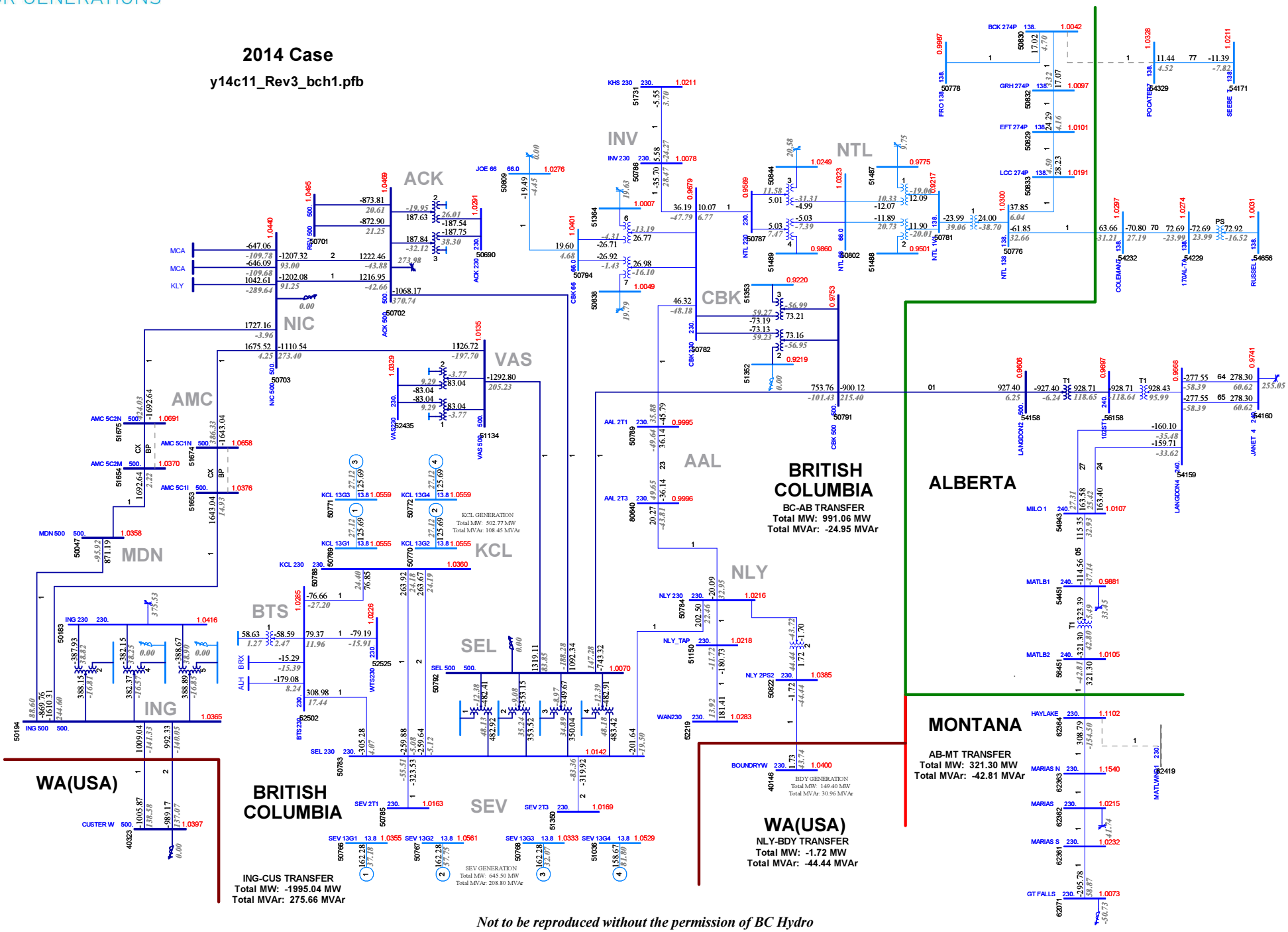


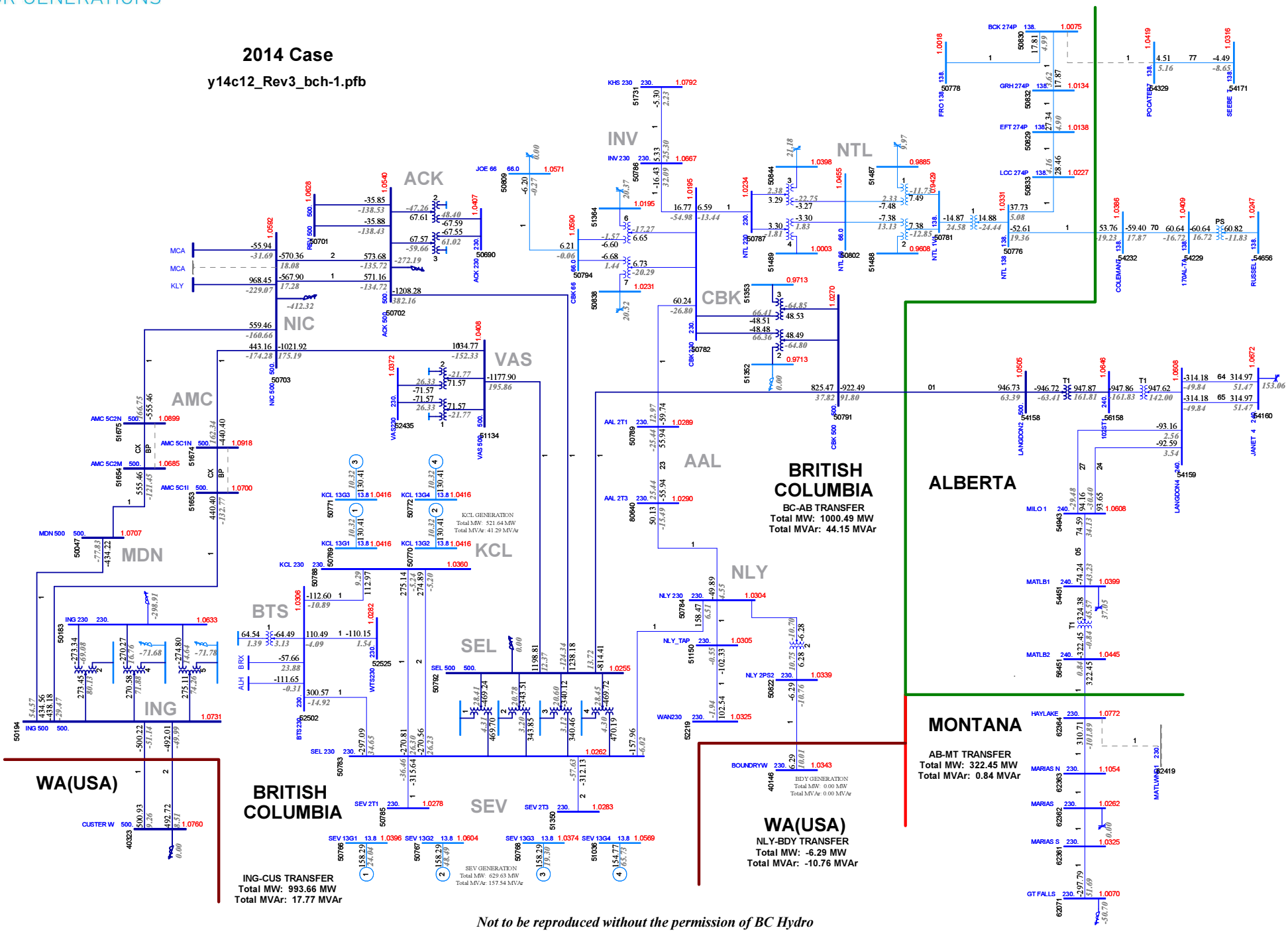


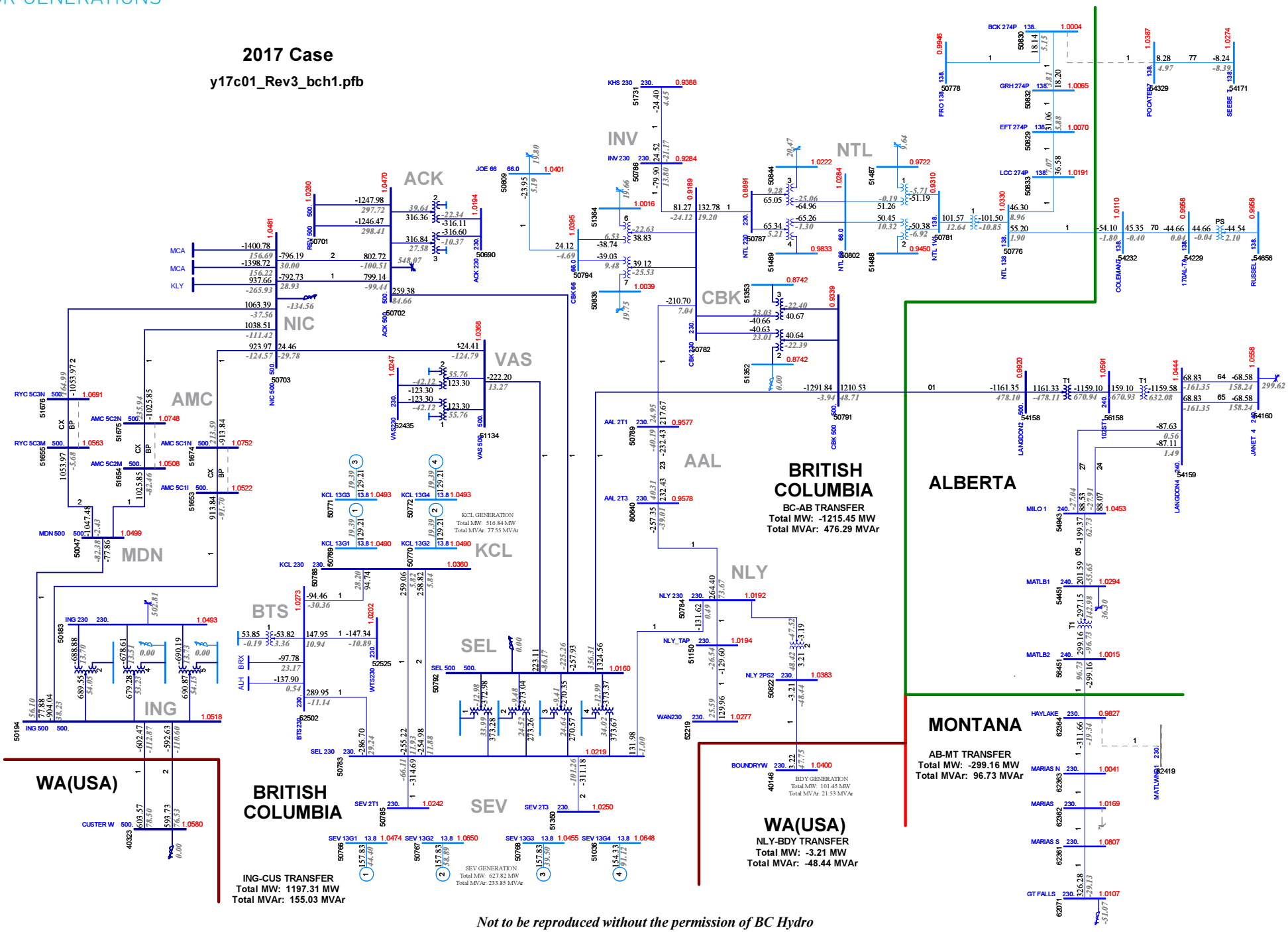


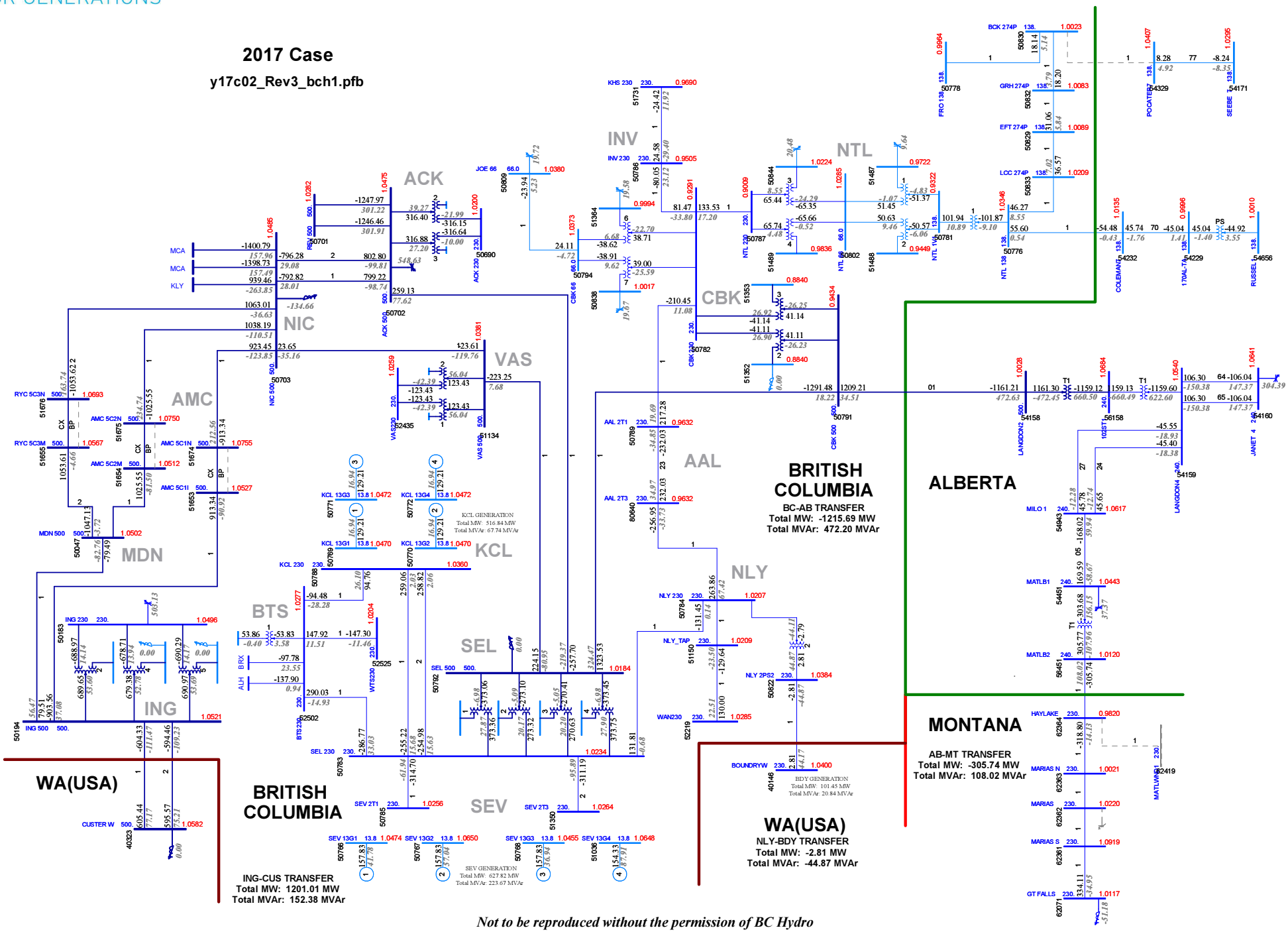


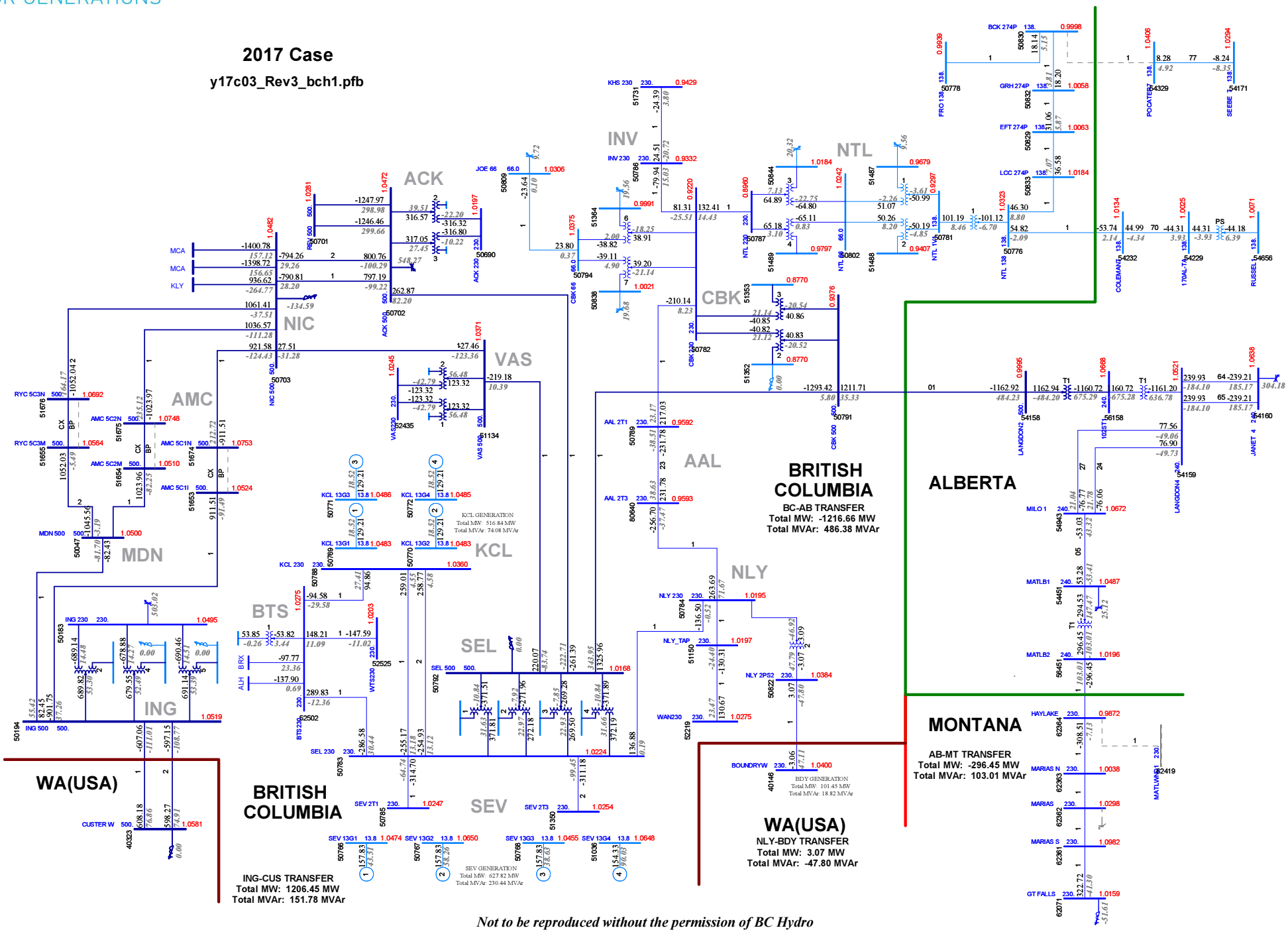


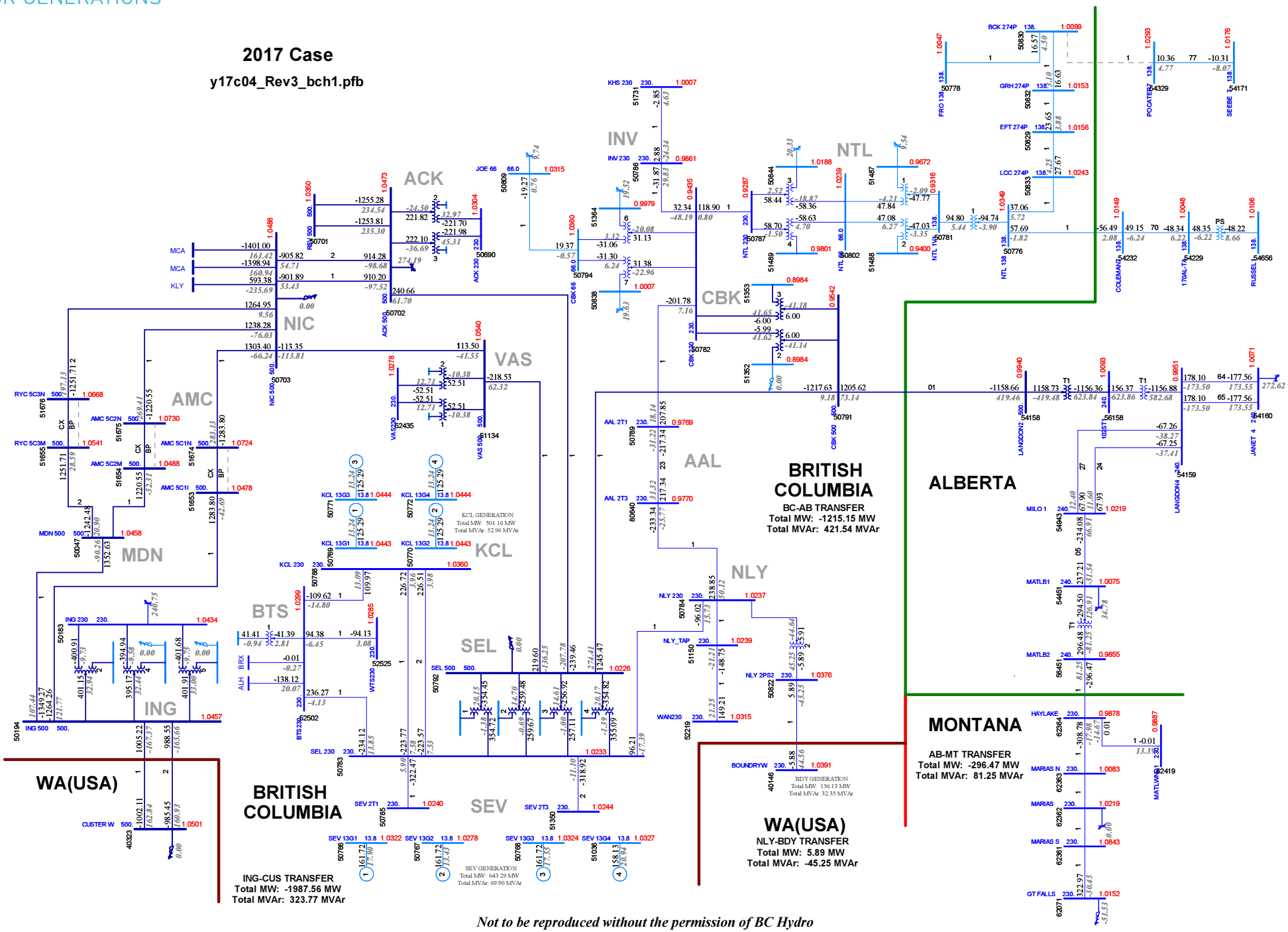


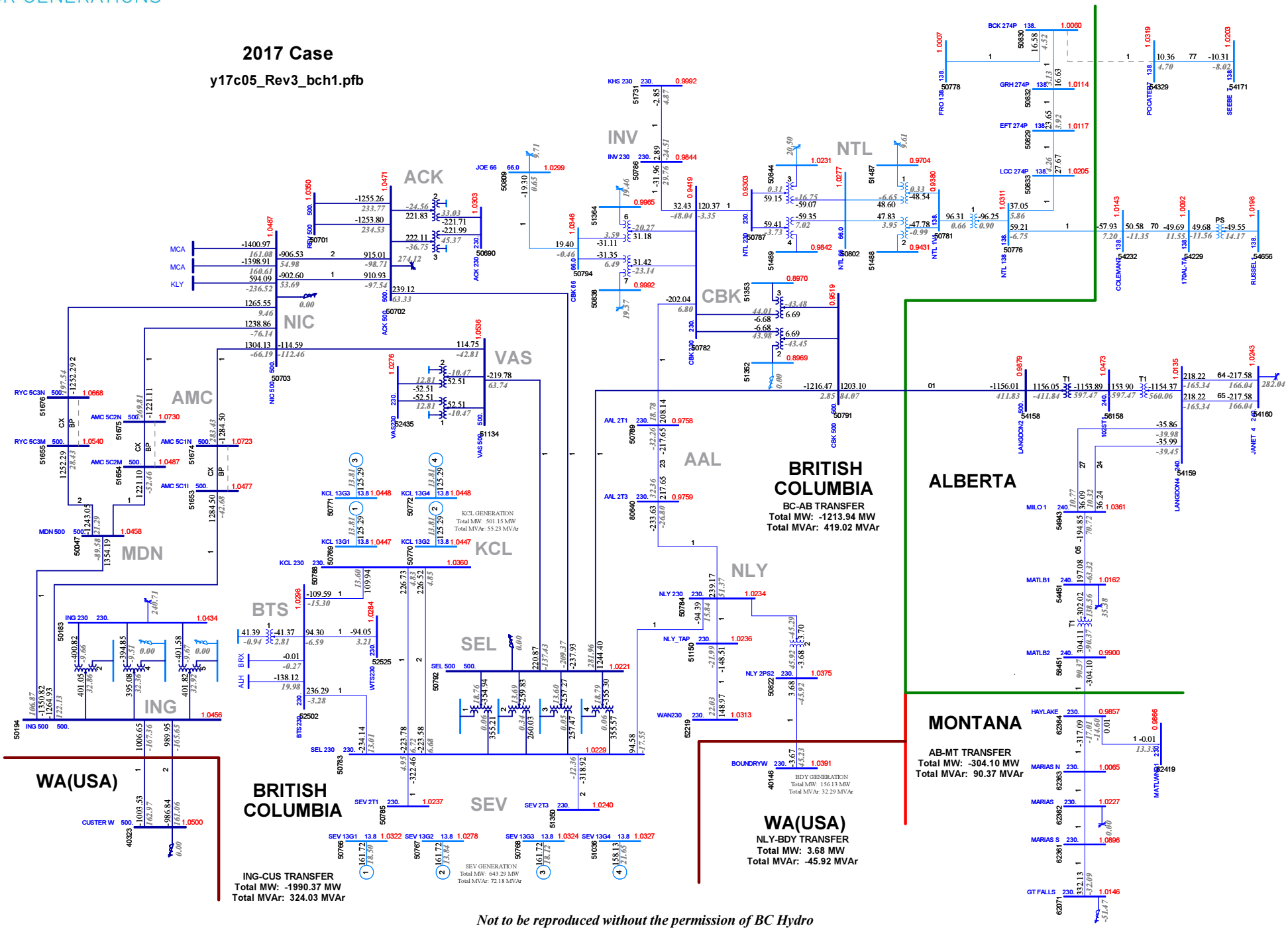


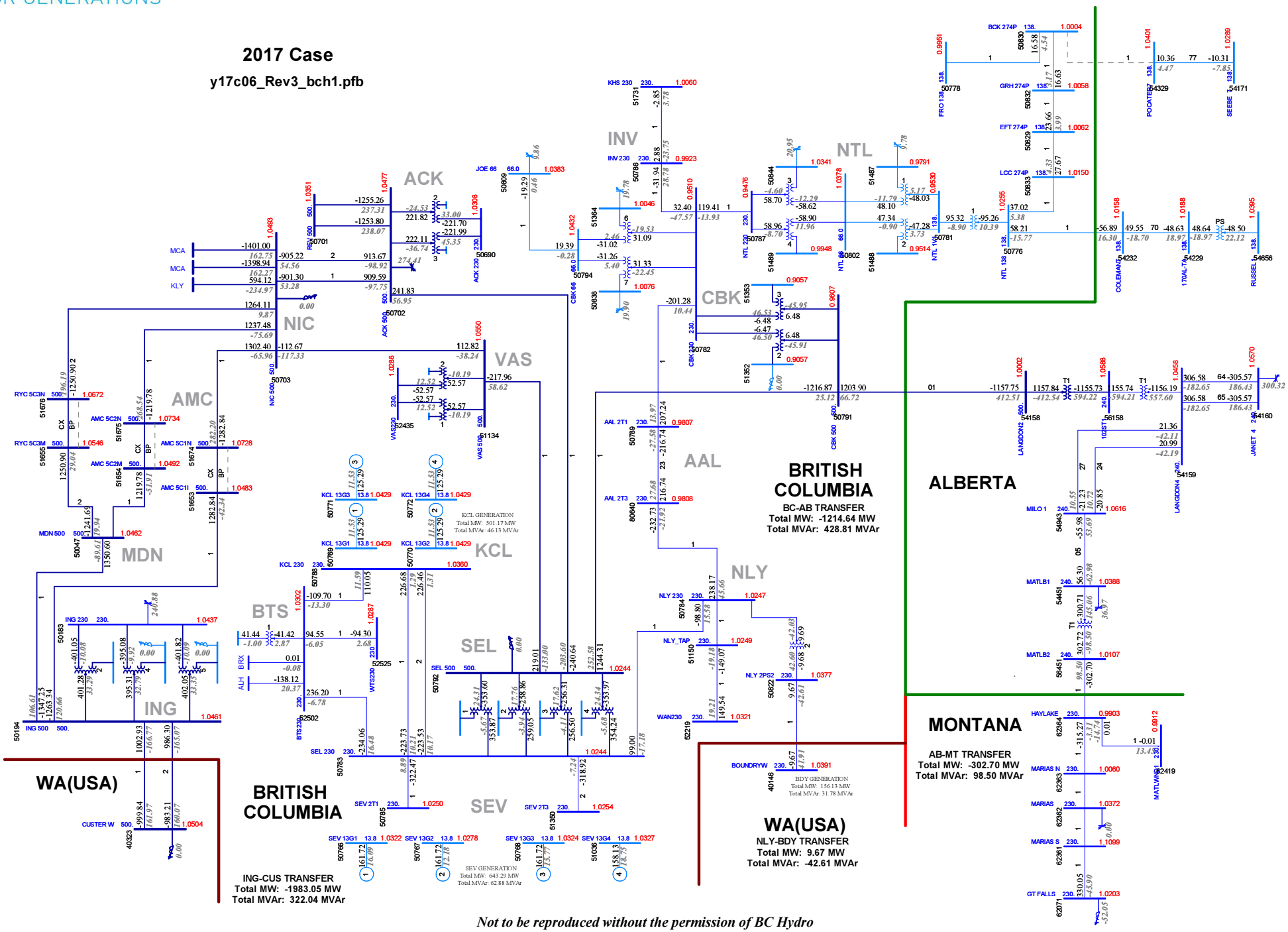


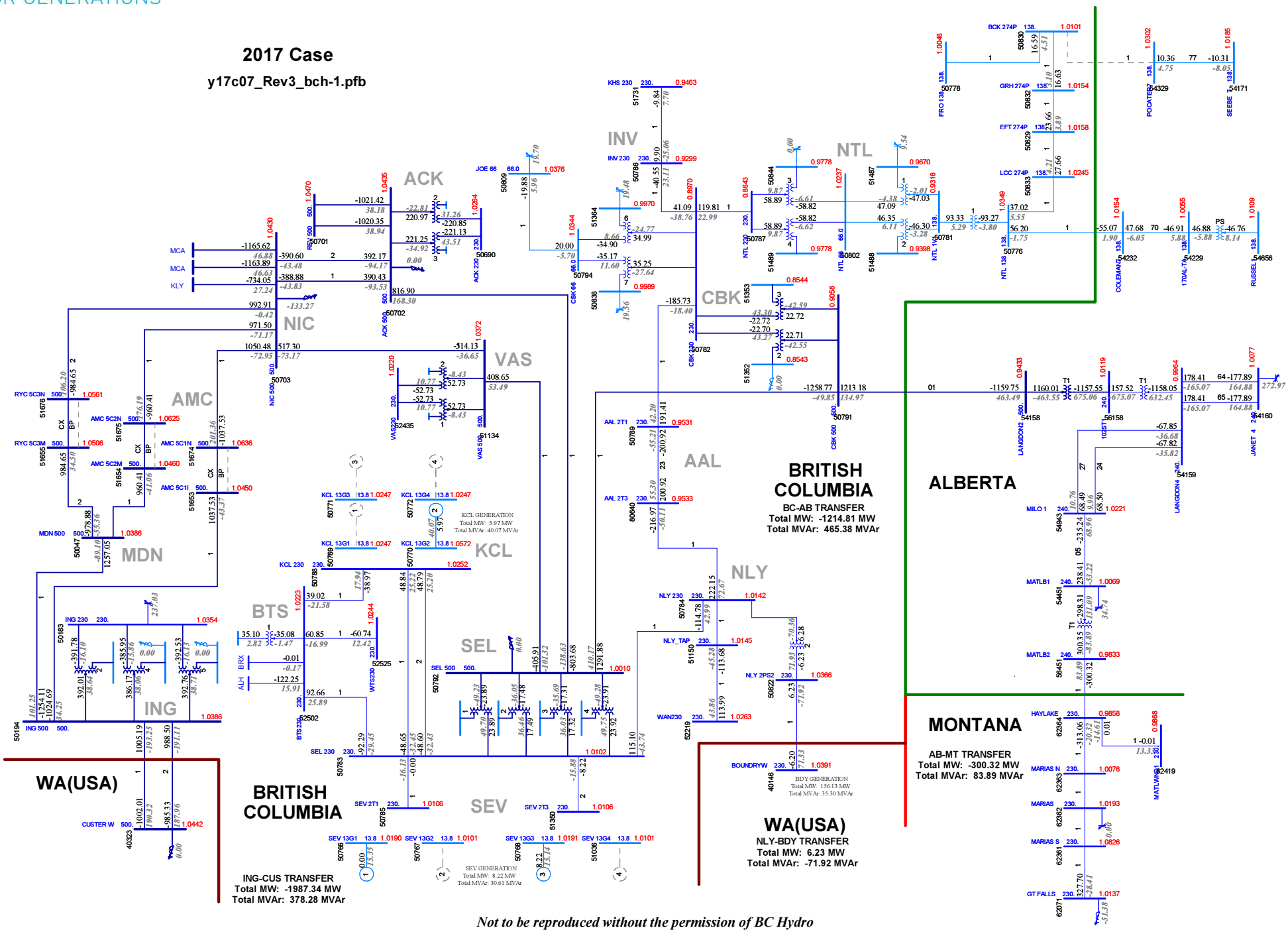


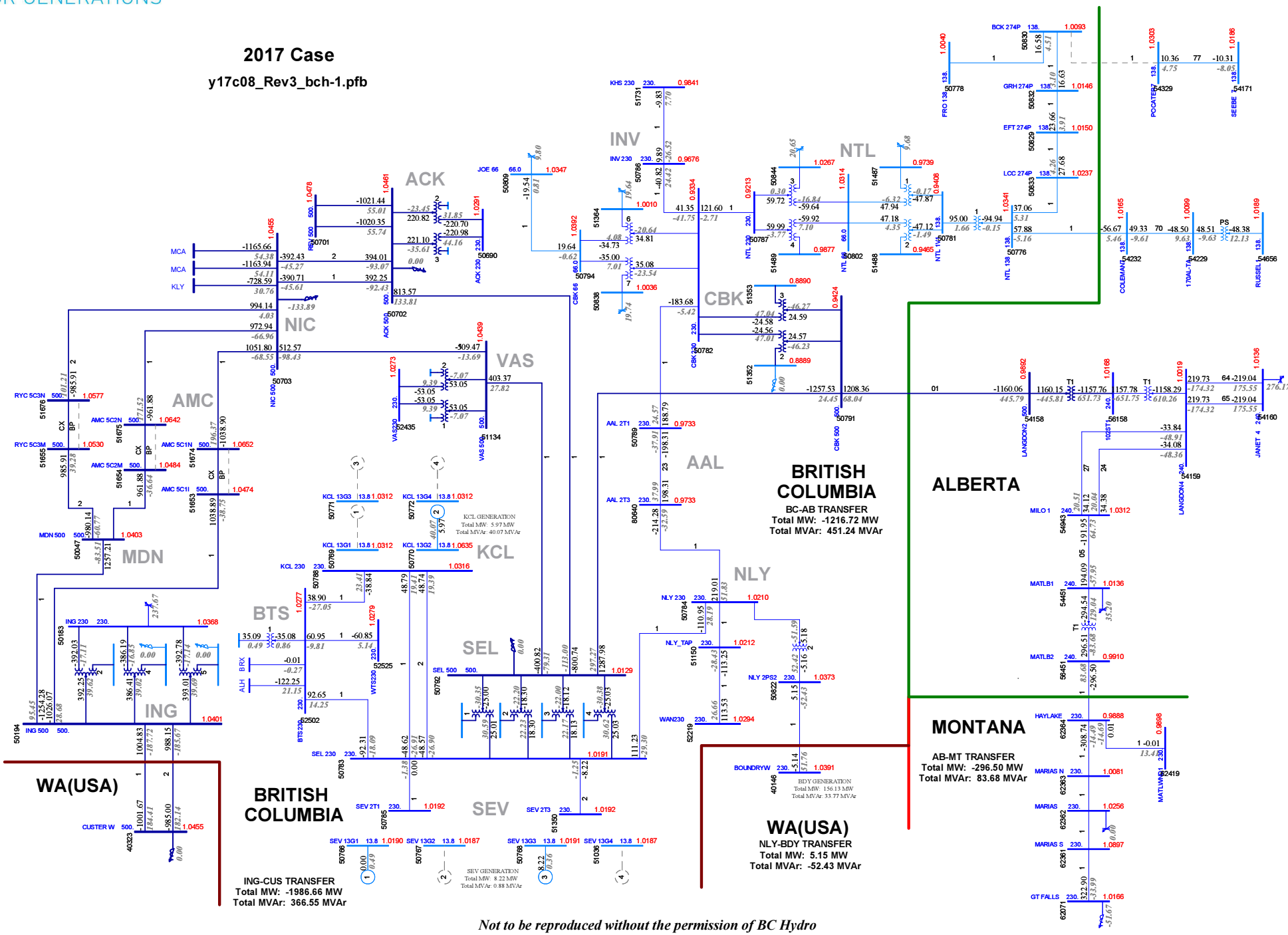


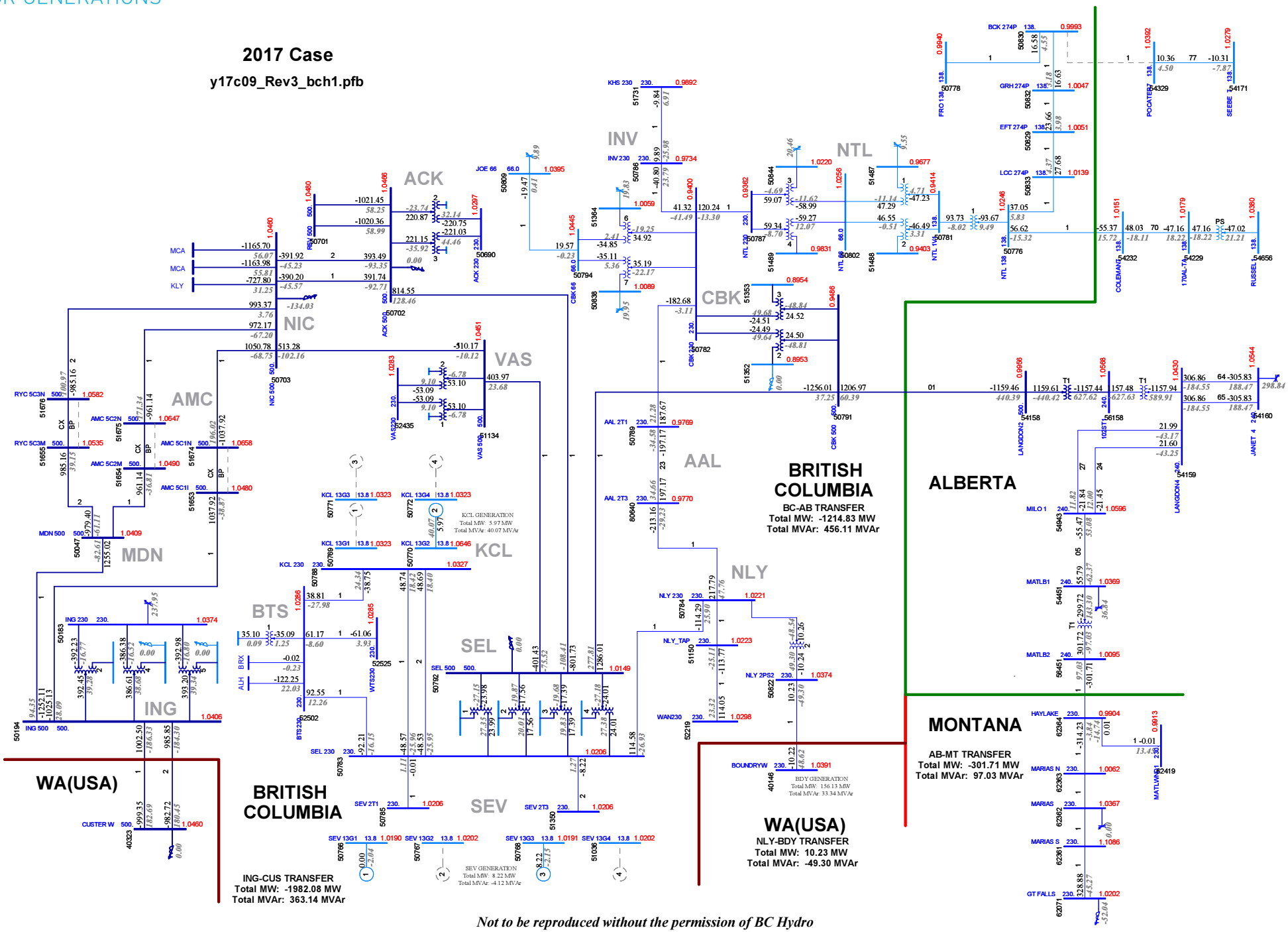


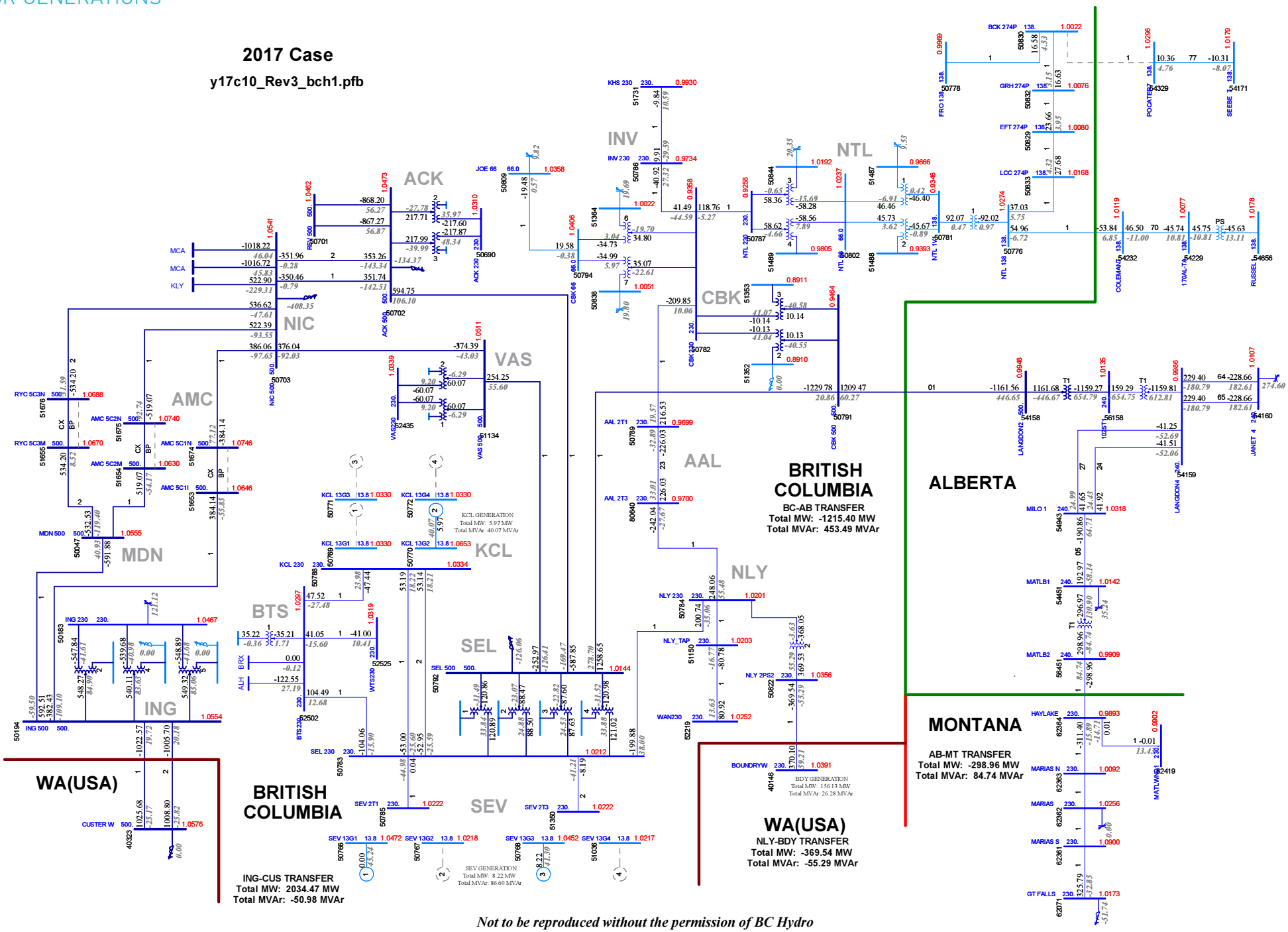


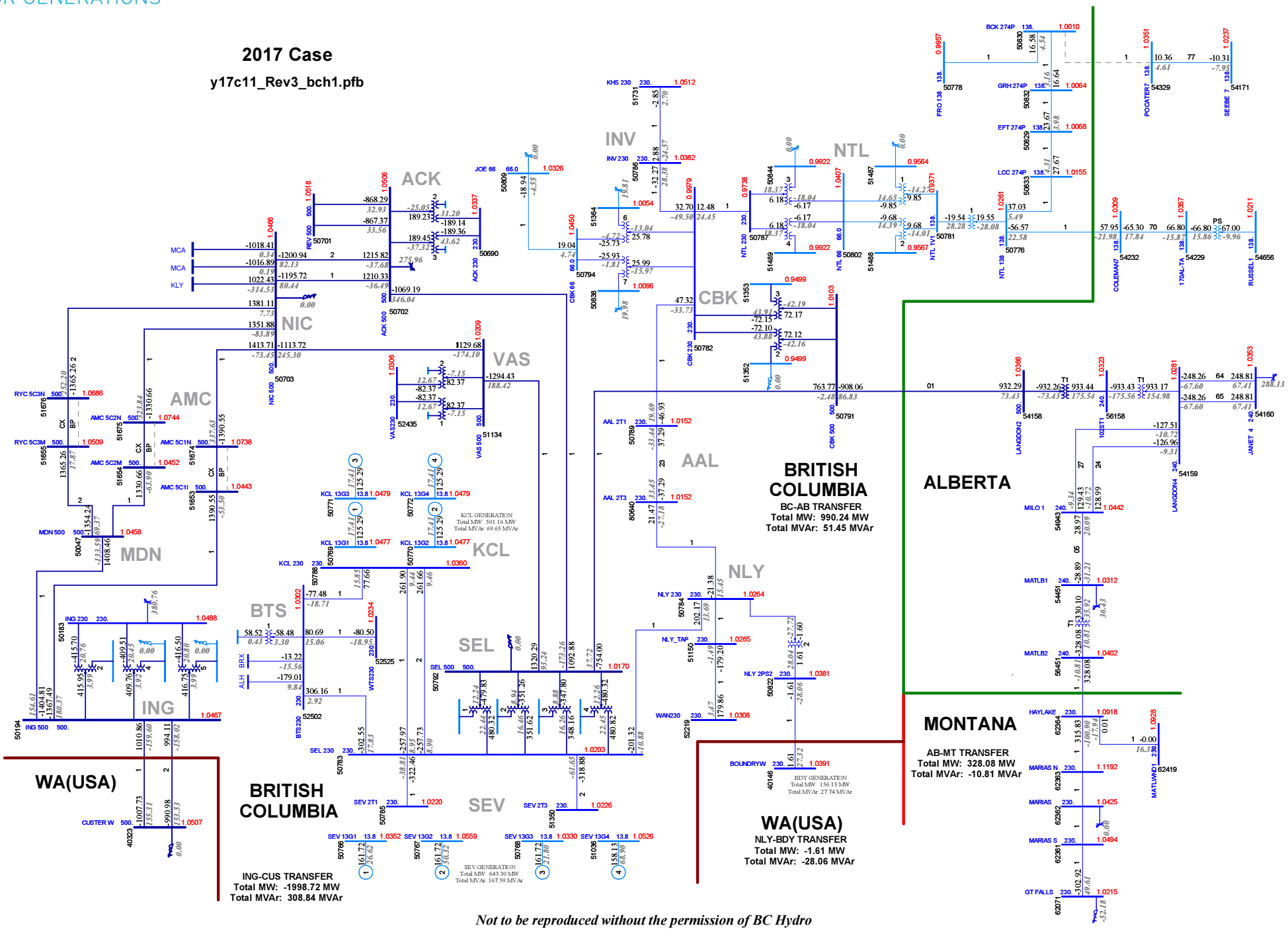


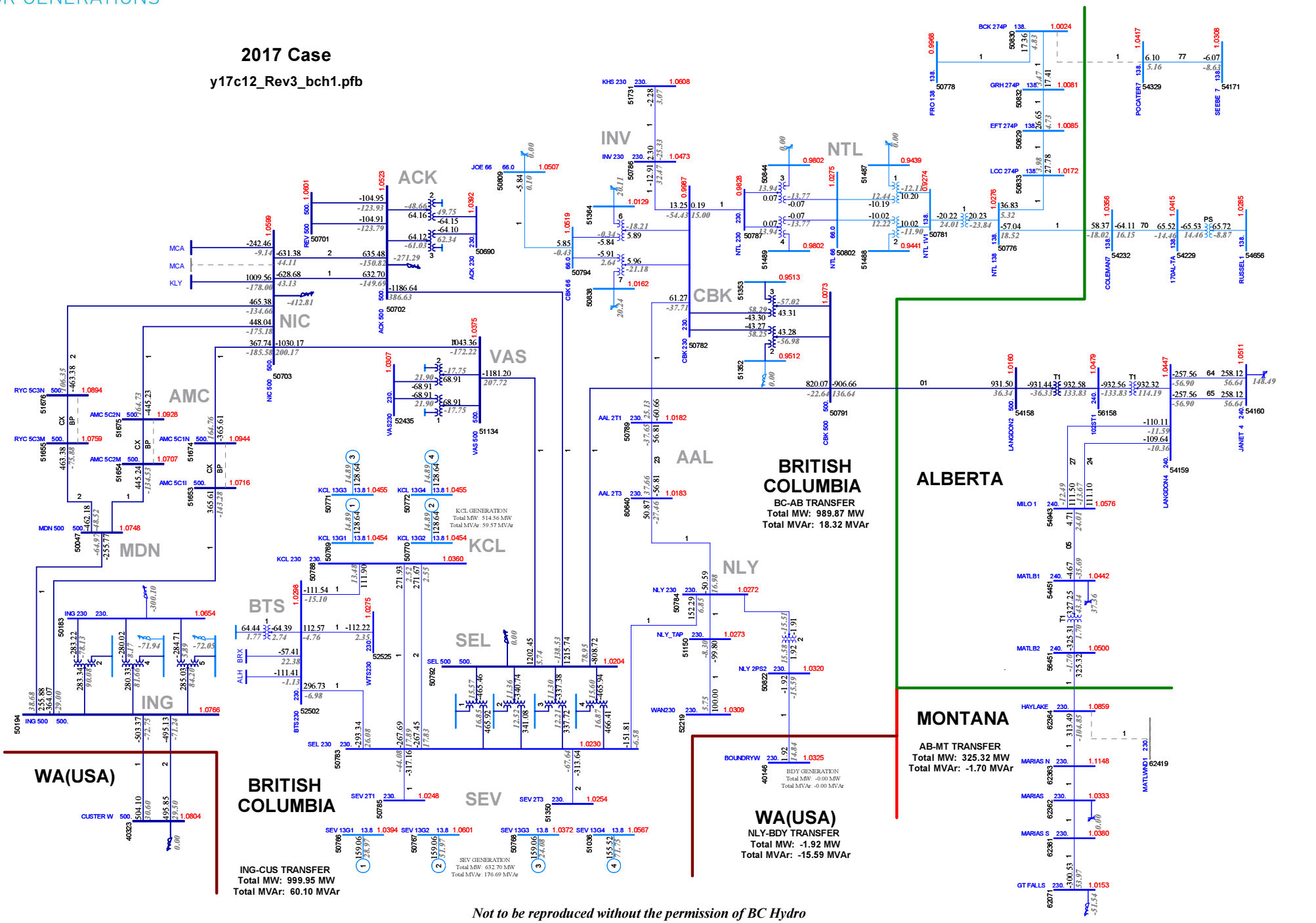


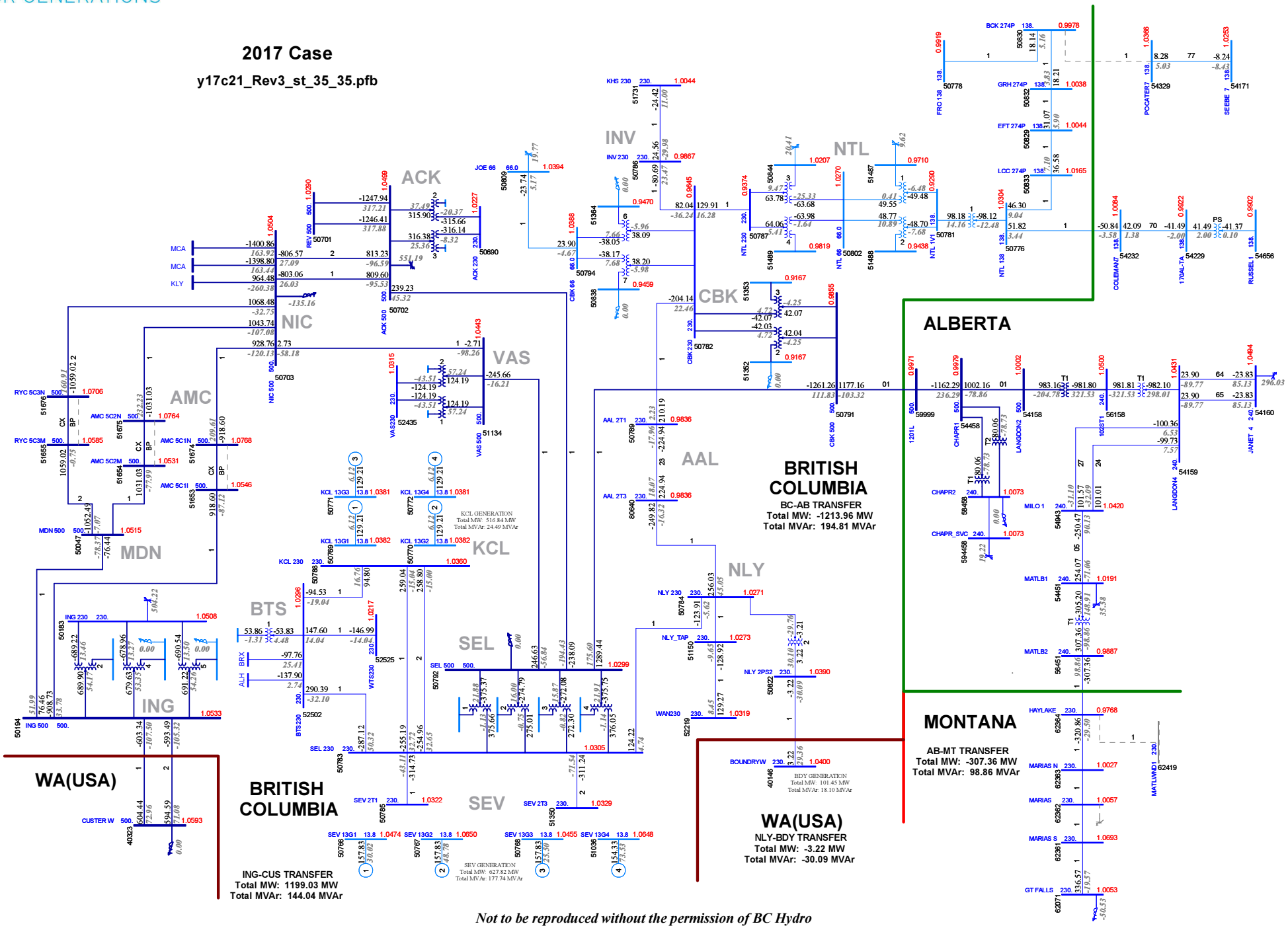


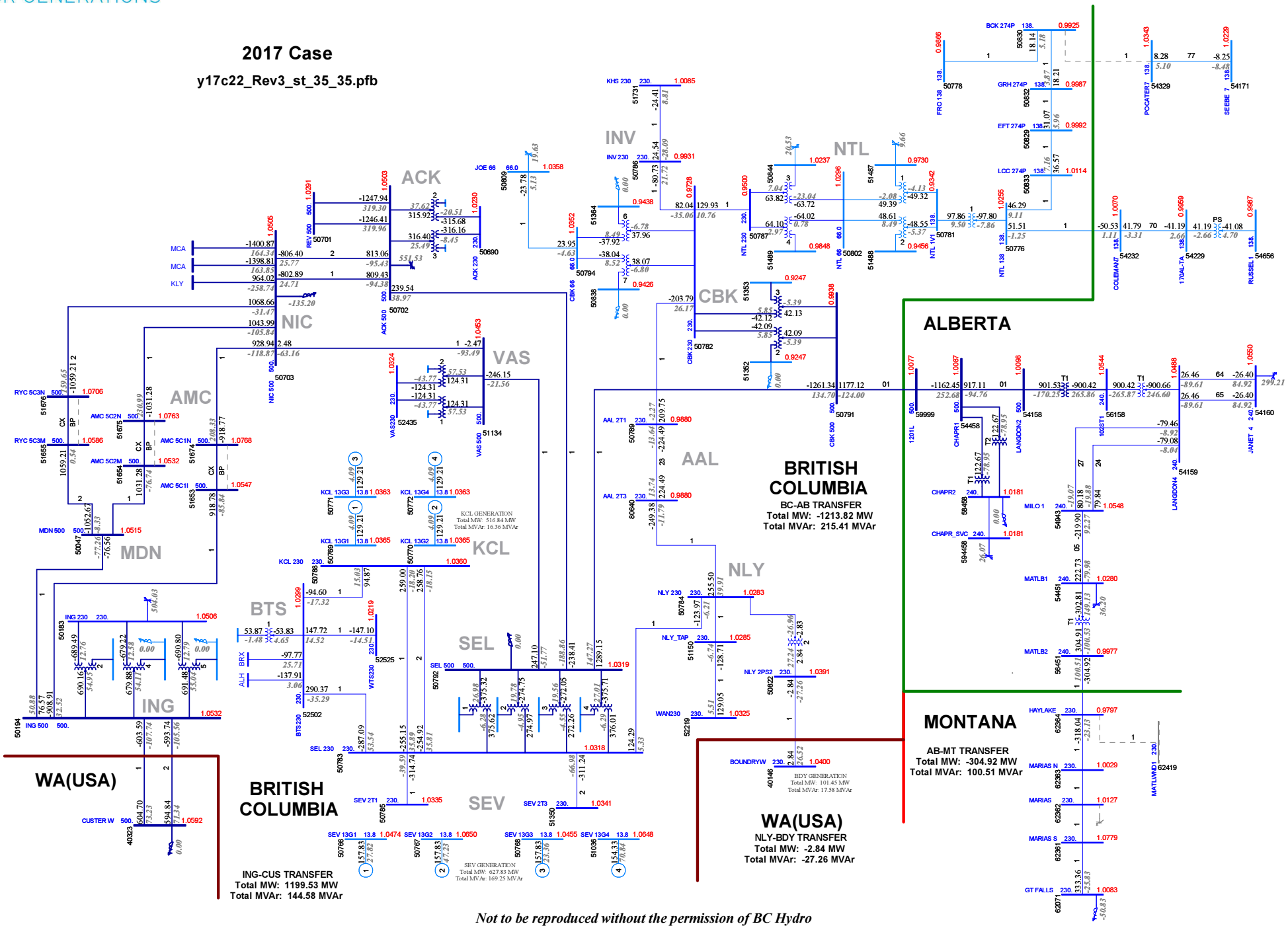


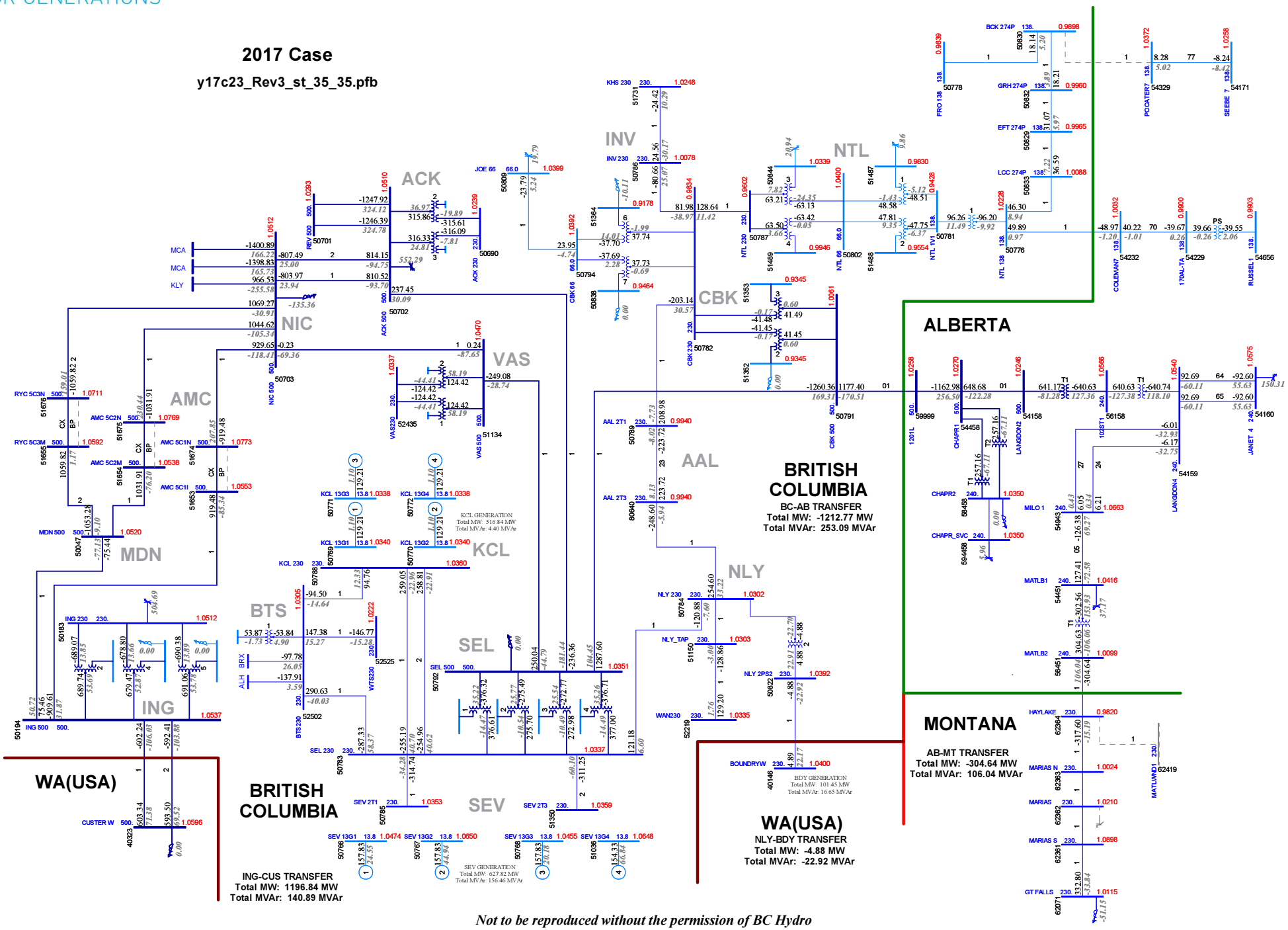


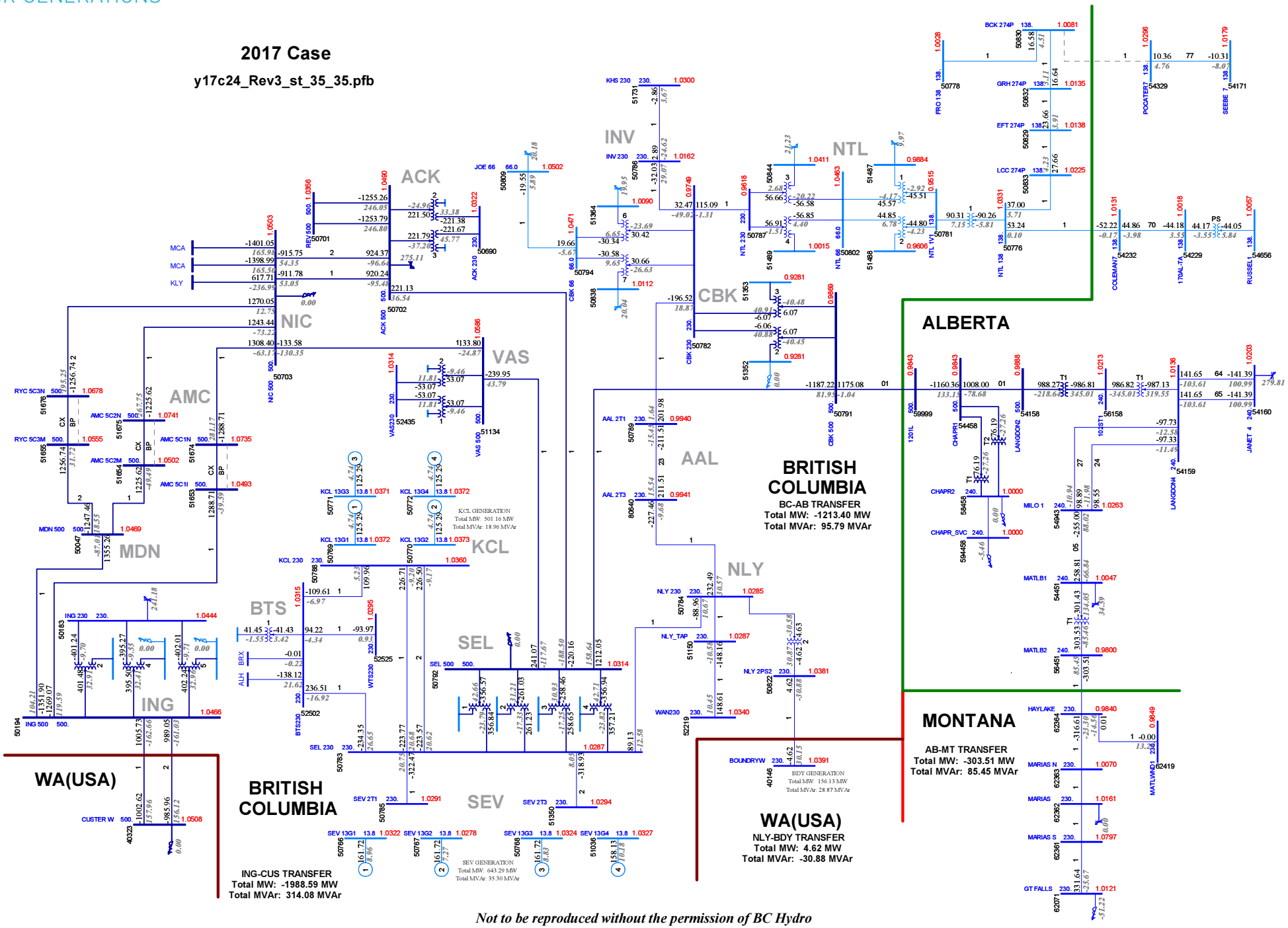


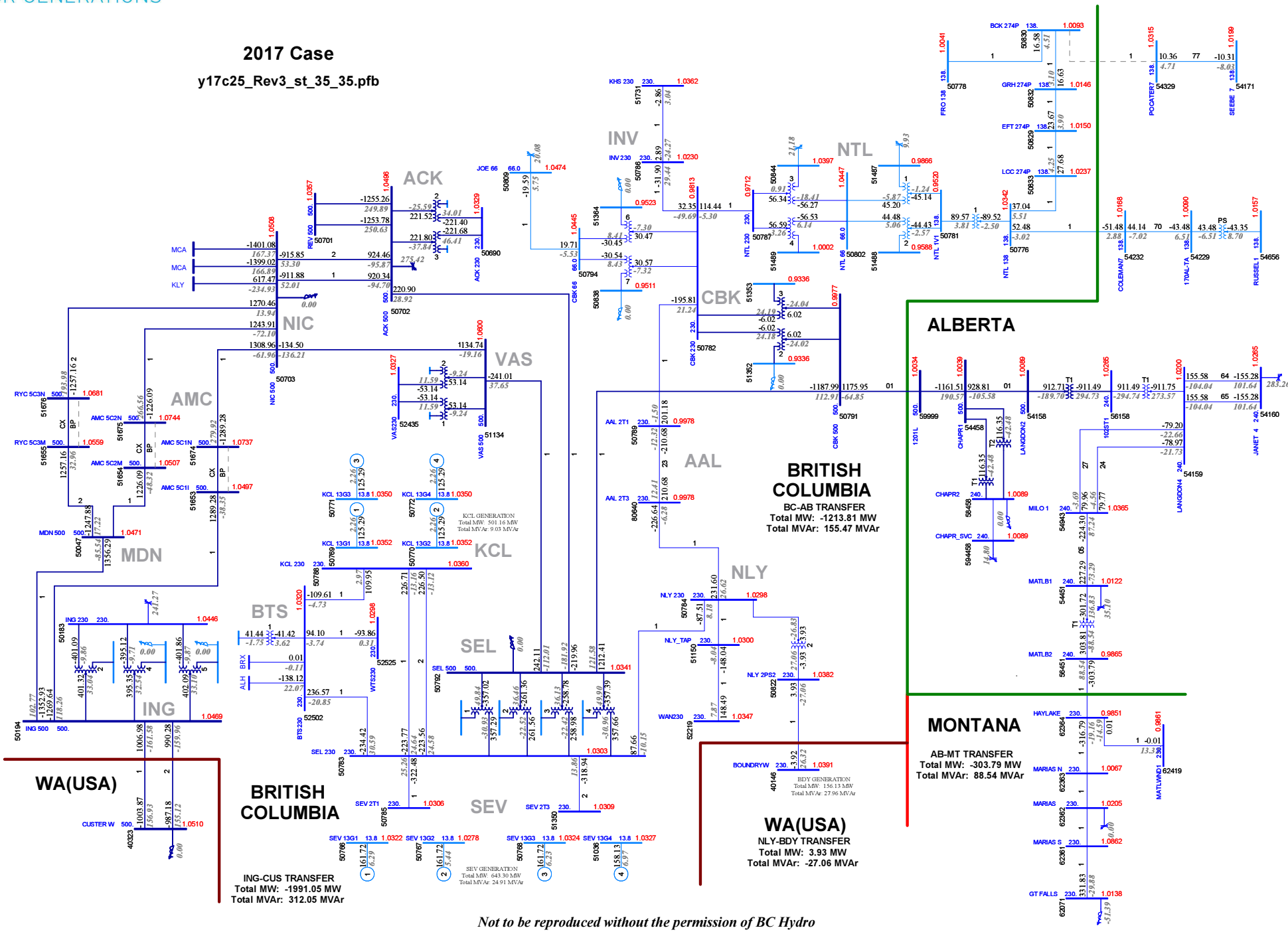


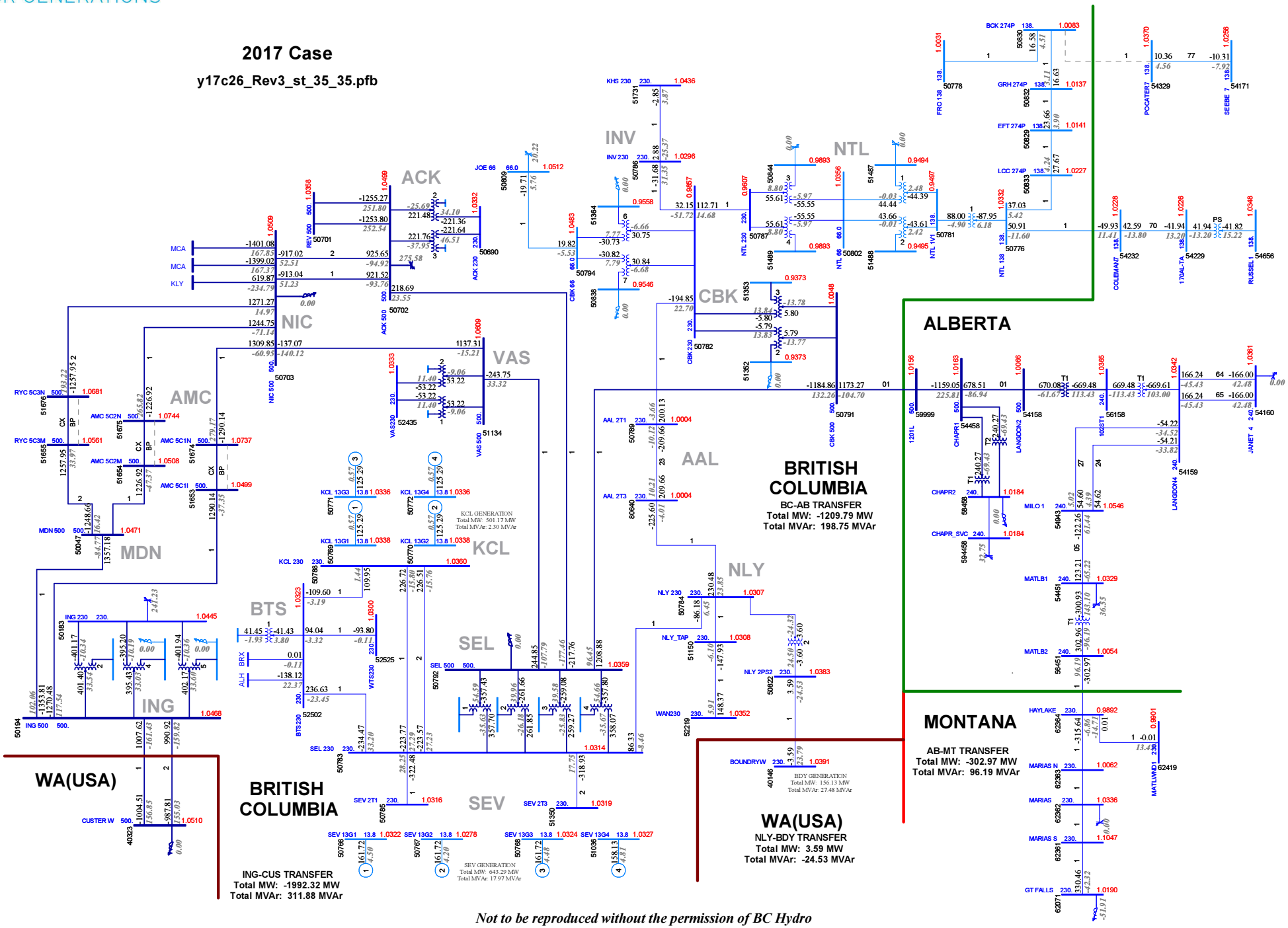


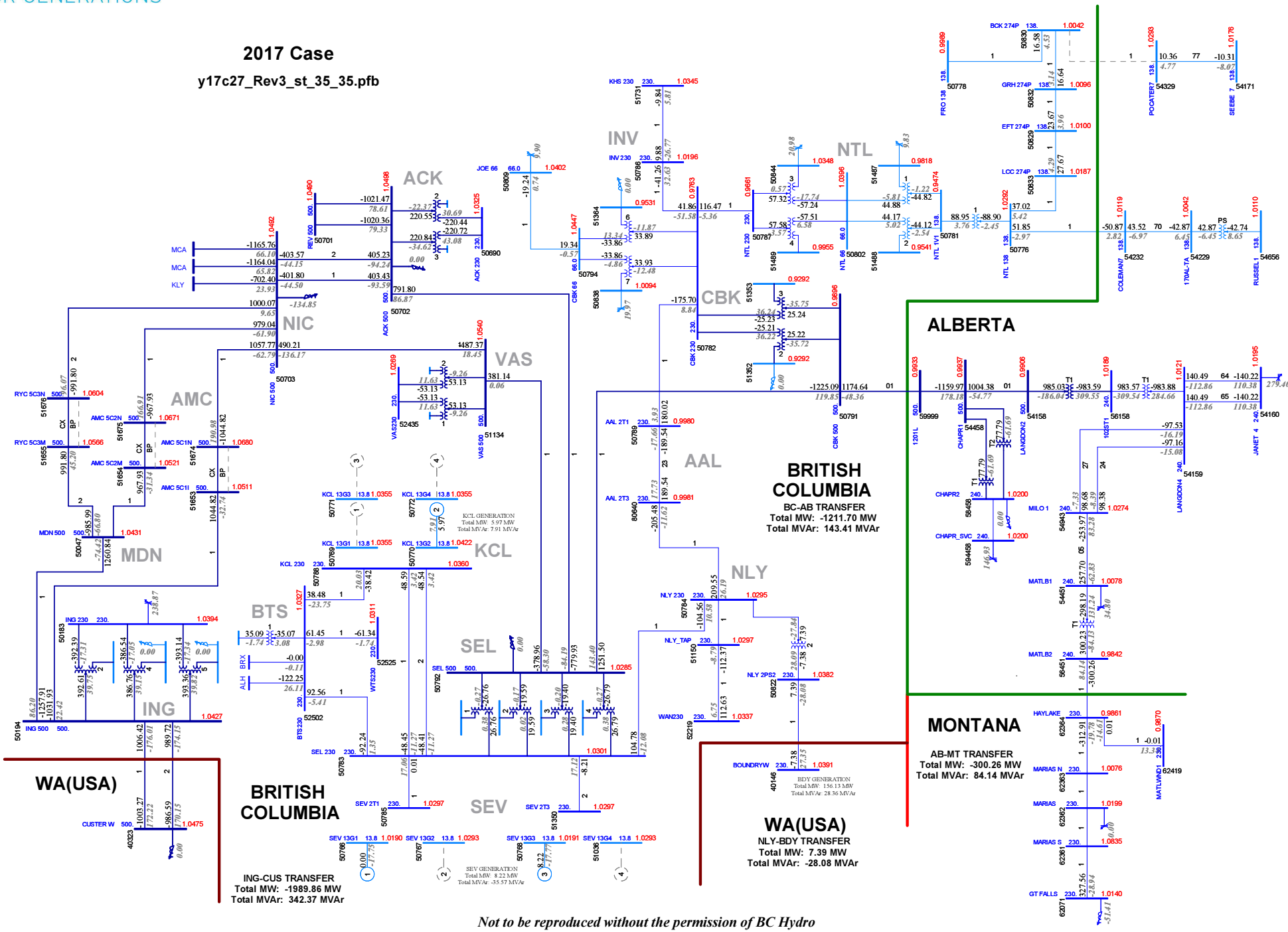


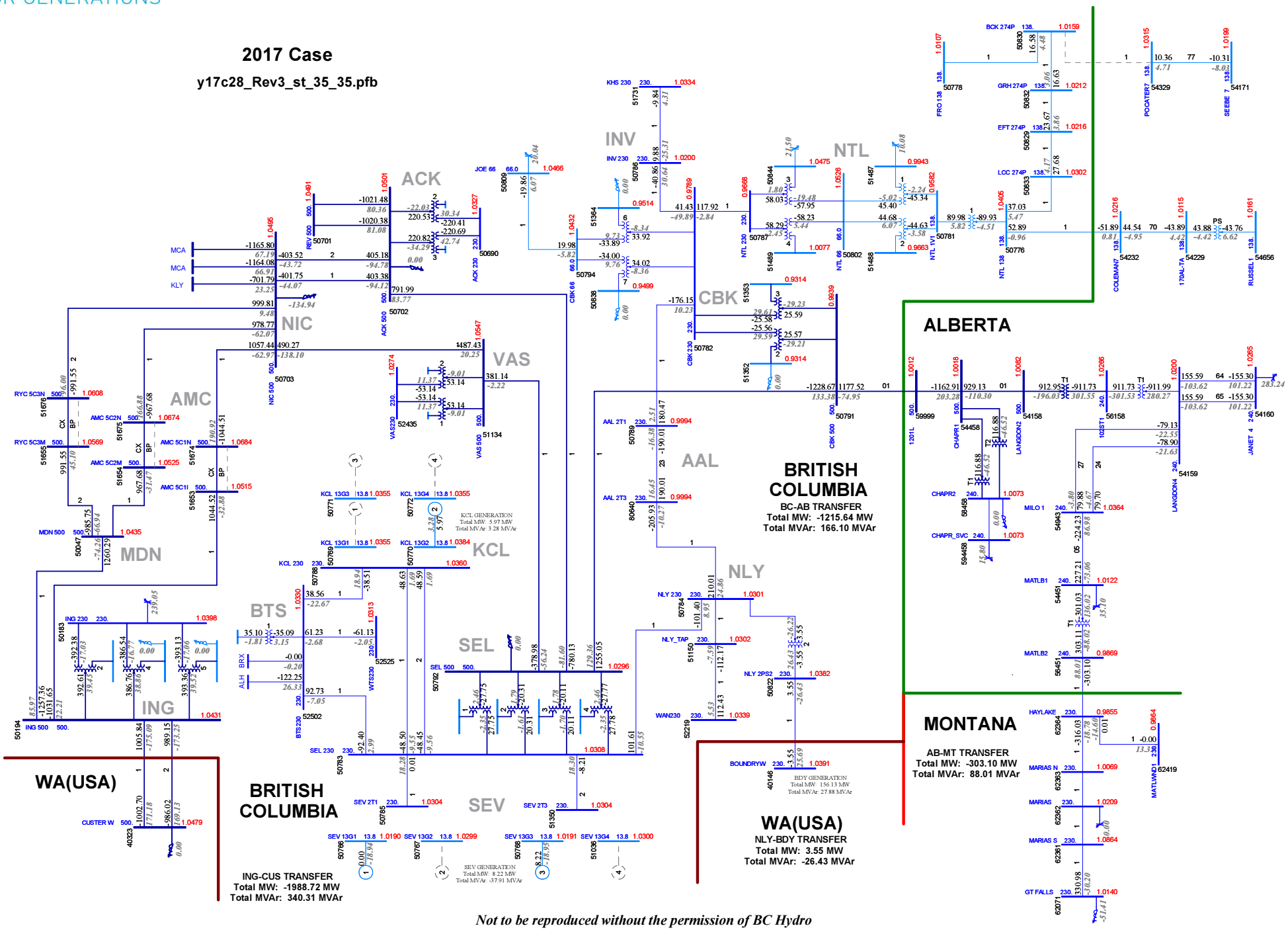


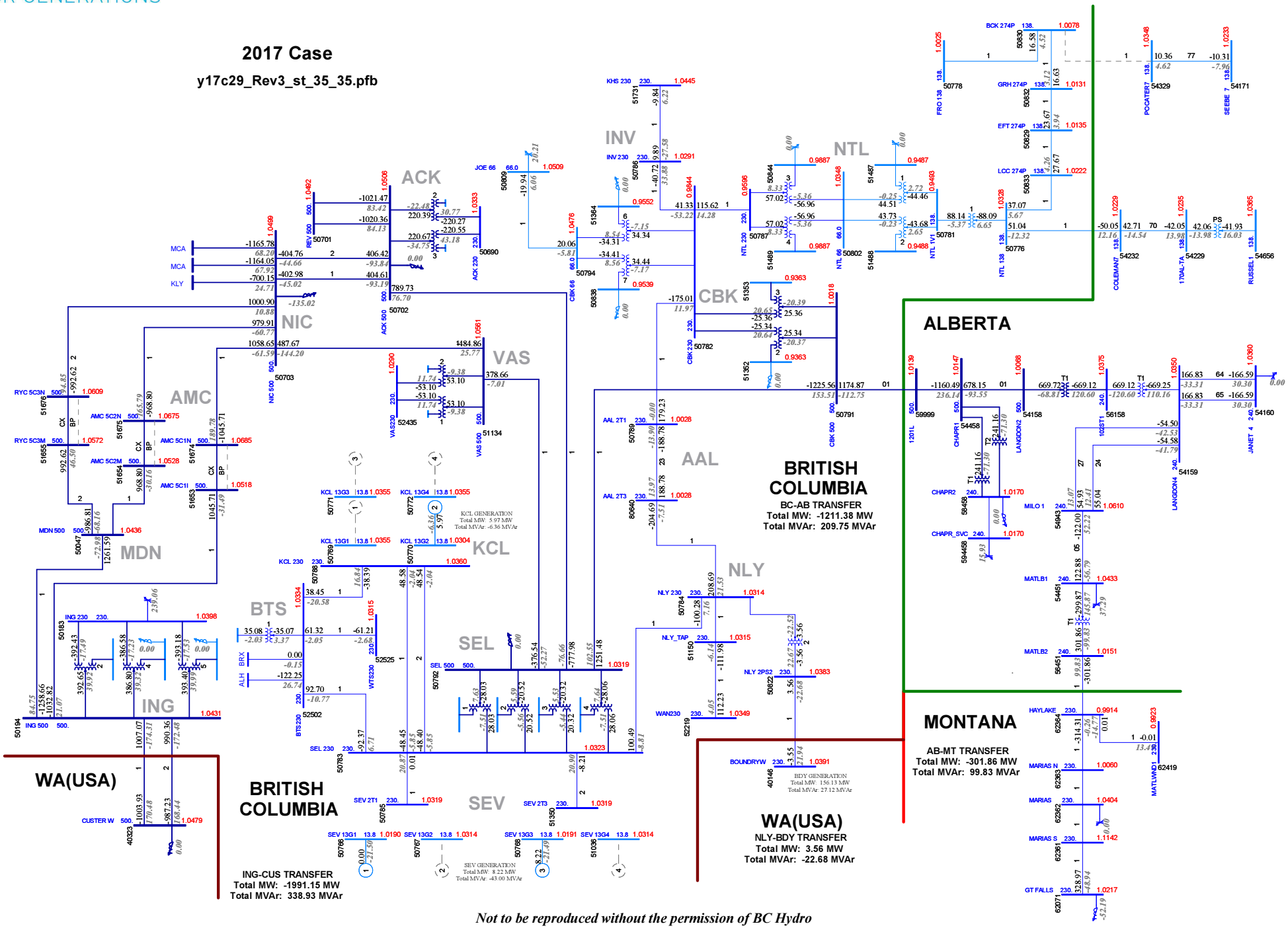


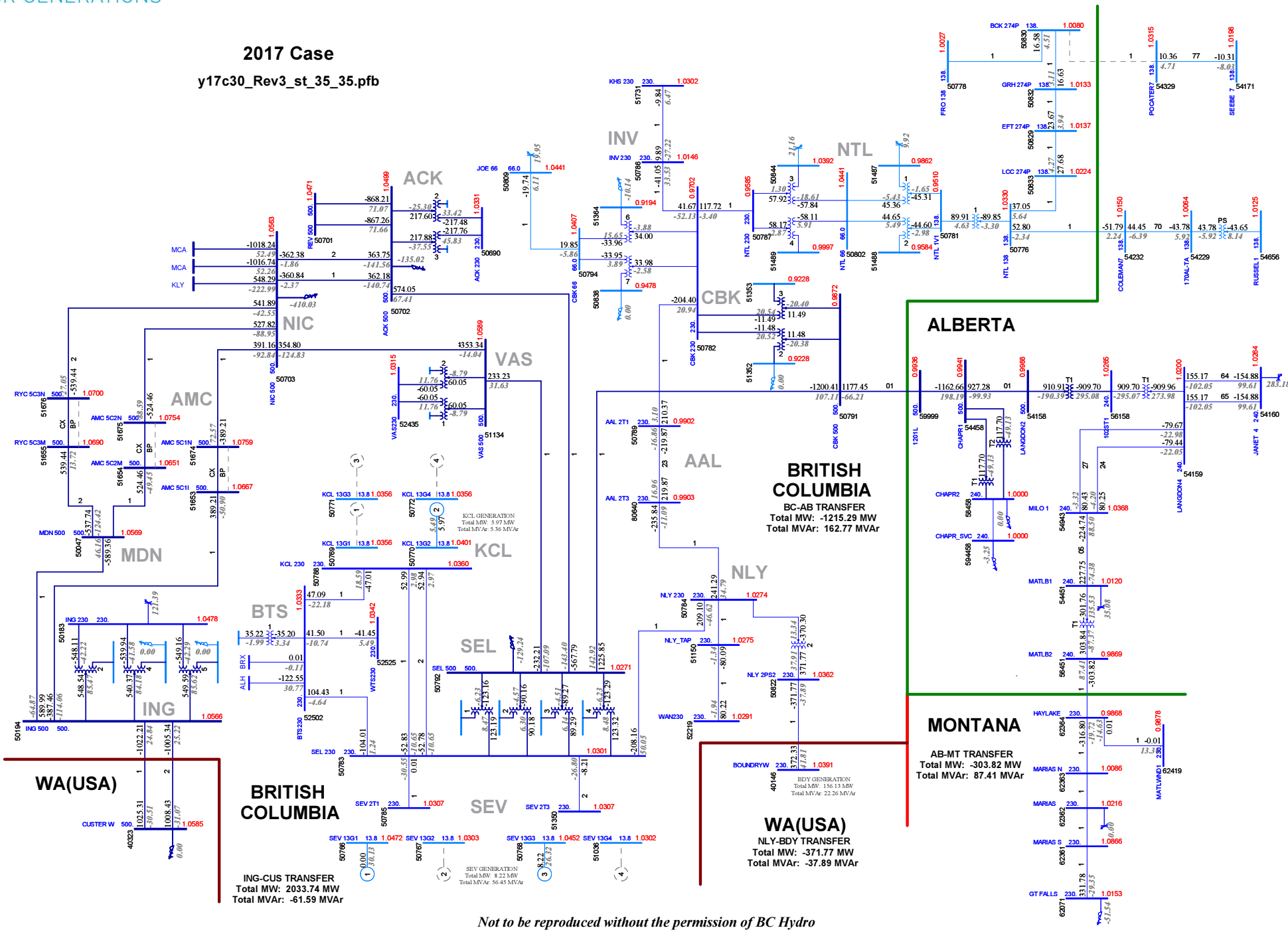


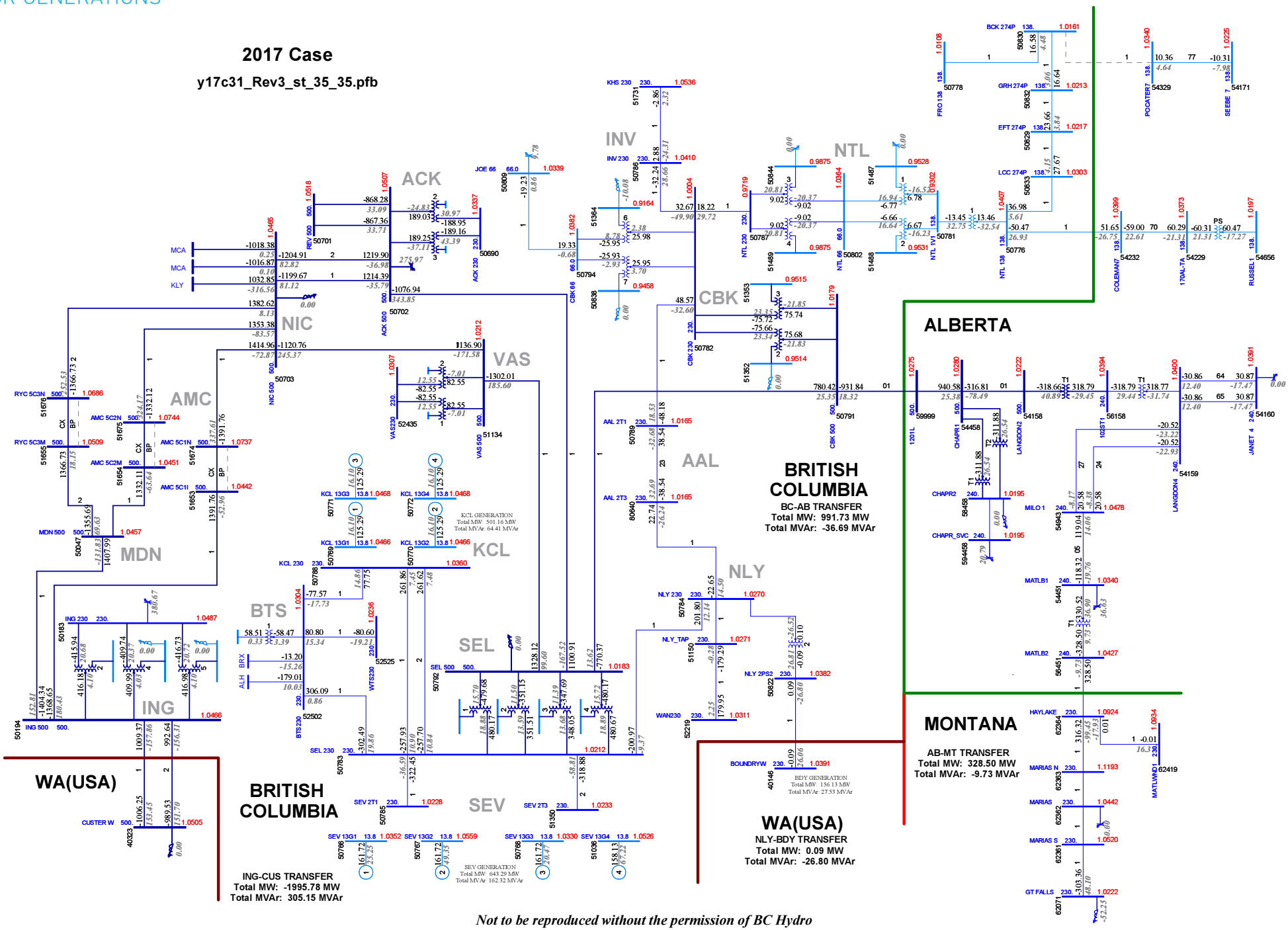


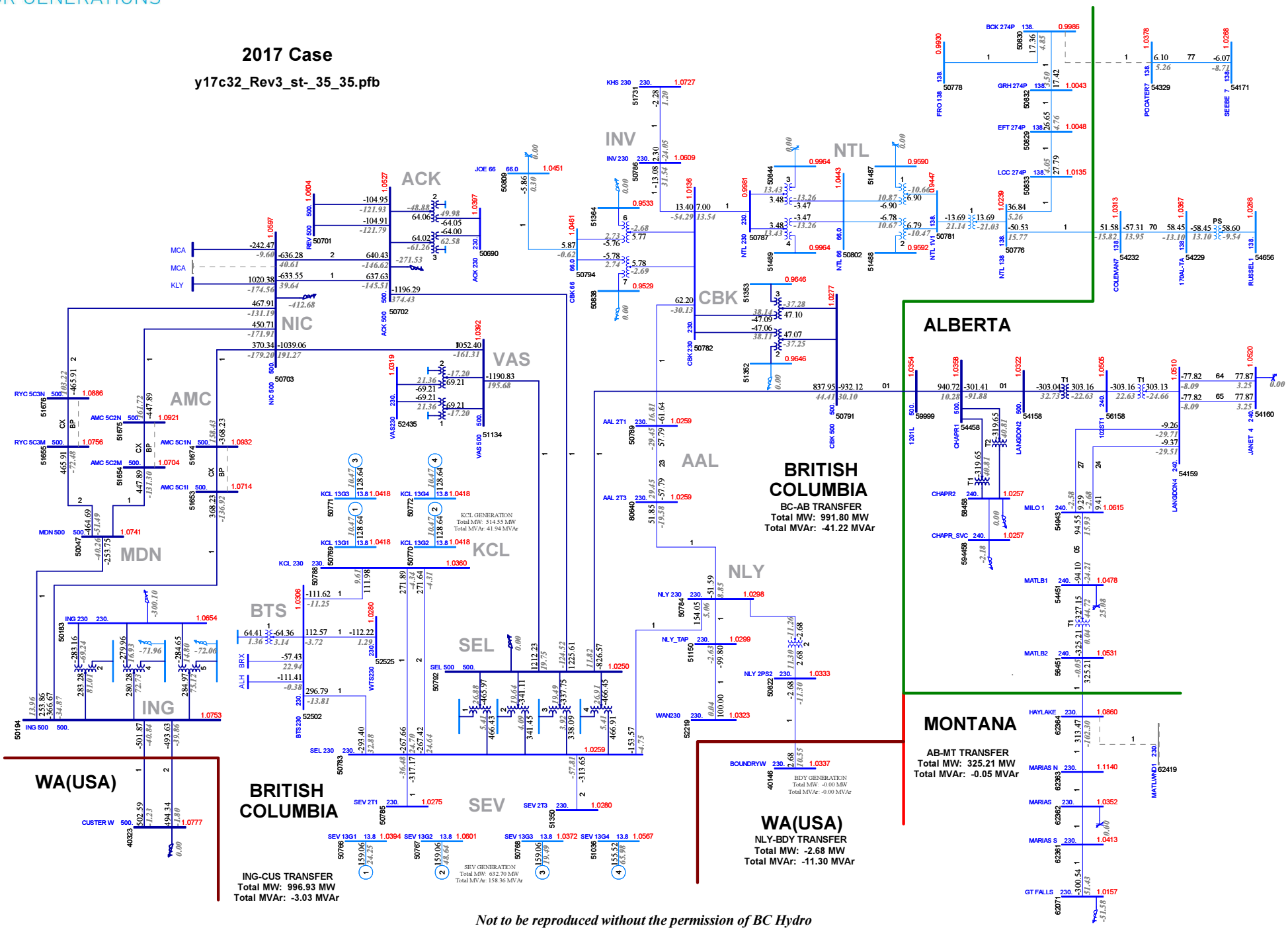


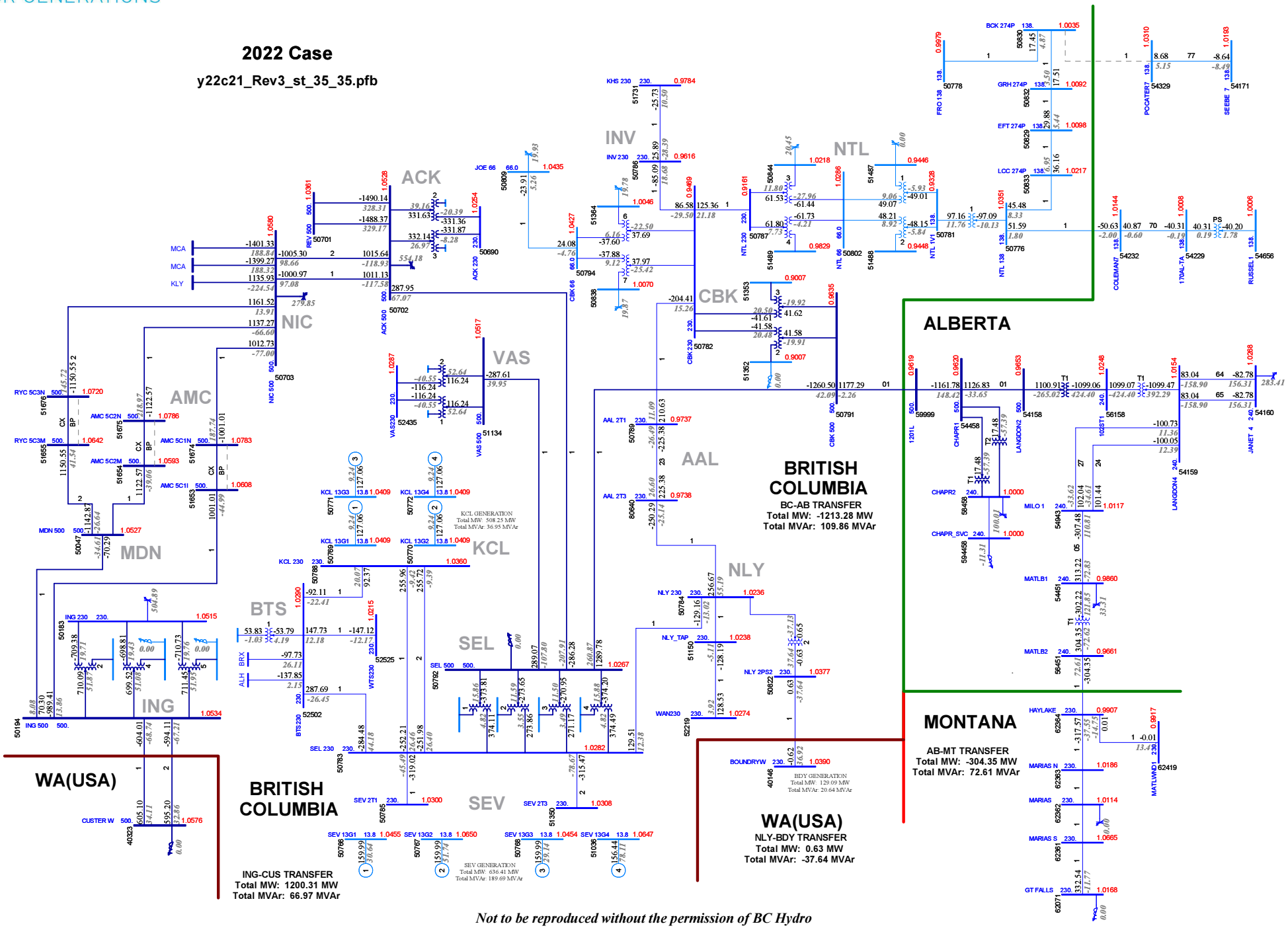


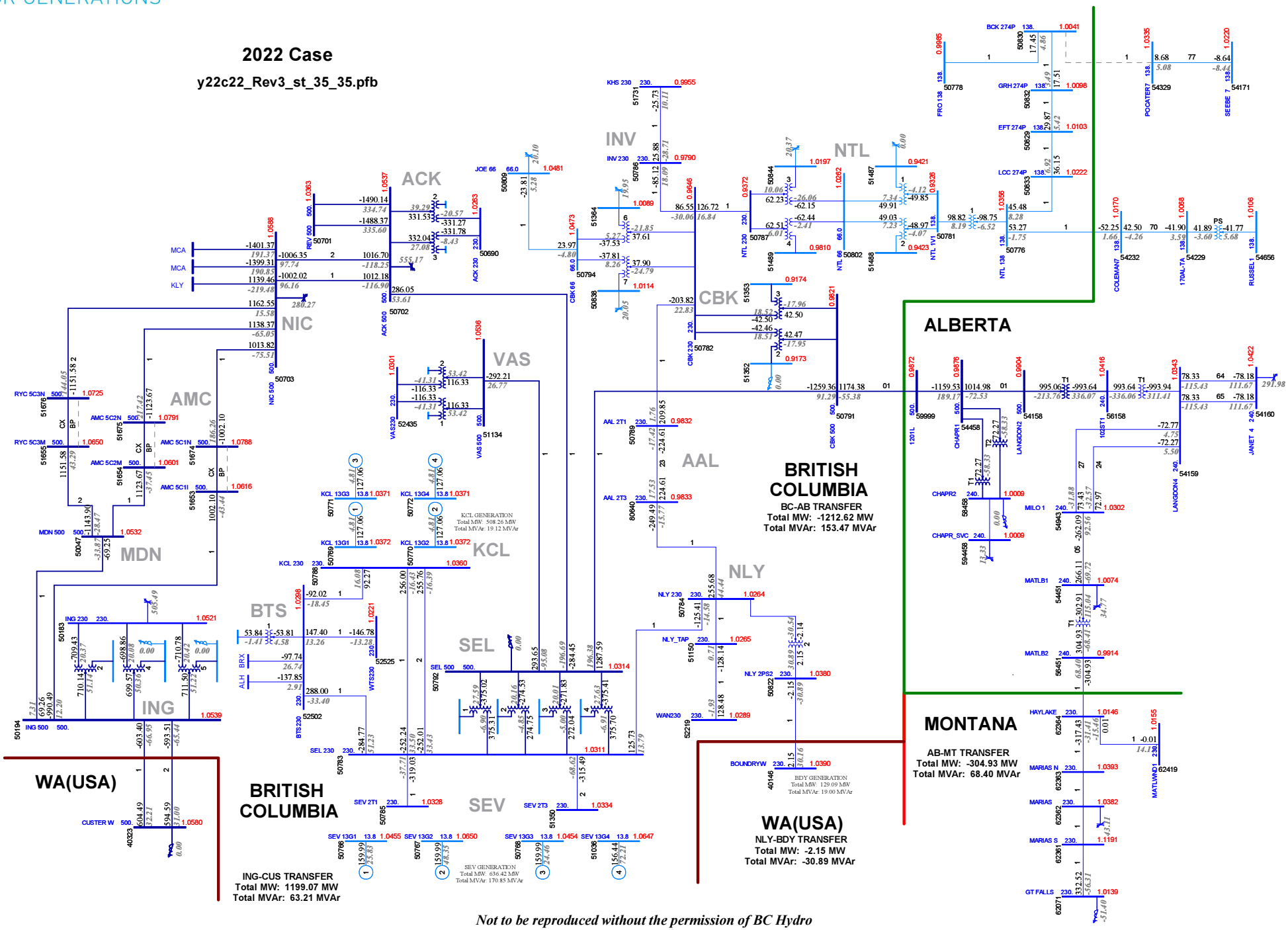


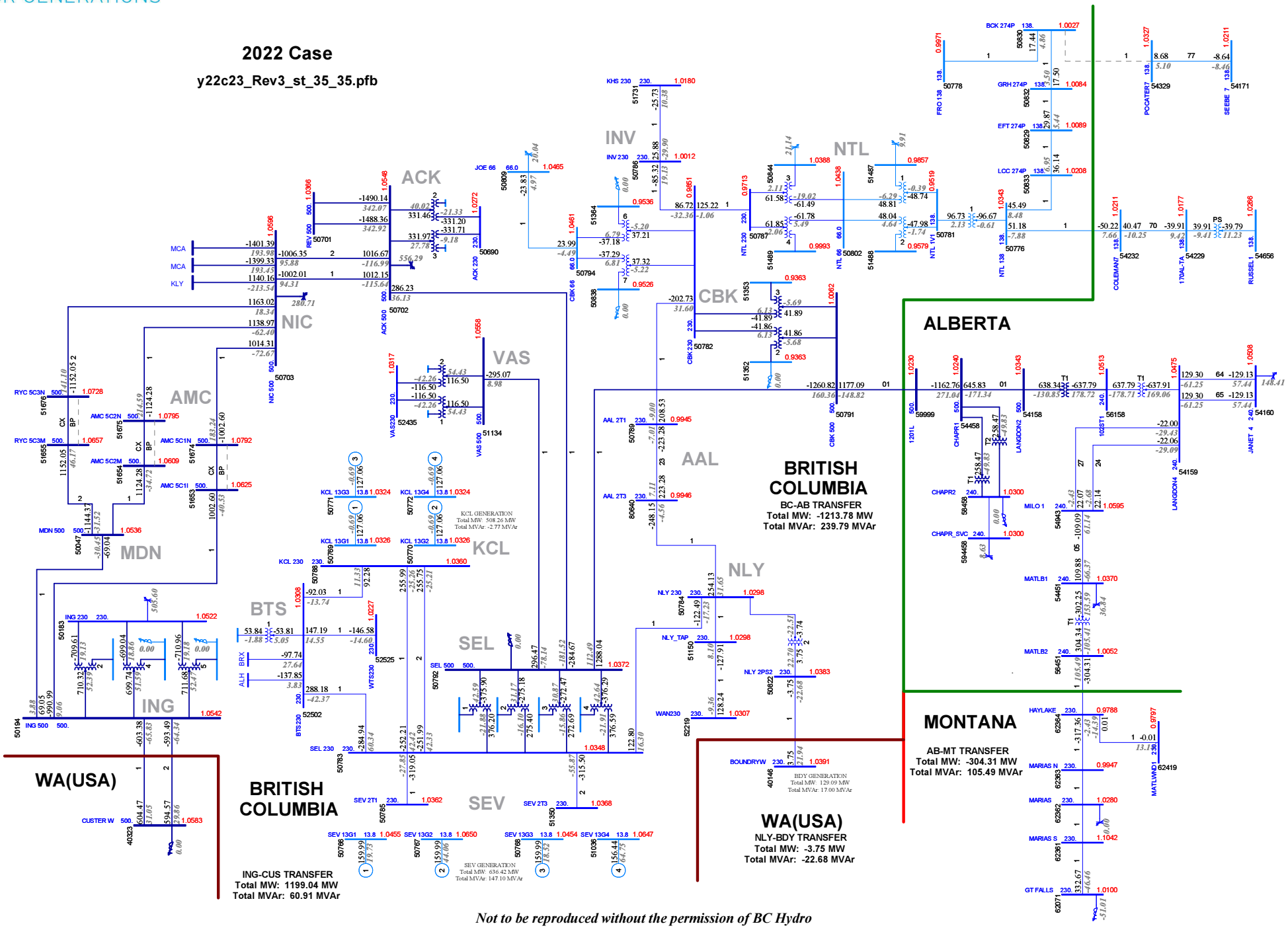


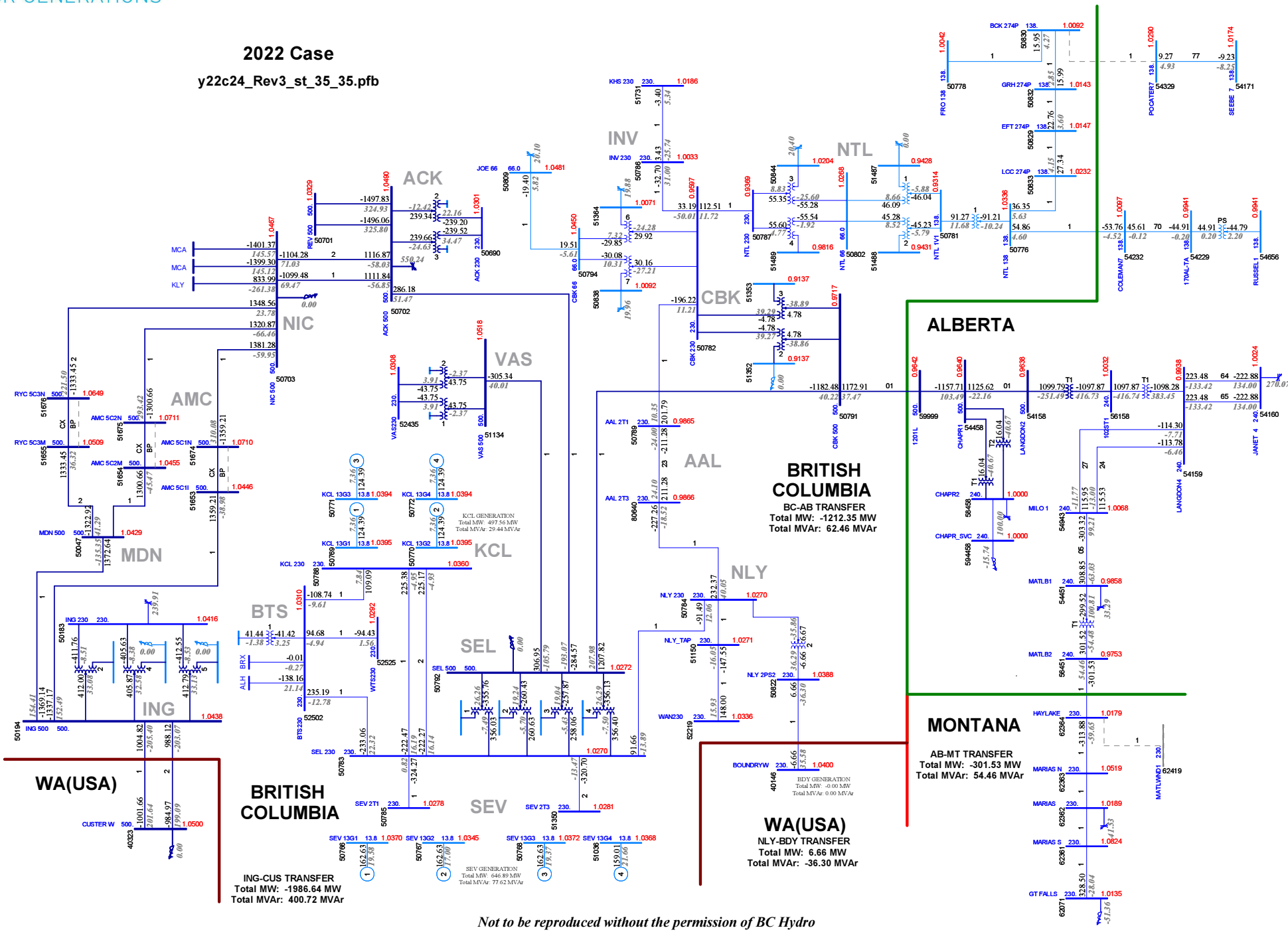


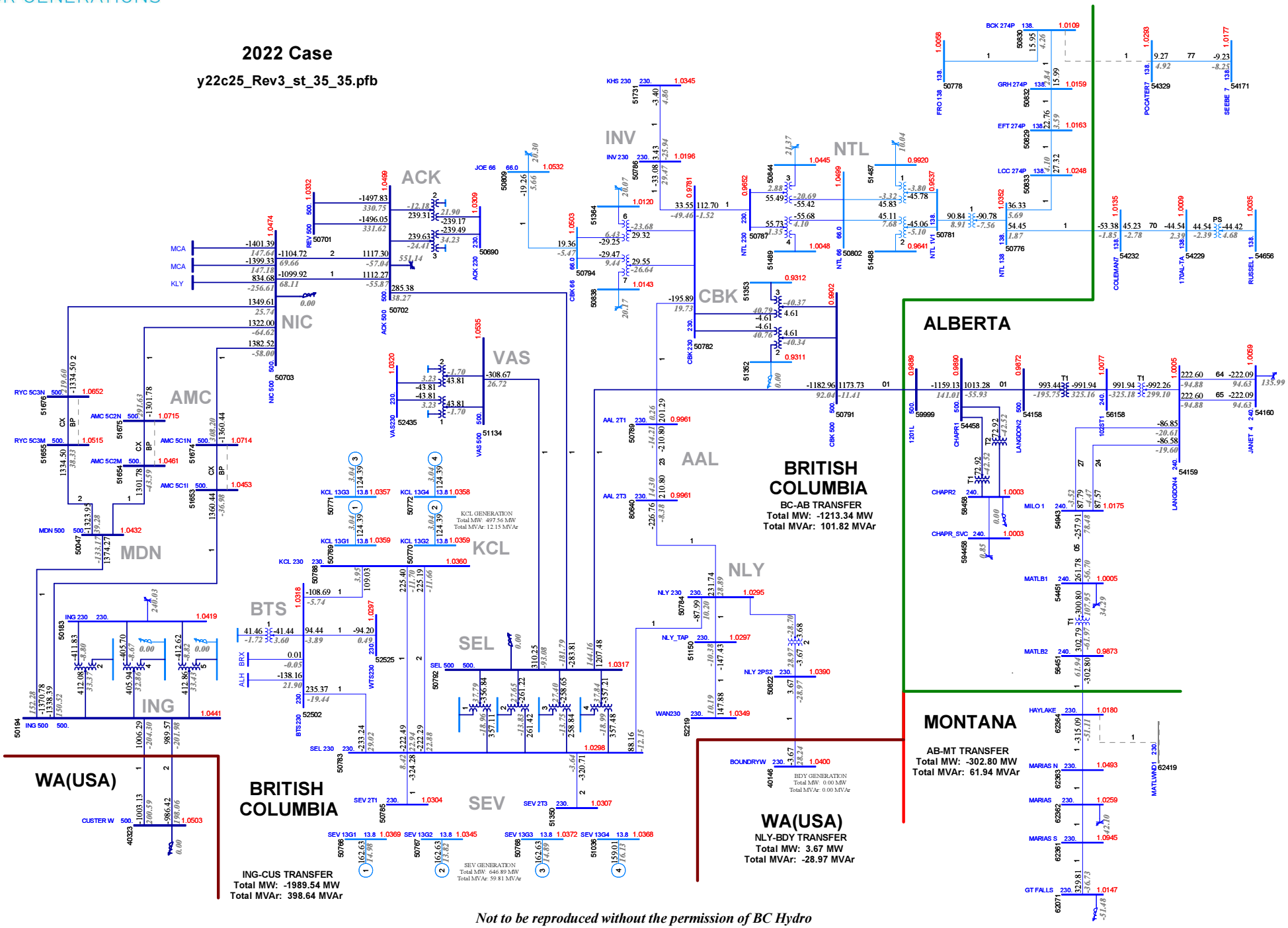


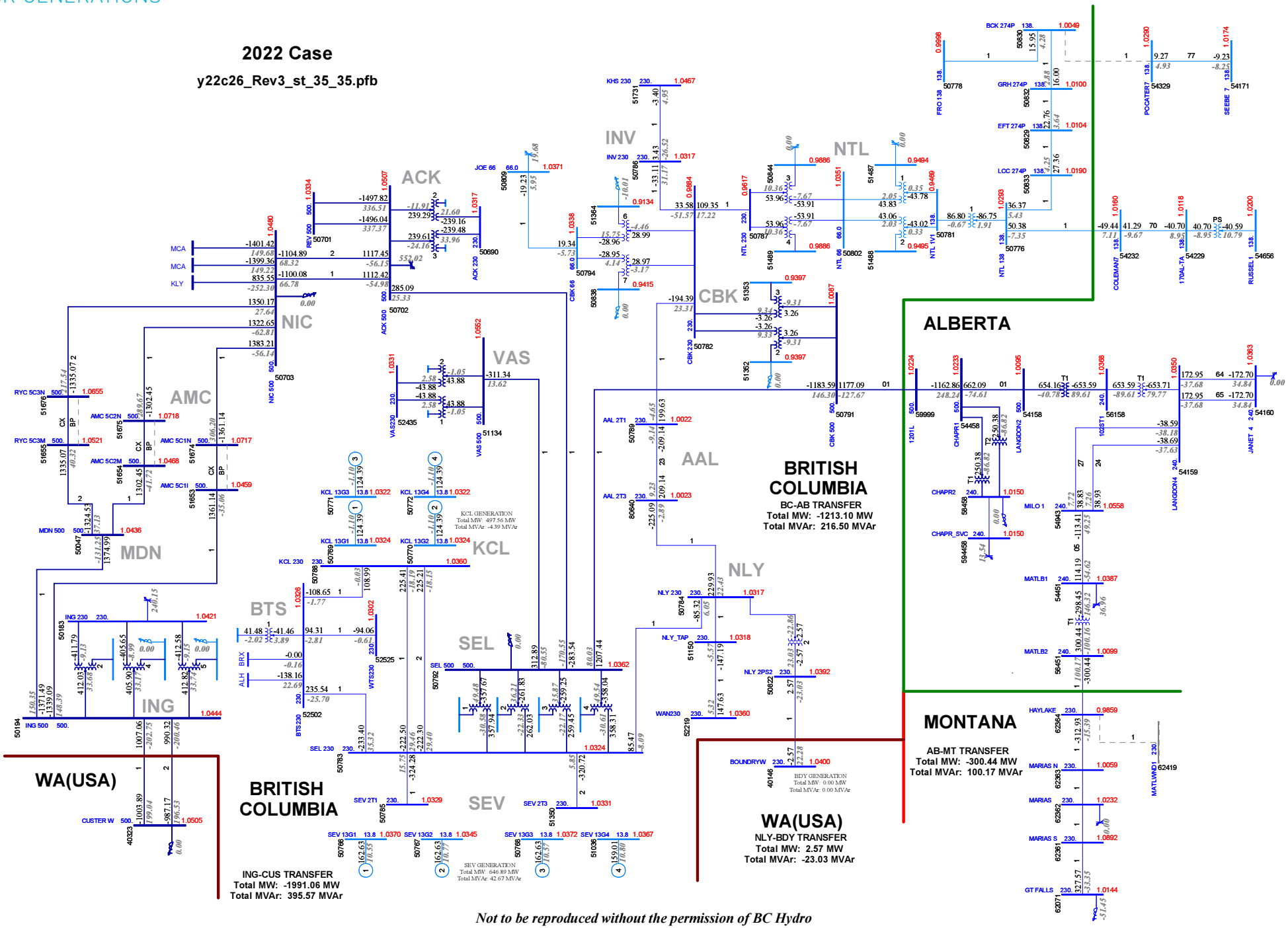


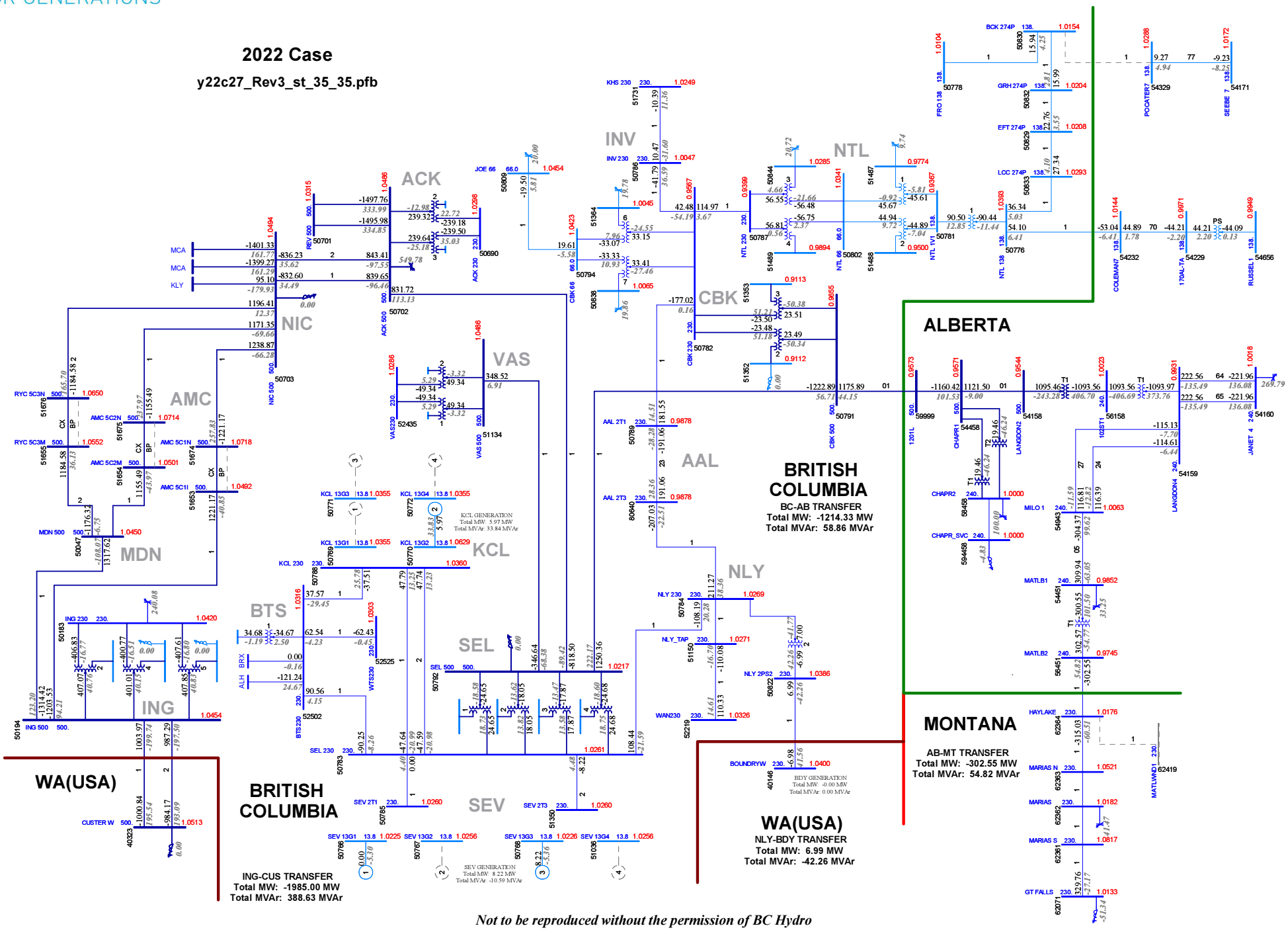


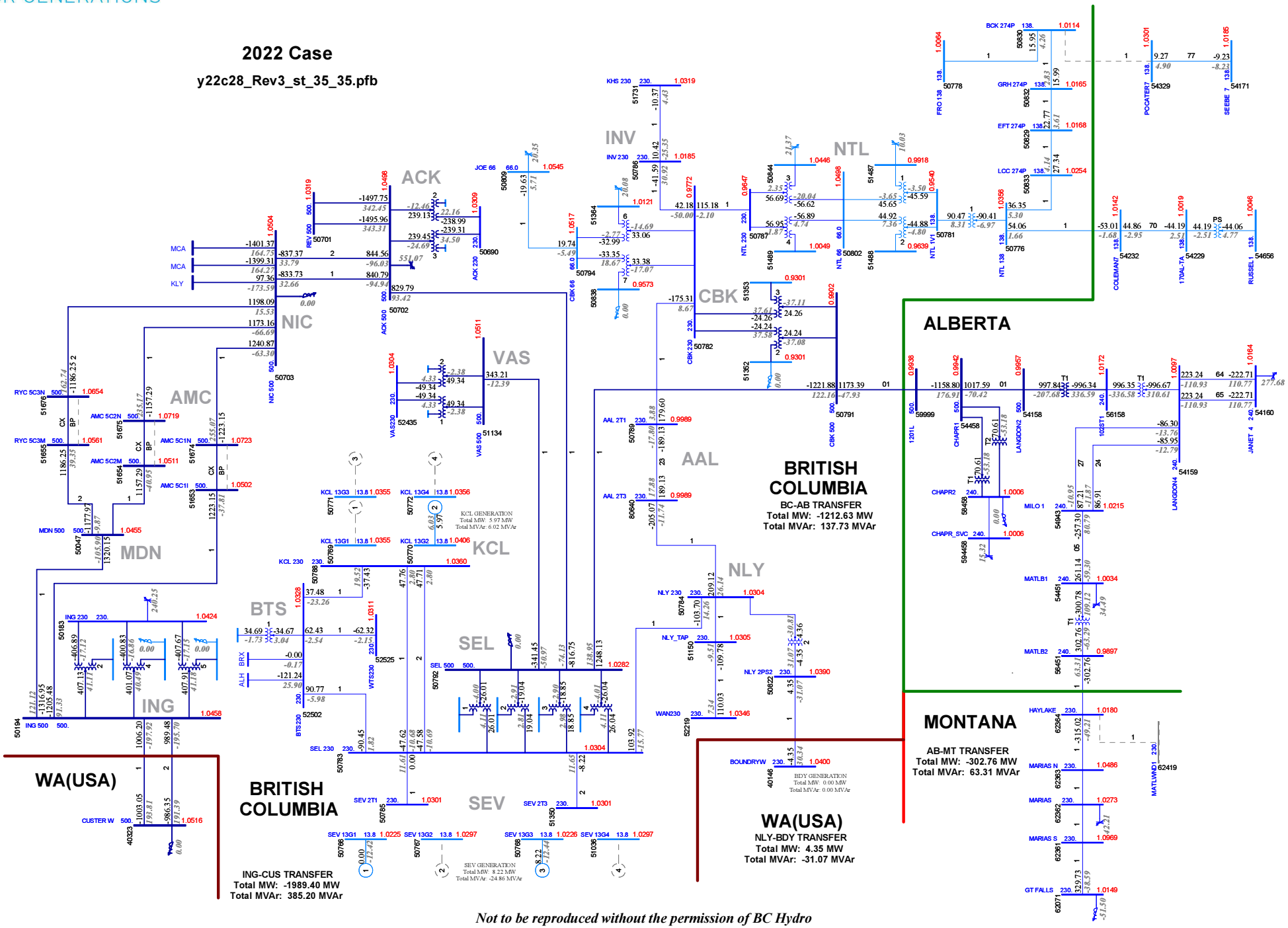


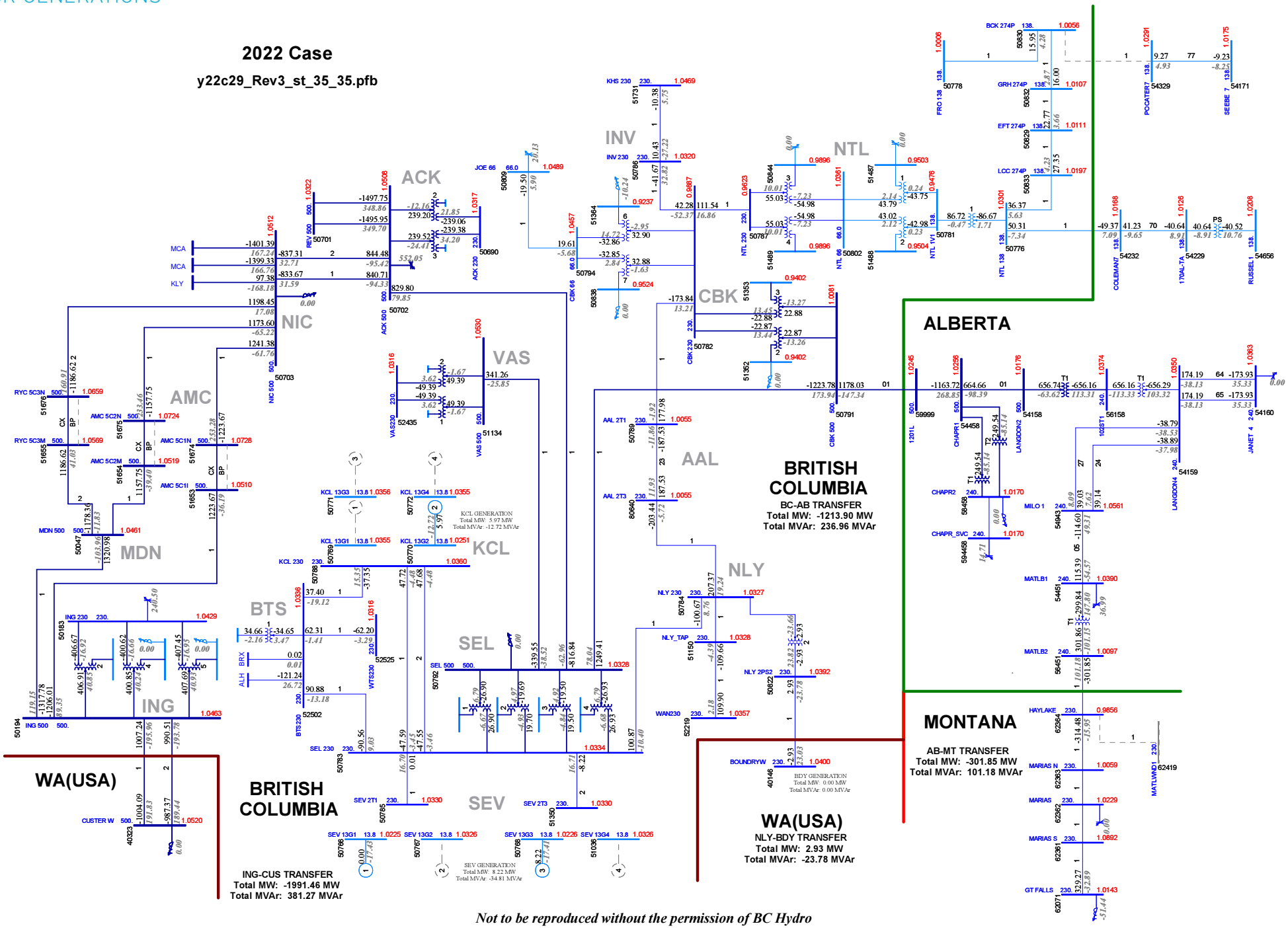


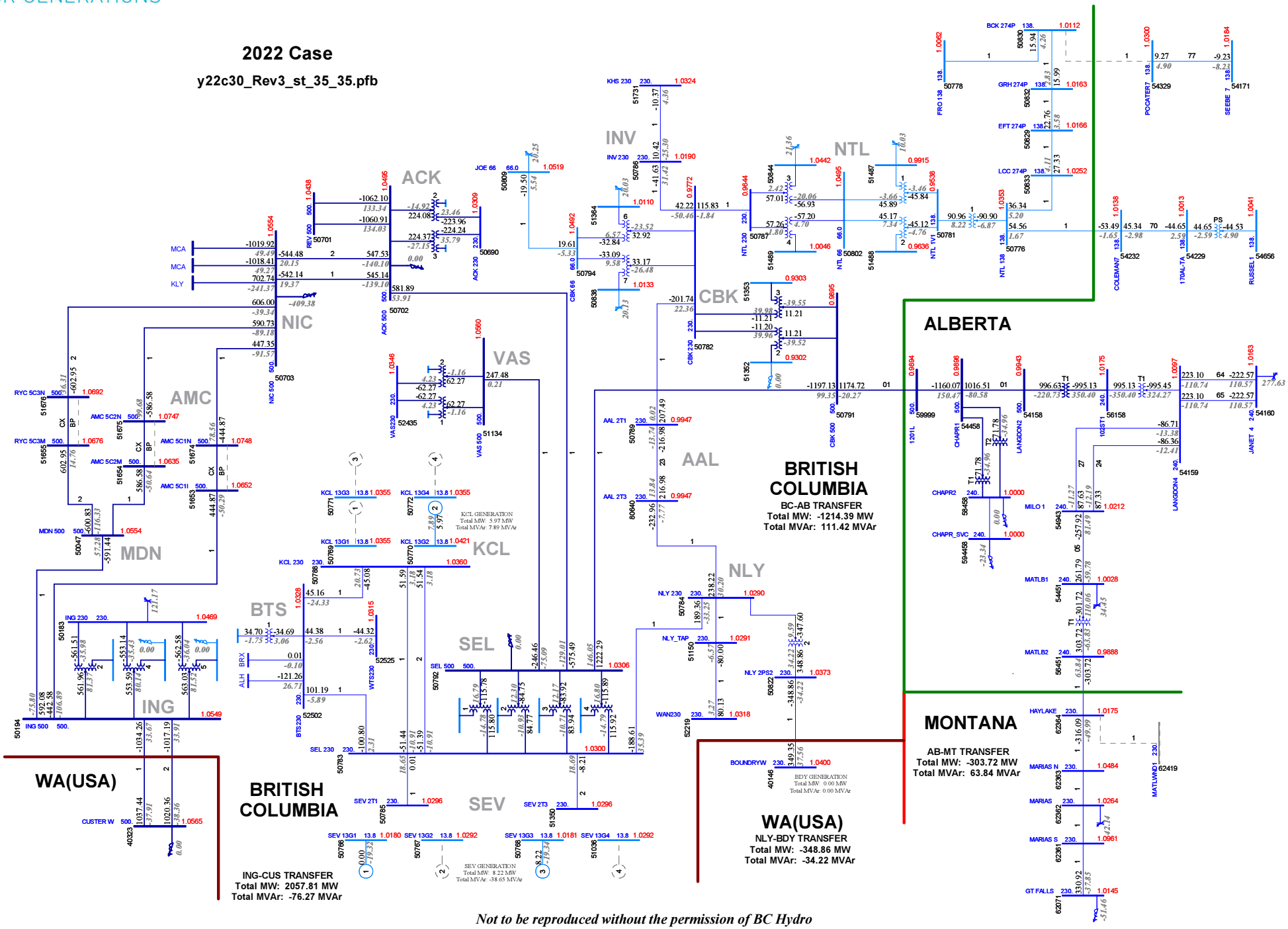


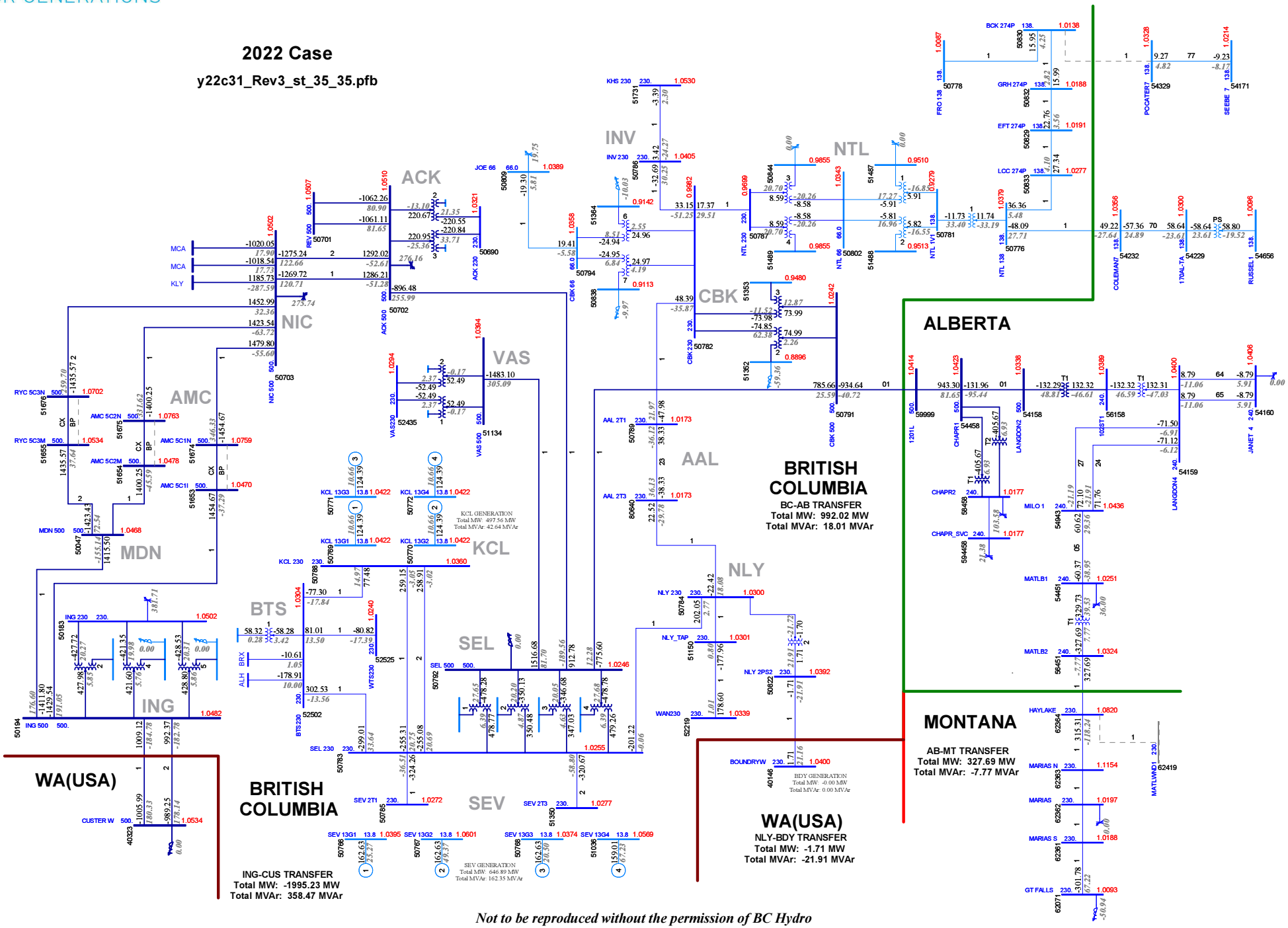


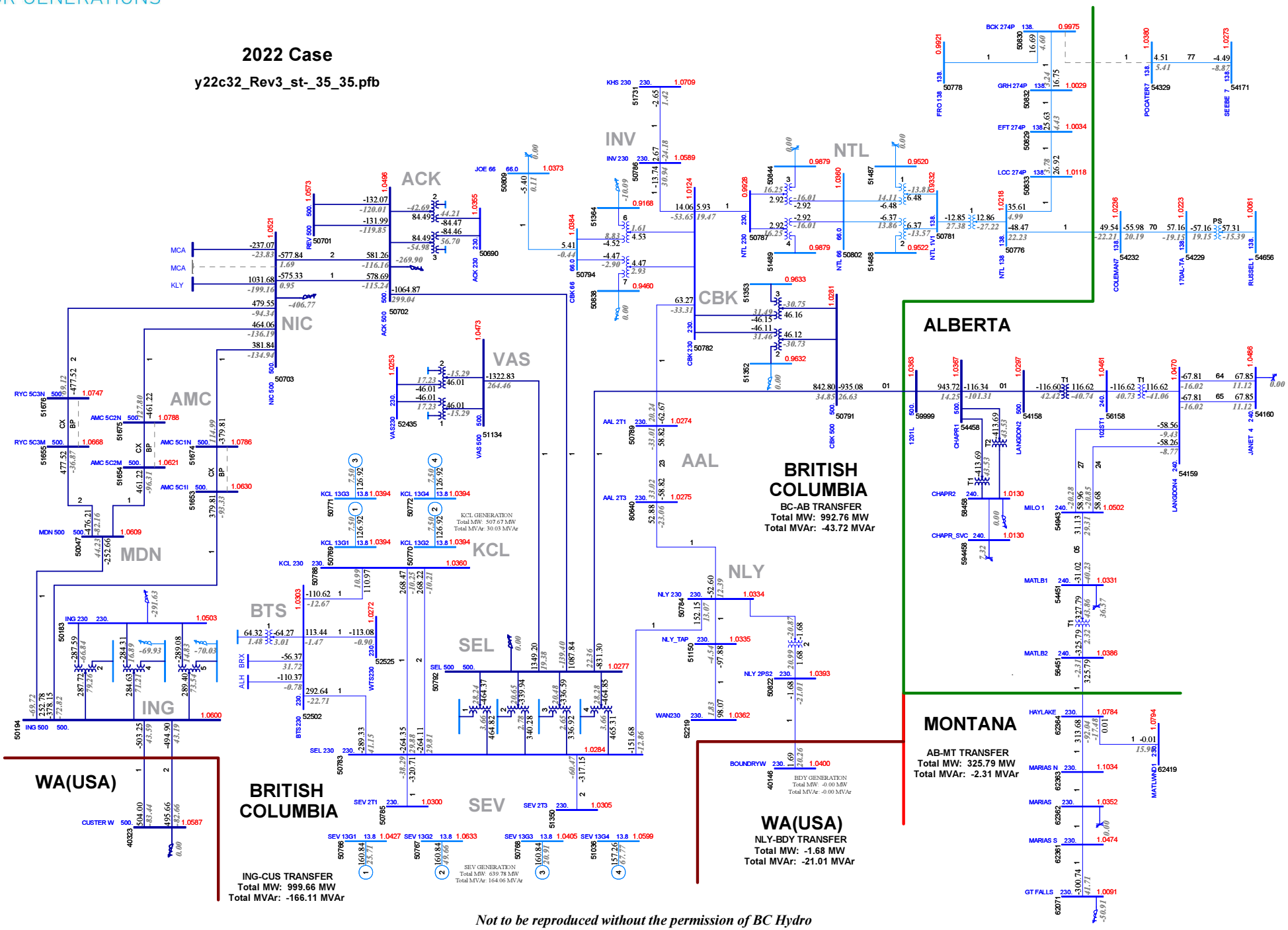












B. LIST OF CONTINGENCIES

Table B- 1 and Table B- 2 list the contingencies studied using post contingency power flows and transient stability analyses. 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 system operating order principles. Modifications to the rules were made where necessary. Multiple devices in the same protection zone are regarded as a single contingency and are tripped with timings according to protection settings.

Table B- 1: Single Contingencies

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
SEV one lead shaft trip T1(G1)	Trip SEV T1 and T2	T1 & T2 in the same protection zone
5L71 MCA-NIC	5L71 contingency and trip out	
5L75 REV-ACK	5L75 contingency and trip out	
5L76 ACK-NIC	5L76 contingency and trip out	
5L79 ACK-NIC	5L76 contingency and trip out	
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 Generation shedding applied in BCH AGC disabled	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. MATL tripped open by its RAS.
5L94 CBK-LGN	5L94 contingency and trip out Open 1L275 at Natal Open 1L274 at Britt Creek if normally closed Generation shedding applied in BCH AGC disabled	During high transfer, loss of 5L94 would result in tripping open 138kV ties with AB. Appropriate amount of generation shedding was applied in BCH. MATL tripped open by its RAS.
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	
2L222 SEV-SEL	2L222 contingency and trip out	

2L258 CBK-INV	2L258 contingency and trip out	
2L277 WAN-NLY	2L277 contingency and trip out	
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	
5L81 NIC-ING	5L81 contingency and trip out AGC disabled	Series-compensated line
5L82 NIC-MDN	5L82 contingency and trip out AGC disabled	Series-compensated line

Table B- 2: Double Contingencies

Contingency Name	Contingency Description	Comment
5L76 & 5L79	5L76 & 5L79 contingency and trip out Trip open 1L209 Trip open 1L214 Generation shedding applied in BCH AGC disabled	Gen shedding applied according to operating order 7T-34 principles
5L91 & 5L96	5L91 & 5L96 contingency and trip out Trip open 2L112 Trip open 48L Generation shedding applied in BCH AGC disabled	Gen shedding applied according to operating order 7T-34 principles MATL tripped open by its RAS.
5L81 & 5L82	5L81 & 5L82 contingency and trip out Generation shedding applied in BCH AGC disabled	Gen shedding applied according to operating order 7T-34 principles
5L96 & 5L98	5L96 & 5L98 contingency and trip out Generation shedding applied in BCH	Gen shedding applied according to operating order 7T-34 principles
5L51 & 5L52	5L51 & 5L52 contingency and trip out Trip open 5L94 Open 1L275 at Natal Open 1L274 at Britt Creek if normally closed Trip open 2L112 Generation shedding applied in BCH AGC disabled	Gen shedding applied according to operating order 7T-18 principles MATL tripped open by its RAS.
2L288 & 2L295	2L288 & 2L295 contingency and trip out	
2L289 & 2L295	2L289 & 2L295 contingency and trip out	Gen shedding applied according to operating order 7T-34 principles

	Generation shedding applied in BCH	
2L295 & 2L299	2L295 & 2L299 contingency and trip out Generation shedding applied in BCH	Gen shedding applied according to operating order 7T-34 principles

C. EXISTING BC HYDRO PROTECTION SYSTEM DATA

C.1 5L94 Under-voltage / Power Protection

At CBK: If CBK voltage drops below 421 kV for at least 500 msec, it will trip 5L94. There is no power supervision of the U/V relay at this terminal.

At BNS: If BNS voltage drops below 425 kV for 290 msec, and 5L94 transfer from Alberta to BC exceeds 234 MW then 5L94 will be tripped.

C.2 5L92 & 5L94 CBK RX/CX RAS

On loss of both 5L92 and 5L94 circuits, and if the CBK 230 kV voltage is lower than 218.5 kV:

- Trips 12RX32 (75 MVAr) after 0.2 sec,
- Trips both 12RX6 (10 MVAR) and 12RX7 (10 MVAR) after 0.5 sec,
- switches in both 12CX2 (19.2 MVAR) and 12CX3 (19.2 MVAR) after 0.8 sec,
- Stops the switching if the CBK 230 kV voltage has recovered to 218.5 kV or higher.

On loss of both 5L92 and 5L94 circuits, and if the CBK 230 kV voltage is higher than 248.4 kV:

- Trips both 12CX2 (19.2 MVAR) and 12CX3 (19.2 MVAR) after 0.4 sec,
- Switches in both 12RX6 (10 MVAR) and 12RX7 (10 MVAR) after 0.7 sec
- Switches in 12RX32 (75 MVAR) after 1.0 sec.
- Stops the switching sequence if the CBK 230 kV voltage has dropped to 248.4 kV or lower.

D. POWER FLOW CONTINGENCY RESULTS

The post contingency power flow results of each one of the 48 cases for both short and long terms are presented for reference.

D.1 2014 BC to AB transfer

D.1.1 y14c01

y14c01		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.939	0.939	0.000	0.955	0.955	0.000	1.027	1.027	0.000	0.918	0.918	0.000
N-1	SEL T1	0.937	0.936	0.004	0.953	0.952	0.003	1.025	1.032	-0.006	0.916	0.912	0.005
	CBK T2+T6	0.934	0.932	0.007	0.949	0.948	0.007	1.024	1.031	-0.004	0.914	0.910	0.008
	SEL Shaft Trip T1	0.948	0.934	0.005	0.964	0.950	0.005	1.034	1.031	-0.004	0.927	0.911	0.007
	5L75 REV-ACK	0.936	0.934	0.005	0.952	0.950	0.005	1.024	1.031	-0.004	0.915	0.911	0.007
	5L91 ACK-SEL	0.925	0.916	0.023	0.940	0.932	0.023	1.015	1.042	-0.016	0.905	0.889	0.029
	5L92 CBK-SEL	1.037	0.974	-0.035	1.061	0.996	-0.041	1.160	1.039	-0.012	1.035	0.967	-0.049
	5L94 CBK-LGN	1.048	0.990	-0.051	1.063	1.018	-0.063	1.174	1.030	-0.004	1.047	0.984	-0.066
	5L96 VAS-SEL	0.933	0.934	0.005	0.948	0.950	0.005	1.021	1.032	-0.005	0.912	0.911	0.006
	5L98 NIC-VAS	0.933	0.932	0.007	0.949	0.947	0.008	1.022	1.021	0.006	0.912	0.911	0.007
	2L112 NLY-BDY	0.937	0.936	0.004	0.953	0.952	0.003	1.025	1.032	-0.006	0.916	0.912	0.005
	2L222 SEV-SEL	0.946	0.933	0.007	0.962	0.948	0.007	1.033	1.030	-0.004	0.925	0.910	0.008
	2L258 CBK-INV	0.936	0.940	0.000	0.954	0.958	-0.003	1.024	1.027	0.000	0.915	0.918	0.000
	2L277 WAN-NLY	0.937	0.936	0.003	0.953	0.952	0.003	1.025	1.032	-0.006	0.916	0.913	0.005
	2L288 KCL-BTS	0.939	0.939	0.000	0.954	0.954	0.000	1.026	1.026	0.000	0.917	0.917	0.000
	2L289 SEL-BTS	0.938	0.937	0.002	0.954	0.953	0.002	1.026	1.033	-0.007	0.917	0.914	0.004
	2L293 SEL-NLY	0.940	0.940	0.000	0.953	0.954	0.001	1.027	1.027	0.000	0.918	0.919	0.000
	2L294 CBK-NLY	0.912	0.899	0.040	0.926	0.914	0.041	1.007	1.040	-0.013	0.895	0.871	0.046
	2L295 SEL-KCL	0.937	0.936	0.003	0.953	0.952	0.003	1.025	1.032	-0.006	0.916	0.913	0.005
	1L274 NTL-POCATER	0.949	0.955	-0.016	0.964	0.968	-0.013	1.059	1.029	-0.003	0.940	0.960	-0.042
	1L275 NTL-COLEMAN	0.939	0.933	0.006	0.953	0.946	0.009	1.039	1.032	-0.005	0.931	0.925	-0.007
	5L82 NIC-MDN	0.936	0.937	0.002	0.951	0.953	0.002	1.024	1.034	-0.007	0.914	0.914	0.004
N-2	5L76&5L79												
	5L91&5L96	0.995	0.966	-0.027	1.014	0.998	-0.043	1.080	1.041	-0.015	0.976	0.944	-0.027
	5L81&5L82	0.935	0.934	0.005	0.951	0.949	0.006	1.024	1.031	-0.004	0.915	0.911	0.007
	5L96&5L98	0.930	0.933	0.006	0.945	0.949	0.006	1.019	1.038	-0.012	0.909	0.909	0.009
	5L51&5L52	1.034	0.982	-0.043	1.048	1.010	-0.055	1.156	1.034	-0.007	1.031	0.975	-0.057
	2L288&2L295	0.936	0.934	0.006	0.951	0.949	0.006	1.024	1.031	-0.004	0.915	0.911	0.007
	2L289&2L295	0.958	0.938	0.000	0.975	0.954	0.000	1.043	1.035	-0.008	0.936	0.915	0.002
	2L295&2L299	0.947	0.935	0.004	0.963	0.951	0.004	1.034	1.032	-0.006	0.926	0.912	0.006

D.1.2 **y14c02**

y14c02		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.940	0.940	0.000	0.956	0.956	0.000	1.031	1.031	0.000	0.920	0.920	0.000
N-1	SEL T1	0.938	0.938	0.003	0.954	0.954	0.002	1.030	1.029	0.002	0.918	0.917	0.003
	CBK T2+T6	0.935	0.935	0.006	0.950	0.950	0.006	1.029	1.029	0.003	0.917	0.916	0.004
	SEL Shaft Trip T1	0.948	0.936	0.004	0.964	0.952	0.004	1.039	1.037	-0.005	0.928	0.914	0.006
	5L75 REV-ACK	0.937	0.936	0.004	0.953	0.952	0.004	1.029	1.028	0.003	0.917	0.916	0.004
	5L91 ACK-SEL	0.926	0.918	0.022	0.941	0.933	0.023	1.020	1.032	0.000	0.907	0.896	0.024
	5L92 CBK-SEL	1.042	0.975	-0.035	1.066	0.997	-0.041	1.167	1.040	-0.009	1.040	0.968	-0.048
	5L94 CBK-LGN	1.049	0.991	-0.050	1.063	1.019	-0.063	1.175	1.030	0.001	1.047	0.984	-0.064
	5L96 VAS-SEL	0.934	0.936	0.005	0.949	0.951	0.005	1.026	1.036	-0.005	0.914	0.914	0.006
	5L98 NIC-VAS	0.934	0.934	0.007	0.950	0.949	0.007	1.027	1.026	0.005	0.915	0.914	0.006
	2L112 NLY-BDY	0.939	0.938	0.002	0.954	0.954	0.002	1.030	1.030	0.002	0.919	0.918	0.002
	2L222 SEV-SEL	0.947	0.934	0.007	0.963	0.949	0.007	1.037	1.035	-0.003	0.927	0.912	0.008
	2L258 CBK-INV	0.937	0.941	0.000	0.955	0.958	-0.003	1.028	1.032	0.000	0.916	0.920	0.000
	2L277 WAN-NLY	0.939	0.938	0.002	0.954	0.953	0.003	1.030	1.029	0.002	0.918	0.918	0.002
	2L288 KCL-BTS	0.940	0.940	0.000	0.955	0.955	0.000	1.031	1.031	0.000	0.920	0.919	0.000
	2L289 SEL-BTS	0.939	0.939	0.001	0.955	0.955	0.001	1.030	1.030	0.001	0.919	0.919	0.001
	2L293 SEL-NLY	0.941	0.941	0.000	0.954	0.955	0.001	1.032	1.032	0.000	0.920	0.921	0.000
	2L294 CBK-NLY	0.913	0.901	0.040	0.927	0.915	0.041	1.012	1.043	-0.012	0.897	0.875	0.045
	2L295 SEL-KCL	0.939	0.938	0.002	0.954	0.954	0.002	1.030	1.030	0.002	0.918	0.918	0.002
	1L274 NTL-POCATER	0.950	0.957	-0.016	0.964	0.969	-0.013	1.063	1.041	-0.010	0.942	0.960	-0.040
	1L275 NTL-COLEMAN	0.939	0.934	0.007	0.953	0.947	0.009	1.039	1.033	-0.001	0.932	0.926	-0.006
	5L82 NIC-MDN	0.937	0.938	0.002	0.952	0.954	0.002	1.028	1.030	0.002	0.917	0.918	0.002
N-2	5L76&5L79												
	5L91&5L96	0.998	0.974	-0.033	1.016	1.004	-0.048	1.085	1.042	-0.011	0.979	0.954	-0.034
	5L81&5L82	0.937	0.935	0.005	0.951	0.950	0.006	1.029	1.036	-0.005	0.917	0.913	0.007
	5L96&5L98	0.931	0.935	0.006	0.946	0.950	0.006	1.024	1.036	-0.004	0.911	0.913	0.007
	5L51&5L52	1.035	0.982	-0.042	1.049	1.010	-0.054	1.157	1.022	0.010	1.032	0.975	-0.055
	2L288&2L295	0.937	0.936	0.004	0.952	0.952	0.004	1.029	1.036	-0.005	0.917	0.914	0.006
	2L289&2L295	0.959	0.941	0.000	0.975	0.956	0.000	1.047	1.032	0.000	0.938	0.921	0.000
	2L295&2L299	0.948	0.938	0.003	0.964	0.953	0.003	1.038	1.029	0.002	0.928	0.917	0.003

D.1.3 **y14c03**

y14c03		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.943	0.943	0.000	0.958	0.958	0.000	1.033	1.033	0.000	0.922	0.922	0.000
N-1	SEL T1	0.941	0.940	0.003	0.957	0.956	0.002	1.031	1.030	0.002	0.920	0.920	0.003
	CBK T2+T6	0.938	0.937	0.005	0.953	0.952	0.006	1.031	1.030	0.003	0.919	0.918	0.004
	SEL Shaft Trip T1	0.950	0.939	0.004	0.966	0.954	0.004	1.039	1.030	0.003	0.930	0.919	0.003
	5L75 REV-ACK	0.940	0.939	0.004	0.955	0.954	0.004	1.030	1.030	0.003	0.920	0.919	0.003
	5L91 ACK-SEL	0.929	0.920	0.023	0.944	0.935	0.023	1.021	1.033	0.000	0.909	0.898	0.024
	5L92 CBK-SEL	1.045	0.950	-0.007	1.069	0.971	-0.013	1.171	1.010	0.022	1.044	0.941	-0.019
	5L94 CBK-LGN	1.049	0.991	-0.048	1.063	1.019	-0.060	1.175	1.030	0.002	1.047	0.984	-0.062
	5L96 VAS-SEL	0.937	0.939	0.004	0.952	0.954	0.004	1.028	1.029	0.003	0.916	0.918	0.004
	5L98 NIC-VAS	0.937	0.936	0.007	0.952	0.951	0.007	1.028	1.027	0.006	0.917	0.916	0.006
	2L112 NLY-BDY	0.941	0.940	0.002	0.957	0.956	0.002	1.032	1.031	0.002	0.921	0.920	0.002
	2L222 SEV-SEL	0.948	0.937	0.006	0.964	0.952	0.006	1.038	1.028	0.005	0.928	0.917	0.005
	2L258 CBK-INV	0.940	0.943	0.000	0.957	0.960	-0.002	1.030	1.033	0.000	0.919	0.922	0.000
	2L277 WAN-NLY	0.941	0.940	0.002	0.956	0.956	0.002	1.031	1.031	0.002	0.921	0.920	0.002
	2L288 KCL-BTS	0.942	0.942	0.000	0.958	0.958	0.000	1.032	1.032	0.000	0.922	0.922	0.000
	2L289 SEL-BTS	0.941	0.941	0.001	0.957	0.957	0.001	1.032	1.032	0.001	0.921	0.921	0.001
	2L293 SEL-NLY	0.943	0.943	0.000	0.957	0.957	0.001	1.033	1.033	0.000	0.923	0.923	0.000
	2L294 CBK-NLY	0.917	0.904	0.039	0.930	0.918	0.040	1.013	1.039	-0.006	0.900	0.880	0.042
	2L295 SEL-KCL	0.941	0.941	0.002	0.957	0.956	0.002	1.031	1.031	0.002	0.921	0.920	0.002
	1L274 NTL-POCATER	0.953	0.959	-0.016	0.967	0.971	-0.013	1.066	1.034	-0.002	0.945	0.964	-0.042
	1L275 NTL-COLEMAN	0.941	0.937	0.006	0.954	0.950	0.008	1.041	1.036	-0.003	0.933	0.929	-0.006
	5L82 NIC-MDN	0.939	0.940	0.002	0.954	0.956	0.003	1.030	1.031	0.002	0.919	0.920	0.002
N-2	5L76&5L79												
	5L91&5L96	0.992	0.974	-0.032	1.010	1.004	-0.046	1.084	1.031	0.002	0.975	0.960	-0.038
	5L81&5L82	0.938	0.938	0.005	0.953	0.953	0.005	1.030	1.029	0.004	0.918	0.918	0.004
	5L96&5L98	0.934	0.937	0.005	0.949	0.952	0.006	1.026	1.037	-0.005	0.914	0.915	0.007
	5L51&5L52	1.035	0.982	-0.040	1.049	1.010	-0.052	1.157	1.022	0.011	1.032	0.975	-0.053
	2L288&2L295	0.940	0.939	0.004	0.955	0.954	0.004	1.030	1.029	0.003	0.919	0.918	0.004
	2L289&2L295	0.959	0.943	0.000	0.976	0.958	0.000	1.047	1.033	0.000	0.939	0.923	0.000
	2L295&2L299	0.949	0.941	0.002	0.965	0.956	0.002	1.039	1.031	0.002	0.929	0.920	0.002

D.1.4 **y14c04**

y14c04		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.935	0.935	0.000	0.943	0.944	0.000	1.037	1.037	0.000	0.926	0.926	0.000
N-1	SEL T1	0.934	0.933	0.002	0.942	0.942	0.001	1.036	1.035	0.002	0.925	0.924	0.002
	CBK T2+T6	0.936	0.936	0.000	0.937	0.937	0.007	1.038	1.039	-0.002	0.928	0.928	-0.001
	SEL Shaft Trip T1	0.946	0.933	0.002	0.954	0.941	0.002	1.046	1.035	0.001	0.937	0.924	0.002
	5L75 REV-ACK	0.933	0.932	0.003	0.941	0.940	0.003	1.035	1.034	0.002	0.924	0.923	0.003
	5L91 ACK-SEL	0.922	0.916	0.020	0.929	0.923	0.020	1.026	1.040	-0.004	0.914	0.906	0.021
	5L92 CBK-SEL	1.321	0.976	-0.041	1.351	0.999	-0.056	1.510	1.019	0.017	1.345	0.978	-0.052
	5L94 CBK-LGN	1.082	1.022	-0.087	1.094	1.048	-0.104	1.217	1.030	0.007	1.092	1.025	-0.099
	5L96 VAS-SEL	0.925	0.925	0.010	0.932	0.933	0.010	1.028	1.039	-0.002	0.916	0.916	0.010
	5L98 NIC-VAS	0.932	0.932	0.004	0.940	0.939	0.004	1.034	1.043	-0.007	0.923	0.922	0.005
	2L112 NLY-BDY	0.932	0.932	0.004	0.941	0.940	0.003	1.034	1.043	-0.007	0.923	0.922	0.005
	2L222 SEV-SEL	0.945	0.932	0.003	0.954	0.940	0.003	1.046	1.035	0.002	0.936	0.924	0.003
	2L258 CBK-INV	0.923	0.923	0.013	0.935	0.935	0.008	1.027	1.037	0.000	0.915	0.914	0.012
	2L277 WAN-NLY	0.933	0.933	0.002	0.941	0.941	0.003	1.035	1.035	0.002	0.924	0.924	0.002
	2L288 KCL-BTS	0.935	0.935	0.000	0.943	0.943	0.000	1.036	1.036	0.000	0.926	0.926	0.000
	2L289 SEL-BTS	0.933	0.933	0.002	0.941	0.941	0.002	1.035	1.035	0.002	0.924	0.924	0.002
	2L293 SEL-NLY	0.936	0.936	0.000	0.942	0.942	0.001	1.037	1.037	0.000	0.926	0.927	0.000
	2L294 CBK-NLY	0.909	0.889	0.046	0.915	0.897	0.047	1.018	1.040	-0.003	0.904	0.879	0.048
	2L295 SEL-KCL	0.933	0.933	0.002	0.941	0.941	0.002	1.035	1.035	0.002	0.924	0.924	0.002
	1L274 NTL-POCATER	0.943	0.948	-0.012	0.950	0.953	-0.010	1.059	1.029	0.007	0.943	0.961	-0.035
	1L275 NTL-COLEMAN	0.932	0.924	0.012	0.938	0.929	0.014	1.035	1.040	-0.003	0.933	0.925	0.000
	5L82 NIC-MDN	0.929	0.931	0.004	0.937	0.939	0.004	1.032	1.043	-0.006	0.920	0.921	0.005
N-2	5L76&5L79	0.968	0.931	0.004	0.979	0.940	0.004	1.067	1.035	0.002	0.961	0.924	0.003
	5L91&5L96	0.988	0.984	-0.049	0.999	1.001	-0.058	1.087	1.025	0.011	0.982	0.980	-0.054
	5L81&5L82	0.956	0.935	0.000	0.965	0.943	0.000	1.056	1.036	0.000	0.948	0.926	0.000
	5L96&5L98	0.924	0.925	0.010	0.931	0.933	0.011	1.027	1.039	-0.002	0.915	0.916	0.010
	5L51&5L52	1.081	1.019	-0.083	1.093	1.044	-0.101	1.215	1.026	0.011	1.090	1.022	-0.095
	2L288&2L295	0.932	0.930	0.005	0.940	0.938	0.005	1.034	1.042	-0.005	0.923	0.920	0.006
	2L289&2L295	0.945	0.933	0.003	0.954	0.941	0.002	1.045	1.037	0.000	0.936	0.924	0.002
	2L295&2L299	0.936	0.930	0.006	0.945	0.938	0.006	1.038	1.042	-0.005	0.928	0.920	0.007

D.1.5 **y14c05**

y14c05		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.958	0.958	0.000	0.967	0.967	0.000	1.024	1.024	0.000	0.959	0.959	0.000
N-1	SEL T1	0.957	0.957	0.001	0.966	0.966	0.000	1.023	1.023	0.001	0.958	0.958	0.001
	CBK T2+T6	0.960	0.959	0.000	0.961	0.960	0.007	1.026	1.026	-0.001	0.961	0.960	-0.001
	SEL Shaft Trip T1	0.968	0.957	0.001	0.977	0.965	0.002	1.032	1.024	0.000	0.969	0.958	0.000
	5L75 REV-ACK	0.956	0.955	0.003	0.964	0.963	0.003	1.023	1.022	0.002	0.957	0.956	0.002
	5L91 ACK-SEL	0.946	0.941	0.018	0.954	0.949	0.018	1.015	1.036	-0.012	0.948	0.939	0.020
	5L92 CBK-SEL	1.271	0.981	-0.023	1.300	1.005	-0.038	1.359	1.024	0.000	1.290	0.983	-0.024
	5L94 CBK-LGN	1.080	1.023	-0.064	1.092	1.048	-0.081	1.137	1.030	-0.006	1.087	1.026	-0.067
	5L96 VAS-SEL	0.949	0.951	0.008	0.956	0.959	0.008	1.017	1.027	-0.003	0.950	0.951	0.008
	5L98 NIC-VAS	0.956	0.955	0.003	0.964	0.964	0.003	1.022	1.022	0.002	0.956	0.957	0.002
	2L112 NLY-BDY	0.956	0.955	0.003	0.964	0.964	0.003	1.022	1.022	0.002	0.957	0.956	0.003
	2L222 SEV-SEL	0.967	0.956	0.002	0.976	0.964	0.002	1.032	1.023	0.001	0.968	0.957	0.001
	2L258 CBK-INV	0.946	0.946	0.012	0.958	0.959	0.008	1.015	1.024	0.000	0.947	0.947	0.012
	2L277 WAN-NLY	0.957	0.956	0.002	0.965	0.964	0.002	1.023	1.023	0.002	0.957	0.957	0.002
	2L288 KCL-BTS	0.958	0.958	0.000	0.966	0.966	0.000	1.024	1.024	0.000	0.958	0.958	0.000
	2L289 SEL-BTS	0.957	0.957	0.002	0.965	0.965	0.002	1.023	1.023	0.001	0.958	0.957	0.001
	2L293 SEL-NLY	0.959	0.959	0.000	0.965	0.966	0.000	1.024	1.025	0.000	0.959	0.960	0.000
	2L294 CBK-NLY	0.938	0.929	0.029	0.944	0.936	0.031	1.010	1.036	-0.012	0.942	0.927	0.032
	2L295 SEL-KCL	0.957	0.956	0.002	0.965	0.965	0.002	1.023	1.023	0.002	0.957	0.957	0.002
	1L274 NTL-POCATER	0.965	0.969	-0.011	0.973	0.976	-0.009	1.046	1.028	-0.004	0.975	0.987	-0.028
	1L275 NTL-COLEMAN	0.951	0.945	0.013	0.959	0.953	0.014	0.993	1.025	0.000	0.952	0.948	0.011
	5L82 NIC-MDN	0.953	0.955	0.004	0.960	0.963	0.004	1.020	1.030	-0.006	0.953	0.955	0.004
N-2	5L76&5L79	0.988	0.953	0.005	0.999	0.962	0.004	1.050	1.029	-0.005	0.991	0.954	0.005
	5L91&5L96	1.004	0.982	-0.024	1.014	1.005	-0.039	1.066	1.034	-0.009	1.007	0.982	-0.023
	5L81&5L82	0.977	0.958	0.000	0.986	0.966	0.000	1.041	1.024	0.000	0.979	0.959	0.000
	5L96&5L98	0.948	0.950	0.008	0.956	0.958	0.009	1.016	1.027	-0.003	0.949	0.950	0.008
	5L51&5L52	1.078	1.019	-0.060	1.090	1.044	-0.077	1.135	1.026	-0.002	1.084	1.022	-0.063
	2L288&2L295	0.955	0.955	0.004	0.964	0.963	0.004	1.022	1.022	0.002	0.956	0.956	0.003
	2L289&2L295	0.968	0.956	0.003	0.977	0.964	0.003	1.032	1.023	0.001	0.969	0.957	0.002
	2L295&2L299	0.960	0.954	0.004	0.968	0.962	0.004	1.026	1.029	-0.005	0.961	0.954	0.005

D.1.6 **y14c06**

y14c06		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.975	0.975	0.000	0.989	0.989	0.000	1.032	1.032	0.000	0.946	0.946	0.000
N-1	SEL T1	0.974	0.974	0.000	0.989	0.989	0.000	1.031	1.031	0.000	0.945	0.945	0.000
	CBK T2+T6	0.973	0.972	0.003	0.984	0.984	0.005	1.031	1.030	0.001	0.945	0.944	0.002
	SEL Shaft Trip T1	0.983	0.975	0.000	0.998	0.989	0.000	1.038	1.032	0.000	0.954	0.946	0.000
	5L75 REV-ACK	0.973	0.972	0.003	0.987	0.987	0.003	1.030	1.030	0.002	0.944	0.944	0.002
	5L91 ACK-SEL	0.964	0.959	0.016	0.978	0.973	0.016	1.023	1.029	0.003	0.936	0.930	0.016
	5L92 CBK-SEL	1.135	1.017	-0.042	1.161	1.040	-0.051	1.215	1.077	-0.046	1.118	0.996	-0.050
	5L94 CBK-LGN	1.066	1.015	-0.040	1.082	1.042	-0.053	1.134	1.023	0.009	1.047	0.996	-0.050
	5L96 VAS-SEL	0.966	0.968	0.007	0.980	0.982	0.008	1.025	1.027	0.005	0.938	0.940	0.006
	5L98 NIC-VAS	0.973	0.973	0.002	0.987	0.987	0.002	1.030	1.031	0.001	0.944	0.945	0.001
	2L112 NLY-BDY	0.973	0.973	0.002	0.988	0.988	0.002	1.030	1.030	0.001	0.944	0.944	0.002
	2L222 SEV-SEL	0.983	0.974	0.000	0.998	0.988	0.000	1.038	1.032	0.000	0.954	0.946	0.000
	2L258 CBK-INV	0.962	0.962	0.013	0.981	0.981	0.008	1.022	1.031	0.000	0.935	0.933	0.013
	2L277 WAN-NLY	0.973	0.973	0.001	0.988	0.988	0.002	1.031	1.031	0.001	0.945	0.945	0.001
	2L288 KCL-BTS	0.974	0.974	0.000	0.989	0.989	0.000	1.031	1.031	0.000	0.946	0.946	0.000
	2L289 SEL-BTS	0.974	0.974	0.001	0.988	0.988	0.001	1.031	1.031	0.000	0.945	0.945	0.001
	2L293 SEL-NLY	0.975	0.975	0.000	0.988	0.988	0.000	1.032	1.032	0.000	0.946	0.946	0.000
	2L294 CBK-NLY	0.959	0.951	0.024	0.971	0.964	0.026	1.021	1.040	-0.008	0.933	0.920	0.026
	2L295 SEL-KCL	0.973	0.973	0.001	0.988	0.988	0.001	1.031	1.031	0.001	0.945	0.945	0.001
	1L274 NTL-POCATER	0.981	0.984	-0.009	0.995	0.997	-0.007	1.053	1.043	-0.011	0.961	0.971	-0.025
	1L275 NTL-COLEMAN	0.971	0.967	0.008	0.984	0.980	0.009	1.027	1.023	0.009	0.950	0.947	0.000
	5L82 NIC-MDN	0.969	0.972	0.003	0.983	0.986	0.004	1.028	1.030	0.002	0.941	0.943	0.002
N-2	5L76&5L79	0.999	0.971	0.004	1.016	0.986	0.003	1.052	1.030	0.002	0.971	0.943	0.002
	5L91&5L96	1.014	0.995	-0.020	1.030	1.024	-0.035	1.071	1.029	0.003	0.987	0.972	-0.026
	5L81&5L82	0.990	0.975	0.000	1.005	0.989	0.000	1.045	1.032	0.000	0.961	0.946	0.000
	5L96&5L98	0.966	0.968	0.007	0.980	0.982	0.008	1.025	1.027	0.005	0.938	0.940	0.006
	5L51&5L52	1.065	1.011	-0.036	1.081	1.038	-0.049	1.132	1.031	0.000	1.045	0.991	-0.045
	2L288&2L295	0.972	0.972	0.003	0.987	0.986	0.003	1.030	1.029	0.002	0.944	0.943	0.002
	2L289&2L295	0.983	0.974	0.000	0.998	0.989	0.000	1.038	1.032	0.000	0.954	0.946	0.000
	2L295&2L299	0.976	0.972	0.003	0.991	0.987	0.003	1.033	1.030	0.002	0.948	0.944	0.002

D.1.7 **y14c07**

y14c07		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.933	0.933	0.000	0.939	0.939	0.000	1.031	1.031	0.000	0.927	0.927	0.000
N-1	SEL T1	0.932	0.932	0.001	0.938	0.938	0.001	1.030	1.030	0.000	0.926	0.926	0.001
	CBK T2+T6	0.935	0.934	0.000	0.932	0.931	0.008	1.033	1.033	-0.002	0.929	0.928	-0.002
	SEL Shaft Trip T1	0.933	0.933	0.000	0.939	0.939	0.000	1.031	1.031	0.000	0.927	0.927	0.000
	5L75 REV-ACK	0.930	0.928	0.005	0.936	0.934	0.005	1.028	1.027	0.003	0.924	0.923	0.004
	5L91 ACK-SEL												
	5L92 CBK-SEL	1.329	0.971	-0.038	1.360	0.995	-0.055	1.503	1.027	0.004	1.354	0.973	-0.047
	5L94 CBK-LGN	1.095	1.030	-0.097	1.106	1.055	-0.116	1.220	1.025	0.005	1.106	1.033	-0.107
	5L96 VAS-SEL	0.916			0.922			1.018			0.912		
	5L98 NIC-VAS	0.926	0.915	0.018	0.932	0.921	0.019	1.026	1.036	-0.005	0.921	0.908	0.019
	2L112 NLY-BDY	0.930	0.930	0.004	0.936	0.936	0.003	1.028	1.029	0.002	0.924	0.924	0.003
	2L222 SEV-SEL	0.933	0.933	0.000	0.939	0.939	0.000	1.031	1.031	0.000	0.927	0.927	0.000
	2L258 CBK-INV	0.920	0.921	0.012	0.930	0.932	0.007	1.021	1.031	0.000	0.915	0.915	0.012
	2L277 WAN-NLY	0.930	0.929	0.004	0.936	0.935	0.004	1.028	1.028	0.003	0.924	0.924	0.003
	2L288 KCL-BTS	0.933	0.934	0.000	0.939	0.940	0.000	1.031	1.031	0.000	0.927	0.927	0.000
	2L289 SEL-BTS	0.931	0.930	0.003	0.938	0.936	0.003	1.030	1.029	0.002	0.925	0.925	0.002
	2L293 SEL-NLY	0.933	0.933	0.000	0.938	0.937	0.002	1.031	1.031	0.000	0.927	0.927	0.000
	2L294 CBK-NLY	0.891			0.897			0.997			0.888		
	2L295 SEL-KCL	0.932	0.931	0.002	0.938	0.937	0.002	1.030	1.030	0.001	0.926	0.925	0.001
	1L274 NTL-POCATER	0.942	0.948	-0.015	0.947	0.952	-0.013	1.055	1.032	-0.001	0.945	0.961	-0.034
	1L275 NTL-COLEMAN	0.928	0.917	0.016	0.933	0.921	0.018	1.018	1.045	-0.014	0.929	0.919	0.008
	5L82 NIC-MDN	0.926	0.927	0.006	0.932	0.933	0.007	1.025	1.036	-0.005	0.920	0.920	0.007
N-2	5L76&5L79	0.953	0.934	0.000	0.960	0.940	0.000	1.048	1.032	-0.001	0.947	0.928	-0.001
	5L91&5L96	1.087	1.026	-0.093	1.101	1.054	-0.115	1.158	1.109	-0.078	1.082	1.013	-0.086
	5L81&5L82	0.956	0.937	-0.004	0.963	0.943	-0.004	1.051	1.034	-0.003	0.950	0.930	-0.004
	5L96&5L98	0.915			0.920			1.017			0.911		
	5L51&5L52	1.108	1.034	-0.101	1.119	1.059	-0.120	1.235	1.029	0.002	1.120	1.037	-0.110
	2L288&2L295	0.931	0.931	0.002	0.937	0.937	0.003	1.029	1.030	0.001	0.925	0.925	0.002
	2L289&2L295	0.929	0.928	0.006	0.935	0.934	0.006	1.028	1.027	0.004	0.923	0.922	0.005
	2L295&2L299	0.929	0.928	0.005	0.935	0.934	0.006	1.028	1.027	0.004	0.923	0.922	0.005

D.1.8 **y14c08**

y14c08		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.939	0.940	0.000	0.945	0.945	0.000	1.032	1.032	0.000	0.936	0.936	0.000
N-1	SEL T1	0.939	0.938	0.000	0.944	0.944	0.000	1.031	1.031	0.000	0.936	0.935	0.000
	CBK T2+T6	0.941	0.941	-0.002	0.938	0.937	0.008	1.035	1.034	-0.002	0.939	0.938	-0.002
	SEL Shaft Trip T1	0.939	0.940	0.000	0.945	0.945	0.000	1.032	1.032	0.000	0.936	0.936	0.000
	5L75 REV-ACK	0.936	0.935	0.005	0.941	0.940	0.005	1.030	1.028	0.004	0.933	0.932	0.004
	5L91 ACK-SEL	0.904			0.909			1.004			0.904		
	5L92 CBK-SEL	1.345	0.978	-0.039	1.375	1.002	-0.057	1.502	1.034	-0.002	1.371	0.980	-0.044
	5L94 CBK-LGN	1.097	1.032	-0.093	1.107	1.057	-0.112	1.206	1.028	0.004	1.108	1.035	-0.099
	5L96 VAS-SEL	0.923	0.909	0.030	0.928	0.914	0.031	1.020	1.043	-0.011	0.922	0.902	0.034
	5L98 NIC-VAS	0.933	0.920	0.020	0.938	0.925	0.020	1.027	1.034	-0.003	0.931	0.915	0.021
	2L112 NLY-BDY	0.936	0.936	0.003	0.942	0.942	0.003	1.029	1.029	0.003	0.933	0.933	0.003
	2L222 SEV-SEL	0.940	0.939	0.000	0.945	0.945	0.000	1.032	1.032	0.000	0.936	0.936	0.000
	2L258 CBK-INV	0.925	0.925	0.014	0.935	0.936	0.009	1.020	1.030	0.002	0.922	0.922	0.014
	2L277 WAN-NLY	0.936	0.936	0.004	0.942	0.941	0.004	1.030	1.029	0.003	0.933	0.933	0.003
	2L288 KCL-BTS	0.940	0.940	0.000	0.945	0.945	0.000	1.032	1.032	0.000	0.936	0.937	0.000
	2L289 SEL-BTS	0.938	0.937	0.002	0.943	0.943	0.002	1.031	1.030	0.002	0.935	0.934	0.002
	2L293 SEL-NLY	0.940	0.940	0.000	0.943	0.944	0.001	1.032	1.033	0.000	0.937	0.937	0.000
	2L294 CBK-NLY	0.909	0.897	0.042	0.914	0.903	0.042	1.009	1.037	-0.005	0.909	0.892	0.044
	2L295 SEL-KCL	0.938	0.938	0.002	0.944	0.943	0.002	1.031	1.031	0.001	0.935	0.935	0.002
	1L274 NTL-POCATER	0.948	0.953	-0.014	0.952	0.957	-0.012	1.055	1.031	0.000	0.953	0.969	-0.033
	1L275 NTL-COLEMAN	0.933	0.924	0.015	0.937	0.928	0.017	1.010	1.040	-0.009	0.934	0.926	0.010
	5L82 NIC-MDN	0.933	0.934	0.006	0.938	0.939	0.006	1.027	1.036	-0.004	0.930	0.929	0.007
N-2	5L76&5L79	0.958	0.940	0.000	0.965	0.946	-0.001	1.048	1.033	0.000	0.955	0.937	0.000
	5L91&5L96	1.090	1.035	-0.095	1.104	1.060	-0.116	1.152	1.027	0.004	1.088	1.037	-0.101
	5L81&5L82	0.961	0.942	-0.003	0.968	0.948	-0.003	1.051	1.034	-0.003	0.958	0.939	-0.003
	5L96&5L98	0.921	0.907	0.032	0.926	0.912	0.032	1.018	1.042	-0.011	0.919	0.901	0.035
	5L51&5L52	1.109	1.035	-0.096	1.120	1.060	-0.115	1.221	1.030	0.001	1.121	1.038	-0.102
	2L288&2L295	0.937	0.937	0.002	0.943	0.943	0.002	1.030	1.030	0.002	0.934	0.934	0.002
	2L289&2L295	0.935	0.935	0.005	0.941	0.940	0.005	1.029	1.036	-0.005	0.933	0.930	0.006
	2L295&2L299	0.935	0.934	0.005	0.940	0.940	0.005	1.029	1.036	-0.004	0.932	0.930	0.007

D.1.9 **y14c09**

y14c09		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.967	0.967	0.000	0.980	0.980	0.000	1.026	1.026	0.000	0.939	0.939	0.000
N-1	SEL T1	0.967	0.967	0.000	0.980	0.980	0.000	1.025	1.025	0.000	0.939	0.939	0.000
	CBK T2+T6	0.966	0.965	0.003	0.975	0.974	0.007	1.026	1.025	0.000	0.939	0.938	0.002
	SEL Shaft Trip T1	0.968	0.968	0.000	0.981	0.981	0.000	1.026	1.026	0.000	0.940	0.940	0.000
	5L75 REV-ACK	0.965	0.965	0.003	0.978	0.977	0.003	1.024	1.023	0.002	0.937	0.937	0.003
	5L91 ACK-SEL	0.945	0.918	0.050	0.957	0.930	0.050	1.007	1.039	-0.014	0.919	0.883	0.056
	5L92 CBK-SEL	1.145	1.006	-0.039	1.172	1.029	-0.049	1.230	1.066	-0.040	1.131	0.986	-0.046
	5L94 CBK-LGN	1.078	1.019	-0.052	1.093	1.047	-0.067	1.151	1.028	-0.002	1.061	1.000	-0.061
	5L96 VAS-SEL	0.957	0.947	0.020	0.969	0.960	0.020	1.017	1.035	-0.010	0.930	0.916	0.024
	5L98 NIC-VAS	0.963	0.953	0.014	0.976	0.966	0.014	1.022	1.040	-0.014	0.936	0.921	0.018
	2L112 NLY-BDY	0.966	0.965	0.002	0.979	0.978	0.002	1.024	1.024	0.002	0.938	0.938	0.002
	2L222 SEV-SEL	0.968	0.968	0.000	0.981	0.981	0.000	1.026	1.026	0.000	0.940	0.940	0.000
	2L258 CBK-INV	0.956	0.956	0.011	0.973	0.974	0.007	1.017	1.033	-0.008	0.929	0.926	0.014
	2L277 WAN-NLY	0.966	0.966	0.002	0.979	0.978	0.002	1.025	1.024	0.001	0.938	0.938	0.002
	2L288 KCL-BTS	0.967	0.967	0.000	0.980	0.980	0.000	1.025	1.025	0.000	0.939	0.939	0.000
	2L289 SEL-BTS	0.967	0.966	0.001	0.979	0.979	0.001	1.025	1.025	0.000	0.939	0.938	0.001
	2L293 SEL-NLY	0.968	0.968	0.000	0.980	0.980	0.000	1.026	1.026	0.000	0.940	0.940	0.000
	2L294 CBK-NLY	0.947	0.937	0.030	0.959	0.950	0.031	1.011	1.037	-0.011	0.922	0.905	0.035
	2L295 SEL-KCL	0.966	0.966	0.002	0.979	0.979	0.002	1.025	1.024	0.001	0.939	0.938	0.002
	1L274 NTL-POCATER	0.975	0.974	-0.006	0.987	0.986	-0.006	1.048	1.027	-0.001	0.956	0.963	-0.024
	1L275 NTL-COLEMAN	0.963	0.959	0.009	0.975	0.970	0.010	1.019	1.026	0.000	0.943	0.939	0.000
	5L82 NIC-MDN	0.962	0.962	0.005	0.975	0.975	0.005	1.022	1.030	-0.005	0.935	0.933	0.007
N-2	5L76&5L79	0.981	0.967	0.000	0.995	0.980	0.000	1.037	1.026	0.000	0.953	0.940	0.000
	5L91&5L96	1.097	1.042	-0.074	1.117	1.073	-0.092	1.134	1.028	-0.003	1.070	1.021	-0.081
	5L81&5L82	0.983	0.969	-0.002	0.997	0.982	-0.002	1.039	1.027	-0.001	0.955	0.941	-0.002
	5L96&5L98	0.955	0.945	0.022	0.967	0.958	0.023	1.016	1.034	-0.008	0.928	0.914	0.026
	5L51&5L52	1.089	1.022	-0.054	1.104	1.050	-0.070	1.163	1.031	-0.005	1.072	1.003	-0.063
	2L288&2L295	0.966	0.965	0.002	0.979	0.978	0.002	1.024	1.024	0.002	0.938	0.937	0.002
	2L289&2L295	0.965	0.964	0.004	0.978	0.977	0.003	1.023	1.023	0.003	0.937	0.936	0.003
	2L295&2L299	0.965	0.964	0.004	0.977	0.977	0.004	1.023	1.023	0.003	0.937	0.936	0.003

D.1.10 **y14c10**

y14c10		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.946	0.947	0.000	0.955	0.955	0.000	1.032	1.032	0.000	0.945	0.945	0.000
N-1	SEL T1	0.946	0.946	0.000	0.954	0.955	0.000	1.031	1.032	0.000	0.944	0.945	0.000
	CBK T2+T6	0.947	0.955	-0.008	0.948	0.957	-0.002	1.034	1.039	-0.007	0.946	0.953	-0.008
	SEL Shaft Trip T1	0.944	0.954	-0.008	0.952	0.963	-0.008	1.030	1.038	-0.006	0.943	0.952	-0.007
	5L75 REV-ACK	0.943	0.952	-0.005	0.951	0.961	-0.006	1.030	1.036	-0.004	0.942	0.950	-0.005
	5L91 ACK-SEL	0.907	0.904	0.042	0.915	0.913	0.042	1.001	1.043	-0.011	0.909	0.900	0.045
	5L92 CBK-SEL	1.296	0.972	-0.025	1.326	0.995	-0.040	1.426	1.028	0.004	1.318	0.973	-0.028
	5L94 CBK-LGN	1.079	1.028	-0.082	1.090	1.053	-0.099	1.169	1.023	0.009	1.088	1.031	-0.086
	5L96 VAS-SEL	0.927	0.939	0.007	0.935	0.947	0.007	1.017	1.027	0.005	0.927	0.938	0.006
	5L98 NIC-VAS	0.940	0.946	0.000	0.948	0.955	0.000	1.027	1.032	0.000	0.939	0.945	0.000
	2L112 NLY-BDY	0.952	0.951	-0.005	0.959	0.959	-0.004	1.037	1.036	-0.004	0.951	0.950	-0.005
	2L222 SEV-SEL	0.944	0.954	-0.008	0.953	0.963	-0.008	1.030	1.038	-0.006	0.943	0.952	-0.007
	2L258 CBK-INV	0.934	0.944	0.003	0.947	0.957	-0.002	1.022	1.031	0.001	0.933	0.943	0.002
	2L277 WAN-NLY	0.945	0.954	-0.007	0.953	0.962	-0.008	1.031	1.037	-0.006	0.944	0.952	-0.007
	2L288 KCL-BTS	0.946	0.955	-0.008	0.955	0.964	-0.009	1.032	1.038	-0.007	0.945	0.953	-0.008
	2L289 SEL-BTS	0.945	0.954	-0.008	0.953	0.963	-0.008	1.031	1.038	-0.006	0.944	0.952	-0.007
	2L293 SEL-NLY	0.943	0.942	0.005	0.955	0.954	0.001	1.029	1.029	0.003	0.942	0.941	0.004
	2L294 CBK-NLY	0.920	0.923	0.023	0.926	0.930	0.025	1.013	1.032	0.000	0.922	0.921	0.024
	2L295 SEL-KCL	0.945	0.954	-0.007	0.953	0.962	-0.008	1.031	1.037	-0.006	0.944	0.952	-0.007
	1L274 NTL-POCATER	0.955	0.960	-0.013	0.962	0.966	-0.011	1.054	1.022	0.010	0.962	0.979	-0.034
	1L275 NTL-COLEMAN	0.940	0.942	0.004	0.947	0.950	0.005	1.005	1.034	-0.002	0.941	0.944	0.000
	5L82 NIC-MDN	0.943	0.953	-0.006	0.951	0.961	-0.007	1.029	1.037	-0.005	0.942	0.951	-0.006
N-2	5L76&5L79	0.893	0.921	0.026	0.899	0.927	0.027	0.988	1.038	-0.006	0.893	0.917	0.028
	5L91&5L96	1.085	1.041	-0.095	1.099	1.068	-0.113	1.141	1.024	0.007	1.085	1.044	-0.099
	5L81&5L82	0.938	0.952	-0.006	0.945	0.961	-0.006	1.025	1.036	-0.004	0.936	0.950	-0.005
	5L96&5L98	0.924	0.935	0.011	0.931	0.943	0.011	1.014	1.024	0.008	0.924	0.935	0.010
	5L51&5L52	1.084	1.031	-0.085	1.095	1.057	-0.102	1.175	1.026	0.006	1.093	1.034	-0.089
	2L288&2L295	0.944	0.953	-0.007	0.953	0.962	-0.007	1.030	1.037	-0.005	0.943	0.951	-0.006
	2L289&2L295	0.942	0.952	-0.006	0.951	0.961	-0.006	1.029	1.036	-0.004	0.941	0.950	-0.005
	2L295&2L299	0.942	0.952	-0.006	0.950	0.961	-0.006	1.029	1.036	-0.005	0.941	0.950	-0.005

D.2 2017 BC to AB transfer (without Chapel Rock)

D.2.1 y17c01

y17c01		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.919	0.919	0.000	0.934	0.934	0.000	1.033	1.033	0.000	0.889	0.889	0.000
N-1	SEL T1	0.917	0.915	0.004	0.932	0.931	0.003	1.031	1.030	0.003	0.887	0.886	0.003
	CBK T2+T6	0.914	0.912	0.007	0.928	0.926	0.008	1.031	1.029	0.004	0.886	0.884	0.005
	SEL Shaft Trip T1	0.927	0.915	0.004	0.943	0.929	0.005	1.041	1.030	0.003	0.898	0.885	0.004
	5L75 REV-ACK	0.918	0.916	0.003	0.933	0.931	0.003	1.032	1.031	0.002	0.888	0.886	0.003
	5L91 ACK-SEL	0.903	0.893	0.026	0.917	0.907	0.027	1.021	1.031	0.002	0.875	0.862	0.027
	5L92 CBK-SEL	1.118	0.967	-0.048	1.144	0.989	-0.055	1.340	1.035	-0.002	1.126	0.962	-0.073
	5L94 CBK-LGN	1.051	0.991	-0.072	1.065	1.019	-0.085	1.250	1.022	0.011	1.054	0.987	-0.098
	5L96 VAS-SEL	0.911	0.912	0.007	0.925	0.927	0.007	1.026	1.037	-0.004	0.882	0.881	0.008
	5L98 NIC-VAS	0.911	0.906	0.013	0.925	0.920	0.014	1.027	1.032	0.001	0.882	0.875	0.014
	2L112 NLY-BDY	0.916	0.915	0.004	0.932	0.930	0.004	1.031	1.030	0.003	0.887	0.886	0.003
	2L222 SEV-SEL	0.926	0.911	0.007	0.941	0.926	0.008	1.040	1.036	-0.003	0.896	0.880	0.009
	2L258 CBK-INV	0.916	0.919	0.000	0.933	0.936	-0.002	1.030	1.033	0.000	0.886	0.889	0.000
	2L277 WAN-NLY	0.917	0.916	0.003	0.932	0.931	0.003	1.032	1.031	0.002	0.887	0.886	0.003
	2L288 KCL-BTS	0.918	0.918	0.000	0.933	0.933	0.001	1.033	1.032	0.000	0.888	0.888	0.000
	2L289 SEL-BTS	0.917	0.916	0.002	0.932	0.931	0.002	1.032	1.031	0.002	0.888	0.887	0.002
	2L293 SEL-NLY	0.919	0.919	0.000	0.932	0.932	0.002	1.033	1.033	0.000	0.889	0.889	0.000
	2L294 CBK-NLY	0.887	0.873	0.046	0.900	0.886	0.047	1.009	1.028	0.005	0.862	0.841	0.048
	2L295 SEL-KCL	0.917	0.916	0.003	0.932	0.931	0.003	1.031	1.031	0.002	0.887	0.886	0.003
	1L274 NTL-POCATER	0.929	0.935	-0.016	0.943	0.947	-0.013	1.065	1.036	-0.003	0.911	0.932	-0.043
	1L275 NTL-COLEMAN	0.922	0.916	0.003	0.933	0.927	0.007	1.079	1.032	0.001	0.916	0.910	-0.021
	5L82 NIC-MDN	0.915	0.913	0.005	0.929	0.928	0.006	1.030	1.029	0.004	0.885	0.884	0.005
N-2	5L76&5L79												
	5L91&5L96	0.976	0.965	-0.046	0.995	0.989	-0.055	1.086	1.023	0.010	0.947	0.942	-0.053
	5L81&5L82	0.932	0.913	0.005	0.948	0.928	0.006	1.046	1.029	0.004	0.903	0.884	0.005
	5L96&5L98	0.906	0.911	0.008	0.920	0.925	0.008	1.023	1.036	-0.003	0.877	0.880	0.009
	5L51&5L52	1.035	0.975	-0.057	1.048	1.003	-0.069	1.227	1.031	0.002	1.036	0.971	-0.082
	2L288&2L295	0.915	0.913	0.006	0.930	0.928	0.006	1.030	1.037	-0.004	0.886	0.881	0.008
	2L289&2L295	0.936	0.910	0.008	0.953	0.926	0.008	1.048	1.035	-0.002	0.906	0.879	0.010
	2L295&2L299	0.926	0.908	0.011	0.942	0.924	0.010	1.040	1.034	-0.001	0.897	0.878	0.011

D.2.2 **y17c02**

y17c02		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.929	0.929	0.000	0.944	0.944	0.000	1.035	1.035	0.000	0.901	0.901	0.000
N-1	SEL T1	0.928	0.927	0.003	0.942	0.941	0.003	1.033	1.033	0.002	0.900	0.899	0.003
	CBK T2+T6	0.925	0.924	0.005	0.938	0.937	0.007	1.033	1.033	0.002	0.899	0.898	0.004
	SEL Shaft Trip T1	0.938	0.926	0.004	0.953	0.940	0.004	1.043	1.032	0.003	0.910	0.898	0.003
	5L75 REV-ACK	0.928	0.927	0.002	0.943	0.941	0.002	1.034	1.033	0.002	0.901	0.899	0.002
	5L91 ACK-SEL	0.915	0.905	0.024	0.928	0.919	0.025	1.023	1.034	0.000	0.888	0.876	0.025
	5L92 CBK-SEL	1.163	0.960	-0.031	1.189	0.982	-0.039	1.378	1.027	0.007	1.173	0.955	-0.054
	5L94 CBK-LGN	1.054	0.995	-0.065	1.068	1.022	-0.078	1.235	1.026	0.009	1.056	0.990	-0.089
	5L96 VAS-SEL	0.922	0.923	0.006	0.936	0.937	0.007	1.029	1.039	-0.004	0.894	0.893	0.008
	5L98 NIC-VAS	0.922	0.917	0.012	0.936	0.931	0.013	1.029	1.034	0.000	0.895	0.888	0.013
	2L112 NLY-BDY	0.927	0.926	0.003	0.942	0.941	0.003	1.033	1.033	0.002	0.899	0.899	0.003
	2L222 SEV-SEL	0.936	0.924	0.006	0.951	0.937	0.006	1.041	1.030	0.005	0.909	0.896	0.005
	2L258 CBK-INV	0.923	0.926	0.004	0.940	0.943	0.000	1.030	1.032	0.003	0.895	0.898	0.003
	2L277 WAN-NLY	0.928	0.927	0.002	0.942	0.941	0.003	1.034	1.033	0.002	0.900	0.899	0.002
	2L288 KCL-BTS	0.929	0.929	0.000	0.943	0.943	0.000	1.035	1.034	0.000	0.901	0.901	0.000
	2L289 SEL-BTS	0.928	0.928	0.002	0.943	0.942	0.002	1.034	1.034	0.001	0.900	0.900	0.002
	2L293 SEL-NLY	0.930	0.930	0.000	0.942	0.942	0.001	1.035	1.035	0.000	0.902	0.902	0.000
	2L294 CBK-NLY	0.901	0.887	0.042	0.913	0.901	0.043	1.014	1.036	0.000	0.878	0.856	0.045
	2L295 SEL-KCL	0.928	0.927	0.003	0.942	0.941	0.003	1.034	1.033	0.002	0.900	0.899	0.002
	1L274 NTL-POCATER	0.939	0.945	-0.016	0.952	0.957	-0.013	1.066	1.030	0.005	0.923	0.945	-0.044
	1L275 NTL-COLEMAN	0.932	0.927	0.003	0.943	0.937	0.006	1.076	1.030	0.005	0.926	0.921	-0.019
	5L82 NIC-MDN	0.926	0.925	0.005	0.939	0.938	0.005	1.032	1.031	0.004	0.898	0.897	0.005
N-2	5L76&5L79												
	5L91&5L96	0.985	0.961	-0.032	1.003	0.988	-0.045	1.086	1.030	0.005	0.958	0.938	-0.037
	5L81&5L82	0.943	0.925	0.005	0.958	0.939	0.005	1.047	1.031	0.004	0.915	0.897	0.004
	5L96&5L98	0.918	0.922	0.008	0.932	0.935	0.008	1.026	1.038	-0.003	0.891	0.892	0.009
	5L51&5L52	1.038	0.987	-0.057	1.051	1.014	-0.070	1.213	1.030	0.005	1.038	0.983	-0.081
	2L288&2L295	0.926	0.925	0.005	0.940	0.938	0.005	1.032	1.031	0.004	0.898	0.897	0.004
	2L289&2L295	0.947	0.923	0.006	0.963	0.938	0.005	1.050	1.039	-0.004	0.919	0.893	0.008
	2L295&2L299	0.937	0.920	0.009	0.952	0.935	0.009	1.042	1.036	-0.002	0.909	0.891	0.011

D.2.3 **y17c03**

y17c03		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.922	0.922	0.000	0.938	0.938	0.000	1.032	1.032	0.000	0.896	0.896	0.000
N-1	SEL T1	0.920	0.918	0.004	0.936	0.934	0.003	1.031	1.038	-0.006	0.894	0.890	0.006
	CBK T2+T6	0.917	0.914	0.008	0.932	0.931	0.007	1.030	1.037	-0.004	0.892	0.888	0.008
	SEL Shaft Trip T1	0.930	0.917	0.006	0.946	0.932	0.006	1.040	1.037	-0.004	0.904	0.889	0.007
	5L75 REV-ACK	0.921	0.919	0.003	0.936	0.935	0.002	1.032	1.040	-0.007	0.895	0.892	0.004
	5L91 ACK-SEL	0.907	0.897	0.026	0.922	0.912	0.026	1.020	1.040	-0.007	0.882	0.867	0.029
	5L92 CBK-SEL	1.029	0.958	-0.036	1.053	0.980	-0.042	1.202	1.025	0.008	1.029	0.953	-0.057
	5L94 CBK-LGN	1.047	0.987	-0.065	1.062	1.017	-0.079	1.226	1.031	0.002	1.049	0.983	-0.087
	5L96 VAS-SEL	0.914	0.916	0.006	0.929	0.932	0.006	1.026	1.037	-0.004	0.889	0.889	0.007
	5L98 NIC-VAS	0.914	0.910	0.012	0.929	0.925	0.013	1.026	1.032	0.000	0.889	0.883	0.013
	2L112 NLY-BDY	0.919	0.918	0.004	0.935	0.934	0.004	1.030	1.038	-0.006	0.894	0.890	0.006
	2L222 SEV-SEL	0.928	0.915	0.007	0.944	0.931	0.007	1.039	1.036	-0.004	0.903	0.888	0.008
	2L258 CBK-INV	0.918	0.922	0.000	0.936	0.940	-0.002	1.029	1.033	0.000	0.892	0.896	0.000
	2L277 WAN-NLY	0.920	0.919	0.003	0.935	0.934	0.003	1.031	1.039	-0.006	0.894	0.891	0.005
	2L288 KCL-BTS	0.921	0.921	0.000	0.937	0.937	0.000	1.032	1.032	0.000	0.896	0.896	0.000
	2L289 SEL-BTS	0.921	0.920	0.003	0.936	0.935	0.002	1.031	1.040	-0.007	0.895	0.892	0.004
	2L293 SEL-NLY	0.922	0.923	0.000	0.936	0.936	0.001	1.033	1.033	0.000	0.896	0.897	0.000
	2L294 CBK-NLY	0.892	0.877	0.045	0.906	0.891	0.046	1.009	1.037	-0.004	0.870	0.846	0.050
	2L295 SEL-KCL	0.920	0.919	0.004	0.936	0.934	0.003	1.031	1.039	-0.006	0.894	0.891	0.005
	1L274 NTL-POCATER	0.932	0.938	-0.016	0.947	0.951	-0.013	1.066	1.035	-0.003	0.919	0.938	-0.042
	1L275 NTL-COLEMAN	0.923	0.918	0.004	0.935	0.931	0.007	1.065	1.033	0.000	0.917	0.912	-0.016
	5L82 NIC-MDN	0.918	0.916	0.006	0.933	0.932	0.006	1.029	1.037	-0.004	0.892	0.889	0.008
N-2	5L76&5L79	0.964	0.922	0.000	0.983	0.938	0.000	1.071	1.034	-0.001	0.938	0.897	0.000
	5L91&5L96	0.978	0.966	-0.044	0.997	0.991	-0.053	1.088	1.030	0.003	0.954	0.946	-0.050
	5L81&5L82	0.934	0.915	0.007	0.950	0.930	0.008	1.045	1.035	-0.003	0.909	0.887	0.009
	5L96&5L98	0.910	0.916	0.006	0.925	0.931	0.007	1.022	1.037	-0.004	0.885	0.888	0.008
	5L51&5L52	1.030	0.972	-0.050	1.045	1.000	-0.063	1.204	1.027	0.005	1.031	0.967	-0.071
	2L288&2L295	0.918	0.916	0.006	0.934	0.932	0.006	1.029	1.037	-0.005	0.893	0.889	0.007
	2L289&2L295	0.939	0.913	0.009	0.956	0.929	0.008	1.048	1.034	-0.002	0.913	0.886	0.010
	2L295&2L299	0.929	0.912	0.010	0.945	0.929	0.009	1.039	1.034	-0.002	0.903	0.886	0.010

D.2.4 **y17c04**

y17c04		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.944	0.944	0.000	0.955	0.955	0.000	1.036	1.036	0.000	0.929	0.930	0.000
N-1	SEL T1	0.943	0.943	0.001	0.954	0.954	0.000	1.035	1.035	0.001	0.928	0.928	0.001
	CBK T2+T6	0.944	0.943	0.000	0.949	0.949	0.006	1.036	1.036	0.000	0.930	0.930	0.000
	SEL Shaft Trip T1	0.953	0.943	0.001	0.965	0.953	0.002	1.044	1.035	0.000	0.939	0.928	0.001
	5L75 REV-ACK	0.942	0.941	0.003	0.953	0.951	0.003	1.034	1.042	-0.006	0.928	0.925	0.005
	5L91 ACK-SEL	0.932	0.925	0.019	0.942	0.935	0.020	1.027	1.039	-0.003	0.919	0.909	0.021
	5L92 CBK-SEL	1.249	0.982	-0.038	1.278	1.005	-0.051	1.440	1.029	0.007	1.270	0.986	-0.056
	5L94 CBK-LGN	1.074	1.018	-0.074	1.088	1.044	-0.089	1.223	1.028	0.008	1.084	1.022	-0.093
	5L96 VAS-SEL	0.934	0.935	0.009	0.944	0.945	0.009	1.028	1.038	-0.003	0.921	0.920	0.009
	5L98 NIC-VAS	0.941	0.941	0.003	0.952	0.951	0.003	1.034	1.042	-0.006	0.927	0.925	0.005
	2L112 NLY-BDY	0.942	0.940	0.004	0.953	0.951	0.003	1.034	1.041	-0.005	0.927	0.924	0.005
	2L222 SEV-SEL	0.953	0.943	0.001	0.964	0.953	0.001	1.043	1.035	0.000	0.938	0.928	0.001
	2L258 CBK-INV	0.931	0.931	0.013	0.946	0.946	0.009	1.027	1.035	0.000	0.918	0.916	0.013
	2L277 WAN-NLY	0.942	0.941	0.003	0.953	0.952	0.003	1.035	1.042	-0.006	0.928	0.925	0.004
	2L288 KCL-BTS	0.944	0.943	0.000	0.954	0.954	0.000	1.035	1.035	0.000	0.929	0.929	0.000
	2L289 SEL-BTS	0.942	0.942	0.002	0.953	0.953	0.002	1.035	1.034	0.002	0.928	0.928	0.002
	2L293 SEL-NLY	0.944	0.944	0.000	0.953	0.954	0.001	1.036	1.036	0.000	0.930	0.930	0.000
	2L294 CBK-NLY	0.922	0.913	0.031	0.931	0.922	0.033	1.021	1.039	-0.003	0.911	0.896	0.033
	2L295 SEL-KCL	0.942	0.941	0.003	0.953	0.952	0.003	1.035	1.042	-0.006	0.928	0.925	0.004
	1L274 NTL-POCATER	0.951	0.955	-0.011	0.961	0.964	-0.009	1.057	1.034	0.002	0.945	0.959	-0.030
	1L275 NTL-COLEMAN	0.945	0.939	0.005	0.952	0.946	0.008	1.066	1.034	0.002	0.949	0.942	-0.013
	5L82 NIC-MDN	0.940	0.940	0.004	0.950	0.951	0.004	1.032	1.041	-0.005	0.925	0.924	0.005
N-2	5L76&5L79	0.978	0.946	-0.002	0.992	0.957	-0.003	1.064	1.038	-0.002	0.964	0.932	-0.002
	5L91&5L96	0.989	0.987	-0.043	1.003	1.007	-0.052	1.075	1.037	0.000	0.976	0.975	-0.046
	5L81&5L82	0.957	0.943	0.000	0.969	0.954	0.000	1.047	1.035	0.000	0.943	0.929	0.000
	5L96&5L98	0.934	0.935	0.009	0.944	0.945	0.010	1.028	1.038	-0.002	0.920	0.920	0.010
	5L51&5L52	1.082	1.016	-0.072	1.096	1.043	-0.088	1.232	1.027	0.009	1.092	1.021	-0.092
	2L288&2L295	0.941	0.940	0.004	0.952	0.950	0.005	1.034	1.041	-0.005	0.927	0.923	0.006
	2L289&2L295	0.953	0.940	0.004	0.964	0.951	0.003	1.043	1.042	-0.006	0.938	0.924	0.005
	2L295&2L299	0.945	0.939	0.005	0.956	0.950	0.005	1.037	1.040	-0.004	0.931	0.923	0.007

D.2.5 **y17c05**

y17c05		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.942	0.942	0.000	0.952	0.952	0.000	1.031	1.032	0.000	0.930	0.930	0.000
N-1	SEL T1	0.941	0.940	0.002	0.951	0.950	0.002	1.031	1.030	0.001	0.929	0.929	0.002
	CBK T2+T6	0.942	0.942	0.000	0.946	0.945	0.006	1.032	1.032	0.000	0.931	0.931	0.000
	SEL Shaft Trip T1	0.951	0.940	0.002	0.962	0.950	0.002	1.040	1.030	0.001	0.940	0.929	0.002
	5L75 REV-ACK	0.940	0.938	0.003	0.950	0.948	0.004	1.030	1.029	0.002	0.929	0.928	0.003
	5L91 ACK-SEL	0.930	0.922	0.020	0.939	0.931	0.021	1.022	1.035	-0.003	0.920	0.910	0.021
	5L92 CBK-SEL	1.249	0.982	-0.040	1.277	1.005	-0.053	1.422	1.029	0.003	1.269	0.986	-0.055
	5L94 CBK-LGN	1.074	1.017	-0.076	1.088	1.044	-0.092	1.208	1.028	0.004	1.084	1.022	-0.092
	5L96 VAS-SEL	0.932	0.933	0.009	0.941	0.942	0.010	1.024	1.034	-0.002	0.921	0.921	0.009
	5L98 NIC-VAS	0.939	0.939	0.003	0.949	0.948	0.004	1.029	1.029	0.002	0.928	0.927	0.003
	2L112 NLY-BDY	0.940	0.938	0.004	0.950	0.948	0.004	1.030	1.029	0.003	0.928	0.927	0.003
	2L222 SEV-SEL	0.951	0.940	0.002	0.961	0.950	0.002	1.039	1.030	0.001	0.939	0.929	0.001
	2L258 CBK-INV	0.929	0.928	0.014	0.943	0.942	0.010	1.022	1.030	0.001	0.919	0.917	0.014
	2L277 WAN-NLY	0.940	0.939	0.003	0.950	0.949	0.003	1.030	1.030	0.002	0.929	0.928	0.002
	2L288 KCL-BTS	0.941	0.941	0.000	0.951	0.951	0.001	1.031	1.031	0.000	0.930	0.930	0.000
	2L289 SEL-BTS	0.940	0.939	0.002	0.950	0.949	0.002	1.030	1.030	0.002	0.929	0.928	0.002
	2L293 SEL-NLY	0.942	0.942	0.000	0.951	0.950	0.002	1.032	1.032	0.000	0.931	0.931	0.000
	2L294 CBK-NLY	0.919	0.908	0.034	0.928	0.918	0.034	1.016	1.040	-0.009	0.912	0.894	0.037
	2L295 SEL-KCL	0.940	0.939	0.003	0.950	0.949	0.003	1.030	1.030	0.002	0.929	0.928	0.002
	1L274 NTL-POCATER	0.949	0.952	-0.010	0.958	0.960	-0.008	1.053	1.036	-0.005	0.946	0.958	-0.027
	1L275 NTL-COLEMAN	0.941	0.935	0.007	0.948	0.942	0.010	1.048	1.030	0.001	0.944	0.939	-0.008
	5L82 NIC-MDN	0.938	0.938	0.004	0.947	0.948	0.004	1.028	1.029	0.002	0.926	0.927	0.003
N-2	5L76&5L79	0.976	0.943	-0.001	0.990	0.954	-0.002	1.060	1.034	-0.002	0.965	0.933	-0.002
	5L91&5L96	0.987	0.985	-0.043	1.000	1.003	-0.051	1.071	1.032	0.000	0.977	0.976	-0.046
	5L81&5L82	0.955	0.941	0.001	0.966	0.951	0.001	1.043	1.031	0.000	0.944	0.930	0.000
	5L96&5L98	0.932	0.932	0.010	0.941	0.941	0.011	1.023	1.033	-0.002	0.921	0.920	0.010
	5L51&5L52	1.082	1.016	-0.074	1.095	1.043	-0.091	1.217	1.027	0.005	1.092	1.021	-0.091
	2L288&2L295	0.939	0.937	0.004	0.949	0.947	0.005	1.029	1.028	0.003	0.928	0.927	0.004
	2L289&2L295	0.950	0.939	0.003	0.961	0.949	0.003	1.039	1.030	0.002	0.939	0.928	0.002
	2L295&2L299	0.943	0.937	0.005	0.953	0.947	0.005	1.033	1.028	0.003	0.932	0.926	0.004

D.2.6 **y17c06**

y17c06		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.951	0.951	0.000	0.961	0.961	0.000	1.025	1.025	0.000	0.948	0.948	0.000
N-1	SEL T1	0.950	0.950	0.001	0.960	0.960	0.000	1.024	1.024	0.000	0.947	0.947	0.001
	CBK T2+T6	0.952	0.951	0.000	0.955	0.955	0.006	1.026	1.026	0.000	0.948	0.948	0.000
	SEL Shaft Trip T1	0.960	0.951	0.000	0.970	0.961	0.000	1.032	1.025	0.000	0.956	0.947	0.000
	5L75 REV-ACK	0.949	0.949	0.002	0.959	0.958	0.003	1.024	1.023	0.002	0.946	0.945	0.002
	5L91 ACK-SEL	0.940	0.934	0.017	0.949	0.943	0.018	1.016	1.029	-0.004	0.937	0.929	0.019
	5L92 CBK-SEL	1.243	0.982	-0.031	1.271	1.005	-0.045	1.364	1.029	-0.004	1.263	0.986	-0.038
	5L94 CBK-LGN	1.074	1.018	-0.066	1.087	1.044	-0.083	1.164	1.028	-0.003	1.083	1.022	-0.075
	5L96 VAS-SEL	0.942	0.943	0.008	0.951	0.952	0.009	1.018	1.027	-0.002	0.939	0.939	0.009
	5L98 NIC-VAS	0.949	0.949	0.002	0.958	0.959	0.002	1.023	1.024	0.002	0.945	0.946	0.002
	2L112 NLY-BDY	0.949	0.948	0.003	0.959	0.958	0.003	1.023	1.023	0.002	0.946	0.945	0.003
	2L222 SEV-SEL	0.959	0.950	0.000	0.969	0.960	0.001	1.032	1.025	0.000	0.955	0.947	0.000
	2L258 CBK-INV	0.939	0.939	0.012	0.953	0.953	0.008	1.016	1.024	0.002	0.937	0.935	0.013
	2L277 WAN-NLY	0.950	0.949	0.002	0.959	0.959	0.002	1.024	1.024	0.001	0.946	0.946	0.002
	2L288 KCL-BTS	0.951	0.951	0.000	0.960	0.960	0.000	1.025	1.025	0.000	0.947	0.947	0.000
	2L289 SEL-BTS	0.950	0.950	0.002	0.960	0.959	0.001	1.024	1.024	0.001	0.946	0.946	0.001
	2L293 SEL-NLY	0.951	0.952	0.000	0.960	0.960	0.001	1.025	1.026	0.000	0.948	0.948	0.000
	2L294 CBK-NLY	0.931	0.922	0.029	0.939	0.930	0.030	1.011	1.037	-0.012	0.931	0.916	0.032
	2L295 SEL-KCL	0.950	0.949	0.002	0.959	0.959	0.002	1.024	1.024	0.001	0.946	0.946	0.002
	1L274 NTL-POCATER	0.958	0.961	-0.010	0.967	0.969	-0.008	1.046	1.028	-0.003	0.963	0.975	-0.027
	1L275 NTL-COLEMAN	0.946	0.942	0.009	0.955	0.950	0.011	1.017	1.024	0.001	0.950	0.946	0.002
	5L82 NIC-MDN	0.947	0.948	0.003	0.956	0.958	0.003	1.022	1.023	0.002	0.944	0.945	0.003
N-2	5L76&5L79	0.982	0.953	-0.002	0.995	0.963	-0.002	1.052	1.027	-0.002	0.979	0.950	-0.002
	5L91&5L96	0.994	0.981	-0.030	1.006	1.004	-0.043	1.067	1.028	-0.003	0.994	0.982	-0.034
	5L81&5L82	0.962	0.951	0.000	0.972	0.960	0.000	1.035	1.025	0.000	0.959	0.947	0.000
	5L96&5L98	0.942	0.944	0.007	0.951	0.953	0.008	1.018	1.028	-0.003	0.939	0.940	0.008
	5L51&5L52	1.081	1.016	-0.065	1.095	1.043	-0.082	1.173	1.027	-0.002	1.091	1.021	-0.073
	2L288&2L295	0.949	0.948	0.003	0.958	0.957	0.003	1.023	1.023	0.002	0.945	0.945	0.003
	2L289&2L295	0.959	0.950	0.001	0.969	0.960	0.001	1.032	1.024	0.001	0.955	0.946	0.001
	2L295&2L299	0.952	0.948	0.004	0.962	0.957	0.004	1.026	1.022	0.003	0.949	0.944	0.003

D.2.7 **y17c07**

y17c07		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.897	0.900	-0.003	0.906	0.908	-0.002	1.035	1.039	-0.005	0.864	0.875	-0.011
N-1	SEL T1	0.896	0.898	-0.002	0.904	0.906	0.000	1.034	1.038	-0.003	0.863	0.874	-0.010
	CBK T2+T6	0.895	0.899	-0.002	0.898	0.900	0.006	1.035	1.039	-0.005	0.863	0.875	-0.011
	SEL Shaft Trip T1	0.896	0.899	-0.002	0.905	0.906	0.000	1.034	1.038	-0.004	0.863	0.874	-0.010
	5L75 REV-ACK	0.892	0.892	0.005	0.901	0.899	0.006	1.031	1.042	-0.007	0.860	0.866	-0.002
	5L91 ACK-SEL	0.839			0.846			0.987			0.813		
	5L92 CBK-SEL	1.211	1.009	-0.112	1.239	1.032	-0.127	1.475	1.062	-0.027	1.211	1.007	-0.143
	5L94 CBK-LGN	1.077	1.016	-0.119	1.090	1.042	-0.136	1.300	1.029	0.006	1.071	1.014	-0.150
	5L96 VAS-SEL	0.877			0.884			1.019			0.847		
	5L98 NIC-VAS	0.887	0.873	0.024	0.895	0.879	0.026	1.027	1.027	0.008	0.856	0.849	0.015
	2L112 NLY-BDY	0.889	0.889	0.008	0.898	0.897	0.008	1.028	1.040	-0.006	0.857	0.864	0.000
	2L222 SEV-SEL	0.896	0.898	-0.001	0.905	0.906	0.000	1.034	1.038	-0.003	0.863	0.873	-0.009
	2L258 CBK-INV	0.885	0.893	0.004	0.898	0.904	0.002	1.025	1.034	0.000	0.854	0.869	-0.005
	2L277 WAN-NLY	0.893	0.895	0.002	0.901	0.902	0.004	1.032	1.035	0.000	0.861	0.870	-0.006
	2L288 KCL-BTS	0.897	0.900	-0.003	0.906	0.908	-0.003	1.035	1.040	-0.005	0.864	0.875	-0.011
	2L289 SEL-BTS	0.894	0.897	0.000	0.903	0.904	0.001	1.033	1.037	-0.002	0.862	0.872	-0.008
	2L293 SEL-NLY	0.897	0.899	-0.002	0.903	0.905	0.000	1.035	1.039	-0.004	0.864	0.874	-0.010
	2L294 CBK-NLY	0.854			0.864			1.001			0.827		
	2L295 SEL-KCL	0.896	0.898	-0.001	0.904	0.906	0.000	1.034	1.038	-0.003	0.863	0.873	-0.009
	1L274 NTL-POCATER	0.906	0.915	-0.018	0.914	0.921	-0.015	1.059	1.033	0.001	0.881	0.912	-0.048
	1L275 NTL-COLEMAN	0.896	0.890	0.007	0.902	0.894	0.011	1.065	1.035	0.000	0.883	0.886	-0.022
	5L82 NIC-MDN	0.891	0.895	0.002	0.899	0.902	0.003	1.030	1.035	0.000	0.858	0.871	-0.007
N-2	5L76&5L79	0.920	0.900	-0.004	0.931	0.909	-0.003	1.055	1.040	-0.005	0.886	0.875	-0.011
	5L91&5L96	1.038	1.005	-0.109	1.059	1.033	-0.127	1.133	1.027	0.008	0.994	0.989	-0.125
	5L81&5L82	0.924	0.905	-0.008	0.936	0.913	-0.007	1.058	1.036	-0.001	0.890	0.881	-0.017
	5L96&5L98	0.873			0.881			1.016			0.844		
	5L51&5L52	1.115	1.033	-0.136	1.129	1.060	-0.154	1.350	1.034	0.001	1.111	1.032	-0.168
	2L288&2L295	0.895	0.898	-0.001	0.904	0.906	0.000	1.034	1.038	-0.003	0.863	0.873	-0.009
	2L289&2L295	0.892	0.892	0.005	0.901	0.900	0.006	1.031	1.042	-0.007	0.860	0.866	-0.002
	2L295&2L299	0.892	0.893	0.004	0.901	0.901	0.005	1.031	1.042	-0.008	0.860	0.867	-0.003

D.2.8 **y17c08**

y17c08		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.934	0.934	0.000	0.943	0.943	0.000	1.034	1.034	0.000	0.921	0.921	0.000
N-1	SEL T1	0.933	0.933	0.001	0.942	0.942	0.001	1.033	1.033	0.000	0.921	0.920	0.000
	CBK T2+T6	0.934	0.933	0.000	0.936	0.936	0.007	1.035	1.034	0.000	0.922	0.921	0.000
	SEL Shaft Trip T1	0.934	0.934	0.000	0.943	0.943	0.000	1.034	1.034	0.000	0.921	0.921	0.000
	5L75 REV-ACK	0.930	0.928	0.005	0.939	0.937	0.006	1.031	1.029	0.004	0.918	0.916	0.005
	5L91 ACK-SEL	0.905			0.913			1.012			0.896		
	5L92 CBK-SEL	1.226	0.972	-0.038	1.254	0.996	-0.053	1.416	1.019	0.014	1.247	0.977	-0.055
	5L94 CBK-LGN	1.079	1.016	-0.083	1.092	1.042	-0.099	1.233	1.027	0.007	1.090	1.021	-0.100
	5L96 VAS-SEL	0.920	0.909	0.025	0.929	0.917	0.025	1.024	1.033	0.000	0.910	0.896	0.025
	5L98 NIC-VAS	0.928	0.916	0.017	0.937	0.925	0.018	1.030	1.030	0.004	0.917	0.904	0.017
	2L112 NLY-BDY	0.930	0.929	0.004	0.939	0.939	0.004	1.031	1.030	0.003	0.918	0.917	0.004
	2L222 SEV-SEL	0.934	0.933	0.000	0.943	0.943	0.000	1.034	1.034	0.000	0.921	0.921	0.000
	2L258 CBK-INV	0.922	0.925	0.008	0.935	0.938	0.005	1.025	1.028	0.006	0.911	0.914	0.007
	2L277 WAN-NLY	0.931	0.930	0.003	0.940	0.939	0.003	1.032	1.031	0.003	0.919	0.918	0.003
	2L288 KCL-BTS	0.934	0.934	0.000	0.943	0.943	0.000	1.034	1.034	0.000	0.922	0.922	0.000
	2L289 SEL-BTS	0.932	0.931	0.002	0.941	0.941	0.002	1.033	1.032	0.002	0.920	0.919	0.002
	2L293 SEL-NLY	0.934	0.934	0.000	0.941	0.941	0.002	1.034	1.034	0.000	0.921	0.921	0.000
	2L294 CBK-NLY	0.904	0.896	0.038	0.913	0.905	0.038	1.012	1.039	-0.005	0.896	0.881	0.040
	2L295 SEL-KCL	0.933	0.932	0.002	0.942	0.941	0.002	1.033	1.032	0.001	0.920	0.920	0.001
	1L274 NTL-POCATER	0.941	0.946	-0.013	0.950	0.954	-0.011	1.056	1.032	0.002	0.937	0.953	-0.032
	1L275 NTL-COLEMAN	0.933	0.926	0.008	0.939	0.932	0.011	1.054	1.033	0.000	0.936	0.929	-0.008
	5L82 NIC-MDN	0.929	0.930	0.003	0.937	0.939	0.004	1.030	1.031	0.002	0.917	0.918	0.003
N-2	5L76&5L79	0.953	0.934	0.000	0.964	0.944	-0.001	1.050	1.034	0.000	0.941	0.922	0.000
	5L91&5L96	1.065	1.024	-0.090	1.085	1.052	-0.109	1.125	1.025	0.009	1.048	1.017	-0.096
	5L81&5L82	0.957	0.937	-0.003	0.968	0.947	-0.004	1.053	1.036	-0.003	0.944	0.924	-0.003
	5L96&5L98	0.918	0.910	0.024	0.927	0.917	0.026	1.022	1.041	-0.007	0.908	0.895	0.026
	5L51&5L52	1.117	1.034	-0.101	1.131	1.061	-0.118	1.281	1.032	0.002	1.131	1.039	-0.118
	2L288&2L295	0.932	0.932	0.002	0.941	0.941	0.002	1.032	1.032	0.002	0.920	0.919	0.002
	2L289&2L295	0.930	0.929	0.005	0.939	0.938	0.005	1.031	1.030	0.004	0.918	0.917	0.005
	2L295&2L299	0.930	0.929	0.005	0.939	0.938	0.005	1.031	1.030	0.004	0.918	0.917	0.005

D.2.9 **y17c09**

y17c09		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.940	0.940	0.000	0.949	0.949	0.000	1.025	1.025	0.000	0.936	0.936	0.000
N-1	SEL T1	0.940	0.939	0.000	0.948	0.948	0.000	1.025	1.024	0.000	0.936	0.936	0.000
	CBK T2+T6	0.941	0.940	0.000	0.942	0.942	0.007	1.026	1.026	0.000	0.937	0.937	0.000
	SEL Shaft Trip T1	0.940	0.940	0.000	0.949	0.949	0.000	1.025	1.025	0.000	0.937	0.937	0.000
	5L75 REV-ACK	0.937	0.935	0.005	0.945	0.944	0.005	1.023	1.029	-0.004	0.934	0.930	0.007
	5L91 ACK-SEL	0.913	0.892	0.048	0.921	0.898	0.051	1.003	0.986	0.039	0.912	0.891	0.045
	5L92 CBK-SEL	1.211	0.971	-0.031	1.239	0.995	-0.046	1.346	1.019	0.006	1.231	0.976	-0.040
	5L94 CBK-LGN	1.077	1.016	-0.076	1.091	1.042	-0.093	1.185	1.027	-0.002	1.089	1.021	-0.084
	5L96 VAS-SEL	0.928	0.916	0.024	0.936	0.924	0.025	1.016	1.040	-0.015	0.926	0.908	0.029
	5L98 NIC-VAS	0.935	0.925	0.015	0.944	0.934	0.015	1.021	1.031	-0.006	0.932	0.919	0.017
	2L112 NLY-BDY	0.937	0.936	0.004	0.946	0.945	0.004	1.023	1.030	-0.005	0.934	0.931	0.006
	2L222 SEV-SEL	0.940	0.940	0.000	0.949	0.949	0.000	1.025	1.025	0.000	0.937	0.936	0.000
	2L258 CBK-INV	0.930	0.933	0.007	0.942	0.945	0.004	1.017	1.020	0.005	0.927	0.930	0.007
	2L277 WAN-NLY	0.938	0.937	0.003	0.946	0.946	0.003	1.023	1.023	0.002	0.935	0.934	0.003
	2L288 KCL-BTS	0.940	0.940	0.000	0.949	0.949	0.000	1.025	1.025	0.000	0.937	0.937	0.000
	2L289 SEL-BTS	0.939	0.938	0.002	0.947	0.947	0.002	1.024	1.024	0.001	0.935	0.935	0.002
	2L293 SEL-NLY	0.940	0.941	0.000	0.947	0.947	0.001	1.025	1.025	0.000	0.937	0.937	0.000
	2L294 CBK-NLY	0.913	0.907	0.033	0.921	0.915	0.034	1.005	1.034	-0.009	0.913	0.900	0.036
	2L295 SEL-KCL	0.939	0.939	0.001	0.948	0.947	0.001	1.024	1.024	0.001	0.936	0.935	0.001
	1L274 NTL-POCATER	0.948	0.952	-0.012	0.956	0.960	-0.011	1.047	1.030	-0.005	0.953	0.965	-0.029
	1L275 NTL-COLEMAN	0.935	0.931	0.009	0.942	0.938	0.011	1.017	1.038	-0.013	0.939	0.935	0.002
	5L82 NIC-MDN	0.936	0.938	0.003	0.944	0.946	0.003	1.021	1.031	-0.007	0.932	0.932	0.004
N-2	5L76&5L79	0.957	0.941	0.000	0.968	0.950	-0.001	1.040	1.026	0.000	0.954	0.937	-0.001
	5L91&5L96	1.068	1.023	-0.083	1.085	1.050	-0.101	1.126	1.023	0.002	1.065	1.025	-0.089
	5L81&5L82	0.961	0.943	-0.003	0.971	0.952	-0.004	1.043	1.027	-0.002	0.957	0.939	-0.003
	5L96&5L98	0.926	0.919	0.021	0.934	0.926	0.023	1.014	1.034	-0.009	0.924	0.912	0.024
	5L51&5L52	1.115	1.034	-0.094	1.130	1.061	-0.112	1.231	1.032	-0.007	1.129	1.039	-0.103
	2L288&2L295	0.939	0.938	0.002	0.947	0.947	0.002	1.024	1.023	0.001	0.935	0.935	0.002
	2L289&2L295	0.937	0.936	0.005	0.945	0.944	0.004	1.022	1.030	-0.005	0.934	0.930	0.006
	2L295&2L299	0.937	0.936	0.005	0.945	0.944	0.005	1.022	1.030	-0.005	0.933	0.930	0.006

D.2.10 **y17c10**

y17c10		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.936	0.936	0.000	0.947	0.946	0.000	1.028	1.028	0.000	0.926	0.926	0.000
N-1	SEL T1	0.935	0.935	0.000	0.946	0.946	0.000	1.027	1.027	0.000	0.925	0.925	0.000
	CBK T2+T6	0.935	0.942	-0.006	0.940	0.949	-0.002	1.028	1.033	-0.005	0.926	0.932	-0.006
	SEL Shaft Trip T1	0.933	0.942	-0.006	0.943	0.953	-0.007	1.025	1.032	-0.004	0.923	0.931	-0.005
	5L75 REV-ACK	0.933	0.941	-0.006	0.944	0.953	-0.006	1.026	1.032	-0.004	0.924	0.931	-0.005
	5L91 ACK-SEL	0.897	0.897	0.039	0.907	0.906	0.040	0.998	1.042	-0.014	0.891	0.882	0.044
	5L92 CBK-SEL	1.245	0.966	-0.030	1.274	0.990	-0.043	1.421	1.025	0.002	1.267	0.970	-0.044
	5L94 CBK-LGN	1.071	1.024	-0.088	1.084	1.050	-0.103	1.208	1.022	0.006	1.082	1.029	-0.103
	5L96 VAS-SEL	0.916	0.926	0.010	0.926	0.936	0.010	1.013	1.028	0.000	0.908	0.915	0.011
	5L98 NIC-VAS	0.928	0.935	0.000	0.938	0.946	0.000	1.022	1.027	0.000	0.919	0.925	0.000
	2L112 NLY-BDY	0.940	0.939	-0.004	0.949	0.949	-0.002	1.031	1.031	-0.003	0.930	0.929	-0.004
	2L222 SEV-SEL	0.934	0.943	-0.007	0.944	0.954	-0.008	1.026	1.033	-0.005	0.924	0.932	-0.006
	2L258 CBK-INV	0.924	0.934	0.002	0.939	0.949	-0.003	1.018	1.027	0.001	0.915	0.925	0.001
	2L277 WAN-NLY	0.935	0.944	-0.008	0.945	0.955	-0.008	1.027	1.033	-0.006	0.925	0.933	-0.007
	2L288 KCL-BTS	0.936	0.943	-0.008	0.947	0.955	-0.008	1.028	1.033	-0.006	0.926	0.933	-0.007
	2L289 SEL-BTS	0.934	0.943	-0.007	0.945	0.954	-0.008	1.026	1.033	-0.005	0.924	0.932	-0.006
	2L293 SEL-NLY	0.933	0.931	0.005	0.947	0.945	0.001	1.025	1.032	-0.005	0.923	0.920	0.006
	2L294 CBK-NLY	0.908	0.909	0.027	0.916	0.919	0.028	1.007	1.041	-0.013	0.902	0.895	0.031
	2L295 SEL-KCL	0.935	0.943	-0.007	0.945	0.955	-0.008	1.027	1.033	-0.005	0.925	0.932	-0.007
	1L274 NTL-POCATER	0.943	0.947	-0.011	0.953	0.956	-0.009	1.050	1.032	-0.005	0.942	0.954	-0.028
	1L275 NTL-COLEMAN	0.934	0.938	-0.002	0.943	0.947	0.000	1.042	1.046	-0.018	0.938	0.942	-0.016
	5L82 NIC-MDN	0.933	0.942	-0.006	0.944	0.953	-0.006	1.026	1.032	-0.004	0.924	0.931	-0.005
N-2	5L76&5L79	0.899	0.920	0.016	0.907	0.929	0.018	0.998	1.040	-0.012	0.891	0.906	0.020
	5L91&5L96	1.065	1.033	-0.098	1.083	1.062	-0.115	1.115	1.024	0.003	1.050	1.028	-0.103
	5L81&5L82	0.929	0.940	-0.004	0.939	0.951	-0.004	1.022	1.031	-0.003	0.920	0.930	-0.004
	5L96&5L98	0.913	0.923	0.013	0.923	0.933	0.013	1.010	1.035	-0.007	0.905	0.910	0.016
	5L51&5L52	1.077	1.027	-0.092	1.089	1.053	-0.107	1.214	1.025	0.002	1.088	1.032	-0.106
	2L288&2L295	0.934	0.942	-0.006	0.945	0.954	-0.007	1.026	1.032	-0.005	0.924	0.932	-0.006
	2L289&2L295	0.931	0.941	-0.005	0.942	0.952	-0.006	1.024	1.031	-0.004	0.922	0.931	-0.005
	2L295&2L299	0.931	0.941	-0.005	0.942	0.952	-0.006	1.024	1.031	-0.004	0.922	0.931	-0.005

D.3 2017 BC to AB transfer (with Chapel Rock)

D.3.1 y17c21

y17c21		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.965	0.965	0.000	0.986	0.986	0.000	1.031	1.031	0.000	0.938	0.938	0.000
N-1	SEL T1	0.964	0.964	0.001	0.985	0.985	0.000	1.030	1.030	0.000	0.937	0.937	0.000
	CBK T2+T6	0.964	0.964	0.000	0.985	0.985	0.000	1.032	1.032	0.000	0.938	0.938	0.000
	SEL Shaft Trip T1	0.968	0.964	0.001	0.989	0.984	0.001	1.034	1.030	0.000	0.941	0.937	0.000
	5L75 REV-ACK	0.964	0.964	0.000	0.985	0.985	0.001	1.031	1.030	0.000	0.937	0.937	0.000
	5L91 ACK-SEL	0.958	0.964	0.001	0.979	0.981	0.004	1.026	1.031	0.000	0.932	0.937	0.000
	5L92 CBK-SEL	0.985	0.969	-0.004	1.007	0.991	-0.006	1.095	1.037	-0.006	0.980	0.964	-0.026
	5L94 CBK-LGN	1.036	0.995	-0.030	1.054	1.022	-0.036	1.158	1.027	0.004	1.034	0.991	-0.053
	5L96 VAS-SEL	0.962	0.966	-0.002	0.983	0.986	0.000	1.029	1.033	-0.002	0.936	0.939	-0.002
	5L98 NIC-VAS	0.962	0.965	0.000	0.982	0.984	0.002	1.029	1.031	0.000	0.935	0.938	0.000
	2L112 NLY-BDY	0.964	0.964	0.000	0.985	0.985	0.000	1.030	1.030	0.000	0.937	0.937	0.000
	2L222 SEV-SEL	0.967	0.966	-0.002	0.988	0.986	0.000	1.033	1.033	-0.002	0.940	0.939	-0.002
	2L258 CBK-INV	0.960	0.968	-0.003	0.984	0.989	-0.003	1.027	1.034	-0.003	0.933	0.941	-0.003
	2L277 WAN-NLY	0.964	0.964	0.000	0.985	0.985	0.000	1.031	1.031	0.000	0.937	0.937	0.000
	2L288 KCL-BTS	0.965	0.965	0.000	0.985	0.985	0.000	1.031	1.031	0.000	0.938	0.938	0.000
	2L289 SEL-BTS	0.964	0.964	0.000	0.985	0.985	0.000	1.031	1.031	0.000	0.937	0.937	0.000
	2L293 SEL-NLY	0.966	0.966	-0.001	0.985	0.985	0.000	1.032	1.032	-0.001	0.939	0.939	-0.001
	2L294 CBK-NLY	0.956	0.963	0.002	0.975	0.977	0.008	1.026	1.031	0.000	0.932	0.937	0.000
	2L295 SEL-KCL	0.964	0.964	0.000	0.985	0.985	0.000	1.031	1.031	0.000	0.937	0.937	0.000
	1L274 NTL-POCATER	0.970	0.969	-0.004	0.990	0.989	-0.003	1.059	1.040	-0.009	0.955	0.964	-0.026
	1L275 NTL-COLEMAN	0.970	0.965	0.000	0.988	0.985	0.000	1.077	1.032	-0.001	0.965	0.960	-0.022
	5L82 NIC-MDN	0.963	0.966	-0.001	0.984	0.985	0.000	1.030	1.032	-0.001	0.936	0.939	-0.001
N-2	5L76&5L79												
	5L91&5L96	0.985	0.972	-0.007	1.007	1.002	-0.016	1.052	1.040	-0.009	0.960	0.946	-0.008
	5L81&5L82	0.969	0.965	0.000	0.990	0.985	0.001	1.036	1.032	0.000	0.943	0.938	0.000
	5L96&5L98	0.962	0.967	-0.002	0.982	0.985	0.000	1.029	1.033	-0.002	0.935	0.940	-0.002
	5L51&5L52	1.021	0.989	-0.024	1.038	1.015	-0.030	1.138	1.032	-0.001	1.018	0.984	-0.047
	2L288&2L295	0.963	0.966	-0.002	0.984	0.986	0.000	1.030	1.033	-0.002	0.937	0.939	-0.002
	2L289&2L295	0.972	0.966	-0.002	0.993	0.987	0.000	1.037	1.032	-0.001	0.945	0.939	-0.002
	2L295&2L299	0.968	0.966	-0.001	0.989	0.986	0.000	1.034	1.032	-0.001	0.941	0.939	-0.001

D.3.2 **y17c22**

y17c22		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.973	0.973	0.000	0.994	0.994	0.000	1.026	1.026	0.000	0.950	0.950	0.000
N-1	SEL T1	0.972	0.972	0.001	0.993	0.993	0.000	1.025	1.025	0.000	0.949	0.949	0.001
	CBK T2+T6	0.972	0.972	0.000	0.993	0.993	0.000	1.027	1.027	0.000	0.951	0.951	0.000
	SEL Shaft Trip T1	0.976	0.972	0.001	0.997	0.993	0.001	1.029	1.025	0.000	0.953	0.949	0.001
	5L75 REV-ACK	0.972	0.972	0.000	0.993	0.993	0.000	1.025	1.025	0.000	0.950	0.949	0.000
	5L91 ACK-SEL	0.966	0.972	0.000	0.987	0.990	0.004	1.021	1.026	0.000	0.944	0.950	0.000
	5L92 CBK-SEL	0.988	0.969	0.004	1.011	0.991	0.003	1.071	1.036	-0.011	0.983	0.963	-0.013
	5L94 CBK-LGN	1.036	0.999	-0.026	1.054	1.025	-0.031	1.128	1.030	-0.004	1.033	0.995	-0.045
	5L96 VAS-SEL	0.971	0.972	0.001	0.991	0.992	0.002	1.024	1.025	0.000	0.948	0.949	0.001
	5L98 NIC-VAS	0.970	0.973	0.000	0.991	0.992	0.002	1.024	1.026	0.000	0.947	0.951	0.000
	2L112 NLY-BDY	0.972	0.972	0.000	0.993	0.993	0.000	1.025	1.025	0.000	0.949	0.949	0.000
	2L222 SEV-SEL	0.975	0.971	0.002	0.996	0.992	0.002	1.028	1.025	0.001	0.953	0.949	0.002
	2L258 CBK-INV	0.968	0.973	0.000	0.992	0.995	-0.001	1.022	1.026	0.000	0.945	0.950	0.000
	2L277 WAN-NLY	0.973	0.972	0.000	0.993	0.993	0.000	1.026	1.025	0.000	0.950	0.950	0.000
	2L288 KCL-BTS	0.973	0.973	0.000	0.994	0.994	0.000	1.026	1.026	0.000	0.950	0.950	0.000
	2L289 SEL-BTS	0.973	0.973	0.000	0.994	0.994	0.000	1.026	1.026	0.000	0.950	0.950	0.000
	2L293 SEL-NLY	0.974	0.972	0.001	0.993	0.992	0.002	1.027	1.025	0.000	0.951	0.949	0.000
	2L294 CBK-NLY	0.965	0.972	0.000	0.983	0.987	0.007	1.022	1.026	0.000	0.945	0.950	0.000
	2L295 SEL-KCL	0.972	0.972	0.000	0.993	0.993	0.000	1.025	1.025	0.000	0.950	0.950	0.000
	1L274 NTL-POCATER	0.978	0.977	-0.004	0.998	0.997	-0.003	1.053	1.034	-0.008	0.968	0.976	-0.026
	1L275 NTL-COLEMAN	0.977	0.972	0.000	0.995	0.993	0.001	1.058	1.040	-0.014	0.972	0.967	-0.017
	5L82 NIC-MDN	0.971	0.971	0.002	0.992	0.992	0.002	1.025	1.025	0.001	0.949	0.949	0.002
N-2	5L76&5L79												
	5L91&5L96	0.992	0.978	-0.005	1.013	1.008	-0.014	1.045	1.032	-0.006	0.971	0.956	-0.005
	5L81&5L82	0.977	0.970	0.002	0.998	0.991	0.003	1.030	1.024	0.002	0.955	0.948	0.002
	5L96&5L98	0.970	0.972	0.001	0.990	0.992	0.002	1.023	1.025	0.000	0.947	0.949	0.001
	5L51&5L52	1.020	0.993	-0.020	1.038	1.018	-0.025	1.109	1.024	0.002	1.017	0.988	-0.038
	2L288&2L295	0.972	0.972	0.001	0.993	0.992	0.002	1.025	1.025	0.001	0.949	0.949	0.001
	2L289&2L295	0.981	0.972	0.001	1.002	0.993	0.000	1.032	1.025	0.000	0.958	0.949	0.001
	2L295&2L299	0.976	0.972	0.001	0.997	0.993	0.001	1.029	1.025	0.001	0.954	0.949	0.001

D.3.3 **y17c23**

y17c23		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.984	0.984	0.000	1.006	1.006	0.000	1.023	1.023	0.000	0.961	0.961	0.000
N-1	SEL T1	0.983	0.983	0.001	1.005	1.005	0.000	1.023	1.022	0.000	0.960	0.960	0.000
	CBK T2+T6	0.983	0.983	0.001	1.005	1.005	0.000	1.024	1.024	0.000	0.961	0.961	0.000
	SEL Shaft Trip T1	0.986	0.983	0.001	1.008	1.005	0.001	1.025	1.023	0.000	0.963	0.960	0.000
	5L75 REV-ACK	0.983	0.983	0.000	1.005	1.005	0.000	1.023	1.023	0.000	0.960	0.960	0.000
	5L91 ACK-SEL	0.978	0.984	0.000	1.000	1.002	0.004	1.019	1.023	0.000	0.955	0.961	0.000
	5L92 CBK-SEL	0.991	0.977	0.007	1.014	1.000	0.006	1.062	1.046	-0.023	0.987	0.972	-0.012
	5L94 CBK-LGN	1.037	1.000	-0.016	1.055	1.026	-0.020	1.116	1.031	-0.008	1.034	0.996	-0.035
	5L96 VAS-SEL	0.982	0.983	0.001	1.004	1.004	0.001	1.022	1.022	0.000	0.959	0.960	0.001
	5L98 NIC-VAS	0.981	0.984	0.000	1.003	1.004	0.001	1.021	1.024	0.000	0.958	0.961	0.000
	2L112 NLY-BDY	0.983	0.983	0.000	1.005	1.005	0.000	1.023	1.023	0.000	0.960	0.960	0.000
	2L222 SEV-SEL	0.986	0.982	0.002	1.008	1.004	0.002	1.025	1.022	0.001	0.963	0.959	0.002
	2L258 CBK-INV	0.979	0.983	0.001	1.004	1.007	0.000	1.020	1.023	0.000	0.956	0.960	0.000
	2L277 WAN-NLY	0.984	0.983	0.000	1.005	1.005	0.000	1.023	1.023	0.000	0.960	0.960	0.000
	2L288 KCL-BTS	0.984	0.982	0.002	1.006	1.005	0.001	1.023	1.022	0.002	0.960	0.959	0.002
	2L289 SEL-BTS	0.984	0.984	0.000	1.006	1.006	0.000	1.023	1.023	0.000	0.960	0.960	0.000
	2L293 SEL-NLY	0.985	0.983	0.000	1.005	1.004	0.001	1.024	1.023	0.000	0.962	0.960	0.000
	2L294 CBK-NLY	0.978	0.985	0.000	0.996	0.999	0.006	1.020	1.025	-0.001	0.957	0.962	-0.001
	2L295 SEL-KCL	0.983	0.983	0.000	1.005	1.005	0.000	1.023	1.023	0.000	0.960	0.960	0.000
	1L274 NTL-POCATER	0.989	0.989	-0.005	1.010	1.009	-0.004	1.050	1.030	-0.007	0.978	0.987	-0.026
	1L275 NTL-COLEMAN	0.988	0.984	0.000	1.007	1.005	0.000	1.058	1.027	-0.004	0.983	0.979	-0.018
	5L82 NIC-MDN	0.982	0.982	0.002	1.004	1.004	0.002	1.022	1.022	0.001	0.959	0.959	0.001
N-2	5L76&5L79												
	5L91&5L96	1.003	0.989	-0.005	1.024	1.020	-0.014	1.043	1.031	-0.008	0.981	0.967	-0.006
	5L81&5L82	0.987	0.981	0.003	1.009	1.003	0.003	1.027	1.028	-0.005	0.964	0.957	0.004
	5L96&5L98	0.981	0.983	0.001	1.003	1.004	0.002	1.021	1.023	0.000	0.958	0.960	0.000
	5L51&5L52	1.021	0.993	-0.009	1.038	1.019	-0.013	1.097	1.024	0.000	1.018	0.988	-0.028
	2L288&2L295	0.983	0.983	0.001	1.005	1.004	0.001	1.022	1.022	0.000	0.960	0.960	0.001
	2L289&2L295	0.991	0.983	0.001	1.013	1.006	0.000	1.029	1.023	0.000	0.967	0.960	0.000
	2L295&2L299	0.987	0.983	0.001	1.009	1.005	0.000	1.026	1.022	0.000	0.964	0.960	0.001

D.3.4 **y17c24**

y17c24		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.975	0.975	0.000	0.987	0.987	0.000	1.033	1.033	0.000	0.962	0.962	0.000
N-1	SEL T1	0.974	0.974	0.000	0.987	0.987	0.000	1.033	1.033	0.000	0.961	0.961	0.000
	CBK T2+T6	0.976	0.976	-0.001	0.984	0.984	0.003	1.035	1.035	-0.002	0.964	0.963	-0.002
	SEL Shaft Trip T1	0.979	0.975	0.000	0.991	0.987	0.000	1.037	1.034	0.000	0.966	0.962	0.000
	5L75 REV-ACK	0.974	0.974	0.001	0.986	0.986	0.001	1.033	1.033	0.000	0.961	0.961	0.001
	5L91 ACK-SEL	0.969	0.968	0.007	0.981	0.980	0.007	1.029	1.029	0.005	0.957	0.956	0.006
	5L92 CBK-SEL	1.279	0.988	-0.013	1.308	1.012	-0.025	1.421	1.022	0.011	1.299	0.992	-0.030
	5L94 CBK-LGN	1.077	1.022	-0.047	1.089	1.047	-0.060	1.179	1.032	0.002	1.085	1.027	-0.065
	5L96 VAS-SEL	0.971	0.972	0.003	0.983	0.983	0.004	1.031	1.031	0.002	0.959	0.959	0.003
	5L98 NIC-VAS	0.974	0.974	0.000	0.986	0.986	0.000	1.033	1.033	0.000	0.961	0.961	0.000
	2L112 NLY-BDY	0.974	0.974	0.001	0.986	0.986	0.000	1.033	1.033	0.000	0.961	0.961	0.000
	2L222 SEV-SEL	0.979	0.974	0.000	0.991	0.986	0.000	1.036	1.033	0.000	0.965	0.961	0.000
	2L258 CBK-INV	0.967	0.967	0.008	0.983	0.983	0.004	1.028	1.028	0.006	0.955	0.955	0.007
	2L277 WAN-NLY	0.974	0.974	0.000	0.986	0.986	0.000	1.033	1.033	0.000	0.962	0.961	0.000
	2L288 KCL-BTS	0.975	0.975	0.000	0.987	0.987	0.000	1.033	1.033	0.000	0.962	0.962	0.000
	2L289 SEL-BTS	0.974	0.974	0.000	0.986	0.986	0.000	1.033	1.033	0.000	0.961	0.961	0.000
	2L293 SEL-NLY	0.976	0.976	0.000	0.986	0.987	0.000	1.034	1.034	0.000	0.963	0.963	0.000
	2L294 CBK-NLY	0.968	0.967	0.008	0.978	0.976	0.011	1.030	1.028	0.005	0.957	0.956	0.006
	2L295 SEL-KCL	0.974	0.974	0.000	0.986	0.986	0.000	1.033	1.033	0.000	0.961	0.961	0.000
	1L274 NTL-POCATER	0.979	0.977	-0.003	0.990	0.987	0.000	1.052	1.031	0.003	0.974	0.982	-0.020
	1L275 NTL-COLEMAN	0.978	0.978	-0.003	0.988	0.988	0.000	1.064	1.025	0.009	0.982	0.982	-0.020
	5L82 NIC-MDN	0.973	0.974	0.001	0.985	0.985	0.002	1.032	1.033	0.000	0.960	0.961	0.001
N-2	5L76&5L79	0.991	0.972	0.003	1.003	0.985	0.002	1.047	1.032	0.002	0.978	0.960	0.002
	5L91&5L96	0.991	0.986	-0.011	1.003	1.003	-0.016	1.050	1.036	-0.002	0.980	0.974	-0.013
	5L81&5L82	0.980	0.975	0.000	0.993	0.987	0.000	1.038	1.033	0.000	0.968	0.962	0.000
	5L96&5L98	0.971	0.972	0.003	0.982	0.983	0.004	1.031	1.031	0.002	0.958	0.959	0.003
	5L51&5L52	1.084	1.019	-0.044	1.097	1.045	-0.058	1.188	1.030	0.004	1.093	1.024	-0.062
	2L288&2L295	0.974	0.974	0.001	0.986	0.986	0.001	1.033	1.032	0.001	0.961	0.961	0.001
	2L289&2L295	0.979	0.974	0.000	0.991	0.986	0.000	1.036	1.033	0.000	0.965	0.961	0.000
	2L295&2L299	0.975	0.974	0.001	0.987	0.986	0.001	1.034	1.032	0.001	0.962	0.961	0.001

D.3.5 **y17c25**

y17c25		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.981	0.981	0.000	0.998	0.998	0.000	1.034	1.034	0.000	0.971	0.971	0.000
N-1	SEL T1	0.981	0.981	0.000	0.998	0.998	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	CBK T2+T6	0.985	0.982	-0.001	0.997	0.996	0.002	1.037	1.036	-0.001	0.974	0.972	-0.001
	SEL Shaft Trip T1	0.985	0.981	0.000	1.002	0.997	0.000	1.037	1.034	0.000	0.975	0.971	0.000
	5L75 REV-ACK	0.980	0.980	0.001	0.997	0.996	0.001	1.033	1.033	0.000	0.970	0.970	0.001
	5L91 ACK-SEL	0.975	0.981	0.000	0.992	0.994	0.003	1.030	1.034	0.000	0.966	0.971	0.000
	5L92 CBK-SEL	1.117	0.988	-0.007	1.143	1.012	-0.014	1.211	1.022	0.012	1.127	0.992	-0.021
	5L94 CBK-LGN	1.061	1.022	-0.040	1.078	1.047	-0.049	1.145	1.032	0.002	1.068	1.027	-0.056
	5L96 VAS-SEL	0.978	0.981	0.000	0.994	0.996	0.002	1.032	1.034	0.000	0.968	0.971	0.000
	5L98 NIC-VAS	0.981	0.981	0.000	0.997	0.997	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	2L112 NLY-BDY	0.980	0.980	0.000	0.997	0.997	0.000	1.034	1.034	0.000	0.970	0.970	0.000
	2L222 SEV-SEL	0.985	0.981	0.000	1.001	0.997	0.000	1.037	1.034	0.000	0.975	0.971	0.000
	2L258 CBK-INV	0.973	0.980	0.002	0.994	0.997	0.000	1.028	1.033	0.000	0.964	0.970	0.001
	2L277 WAN-NLY	0.981	0.981	0.000	0.997	0.997	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	2L288 KCL-BTS	0.981	0.981	0.000	0.998	0.997	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	2L289 SEL-BTS	0.981	0.981	0.000	0.997	0.997	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	2L293 SEL-NLY	0.982	0.980	0.001	0.997	0.996	0.001	1.035	1.033	0.000	0.972	0.970	0.000
	2L294 CBK-NLY	0.975	0.982	0.000	0.989	0.992	0.006	1.031	1.035	0.000	0.967	0.972	0.000
	2L295 SEL-KCL	0.981	0.981	0.000	0.997	0.997	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	1L274 NTL-POCATER	0.985	0.983	-0.002	1.000	1.000	-0.002	1.052	1.039	-0.004	0.983	0.988	-0.017
	1L275 NTL-COLEMAN	0.984	0.981	0.000	0.998	0.997	0.000	1.056	1.028	0.006	0.988	0.985	-0.014
	5L82 NIC-MDN	0.980	0.980	0.002	0.996	0.996	0.002	1.033	1.033	0.001	0.970	0.970	0.001
N-2	5L76&5L79	0.995	0.982	0.000	1.012	0.997	0.000	1.046	1.035	0.000	0.985	0.972	0.000
	5L91&5L96	0.995	0.982	0.000	1.012	1.007	-0.009	1.049	1.036	-0.002	0.987	0.972	0.000
	5L81&5L82	0.987	0.981	0.000	1.003	0.998	0.000	1.039	1.034	0.000	0.977	0.971	0.000
	5L96&5L98	0.978	0.981	0.000	0.993	0.996	0.002	1.031	1.034	0.000	0.968	0.971	0.000
	5L51&5L52	1.068	1.019	-0.038	1.086	1.045	-0.047	1.153	1.030	0.005	1.076	1.024	-0.053
	2L288&2L295	0.980	0.980	0.001	0.997	0.996	0.001	1.033	1.033	0.000	0.970	0.970	0.001
	2L289&2L295	0.985	0.981	0.000	1.002	0.997	0.000	1.037	1.034	0.000	0.975	0.971	0.000
	2L295&2L299	0.982	0.980	0.001	0.998	0.996	0.001	1.035	1.033	0.001	0.972	0.970	0.001

D.3.6 **y17c26**

y17c26		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.986	0.986	0.000	1.005	1.005	0.000	1.033	1.033	0.000	0.961	0.961	0.000
N-1	SEL T1	0.985	0.985	0.000	1.005	1.005	0.000	1.033	1.033	0.000	0.960	0.960	0.000
	CBK T2+T6	0.987	0.985	0.000	1.004	1.003	0.001	1.035	1.033	0.000	0.962	0.960	0.000
	SEL Shaft Trip T1	0.989	0.985	0.000	1.008	1.005	0.000	1.035	1.033	0.000	0.964	0.961	0.000
	5L75 REV-ACK	0.985	0.984	0.001	1.004	1.003	0.001	1.032	1.032	0.000	0.960	0.960	0.001
	5L91 ACK-SEL	0.980	0.986	0.000	0.999	1.001	0.003	1.029	1.033	0.000	0.956	0.961	0.000
	5L92 CBK-SEL	1.054	0.984	0.002	1.078	1.008	-0.003	1.109	1.032	0.000	1.037	0.966	-0.006
	5L94 CBK-LGN	1.050	1.016	-0.030	1.070	1.042	-0.038	1.105	1.027	0.006	1.033	0.999	-0.038
	5L96 VAS-SEL	0.982	0.986	0.000	1.001	1.003	0.002	1.031	1.033	0.000	0.958	0.961	0.000
	5L98 NIC-VAS	0.985	0.985	0.000	1.004	1.004	0.000	1.033	1.033	0.000	0.960	0.960	0.000
	2L112 NLY-BDY	0.985	0.985	0.000	1.004	1.004	0.000	1.032	1.032	0.000	0.960	0.960	0.000
	2L222 SEV-SEL	0.989	0.985	0.000	1.008	1.004	0.000	1.035	1.033	0.000	0.964	0.960	0.000
	2L258 CBK-INV	0.977	0.983	0.002	1.001	1.004	0.000	1.027	1.032	0.000	0.953	0.959	0.002
	2L277 WAN-NLY	0.985	0.985	0.000	1.004	1.004	0.000	1.033	1.033	0.000	0.960	0.960	0.000
	2L288 KCL-BTS	0.985	0.985	0.000	1.005	1.005	0.000	1.033	1.033	0.000	0.960	0.960	0.000
	2L289 SEL-BTS	0.985	0.985	0.000	1.004	1.004	0.000	1.033	1.033	0.000	0.960	0.960	0.000
	2L293 SEL-NLY	0.986	0.985	0.000	1.004	1.003	0.001	1.034	1.032	0.000	0.961	0.960	0.000
	2L294 CBK-NLY	0.980	0.987	-0.001	0.996	0.999	0.005	1.030	1.034	-0.001	0.957	0.962	-0.001
	2L295 SEL-KCL	0.985	0.985	0.000	1.004	1.004	0.000	1.033	1.033	0.000	0.960	0.960	0.000
	1L274 NTL-POCATER	0.989	0.988	-0.002	1.007	1.007	-0.002	1.051	1.037	-0.004	0.972	0.978	-0.017
	1L275 NTL-COLEMAN	0.986	0.986	0.000	1.004	1.004	0.000	1.034	1.033	0.000	0.968	0.968	-0.007
	5L82 NIC-MDN	0.984	0.984	0.002	1.003	1.003	0.002	1.032	1.032	0.000	0.959	0.959	0.001
N-2	5L76&5L79	0.998	0.986	0.000	1.018	1.004	0.000	1.042	1.034	-0.001	0.973	0.962	0.000
	5L91&5L96	0.997	0.986	0.000	1.016	1.013	-0.008	1.046	1.036	-0.003	0.974	0.962	-0.001
	5L81&5L82	0.990	0.986	0.000	1.009	1.005	0.000	1.037	1.033	0.000	0.965	0.961	0.000
	5L96&5L98	0.982	0.986	0.000	1.001	1.003	0.002	1.031	1.033	0.000	0.957	0.961	0.000
	5L51&5L52	1.057	1.012	-0.027	1.077	1.039	-0.035	1.113	1.024	0.009	1.040	0.995	-0.035
	2L288&2L295	0.985	0.984	0.001	1.004	1.004	0.001	1.032	1.032	0.000	0.960	0.960	0.001
	2L289&2L295	0.989	0.985	0.000	1.008	1.004	0.000	1.035	1.033	0.000	0.964	0.960	0.000
	2L295&2L299	0.986	0.984	0.001	1.005	1.004	0.001	1.033	1.032	0.000	0.961	0.960	0.001

D.3.7 **y17c27**

y17c27		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.976	0.976	0.000	0.989	0.989	0.000	1.029	1.029	0.000	0.966	0.966	0.000
N-1	SEL T1	0.976	0.976	0.000	0.989	0.989	0.000	1.029	1.029	0.000	0.966	0.966	0.000
	CBK T2+T6	0.981	0.977	0.000	0.988	0.987	0.003	1.033	1.030	-0.001	0.971	0.967	-0.001
	SEL Shaft Trip T1	0.976	0.976	0.000	0.990	0.990	0.000	1.029	1.029	0.000	0.966	0.966	0.000
	5L75 REV-ACK	0.975	0.974	0.002	0.988	0.988	0.002	1.028	1.028	0.001	0.965	0.964	0.001
	5L91 ACK-SEL	0.965	0.964	0.012	0.979	0.976	0.014	1.021	1.028	0.000	0.957	0.954	0.012
	5L92 CBK-SEL	1.143	0.973	0.003	1.169	0.996	-0.007	1.244	1.019	0.010	1.156	0.977	-0.011
	5L94 CBK-LGN	1.074	1.019	-0.043	1.088	1.044	-0.055	1.161	1.029	0.000	1.082	1.024	-0.058
	5L96 VAS-SEL	0.971	0.972	0.004	0.984	0.984	0.005	1.025	1.026	0.002	0.962	0.963	0.003
	5L98 NIC-VAS	0.974	0.975	0.001	0.987	0.987	0.003	1.027	1.028	0.000	0.964	0.965	0.000
	2L112 NLY-BDY	0.975	0.975	0.001	0.989	0.989	0.000	1.028	1.028	0.000	0.965	0.965	0.000
	2L222 SEV-SEL	0.976	0.976	0.000	0.990	0.990	0.000	1.029	1.029	0.000	0.966	0.966	0.000
	2L258 CBK-INV	0.968	0.971	0.005	0.985	0.988	0.002	1.023	1.026	0.003	0.958	0.962	0.004
	2L277 WAN-NLY	0.976	0.976	0.000	0.989	0.989	0.000	1.029	1.028	0.000	0.966	0.965	0.000
	2L288 KCL-BTS	0.976	0.976	0.000	0.989	0.989	0.000	1.029	1.029	0.000	0.966	0.966	0.000
	2L289 SEL-BTS	0.976	0.976	0.000	0.989	0.989	0.000	1.029	1.028	0.000	0.966	0.965	0.000
	2L293 SEL-NLY	0.977	0.977	0.000	0.989	0.989	0.000	1.030	1.030	0.000	0.967	0.967	-0.001
	2L294 CBK-NLY	0.968	0.970	0.006	0.980	0.981	0.009	1.024	1.025	0.003	0.960	0.961	0.004
	2L295 SEL-KCL	0.976	0.975	0.000	0.989	0.989	0.000	1.028	1.028	0.000	0.965	0.965	0.000
	1L274 NTL-POCATER	0.980	0.977	0.000	0.992	0.991	-0.002	1.047	1.033	-0.004	0.978	0.982	-0.016
	1L275 NTL-COLEMAN	0.979	0.978	-0.002	0.990	0.990	0.000	1.051	1.025	0.004	0.983	0.982	-0.016
	5L82 NIC-MDN	0.974	0.975	0.000	0.987	0.988	0.001	1.028	1.028	0.000	0.964	0.965	0.000
N-2	5L76&5L79	0.982	0.976	0.000	0.996	0.990	0.000	1.034	1.029	0.000	0.972	0.966	0.000
	5L91&5L96	1.033	0.999	-0.023	1.048	1.025	-0.035	1.081	1.025	0.004	1.027	0.993	-0.028
	5L81&5L82	0.984	0.973	0.003	0.998	0.987	0.003	1.035	1.027	0.002	0.974	0.963	0.002
	5L96&5L98	0.970	0.971	0.005	0.983	0.983	0.006	1.025	1.026	0.003	0.961	0.962	0.004
	5L51&5L52	1.109	1.034	-0.058	1.125	1.060	-0.071	1.203	1.032	-0.003	1.119	1.039	-0.073
	2L288&2L295	0.975	0.975	0.000	0.989	0.989	0.000	1.028	1.028	0.000	0.965	0.965	0.000
	2L289&2L295	0.975	0.975	0.001	0.988	0.988	0.001	1.028	1.028	0.000	0.965	0.965	0.001
	2L295&2L299	0.975	0.975	0.001	0.988	0.988	0.001	1.028	1.028	0.000	0.965	0.965	0.001

D.3.8 **y17c28**

y17c28		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.979	0.979	0.000	0.994	0.994	0.000	1.040	1.040	0.000	0.967	0.967	0.000
N-1	SEL T1	0.979	0.979	0.000	0.994	0.994	0.000	1.040	1.040	0.000	0.967	0.967	0.000
	CBK T2+T6	0.983	0.981	-0.002	0.993	0.992	0.002	1.044	1.035	0.006	0.971	0.971	-0.005
	SEL Shaft Trip T1	0.979	0.979	0.000	0.994	0.994	0.000	1.041	1.041	0.000	0.967	0.967	0.000
	5L75 REV-ACK	0.978	0.977	0.002	0.992	0.992	0.002	1.039	1.039	0.001	0.966	0.965	0.002
	5L91 ACK-SEL	0.968	0.971	0.008	0.983	0.983	0.011	1.033	1.035	0.005	0.958	0.960	0.007
	5L92 CBK-SEL	1.110	0.972	0.007	1.135	0.996	-0.002	1.220	1.018	0.023	1.121	0.976	-0.009
	5L94 CBK-LGN	1.070	1.021	-0.043	1.086	1.046	-0.052	1.171	1.032	0.009	1.078	1.026	-0.060
	5L96 VAS-SEL	0.974	0.979	0.000	0.989	0.991	0.003	1.037	1.041	0.000	0.963	0.967	0.000
	5L98 NIC-VAS	0.977	0.978	0.000	0.992	0.992	0.002	1.039	1.040	0.000	0.965	0.966	0.000
	2L112 NLY-BDY	0.978	0.978	0.000	0.993	0.993	0.000	1.040	1.040	0.000	0.966	0.966	0.000
	2L222 SEV-SEL	0.979	0.979	0.000	0.994	0.994	0.000	1.041	1.041	0.000	0.967	0.967	0.000
	2L258 CBK-INV	0.971	0.978	0.001	0.990	0.994	0.000	1.035	1.040	0.000	0.960	0.966	0.000
	2L277 WAN-NLY	0.978	0.978	0.000	0.993	0.993	0.000	1.040	1.040	0.000	0.966	0.966	0.000
	2L288 KCL-BTS	0.979	0.979	0.000	0.994	0.994	0.000	1.040	1.040	0.000	0.967	0.966	0.000
	2L289 SEL-BTS	0.979	0.978	0.000	0.994	0.994	0.000	1.040	1.040	0.000	0.966	0.966	0.000
	2L293 SEL-NLY	0.980	0.978	0.000	0.994	0.993	0.001	1.041	1.040	0.000	0.968	0.966	0.000
	2L294 CBK-NLY	0.971	0.978	0.001	0.985	0.988	0.006	1.036	1.040	0.000	0.961	0.966	0.000
	2L295 SEL-KCL	0.978	0.978	0.000	0.994	0.993	0.000	1.040	1.040	0.000	0.966	0.966	0.000
	1L274 NTL-POCATER	0.983	0.982	-0.003	0.997	0.997	-0.003	1.059	1.037	0.003	0.979	0.987	-0.020
	1L275 NTL-COLEMAN	0.982	0.980	0.000	0.995	0.993	0.000	1.068	1.026	0.014	0.986	0.983	-0.017
	5L82 NIC-MDN	0.977	0.978	0.000	0.992	0.993	0.001	1.039	1.040	0.000	0.965	0.966	0.000
N-2	5L76&5L79	0.985	0.979	0.000	1.001	0.994	0.000	1.046	1.040	0.000	0.973	0.966	0.000
	5L91&5L96	1.042	1.012	-0.034	1.059	1.038	-0.044	1.097	1.028	0.012	1.033	1.007	-0.041
	5L81&5L82	0.986	0.980	-0.001	1.002	0.995	-0.001	1.047	1.041	0.000	0.974	0.968	0.000
	5L96&5L98	0.973	0.978	0.000	0.988	0.990	0.004	1.036	1.040	0.000	0.962	0.966	0.000
	5L51&5L52	1.104	1.036	-0.058	1.121	1.062	-0.068	1.212	1.022	0.018	1.114	1.041	-0.075
	2L288&2L295	0.978	0.978	0.000	0.993	0.993	0.000	1.040	1.040	0.000	0.966	0.966	0.000
	2L289&2L295	0.978	0.978	0.001	0.993	0.993	0.001	1.040	1.040	0.000	0.966	0.966	0.000
	2L295&2L299	0.978	0.978	0.001	0.993	0.993	0.001	1.040	1.040	0.000	0.966	0.966	0.001

D.3.9 **y17c29**

y17c29		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.984	0.984	0.000	1.002	1.002	0.000	1.033	1.033	0.000	0.960	0.960	0.000
N-1	SEL T1	0.984	0.984	0.000	1.002	1.002	0.000	1.033	1.033	0.000	0.960	0.960	0.000
	CBK T2+T6	0.987	0.984	0.000	1.001	1.000	0.002	1.035	1.034	-0.001	0.962	0.960	0.000
	SEL Shaft Trip T1	0.985	0.985	0.000	1.002	1.002	0.000	1.033	1.033	0.000	0.960	0.960	0.000
	5L75 REV-ACK	0.983	0.983	0.002	1.000	1.000	0.002	1.032	1.032	0.001	0.958	0.958	0.002
	5L91 ACK-SEL	0.975	0.978	0.007	0.992	0.992	0.010	1.026	1.028	0.004	0.951	0.954	0.006
	5L92 CBK-SEL	1.046	1.012	-0.027	1.070	1.035	-0.033	1.101	1.061	-0.029	1.029	0.993	-0.034
	5L94 CBK-LGN	1.057	1.016	-0.031	1.076	1.042	-0.040	1.114	1.027	0.006	1.041	0.998	-0.039
	5L96 VAS-SEL	0.980	0.985	0.000	0.997	0.999	0.003	1.030	1.033	0.000	0.956	0.960	0.000
	5L98 NIC-VAS	0.983	0.984	0.000	1.000	1.000	0.002	1.031	1.033	0.000	0.958	0.959	0.000
	2L112 NLY-BDY	0.984	0.984	0.000	1.001	1.001	0.000	1.032	1.032	0.000	0.959	0.959	0.000
	2L222 SEV-SEL	0.985	0.985	0.000	1.002	1.002	0.000	1.033	1.033	0.000	0.960	0.960	0.000
	2L258 CBK-INV	0.976	0.983	0.002	0.998	1.002	0.000	1.027	1.032	0.000	0.952	0.958	0.001
	2L277 WAN-NLY	0.984	0.984	0.000	1.001	1.001	0.000	1.033	1.033	0.000	0.959	0.959	0.000
	2L288 KCL-BTS	0.984	0.984	0.000	1.002	1.002	0.000	1.033	1.033	0.000	0.959	0.959	0.000
	2L289 SEL-BTS	0.984	0.984	0.000	1.002	1.002	0.000	1.033	1.033	0.000	0.959	0.959	0.000
	2L293 SEL-NLY	0.985	0.984	0.000	1.002	1.001	0.001	1.034	1.032	0.000	0.960	0.959	0.000
	2L294 CBK-NLY	0.977	0.984	0.000	0.993	0.996	0.006	1.029	1.033	0.000	0.954	0.960	0.000
	2L295 SEL-KCL	0.984	0.984	0.000	1.002	1.001	0.000	1.033	1.032	0.000	0.959	0.959	0.000
	1L274 NTL-POCATER	0.988	0.986	-0.002	1.005	1.004	-0.002	1.051	1.045	-0.012	0.972	0.974	-0.015
	1L275 NTL-COLEMAN	0.985	0.984	0.000	1.002	1.001	0.000	1.033	1.032	0.000	0.967	0.967	-0.007
	5L82 NIC-MDN	0.983	0.984	0.000	1.000	1.001	0.001	1.032	1.032	0.000	0.958	0.959	0.000
N-2	5L76&5L79	0.990	0.984	0.000	1.008	1.002	0.000	1.037	1.033	0.000	0.965	0.959	0.000
	5L91&5L96	1.046	1.018	-0.033	1.065	1.045	-0.043	1.092	1.031	0.002	1.025	0.998	-0.039
	5L81&5L82	0.991	0.985	-0.001	1.009	1.003	-0.001	1.038	1.033	0.000	0.966	0.960	0.000
	5L96&5L98	0.979	0.984	0.000	0.996	0.998	0.004	1.029	1.033	0.000	0.955	0.960	0.000
	5L51&5L52	1.089	1.028	-0.044	1.110	1.056	-0.054	1.151	1.027	0.006	1.074	1.011	-0.051
	2L288&2L295	0.984	0.984	0.000	1.001	1.001	0.000	1.032	1.032	0.000	0.959	0.959	0.000
	2L289&2L295	0.984	0.984	0.000	1.001	1.001	0.000	1.032	1.032	0.000	0.959	0.959	0.000
	2L295&2L299	0.983	0.983	0.000	1.001	1.001	0.000	1.032	1.032	0.000	0.959	0.959	0.000

D.3.10 **y17c30**

y17c30		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.970	0.972	-0.002	0.987	0.988	0.000	1.033	1.034	-0.001	0.958	0.960	-0.002
N-1	SEL T1	0.970	0.971	-0.001	0.987	0.988	0.000	1.033	1.034	-0.001	0.958	0.960	-0.001
	CBK T2+T6	0.975	0.973	-0.003	0.987	0.986	0.000	1.037	1.036	-0.003	0.963	0.961	-0.003
	SEL Shaft Trip T1	0.969	0.971	-0.001	0.986	0.987	0.000	1.032	1.034	0.000	0.958	0.959	0.000
	5L75 REV-ACK	0.969	0.971	0.000	0.986	0.987	0.000	1.032	1.033	0.000	0.958	0.959	0.000
	5L91 ACK-SEL	0.959	0.972	-0.002	0.976	0.985	0.002	1.025	1.034	-0.001	0.949	0.960	-0.002
	5L92 CBK-SEL	1.092	0.979	-0.009	1.117	1.003	-0.016	1.199	1.026	0.007	1.102	0.983	-0.025
	5L94 CBK-LGN	1.057	1.028	-0.058	1.074	1.052	-0.065	1.157	1.025	0.008	1.065	1.032	-0.074
	5L96 VAS-SEL	0.965	0.970	0.000	0.982	0.987	0.000	1.029	1.033	0.000	0.954	0.959	0.000
	5L98 NIC-VAS	0.968	0.972	-0.002	0.985	0.989	-0.002	1.031	1.035	-0.002	0.957	0.961	-0.002
	2L112 NLY-BDY	0.972	0.971	0.000	0.988	0.985	0.002	1.035	1.034	0.000	0.961	0.959	0.000
	2L222 SEV-SEL	0.969	0.971	-0.001	0.987	0.987	0.000	1.033	1.034	0.000	0.958	0.959	0.000
	2L258 CBK-INV	0.962	0.970	0.000	0.983	0.988	0.000	1.027	1.034	0.000	0.951	0.959	0.000
	2L277 WAN-NLY	0.970	0.972	-0.002	0.987	0.988	0.000	1.033	1.034	-0.001	0.958	0.960	-0.002
	2L288 KCL-BTS	0.970	0.972	-0.002	0.987	0.988	0.000	1.033	1.034	-0.001	0.958	0.960	-0.001
	2L289 SEL-BTS	0.970	0.971	-0.001	0.987	0.988	0.000	1.033	1.034	0.000	0.958	0.960	-0.001
	2L293 SEL-NLY	0.966	0.971	0.000	0.987	0.989	-0.002	1.030	1.033	0.000	0.955	0.959	0.000
	2L294 CBK-NLY	0.963	0.971	-0.001	0.977	0.981	0.006	1.029	1.035	-0.002	0.953	0.960	-0.002
	2L295 SEL-KCL	0.970	0.971	-0.001	0.987	0.988	0.000	1.033	1.034	0.000	0.958	0.960	-0.001
	1L274 NTL-POCATER	0.974	0.975	-0.005	0.990	0.991	-0.003	1.051	1.032	0.001	0.971	0.981	-0.022
	1L275 NTL-COLEMAN	0.973	0.972	-0.002	0.988	0.988	0.000	1.058	1.032	0.001	0.977	0.976	-0.018
	5L82 NIC-MDN	0.969	0.971	0.000	0.986	0.987	0.000	1.032	1.034	0.000	0.958	0.959	0.000
N-2	5L76&5L79	0.959	0.971	-0.001	0.974	0.985	0.002	1.025	1.034	0.000	0.948	0.960	-0.001
	5L91&5L96	1.033	1.013	-0.043	1.050	1.039	-0.052	1.090	1.029	0.004	1.025	1.008	-0.050
	5L81&5L82	0.968	0.970	0.000	0.985	0.986	0.001	1.031	1.033	0.000	0.956	0.959	0.000
	5L96&5L98	0.964	0.973	-0.003	0.981	0.988	0.000	1.029	1.035	-0.002	0.953	0.961	-0.003
	5L51&5L52	1.062	1.031	-0.061	1.078	1.056	-0.068	1.163	1.028	0.005	1.070	1.035	-0.077
	2L288&2L295	0.969	0.971	0.000	0.986	0.987	0.000	1.032	1.034	0.000	0.958	0.959	0.000
	2L289&2L295	0.969	0.970	0.000	0.986	0.987	0.000	1.032	1.033	0.000	0.957	0.959	0.000
	2L295&2L299	0.969	0.971	0.000	0.986	0.987	0.000	1.032	1.033	0.000	0.957	0.959	0.000

D.4 2022 BC to AB transfer

D.4.1 y22c21

y22c21		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.947	0.947	0.000	0.963	0.963	0.000	1.035	1.035	0.000	0.916	0.916	0.000
N-1	SEL T1	0.946	0.946	0.001	0.963	0.963	0.000	1.034	1.034	0.000	0.915	0.915	0.001
	CBK T2+T6	0.944	0.944	0.003	0.961	0.960	0.003	1.034	1.034	0.000	0.914	0.914	0.002
	SEL Shaft Trip T1	0.950	0.946	0.001	0.967	0.962	0.001	1.038	1.034	0.000	0.920	0.915	0.001
	5L75 REV-ACK	0.946	0.945	0.002	0.962	0.962	0.002	1.034	1.034	0.001	0.915	0.914	0.001
	5L91 ACK-SEL	0.940	0.938	0.009	0.956	0.955	0.009	1.030	1.036	-0.002	0.910	0.906	0.010
	5L92 CBK-SEL	1.036	0.964	-0.017	1.059	0.986	-0.022	1.181	1.024	0.011	1.029	0.953	-0.037
	5L94 CBK-LGN	1.049	0.993	-0.047	1.065	1.022	-0.059	1.199	1.030	0.005	1.043	0.984	-0.069
	5L96 VAS-SEL	0.943	0.944	0.003	0.959	0.960	0.003	1.032	1.032	0.002	0.912	0.913	0.003
	5L98 NIC-VAS	0.943	0.942	0.004	0.959	0.959	0.005	1.032	1.031	0.003	0.913	0.912	0.004
	2L112 NLY-BDY	0.946	0.946	0.001	0.962	0.962	0.001	1.034	1.034	0.000	0.915	0.915	0.001
	2L222 SEV-SEL	0.950	0.945	0.002	0.966	0.962	0.002	1.038	1.034	0.001	0.919	0.914	0.001
	2L258 CBK-INV	0.943	0.944	0.003	0.962	0.964	0.000	1.031	1.033	0.002	0.912	0.913	0.002
	2L277 WAN-NLY	0.946	0.946	0.000	0.963	0.963	0.000	1.035	1.034	0.000	0.916	0.915	0.000
	2L288 KCL-BTS	0.947	0.947	0.000	0.963	0.963	0.000	1.035	1.035	0.000	0.916	0.916	0.000
	2L289 SEL-BTS	0.946	0.946	0.000	0.963	0.963	0.000	1.034	1.034	0.000	0.915	0.915	0.000
	2L293 SEL-NLY	0.948	0.948	0.000	0.963	0.963	0.000	1.036	1.036	0.000	0.917	0.917	0.000
	2L294 CBK-NLY	0.936	0.934	0.013	0.951	0.949	0.014	1.028	1.034	0.000	0.908	0.903	0.013
	2L295 SEL-KCL	0.946	0.946	0.000	0.963	0.962	0.000	1.034	1.034	0.000	0.915	0.915	0.000
	1L274 NTL-POCATER	0.952	0.952	-0.006	0.967	0.965	-0.002	1.061	1.029	0.006	0.933	0.947	-0.032
	1L275 NTL-COLEMAN	0.951	0.951	-0.004	0.965	0.965	-0.001	1.076	1.036	-0.001	0.941	0.940	-0.024
	5L82 NIC-MDN	0.945	0.945	0.001	0.962	0.962	0.002	1.034	1.034	0.001	0.915	0.915	0.001
N-2	5L76&5L79	0.972	0.944	0.003	0.990	0.961	0.003	1.059	1.033	0.002	0.942	0.913	0.003
	5L91&5L96	0.969	0.965	-0.019	0.986	0.986	-0.023	1.058	1.029	0.005	0.940	0.939	-0.023
	5L81&5L82	0.960	0.947	0.000	0.977	0.964	0.000	1.047	1.035	0.000	0.929	0.916	0.000
	5L96&5L98	0.943	0.945	0.002	0.959	0.960	0.003	1.032	1.033	0.002	0.913	0.914	0.002
	5L51&5L52	1.037	0.984	-0.037	1.052	1.012	-0.049	1.183	1.114	-0.079	1.031	0.973	-0.057
	2L288&2L295	0.945	0.945	0.001	0.962	0.962	0.002	1.034	1.034	0.001	0.915	0.915	0.001
	2L289&2L295	0.955	0.944	0.003	0.972	0.960	0.003	1.042	1.032	0.002	0.924	0.913	0.003
	2L295&2L299	0.950	0.946	0.000	0.967	0.963	0.000	1.038	1.034	0.000	0.919	0.915	0.000

D.4.2 **y22c22**

y22c22		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.964	0.964	0.000	0.982	0.982	0.000	1.035	1.035	0.000	0.937	0.937	0.000
N-1	SEL T1	0.964	0.963	0.001	0.982	0.981	0.000	1.035	1.035	0.000	0.936	0.936	0.000
	CBK T2+T6	0.961	0.961	0.003	0.979	0.979	0.003	1.034	1.034	0.000	0.935	0.935	0.002
	SEL Shaft Trip T1	0.968	0.964	0.000	0.986	0.981	0.000	1.039	1.035	0.000	0.941	0.937	0.000
	5L75 REV-ACK	0.963	0.963	0.002	0.981	0.980	0.002	1.035	1.034	0.001	0.936	0.936	0.001
	5L91 ACK-SEL	0.958	0.956	0.008	0.975	0.974	0.008	1.031	1.038	-0.003	0.932	0.928	0.009
	5L92 CBK-SEL	1.028	0.965	0.000	1.052	0.987	-0.005	1.139	1.038	-0.003	1.021	0.955	-0.018
	5L94 CBK-LGN	1.048	0.995	-0.031	1.064	1.023	-0.041	1.164	1.031	0.004	1.041	0.986	-0.049
	5L96 VAS-SEL	0.961	0.961	0.003	0.978	0.979	0.003	1.033	1.042	-0.006	0.934	0.932	0.005
	5L98 NIC-VAS	0.961	0.960	0.005	0.978	0.977	0.005	1.033	1.040	-0.005	0.934	0.931	0.006
	2L112 NLY-BDY	0.964	0.963	0.001	0.981	0.981	0.000	1.035	1.035	0.000	0.936	0.936	0.000
	2L222 SEV-SEL	0.967	0.963	0.002	0.985	0.980	0.002	1.038	1.034	0.000	0.940	0.936	0.001
	2L258 CBK-INV	0.960	0.961	0.004	0.981	0.982	0.000	1.032	1.041	-0.006	0.933	0.932	0.005
	2L277 WAN-NLY	0.964	0.964	0.000	0.982	0.981	0.000	1.035	1.035	0.000	0.937	0.937	0.000
	2L288 KCL-BTS	0.964	0.964	0.000	0.982	0.982	0.000	1.035	1.035	0.000	0.937	0.937	0.000
	2L289 SEL-BTS	0.964	0.964	0.000	0.982	0.982	0.000	1.035	1.035	0.000	0.937	0.937	0.000
	2L293 SEL-NLY	0.965	0.965	-0.001	0.981	0.982	0.000	1.036	1.036	0.000	0.938	0.938	0.000
	2L294 CBK-NLY	0.956	0.955	0.010	0.971	0.970	0.012	1.031	1.037	-0.002	0.931	0.927	0.010
	2L295 SEL-KCL	0.964	0.964	0.000	0.981	0.981	0.000	1.035	1.035	0.000	0.937	0.936	0.000
	1L274 NTL-POCATER	0.970	0.967	-0.002	0.986	0.984	-0.002	1.061	1.034	0.001	0.953	0.963	-0.026
	1L275 NTL-COLEMAN	0.968	0.968	-0.003	0.983	0.983	0.000	1.067	1.041	-0.006	0.958	0.957	-0.020
	5L82 NIC-MDN	0.963	0.963	0.001	0.980	0.980	0.002	1.034	1.035	0.000	0.936	0.936	0.001
N-2	5L76&5L79	0.947	0.943	0.021	0.962	0.959	0.023	1.024	1.020	0.015	0.923	0.918	0.019
	5L91&5L96	0.984	0.965	0.000	1.001	0.993	-0.011	1.055	1.039	-0.004	0.958	0.939	-0.002
	5L81&5L82	0.976	0.964	0.000	0.994	0.982	0.000	1.046	1.036	0.000	0.949	0.937	0.000
	5L96&5L98	0.962	0.963	0.002	0.979	0.980	0.002	1.033	1.034	0.000	0.934	0.936	0.001
	5L51&5L52	1.036	0.986	-0.021	1.051	1.013	-0.031	1.148	1.087	-0.051	1.028	0.976	-0.039
	2L288&2L295	0.963	0.963	0.001	0.981	0.981	0.001	1.034	1.034	0.000	0.936	0.936	0.001
	2L289&2L295	0.973	0.962	0.003	0.991	0.979	0.003	1.042	1.034	0.002	0.945	0.935	0.002
	2L295&2L299	0.968	0.965	0.000	0.986	0.982	0.000	1.038	1.036	0.000	0.941	0.937	0.000

D.4.3 **y22c23**

y22c23		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.985	0.985	0.000	1.006	1.006	0.000	1.034	1.034	0.000	0.971	0.971	0.000
N-1	SEL T1	0.985	0.984	0.001	1.006	1.006	0.000	1.034	1.034	0.000	0.971	0.970	0.000
	CBK T2+T6	0.985	0.985	0.000	1.006	1.006	0.000	1.035	1.035	0.000	0.972	0.971	0.000
	SEL Shaft Trip T1	0.988	0.985	0.000	1.009	1.006	0.000	1.037	1.034	0.000	0.974	0.971	0.000
	5L75 REV-ACK	0.984	0.984	0.001	1.005	1.005	0.002	1.034	1.033	0.001	0.970	0.970	0.001
	5L91 ACK-SEL	0.979	0.985	0.000	1.000	1.003	0.004	1.030	1.034	0.000	0.966	0.971	0.000
	5L92 CBK-SEL	0.990	0.986	-0.001	1.012	1.009	-0.002	1.050	1.033	0.001	0.987	0.984	-0.013
	5L94 CBK-LGN	1.038	1.002	-0.016	1.056	1.028	-0.022	1.106	1.024	0.010	1.037	0.999	-0.028
	5L96 VAS-SEL	0.982	0.983	0.002	1.003	1.004	0.002	1.032	1.033	0.001	0.969	0.970	0.002
	5L98 NIC-VAS	0.982	0.985	0.000	1.003	1.004	0.002	1.032	1.034	0.000	0.969	0.971	0.000
	2L112 NLY-BDY	0.985	0.984	0.000	1.006	1.006	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	2L222 SEV-SEL	0.988	0.984	0.001	1.009	1.005	0.001	1.036	1.033	0.000	0.974	0.970	0.001
	2L258 CBK-INV	0.981	0.985	0.000	1.005	1.007	-0.001	1.031	1.034	0.000	0.967	0.971	0.000
	2L277 WAN-NLY	0.985	0.983	0.002	1.006	1.005	0.001	1.034	1.033	0.001	0.971	0.970	0.002
	2L288 KCL-BTS	0.985	0.985	0.000	1.006	1.006	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	2L289 SEL-BTS	0.985	0.985	0.000	1.006	1.006	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	2L293 SEL-NLY	0.986	0.984	0.000	1.006	1.005	0.001	1.035	1.034	0.000	0.972	0.971	0.000
	2L294 CBK-NLY	0.980	0.986	0.000	0.997	1.000	0.006	1.031	1.035	0.000	0.968	0.972	-0.001
	2L295 SEL-KCL	0.985	0.985	0.000	1.006	1.006	0.000	1.034	1.034	0.000	0.971	0.971	0.000
	1L274 NTL-POCATER	0.990	0.990	-0.004	1.010	1.010	-0.003	1.060	1.039	-0.005	0.987	0.996	-0.025
	1L275 NTL-COLEMAN	0.987	0.985	0.000	1.007	1.005	0.000	1.047	1.031	0.003	0.985	0.982	-0.011
	5L82 NIC-MDN	0.984	0.984	0.001	1.005	1.005	0.002	1.033	1.033	0.000	0.970	0.970	0.001
N-2	5L76&5L79	0.968	0.971	0.014	0.987	0.987	0.019	1.023	1.025	0.010	0.957	0.959	0.012
	5L91&5L96	1.004	0.989	-0.004	1.025	1.019	-0.013	1.054	1.040	-0.006	0.992	0.976	-0.004
	5L81&5L82	0.994	0.986	0.000	1.016	1.007	0.000	1.042	1.035	0.000	0.981	0.972	0.000
	5L96&5L98	0.983	0.984	0.001	1.004	1.005	0.002	1.033	1.033	0.000	0.969	0.970	0.001
	5L51&5L52	1.027	0.999	-0.014	1.045	1.026	-0.020	1.093	1.034	0.000	1.026	0.997	-0.026
	2L288&2L295	0.984	0.984	0.001	1.005	1.005	0.001	1.034	1.033	0.000	0.971	0.970	0.001
	2L289&2L295	0.993	0.983	0.002	1.014	1.004	0.002	1.040	1.033	0.001	0.979	0.969	0.002
	2L295&2L299	0.988	0.986	0.000	1.010	1.007	0.000	1.037	1.035	0.000	0.975	0.972	0.000

D.4.4 **y22c24**

y22c24		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.960	0.960	0.000	0.972	0.972	0.000	1.034	1.034	0.000	0.937	0.937	0.000
N-1	SEL T1	0.959	0.959	0.000	0.971	0.971	0.000	1.034	1.034	0.000	0.936	0.937	0.000
	CBK T2+T6	0.961	0.961	-0.001	0.969	0.969	0.003	1.036	1.036	-0.001	0.939	0.938	-0.001
	SEL Shaft Trip T1	0.963	0.960	0.000	0.975	0.971	0.000	1.037	1.034	0.000	0.941	0.937	0.000
	5L75 REV-ACK	0.959	0.958	0.001	0.970	0.970	0.002	1.033	1.033	0.001	0.936	0.936	0.001
	5L91 ACK-SEL	0.953	0.952	0.008	0.965	0.964	0.008	1.030	1.037	-0.003	0.932	0.928	0.009
	5L92 CBK-SEL	1.259	0.981	-0.021	1.287	1.004	-0.033	1.436	1.032	0.002	1.271	0.979	-0.042
	5L94 CBK-LGN	1.071	1.018	-0.059	1.084	1.044	-0.072	1.207	1.033	0.000	1.074	1.018	-0.081
	5L96 VAS-SEL	0.956	0.957	0.003	0.968	0.969	0.003	1.031	1.032	0.002	0.934	0.935	0.002
	5L98 NIC-VAS	0.959	0.960	0.000	0.971	0.971	0.000	1.033	1.034	0.000	0.936	0.937	0.000
	2L112 NLY-BDY	0.959	0.959	0.001	0.971	0.971	0.001	1.033	1.033	0.000	0.936	0.936	0.001
	2L222 SEV-SEL	0.963	0.959	0.000	0.975	0.971	0.000	1.037	1.034	0.000	0.940	0.937	0.000
	2L258 CBK-INV	0.951	0.951	0.009	0.967	0.967	0.004	1.028	1.036	-0.002	0.929	0.927	0.010
	2L277 WAN-NLY	0.959	0.959	0.000	0.971	0.971	0.001	1.034	1.034	0.000	0.937	0.936	0.000
	2L288 KCL-BTS	0.960	0.960	0.000	0.971	0.971	0.000	1.034	1.034	0.000	0.937	0.937	0.000
	2L289 SEL-BTS	0.959	0.959	0.000	0.971	0.971	0.000	1.034	1.034	0.000	0.936	0.936	0.000
	2L293 SEL-NLY	0.961	0.961	0.000	0.971	0.971	0.000	1.035	1.035	0.000	0.938	0.938	0.000
	2L294 CBK-NLY	0.951	0.949	0.011	0.961	0.960	0.012	1.029	1.035	0.000	0.930	0.926	0.011
	2L295 SEL-KCL	0.959	0.959	0.000	0.971	0.971	0.000	1.034	1.034	0.000	0.936	0.936	0.000
	1L274 NTL-POCATER	0.963	0.965	-0.006	0.974	0.975	-0.004	1.052	1.043	-0.009	0.949	0.957	-0.020
	1L275 NTL-COLEMAN	0.964	0.964	-0.004	0.973	0.973	-0.001	1.079	1.040	-0.006	0.963	0.962	-0.025
	5L82 NIC-MDN	0.958	0.959	0.001	0.970	0.970	0.001	1.033	1.034	0.000	0.935	0.936	0.000
N-2	5L76&5L79	0.980	0.959	0.000	0.993	0.972	0.000	1.052	1.034	0.000	0.958	0.937	0.000
	5L91&5L96	0.978	0.978	-0.018	0.991	0.993	-0.021	1.053	1.037	-0.002	0.957	0.958	-0.021
	5L81&5L82	0.972	0.957	0.002	0.984	0.969	0.002	1.045	1.033	0.001	0.949	0.935	0.002
	5L96&5L98	0.956	0.957	0.002	0.967	0.969	0.003	1.031	1.033	0.002	0.934	0.935	0.002
	5L51&5L52	1.084	1.022	-0.063	1.098	1.049	-0.077	1.223	1.144	-0.110	1.088	1.021	-0.083
	2L288&2L295	0.958	0.958	0.001	0.970	0.970	0.002	1.033	1.033	0.001	0.936	0.936	0.001
	2L289&2L295	0.963	0.959	0.000	0.975	0.971	0.000	1.037	1.034	0.000	0.941	0.937	0.000
	2L295&2L299	0.960	0.958	0.002	0.972	0.970	0.002	1.035	1.033	0.000	0.937	0.936	0.001

D.4.5 **y22c25**

y22c25		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.978	0.978	0.000	0.990	0.990	0.000	1.036	1.036	0.000	0.966	0.966	0.000
N-1	SEL T1	0.978	0.978	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.965	0.965	0.000
	CBK T2+T6	0.980	0.980	-0.001	0.987	0.987	0.003	1.038	1.037	-0.002	0.967	0.967	-0.001
	SEL Shaft Trip T1	0.982	0.978	0.000	0.994	0.990	0.000	1.039	1.036	0.000	0.969	0.966	0.000
	5L75 REV-ACK	0.977	0.977	0.001	0.989	0.989	0.002	1.035	1.035	0.001	0.965	0.964	0.001
	5L91 ACK-SEL	0.973	0.972	0.007	0.984	0.983	0.007	1.032	1.031	0.005	0.961	0.960	0.006
	5L92 CBK-SEL	1.290	0.996	-0.018	1.319	1.020	-0.030	1.436	1.033	0.003	1.312	1.002	-0.037
	5L94 CBK-LGN	1.075	1.021	-0.043	1.087	1.046	-0.056	1.179	1.034	0.001	1.084	1.028	-0.063
	5L96 VAS-SEL	0.975	0.976	0.002	0.987	0.988	0.002	1.033	1.034	0.002	0.963	0.964	0.002
	5L98 NIC-VAS	0.978	0.979	0.000	0.990	0.991	0.000	1.035	1.036	0.000	0.965	0.966	0.000
	2L112 NLY-BDY	0.977	0.977	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.965	0.965	0.000
	2L222 SEV-SEL	0.982	0.978	0.000	0.994	0.990	0.000	1.039	1.036	0.000	0.969	0.965	0.000
	2L258 CBK-INV	0.970	0.970	0.008	0.986	0.986	0.004	1.030	1.030	0.006	0.958	0.958	0.007
	2L277 WAN-NLY	0.978	0.978	0.000	0.990	0.989	0.000	1.035	1.035	0.000	0.965	0.965	0.000
	2L288 KCL-BTS	0.978	0.978	0.000	0.990	0.990	0.000	1.036	1.036	0.000	0.965	0.965	0.000
	2L289 SEL-BTS	0.978	0.978	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.965	0.965	0.000
	2L293 SEL-NLY	0.979	0.979	0.000	0.990	0.990	0.000	1.036	1.036	0.000	0.966	0.966	0.000
	2L294 CBK-NLY	0.972	0.971	0.007	0.981	0.980	0.010	1.033	1.031	0.005	0.961	0.960	0.006
	2L295 SEL-KCL	0.978	0.978	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.965	0.965	0.000
	1L274 NTL-POCATER	0.982	0.981	-0.003	0.993	0.993	-0.002	1.053	1.033	0.003	0.977	0.986	-0.020
	1L275 NTL-COLEMAN	0.982	0.978	0.000	0.992	0.989	0.000	1.071	1.028	0.008	0.988	0.984	-0.018
	5L82 NIC-MDN	0.977	0.977	0.001	0.988	0.989	0.002	1.035	1.035	0.000	0.964	0.964	0.001
N-2	5L76&5L79	0.996	0.974	0.004	1.009	0.986	0.004	1.051	1.033	0.002	0.984	0.963	0.003
	5L91&5L96	0.995	0.979	0.000	1.007	1.000	-0.010	1.052	1.038	-0.003	0.984	0.967	-0.001
	5L81&5L82	0.989	0.976	0.002	1.002	0.988	0.002	1.045	1.034	0.002	0.977	0.964	0.002
	5L96&5L98	0.975	0.976	0.002	0.987	0.988	0.002	1.033	1.034	0.001	0.963	0.964	0.002
	5L51&5L52	1.088	1.027	-0.048	1.101	1.052	-0.062	1.195	1.119	-0.083	1.099	1.032	-0.066
	2L288&2L295	0.977	0.977	0.001	0.989	0.989	0.001	1.035	1.035	0.000	0.965	0.964	0.001
	2L289&2L295	0.982	0.978	0.000	0.994	0.990	0.000	1.039	1.036	0.000	0.969	0.965	0.000
	2L295&2L299	0.979	0.977	0.001	0.991	0.989	0.001	1.036	1.035	0.000	0.966	0.965	0.001

D.4.6 **y22c26**

y22c26		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.988	0.988	0.000	1.009	1.009	0.000	1.029	1.029	0.000	0.962	0.962	0.000
N-1	SEL T1	0.988	0.988	0.000	1.009	1.009	0.000	1.029	1.029	0.000	0.961	0.961	0.000
	CBK T2+T6	0.992	0.989	-0.001	1.009	1.008	0.000	1.033	1.031	-0.002	0.965	0.963	-0.001
	SEL Shaft Trip T1	0.992	0.989	0.000	1.012	1.009	0.000	1.032	1.030	0.000	0.965	0.962	0.000
	5L75 REV-ACK	0.987	0.987	0.001	1.007	1.007	0.001	1.029	1.028	0.001	0.961	0.961	0.001
	5L91 ACK-SEL	0.983	0.987	0.001	1.003	1.005	0.004	1.026	1.029	0.000	0.957	0.961	0.000
	5L92 CBK-SEL	1.048	0.989	-0.001	1.072	1.013	-0.005	1.103	1.041	-0.011	1.031	0.973	-0.012
	5L94 CBK-LGN	1.047	1.016	-0.027	1.066	1.042	-0.033	1.102	1.030	0.000	1.030	1.000	-0.038
	5L96 VAS-SEL	0.985	0.989	0.000	1.006	1.008	0.000	1.027	1.030	0.000	0.959	0.962	0.000
	5L98 NIC-VAS	0.988	0.989	0.000	1.008	1.009	0.000	1.029	1.030	0.000	0.962	0.962	0.000
	2L112 NLY-BDY	0.988	0.988	0.000	1.008	1.008	0.000	1.029	1.029	0.000	0.961	0.961	0.000
	2L222 SEV-SEL	0.991	0.988	0.000	1.012	1.009	0.000	1.032	1.029	0.000	0.965	0.962	0.000
	2L258 CBK-INV	0.979	0.988	0.000	1.004	1.009	0.000	1.023	1.030	0.000	0.954	0.962	0.000
	2L277 WAN-NLY	0.988	0.988	0.000	1.008	1.008	0.000	1.029	1.029	0.000	0.962	0.961	0.000
	2L288 KCL-BTS	0.988	0.988	0.000	1.008	1.008	0.000	1.029	1.029	0.000	0.962	0.962	0.000
	2L289 SEL-BTS	0.988	0.988	0.000	1.008	1.008	0.000	1.029	1.029	0.000	0.961	0.961	0.000
	2L293 SEL-NLY	0.989	0.987	0.001	1.008	1.007	0.001	1.030	1.029	0.000	0.963	0.961	0.001
	2L294 CBK-NLY	0.983	0.988	0.000	1.000	1.003	0.006	1.027	1.030	0.000	0.958	0.962	0.000
	2L295 SEL-KCL	0.988	0.988	0.000	1.008	1.008	0.000	1.029	1.029	0.000	0.961	0.961	0.000
	1L274 NTL-POCATER	0.992	0.991	-0.003	1.011	1.011	-0.002	1.047	1.035	-0.005	0.973	0.980	-0.018
	1L275 NTL-COLEMAN	0.990	0.987	0.001	1.009	1.007	0.001	1.040	1.037	-0.007	0.973	0.970	-0.009
	5L82 NIC-MDN	0.987	0.987	0.001	1.007	1.007	0.001	1.028	1.029	0.000	0.960	0.961	0.001
N-2	5L76&5L79	1.002	0.986	0.002	1.023	1.006	0.003	1.041	1.029	0.000	0.976	0.961	0.001
	5L91&5L96	1.004	0.991	-0.002	1.024	1.019	-0.010	1.046	1.034	-0.004	0.979	0.965	-0.003
	5L81&5L82	0.998	0.986	0.002	1.019	1.007	0.002	1.037	1.028	0.002	0.972	0.960	0.002
	5L96&5L98	0.986	0.987	0.001	1.005	1.007	0.002	1.027	1.028	0.001	0.959	0.961	0.001
	5L51&5L52	1.058	1.020	-0.032	1.078	1.048	-0.039	1.114	1.073	-0.043	1.041	1.003	-0.042
	2L288&2L295	0.987	0.987	0.001	1.008	1.008	0.001	1.029	1.029	0.000	0.961	0.961	0.001
	2L289&2L295	0.992	0.988	0.000	1.012	1.009	0.000	1.032	1.030	0.000	0.965	0.962	0.000
	2L295&2L299	0.989	0.987	0.000	1.009	1.008	0.000	1.030	1.029	0.000	0.962	0.961	0.000

D.4.7 **y22c27**

y22c27		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.957	0.957	0.000	0.966	0.966	0.000	1.039	1.039	0.000	0.940	0.940	0.000
N-1	SEL T1	0.957	0.956	0.000	0.965	0.965	0.000	1.039	1.039	0.000	0.940	0.940	0.000
	CBK T2+T6	0.960	0.960	-0.003	0.962	0.962	0.003	1.042	1.042	-0.003	0.943	0.943	-0.003
	SEL Shaft Trip T1	0.957	0.957	0.000	0.966	0.966	0.000	1.039	1.039	0.000	0.940	0.940	0.000
	5L75 REV-ACK	0.956	0.955	0.002	0.964	0.964	0.002	1.038	1.038	0.001	0.939	0.938	0.002
	5L91 ACK-SEL	0.946	0.941	0.016	0.955	0.950	0.016	1.031	1.036	0.003	0.931	0.924	0.016
	5L92 CBK-SEL	1.326	0.990	-0.033	1.356	1.014	-0.048	1.536	1.027	0.012	1.352	0.996	-0.056
	5L94 CBK-LGN	1.089	1.029	-0.072	1.100	1.053	-0.087	1.244	1.029	0.010	1.101	1.035	-0.095
	5L96 VAS-SEL	0.951	0.949	0.008	0.959	0.958	0.008	1.035	1.033	0.006	0.935	0.933	0.007
	5L98 NIC-VAS	0.955	0.952	0.004	0.963	0.961	0.004	1.038	1.036	0.003	0.938	0.936	0.004
	2L112 NLY-BDY	0.955	0.955	0.002	0.964	0.964	0.001	1.038	1.038	0.001	0.939	0.939	0.001
	2L222 SEV-SEL	0.957	0.957	0.000	0.966	0.966	0.000	1.039	1.039	0.000	0.940	0.940	0.000
	2L258 CBK-INV	0.947	0.948	0.009	0.961	0.962	0.004	1.032	1.033	0.006	0.932	0.932	0.008
	2L277 WAN-NLY	0.956	0.956	0.000	0.965	0.965	0.001	1.039	1.039	0.000	0.939	0.939	0.000
	2L288 KCL-BTS	0.957	0.957	0.000	0.965	0.965	0.000	1.039	1.039	0.000	0.940	0.940	0.000
	2L289 SEL-BTS	0.956	0.956	0.000	0.965	0.965	0.000	1.039	1.039	0.000	0.939	0.939	0.000
	2L293 SEL-NLY	0.958	0.958	-0.001	0.965	0.965	0.000	1.040	1.040	0.000	0.941	0.941	-0.001
	2L294 CBK-NLY	0.946	0.944	0.013	0.954	0.953	0.013	1.032	1.031	0.008	0.931	0.930	0.010
	2L295 SEL-KCL	0.956	0.956	0.000	0.965	0.965	0.000	1.039	1.039	0.000	0.939	0.939	0.000
	1L274 NTL-POCATER	0.961	0.959	-0.002	0.968	0.966	0.000	1.058	1.038	0.001	0.952	0.960	-0.020
	1L275 NTL-COLEMAN	0.962	0.961	-0.004	0.968	0.967	-0.001	1.088	1.035	0.004	0.967	0.967	-0.027
	5L82 NIC-MDN	0.955	0.955	0.002	0.963	0.963	0.002	1.038	1.038	0.001	0.938	0.938	0.002
N-2	5L76&5L79	0.972	0.957	0.000	0.982	0.967	-0.001	1.053	1.040	0.000	0.956	0.941	0.000
	5L91&5L96	1.032	0.992	-0.036	1.044	1.017	-0.052	1.110	1.075	-0.036	1.018	0.975	-0.035
	5L81&5L82	0.966	0.954	0.003	0.975	0.963	0.003	1.047	1.037	0.002	0.949	0.938	0.002
	5L96&5L98	0.950	0.948	0.009	0.959	0.957	0.009	1.034	1.033	0.006	0.934	0.932	0.008
	5L51&5L52	1.117	1.044	-0.087	1.128	1.069	-0.103	1.279	1.183	-0.144	1.132	1.051	-0.111
	2L288&2L295	0.956	0.956	0.001	0.965	0.964	0.001	1.039	1.038	0.000	0.939	0.939	0.001
	2L289&2L295	0.955	0.955	0.002	0.964	0.964	0.002	1.038	1.038	0.001	0.939	0.939	0.001
	2L295&2L299	0.955	0.955	0.002	0.964	0.964	0.002	1.038	1.038	0.001	0.939	0.938	0.001

D.4.8 **y22c28**

y22c28		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.977	0.977	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.965	0.965	0.000
N-1	SEL T1	0.977	0.977	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	CBK T2+T6	0.978	0.976	0.001	0.987	0.986	0.004	1.037	1.035	0.000	0.966	0.964	0.000
	SEL Shaft Trip T1	0.977	0.977	0.000	0.990	0.990	0.000	1.036	1.035	0.000	0.965	0.965	0.000
	5L75 REV-ACK	0.976	0.976	0.002	0.989	0.988	0.002	1.035	1.034	0.001	0.964	0.963	0.001
	5L91 ACK-SEL	0.968	0.967	0.010	0.981	0.978	0.012	1.029	1.029	0.007	0.957	0.956	0.009
	5L92 CBK-SEL	1.205	0.985	-0.008	1.233	1.009	-0.019	1.337	1.022	0.013	1.224	0.991	-0.027
	5L94 CBK-LGN	1.078	1.027	-0.050	1.092	1.052	-0.062	1.185	1.028	0.008	1.089	1.034	-0.069
	5L96 VAS-SEL	0.973	0.974	0.003	0.986	0.986	0.004	1.033	1.034	0.002	0.961	0.962	0.002
	5L98 NIC-VAS	0.976	0.977	0.000	0.989	0.989	0.001	1.035	1.036	0.000	0.963	0.965	0.000
	2L112 NLY-BDY	0.976	0.976	0.001	0.989	0.989	0.000	1.035	1.035	0.000	0.964	0.964	0.001
	2L222 SEV-SEL	0.977	0.977	0.000	0.990	0.990	0.000	1.036	1.035	0.000	0.965	0.965	0.000
	2L258 CBK-INV	0.969	0.973	0.004	0.986	0.989	0.001	1.030	1.033	0.003	0.958	0.961	0.004
	2L277 WAN-NLY	0.977	0.977	0.000	0.989	0.989	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	2L288 KCL-BTS	0.977	0.977	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	2L289 SEL-BTS	0.977	0.977	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	2L293 SEL-NLY	0.978	0.975	0.002	0.990	0.988	0.002	1.036	1.034	0.002	0.965	0.963	0.002
	2L294 CBK-NLY	0.969	0.971	0.006	0.981	0.981	0.009	1.031	1.032	0.003	0.959	0.960	0.004
	2L295 SEL-KCL	0.977	0.977	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	1L274 NTL-POCATER	0.981	0.977	0.000	0.993	0.991	0.000	1.053	1.030	0.006	0.976	0.981	-0.017
	1L275 NTL-COLEMAN	0.981	0.977	0.000	0.991	0.989	0.000	1.070	1.026	0.009	0.986	0.983	-0.018
	5L82 NIC-MDN	0.975	0.976	0.002	0.988	0.988	0.002	1.034	1.034	0.001	0.963	0.963	0.001
N-2	5L76&5L79	0.991	0.978	0.000	1.004	0.991	-0.001	1.047	1.036	0.000	0.978	0.965	0.000
	5L91&5L96	1.044	1.009	-0.032	1.059	1.035	-0.045	1.095	1.064	-0.029	1.034	0.995	-0.030
	5L81&5L82	0.985	0.975	0.002	0.999	0.988	0.002	1.042	1.034	0.002	0.973	0.962	0.002
	5L96&5L98	0.972	0.974	0.003	0.985	0.985	0.005	1.032	1.033	0.002	0.960	0.962	0.003
	5L51&5L52	1.103	1.042	-0.064	1.118	1.067	-0.077	1.215	1.138	-0.103	1.116	1.048	-0.084
	2L288&2L295	0.976	0.976	0.000	0.989	0.989	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	2L289&2L295	0.976	0.976	0.001	0.989	0.989	0.001	1.035	1.035	0.000	0.964	0.964	0.000
	2L295&2L299	0.976	0.976	0.001	0.989	0.989	0.001	1.035	1.035	0.000	0.964	0.964	0.001

D.4.9 **y22c29**

y22c29		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.989	0.989	0.000	1.008	1.008	0.000	1.031	1.031	0.000	0.963	0.963	0.000
N-1	SEL T1	0.989	0.989	0.000	1.008	1.008	0.000	1.031	1.031	0.000	0.963	0.963	0.000
	CBK T2+T6	0.992	0.990	-0.001	1.008	1.008	0.000	1.034	1.033	-0.002	0.966	0.964	-0.002
	SEL Shaft Trip T1	0.989	0.989	0.000	1.009	1.009	0.000	1.031	1.031	0.000	0.963	0.963	0.000
	5L75 REV-ACK	0.988	0.989	0.000	1.007	1.007	0.000	1.030	1.031	0.000	0.962	0.963	0.000
	5L91 ACK-SEL	0.980	0.986	0.003	1.000	1.001	0.008	1.025	1.029	0.002	0.956	0.960	0.003
	5L92 CBK-SEL	1.042	0.982	0.007	1.065	1.006	0.002	1.097	1.033	-0.002	1.025	0.966	-0.004
	5L94 CBK-LGN	1.055	1.021	-0.032	1.075	1.047	-0.039	1.113	1.023	0.008	1.039	1.006	-0.043
	5L96 VAS-SEL	0.985	0.989	0.000	1.004	1.006	0.002	1.028	1.031	0.000	0.959	0.963	0.000
	5L98 NIC-VAS	0.988	0.988	0.000	1.007	1.007	0.002	1.030	1.030	0.000	0.962	0.962	0.000
	2L112 NLY-BDY	0.988	0.988	0.000	1.008	1.008	0.000	1.030	1.030	0.000	0.962	0.962	0.000
	2L222 SEV-SEL	0.989	0.989	0.000	1.009	1.008	0.000	1.031	1.031	0.000	0.963	0.963	0.000
	2L258 CBK-INV	0.980	0.989	0.000	1.004	1.009	0.000	1.025	1.031	0.000	0.955	0.963	0.000
	2L277 WAN-NLY	0.989	0.988	0.000	1.008	1.008	0.000	1.030	1.030	0.000	0.962	0.962	0.000
	2L288 KCL-BTS	0.989	0.989	0.000	1.008	1.008	0.000	1.031	1.031	0.000	0.962	0.962	0.000
	2L289 SEL-BTS	0.989	0.989	0.000	1.008	1.008	0.000	1.031	1.031	0.000	0.962	0.962	0.000
	2L293 SEL-NLY	0.990	0.990	0.000	1.008	1.008	0.000	1.031	1.031	0.000	0.963	0.963	0.000
	2L294 CBK-NLY	0.982	0.987	0.002	1.000	1.002	0.006	1.027	1.030	0.000	0.958	0.962	0.000
	2L295 SEL-KCL	0.989	0.989	0.000	1.008	1.008	0.000	1.031	1.030	0.000	0.962	0.962	0.000
	1L274 NTL-POCATER	0.992	0.993	-0.004	1.011	1.011	-0.003	1.048	1.035	-0.005	0.974	0.981	-0.018
	1L275 NTL-COLEMAN	0.990	0.990	0.000	1.008	1.008	0.000	1.041	1.040	-0.010	0.974	0.973	-0.011
	5L82 NIC-MDN	0.987	0.989	0.000	1.006	1.007	0.000	1.029	1.031	0.000	0.961	0.963	0.000
N-2	5L76&5L79	1.000	0.989	0.000	1.020	1.009	0.000	1.039	1.031	0.000	0.974	0.963	0.000
	5L91&5L96	1.050	1.021	-0.032	1.071	1.050	-0.042	1.086	1.060	-0.030	1.026	0.993	-0.030
	5L81&5L82	0.996	0.986	0.002	1.015	1.006	0.002	1.036	1.029	0.002	0.969	0.960	0.002
	5L96&5L98	0.985	0.989	0.000	1.004	1.005	0.003	1.028	1.031	0.000	0.959	0.962	0.000
	5L51&5L52	1.078	1.031	-0.042	1.099	1.059	-0.051	1.140	1.085	-0.054	1.063	1.014	-0.051
	2L288&2L295	0.988	0.988	0.000	1.008	1.008	0.000	1.030	1.030	0.000	0.962	0.962	0.000
	2L289&2L295	0.988	0.988	0.000	1.008	1.008	0.000	1.030	1.030	0.000	0.962	0.962	0.000
	2L295&2L299	0.988	0.988	0.000	1.008	1.007	0.000	1.030	1.030	0.000	0.962	0.962	0.000

D.4.10 **y22c30**

y22c30		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.977	0.977	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.965	0.965	0.000
N-1	SEL T1	0.977	0.977	0.000	0.990	0.990	0.000	1.035	1.035	0.000	0.965	0.965	0.000
	CBK T2+T6	0.978	0.974	0.003	0.987	0.985	0.005	1.037	1.034	0.002	0.966	0.962	0.002
	SEL Shaft Trip T1	0.978	0.978	0.000	0.990	0.990	0.000	1.036	1.036	0.000	0.965	0.965	0.000
	5L75 REV-ACK	0.976	0.976	0.001	0.989	0.989	0.001	1.035	1.035	0.000	0.964	0.964	0.000
	5L91 ACK-SEL	0.969	0.966	0.011	0.981	0.978	0.012	1.029	1.027	0.008	0.957	0.955	0.010
	5L92 CBK-SEL	1.277	0.984	-0.007	1.306	1.008	-0.018	1.421	1.033	0.002	1.299	0.990	-0.025
	5L94 CBK-LGN	1.077	1.020	-0.043	1.089	1.045	-0.055	1.184	1.033	0.002	1.088	1.027	-0.062
	5L96 VAS-SEL	0.973	0.972	0.005	0.985	0.984	0.006	1.033	1.032	0.004	0.961	0.960	0.005
	5L98 NIC-VAS	0.976	0.975	0.003	0.988	0.987	0.003	1.034	1.033	0.002	0.963	0.962	0.002
	2L112 NLY-BDY	0.979	0.976	0.000	0.990	0.988	0.002	1.037	1.035	0.000	0.967	0.964	0.000
	2L222 SEV-SEL	0.978	0.978	0.000	0.990	0.990	0.000	1.036	1.035	0.000	0.965	0.965	0.000
	2L258 CBK-INV	0.969	0.970	0.008	0.986	0.986	0.003	1.030	1.030	0.005	0.958	0.958	0.007
	2L277 WAN-NLY	0.977	0.977	0.000	0.989	0.989	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	2L288 KCL-BTS	0.977	0.977	0.000	0.990	0.989	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	2L289 SEL-BTS	0.977	0.977	0.000	0.989	0.989	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	2L293 SEL-NLY	0.974	0.974	0.004	0.990	0.989	0.000	1.033	1.033	0.003	0.962	0.961	0.003
	2L294 CBK-NLY	0.971	0.970	0.008	0.980	0.979	0.011	1.032	1.031	0.005	0.960	0.958	0.006
	2L295 SEL-KCL	0.977	0.977	0.000	0.989	0.989	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	1L274 NTL-POCATER	0.981	0.977	0.000	0.992	0.990	0.000	1.053	1.030	0.005	0.976	0.982	-0.017
	1L275 NTL-COLEMAN	0.981	0.977	0.000	0.991	0.989	0.001	1.070	1.027	0.009	0.987	0.983	-0.018
	5L82 NIC-MDN	0.976	0.977	0.000	0.989	0.989	0.000	1.035	1.035	0.000	0.964	0.964	0.000
N-2	5L76&5L79	0.962	0.964	0.013	0.973	0.975	0.015	1.024	1.026	0.009	0.951	0.953	0.012
	5L91&5L96	1.046	1.009	-0.032	1.058	1.033	-0.044	1.097	1.031	0.005	1.036	1.002	-0.038
	5L81&5L82	0.975	0.976	0.001	0.987	0.988	0.002	1.034	1.034	0.001	0.963	0.963	0.001
	5L96&5L98	0.973	0.971	0.006	0.985	0.984	0.006	1.032	1.031	0.004	0.961	0.959	0.005
	5L51&5L52	1.082	1.021	-0.044	1.094	1.046	-0.056	1.190	1.034	0.001	1.093	1.028	-0.063
	2L288&2L295	0.977	0.977	0.000	0.989	0.989	0.000	1.035	1.035	0.000	0.964	0.964	0.000
	2L289&2L295	0.976	0.976	0.001	0.989	0.989	0.001	1.035	1.035	0.000	0.964	0.964	0.001
	2L295&2L299	0.976	0.976	0.001	0.989	0.989	0.001	1.035	1.035	0.000	0.964	0.964	0.001

D.5 2014 AB to BC transfer

D.5.1 y14c11

y14c11		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.968	0.968	0.000	0.976	0.976	0.000	1.030	1.030	0.000	0.957	0.957	0.000
N-1	SEL T1	0.966	0.966	0.002	0.973	0.973	0.003	1.029	1.028	0.002	0.955	0.955	0.002
	CBK T2+T6	0.971	0.971	-0.003	0.970	0.970	0.006	1.031	1.032	-0.002	0.959	0.960	-0.003
	SEL Shaft Trip T1	0.968	0.967	0.001	0.975	0.974	0.001	1.028	1.029	0.002	0.956	0.956	0.001
	5L75 REV-ACK	0.966	0.966	0.002	0.973	0.973	0.003	1.029	1.028	0.002	0.955	0.955	0.002
	5L91 ACK-SEL	0.947			0.953			1.011			0.938		
	5L92 CBK-SEL	1.179	0.980	-0.012	1.206	1.003	-0.028	1.347	1.024	0.007	1.193	0.982	-0.025
	5L94 CBK-LGN	1.051	1.000	-0.032	1.066	1.027	-0.051	1.187	1.031	0.000	1.057	1.003	-0.046
	5L96 VAS-SEL	0.961	0.938	0.030	0.968	0.946	0.030	1.024	1.032	-0.002	0.951	0.926	0.031
	5L98 NIC-VAS	0.968	0.968	0.000	0.976	0.975	0.000	1.030	1.030	0.000	0.957	0.957	0.000
	2L112 NLY-BDY	0.966	0.966	0.002	0.974	0.974	0.002	1.029	1.029	0.002	0.956	0.955	0.002
	2L222 SEV-SEL	0.967	0.972	-0.003	0.974	0.979	-0.004	1.027	1.032	-0.002	0.955	0.960	-0.003
	2L258 CBK-INV	0.956	0.954	0.014	0.967	0.966	0.010	1.022	1.036	-0.005	0.947	0.941	0.016
	2L277 WAN-NLY	0.967	0.967	0.001	0.974	0.974	0.001	1.029	1.029	0.001	0.956	0.956	0.001
	2L288 KCL-BTS	0.968	0.968	0.000	0.975	0.975	0.000	1.030	1.030	0.000	0.957	0.957	0.000
	2L289 SEL-BTS	0.966	0.966	0.002	0.973	0.973	0.003	1.028	1.028	0.002	0.955	0.955	0.002
	2L293 SEL-NLY	0.968	0.968	0.000	0.975	0.975	0.000	1.030	1.031	0.000	0.957	0.957	0.000
	2L294 CBK-NLY	0.953	0.950	0.018	0.966	0.963	0.012	1.020	1.033	-0.002	0.944	0.938	0.019
	2L295 SEL-KCL	0.966	0.966	0.002	0.973	0.973	0.003	1.029	1.029	0.002	0.955	0.955	0.002
	1L274 NTL-POCATER	0.968	0.967	0.000	0.975	0.974	0.001	1.048	1.032	-0.002	0.965	0.963	-0.006
	1L275 NTL-COLEMAN	0.970	0.968	0.000	0.974	0.972	0.003	1.090	1.037	-0.006	0.973	0.971	-0.013
	5L82 NIC-MDN	0.969	0.968	0.000	0.976	0.975	0.000	1.032	1.030	0.000	0.958	0.957	0.000
N-2	5L76&5L79	1.040	0.991	-0.023	1.055	1.016	-0.040	1.173	1.022	0.008	1.045	0.993	-0.036
	5L91&5L96	1.080	1.010	-0.042	1.097	1.039	-0.063	1.150	1.029	0.001	1.061	1.005	-0.048
	5L81&5L82	0.962	0.967	0.001	0.969	0.974	0.002	1.020	1.029	0.001	0.950	0.956	0.001
	5L96&5L98	0.965	0.950	0.018	0.972	0.958	0.018	1.026	1.033	-0.002	0.954	0.938	0.019
	5L51&5L52	1.058	1.024	-0.056	1.075	1.057	-0.081	1.128	1.079	-0.049	1.042	1.007	-0.050
	2L288&2L295	0.965	0.965	0.003	0.972	0.972	0.004	1.028	1.028	0.003	0.954	0.954	0.003
	2L289&2L295	0.969	0.968	0.000	0.976	0.975	0.000	1.028	1.029	0.001	0.957	0.957	0.000
	2L295&2L299	0.967	0.961	0.007	0.974	0.969	0.006	1.027	1.024	0.006	0.956	0.951	0.006

D.5.2 **y14c12**

y14c12		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	1.019	1.019	0.000	1.027	1.027	0.000	1.032	1.032	0.000	1.023	1.023	0.000
N-1	SEL T1	1.018	1.018	0.002	1.025	1.025	0.002	1.031	1.031	0.000	1.022	1.022	0.001
	CBK T2+T6	1.024	1.017	0.003	1.022	1.018	0.009	1.035	1.030	0.003	1.027	1.020	0.003
	SEL Shaft Trip T1	1.017	1.015	0.004	1.024	1.024	0.003	1.029	1.028	0.005	1.021	1.019	0.005
	5L75 REV-ACK	1.018	1.018	0.002	1.025	1.025	0.002	1.031	1.031	0.001	1.022	1.022	0.001
	5L91 ACK-SEL	0.990	0.973	0.046	0.995	0.980	0.047	1.007	1.041	-0.008	0.996	0.975	0.048
	5L92 CBK-SEL	1.263	1.030	-0.011	1.292	1.055	-0.028	1.332	1.032	0.000	1.283	1.038	-0.015
	5L94 CBK-LGN	1.062	1.019	0.000	1.074	1.042	-0.015	1.104	1.033	0.000	1.071	1.027	-0.004
	5L96 VAS-SEL	1.003	1.014	0.006	1.009	1.021	0.006	1.017	1.029	0.004	1.008	1.018	0.005
	5L98 NIC-VAS	1.014	1.016	0.004	1.021	1.023	0.004	1.026	1.030	0.002	1.018	1.020	0.003
	2L112 NLY-BDY	1.019	1.019	0.000	1.027	1.027	0.000	1.032	1.032	0.000	1.023	1.023	0.000
	2L222 SEV-SEL	1.016	1.021	-0.001	1.023	1.030	-0.003	1.028	1.033	0.000	1.020	1.024	0.000
	2L258 CBK-INV	1.007	1.007	0.013	1.019	1.018	0.009	1.024	1.024	0.009	1.012	1.012	0.011
	2L277 WAN-NLY	1.019	1.019	0.000	1.026	1.026	0.000	1.032	1.032	0.000	1.023	1.023	0.000
	2L288 KCL-BTS	1.019	1.019	0.000	1.027	1.027	0.000	1.032	1.032	0.000	1.023	1.023	0.000
	2L289 SEL-BTS	1.018	1.018	0.001	1.026	1.026	0.001	1.031	1.032	0.000	1.022	1.022	0.000
	2L293 SEL-NLY	1.019	1.020	0.000	1.027	1.027	0.000	1.033	1.033	0.000	1.023	1.023	0.000
	2L294 CBK-NLY	1.011	1.010	0.009	1.021	1.020	0.007	1.027	1.026	0.006	1.016	1.015	0.008
	2L295 SEL-KCL	1.018	1.018	0.001	1.025	1.025	0.002	1.031	1.031	0.000	1.022	1.022	0.001
	1L274 NTL-POCATER	1.020	1.019	0.000	1.026	1.026	0.000	1.048	1.025	0.007	1.030	1.031	-0.008
	1L275 NTL-COLEMAN	1.019	1.018	0.001	1.025	1.024	0.003	1.059	1.033	0.000	1.027	1.026	-0.003
	5L82 NIC-MDN	1.019	1.019	0.000	1.026	1.026	0.000	1.032	1.032	0.000	1.023	1.022	0.000
N-2	5L76&5L79	1.011	1.014	0.005	1.018	1.021	0.006	1.023	1.029	0.004	1.015	1.019	0.004
	5L91&5L96	1.223	1.067	-0.048	1.238	1.096	-0.069	1.210	1.072	-0.039	1.211	1.067	-0.044
	5L81&5L82	1.020	1.017	0.002	1.028	1.025	0.002	1.033	1.032	0.000	1.024	1.022	0.002
	5L96&5L98	1.008	1.010	0.010	1.014	1.017	0.010	1.021	1.026	0.006	1.012	1.015	0.008
	5L51&5L52	1.072	1.020	0.000	1.085	1.040	-0.013	1.116	1.059	-0.026	1.082	1.028	-0.004
	2L288&2L295	1.017	1.017	0.002	1.024	1.024	0.003	1.030	1.031	0.002	1.021	1.021	0.002
	2L289&2L295	1.019	1.018	0.002	1.026	1.027	0.000	1.029	1.031	0.001	1.022	1.021	0.002
	2L295&2L299	1.018	1.014	0.005	1.025	1.023	0.004	1.029	1.027	0.005	1.021	1.018	0.005

D.6 2017 AB to BC transfer (without Chapel Rock)

D.6.1 y17c11

y17c11		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.998	0.998	0.000	1.010	1.010	0.000	1.026	1.026	0.000	0.974	0.974	0.000
N-1	SEL T1	0.996	0.996	0.002	1.008	1.008	0.002	1.024	1.024	0.001	0.972	0.972	0.002
	CBK T2+T6	0.999	0.998	0.000	1.006	1.006	0.005	1.025	1.025	0.000	0.974	0.974	0.000
	SEL Shaft Trip T1	0.998	0.997	0.001	1.010	1.009	0.001	1.024	1.025	0.000	0.973	0.973	0.000
	5L75 REV-ACK	0.996	0.996	0.002	1.008	1.008	0.002	1.024	1.024	0.001	0.972	0.972	0.002
	5L91 ACK-SEL	0.983			0.994			1.012			0.960		
	5L92 CBK-SEL	1.076	1.004	-0.006	1.100	1.027	-0.017	1.146	1.039	-0.014	1.058	0.987	-0.013
	5L94 CBK-LGN	1.040	0.997	0.001	1.058	1.024	-0.014	1.106	1.032	-0.006	1.022	0.979	-0.006
	5L96 VAS-SEL	0.993	0.982	0.016	1.004	0.994	0.016	1.021	1.022	0.004	0.969	0.959	0.015
	5L98 NIC-VAS	0.999	0.992	0.006	1.012	1.004	0.006	1.026	1.022	0.004	0.974	0.969	0.005
	2L112 NLY-BDY	0.997	0.997	0.001	1.009	1.009	0.000	1.025	1.025	0.000	0.973	0.973	0.001
	2L222 SEV-SEL	0.997	0.998	0.000	1.010	1.012	-0.002	1.023	1.025	0.000	0.973	0.973	0.000
	2L258 CBK-INV	0.986	0.985	0.013	1.002	1.001	0.009	1.018	1.024	0.002	0.964	0.961	0.012
	2L277 WAN-NLY	0.997	0.997	0.001	1.009	1.009	0.000	1.025	1.025	0.000	0.973	0.973	0.000
	2L288 KCL-BTS	0.998	0.998	0.000	1.010	1.010	0.000	1.025	1.025	0.000	0.973	0.973	0.000
	2L289 SEL-BTS	0.996	0.996	0.002	1.008	1.008	0.002	1.024	1.024	0.001	0.972	0.972	0.002
	2L293 SEL-NLY	0.998	0.998	0.000	1.010	1.010	0.000	1.026	1.026	0.000	0.973	0.974	0.000
	2L294 CBK-NLY	0.988	0.987	0.011	1.004	1.002	0.008	1.020	1.025	0.000	0.966	0.962	0.011
	2L295 SEL-KCL	0.996	0.996	0.002	1.008	1.008	0.002	1.024	1.024	0.001	0.972	0.972	0.002
	1L274 NTL-POCATER	0.998	0.997	0.001	1.010	1.009	0.001	1.042	1.033	-0.008	0.981	0.978	-0.004
	1L275 NTL-COLEMAN	0.998	0.997	0.001	1.008	1.007	0.003	1.059	1.032	-0.007	0.980	0.979	-0.006
	5L82 NIC-MDN	0.997	0.997	0.001	1.010	1.009	0.002	1.026	1.025	0.001	0.973	0.972	0.001
N-2	5L76&5L79	1.051	0.996	0.002	1.069	1.024	-0.013	1.117	1.055	-0.029	1.033	0.977	-0.003
	5L91&5L96	1.082	1.017	-0.019	1.102	1.048	-0.038	1.107	1.029	-0.004	1.048	0.992	-0.018
	5L81&5L82	0.996	0.995	0.003	1.008	1.007	0.004	1.022	1.023	0.002	0.971	0.971	0.003
	5L96&5L98	0.996	0.988	0.010	1.008	1.000	0.010	1.023	1.026	0.000	0.972	0.964	0.010
	5L51&5L52	1.052	1.022	-0.024	1.071	1.055	-0.045	1.081	1.033	-0.007	1.023	0.996	-0.022
	2L288&2L295	0.995	0.995	0.003	1.007	1.007	0.003	1.024	1.024	0.002	0.971	0.971	0.002
	2L289&2L295	1.000	0.998	0.000	1.012	1.010	0.000	1.024	1.024	0.002	0.974	0.973	0.000
	2L295&2L299	0.998	0.994	0.004	1.010	1.007	0.003	1.024	1.023	0.003	0.973	0.970	0.003

D.6.2 **y17c12**

y17c12		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.999	0.999	0.000	1.007	1.007	0.000	1.028	1.028	0.000	0.983	0.983	0.000
N-1	SEL T1	0.997	0.997	0.002	1.005	1.005	0.002	1.026	1.026	0.001	0.981	0.981	0.002
	CBK T2+T6	1.002	0.996	0.003	1.002	0.999	0.008	1.029	1.033	-0.005	0.985	0.978	0.005
	SEL Shaft Trip T1	0.995	0.992	0.007	1.003	1.002	0.005	1.022	1.030	-0.002	0.979	0.974	0.009
	5L75 REV-ACK	0.997	0.997	0.002	1.006	1.005	0.002	1.027	1.026	0.001	0.981	0.981	0.001
	5L91 ACK-SEL	0.955	0.961	0.038	0.960	0.968	0.039	0.988	1.001	0.026	0.943	0.950	0.033
	5L92 CBK-SEL	1.165	1.001	-0.003	1.192	1.026	-0.018	1.241	1.043	-0.016	1.157	0.989	-0.006
	5L94 CBK-LGN	1.050	1.006	-0.008	1.066	1.032	-0.025	1.109	1.036	-0.008	1.038	0.993	-0.011
	5L96 VAS-SEL	0.975	0.990	0.008	0.982	0.999	0.009	1.004	1.030	-0.002	0.961	0.973	0.010
	5L98 NIC-VAS	0.990	0.992	0.006	0.998	1.002	0.006	1.017	1.031	-0.004	0.974	0.975	0.008
	2L112 NLY-BDY	0.998	0.998	0.000	1.007	1.007	0.000	1.027	1.027	0.000	0.982	0.982	0.000
	2L222 SEV-SEL	0.994	0.998	0.000	1.002	1.008	0.000	1.021	1.027	0.000	0.978	0.982	0.000
	2L258 CBK-INV	0.986	0.986	0.013	0.999	0.999	0.009	1.019	1.019	0.009	0.972	0.972	0.011
	2L277 WAN-NLY	0.998	0.998	0.000	1.006	1.006	0.000	1.027	1.027	0.000	0.982	0.982	0.000
	2L288 KCL-BTS	0.998	0.998	0.000	1.007	1.007	0.000	1.027	1.027	0.000	0.982	0.982	0.000
	2L289 SEL-BTS	0.997	0.997	0.001	1.006	1.006	0.001	1.026	1.027	0.000	0.981	0.982	0.001
	2L293 SEL-NLY	0.998	0.999	0.000	1.007	1.007	0.000	1.028	1.028	0.000	0.983	0.983	0.000
	2L294 CBK-NLY	0.987	0.984	0.015	1.000	0.997	0.011	1.021	1.040	-0.013	0.973	0.964	0.019
	2L295 SEL-KCL	0.997	0.997	0.002	1.005	1.005	0.002	1.026	1.026	0.001	0.981	0.981	0.001
	1L274 NTL-POCATER	0.999	0.997	0.002	1.007	1.005	0.002	1.043	1.034	-0.006	0.989	0.985	-0.003
	1L275 NTL-COLEMAN	0.998	0.996	0.002	1.005	1.003	0.004	1.052	1.039	-0.011	0.986	0.984	-0.001
	5L82 NIC-MDN	0.997	0.997	0.001	1.006	1.006	0.002	1.027	1.027	0.001	0.982	0.982	0.001
N-2	5L76&5L79	0.981	0.998	0.000	0.987	1.007	0.000	1.008	1.027	0.000	0.965	0.983	0.000
	5L91&5L96	1.085	1.017	-0.019	1.101	1.045	-0.037	1.108	1.038	-0.010	1.057	0.998	-0.015
	5L81&5L82	0.997	0.996	0.003	1.005	1.004	0.003	1.027	1.025	0.002	0.981	0.980	0.003
	5L96&5L98	0.981	0.985	0.014	0.988	0.993	0.014	1.009	1.033	-0.006	0.966	0.967	0.016
	5L51&5L52	1.062	1.019	-0.020	1.078	1.045	-0.037	1.122	1.073	-0.046	1.050	1.006	-0.023
	2L288&2L295	0.996	0.996	0.003	1.004	1.004	0.003	1.025	1.026	0.002	0.980	0.980	0.002
	2L289&2L295	0.995	0.996	0.003	1.003	1.006	0.001	1.020	1.025	0.002	0.979	0.980	0.003
	2L295&2L299	0.995	0.996	0.002	1.003	1.005	0.003	1.022	1.026	0.002	0.979	0.981	0.002

D.7 2017 AB to BC transfer (with Chapel Rock)

D.7.1 y17c31

y17c31		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	1.000	1.000	0.000	1.018	1.018	0.000	1.041	1.041	0.000	0.972	0.972	0.000
N-1	SEL T1	0.999	0.999	0.001	1.017	1.017	0.001	1.040	1.040	0.000	0.971	0.971	0.000
	CBK T2+T6	1.005	1.003	-0.003	1.018	1.017	0.000	1.043	1.043	-0.002	0.976	0.974	-0.003
	SEL Shaft Trip T1	1.001	0.998	0.002	1.019	1.016	0.002	1.041	1.039	0.002	0.973	0.970	0.002
	5L75 REV-ACK	0.999	0.999	0.001	1.017	1.017	0.001	1.040	1.040	0.000	0.971	0.971	0.001
	5L91 ACK-SEL	0.993			1.009			1.034			0.965		
	5L92 CBK-SEL	1.024	1.013	-0.013	1.048	1.037	-0.019	1.112	1.050	-0.009	1.006	0.995	-0.024
	5L94 CBK-CHAPR	1.028	1.000	0.000	1.049	1.026	-0.008	1.117	1.036	0.005	1.010	0.983	-0.011
	5L96 VAS-SEL	0.997	1.000	0.000	1.015	1.014	0.004	1.038	1.041	0.000	0.969	0.972	0.000
	5L98 NIC-VAS	1.002	0.998	0.003	1.020	1.014	0.004	1.041	1.039	0.002	0.973	0.970	0.002
	2L112 NLY-BDY	1.000	1.000	0.000	1.017	1.017	0.000	1.040	1.040	0.000	0.971	0.971	0.000
	2L222 SEV-SEL	1.001	0.997	0.003	1.019	1.016	0.002	1.040	1.039	0.002	0.972	0.969	0.003
	2L258 CBK-INV	0.991	0.999	0.002	1.013	1.017	0.001	1.035	1.041	0.000	0.964	0.971	0.000
	2L277 WAN-NLY	1.000	1.000	0.000	1.017	1.017	0.000	1.040	1.040	0.000	0.971	0.971	0.000
	2L288 KCL-BTS	1.000	1.000	0.000	1.018	1.018	0.000	1.041	1.041	0.000	0.972	0.972	0.000
	2L289 SEL-BTS	0.999	0.999	0.001	1.017	1.017	0.001	1.040	1.040	0.000	0.971	0.971	0.001
	2L293 SEL-NLY	1.000	1.001	0.000	1.018	1.018	0.000	1.041	1.041	0.000	0.972	0.972	0.000
	2L294 CBK-NLY	0.993	1.001	0.000	1.014	1.018	0.000	1.036	1.042	-0.001	0.966	0.973	-0.001
	2L295 SEL-KCL	0.999	0.999	0.001	1.017	1.017	0.001	1.040	1.040	0.000	0.971	0.971	0.001
	1L274 NTL-POCATER	1.001	1.000	0.000	1.018	1.017	0.000	1.057	1.043	-0.002	0.979	0.978	-0.007
	1L275 NTL-COLEMAN	1.003	1.001	-0.001	1.019	1.018	0.000	1.089	1.037	0.004	0.985	0.984	-0.012
	5L82 NIC-MDN	1.000	0.999	0.001	1.017	1.017	0.001	1.041	1.040	0.000	0.971	0.971	0.001
N-2	5L76&5L79	1.037	0.998	0.003	1.059	1.025	-0.007	1.127	1.083	-0.042	1.019	0.979	-0.008
	5L91&5L96	1.038	1.000	0.000	1.059	1.029	-0.011	1.083	1.042	0.000	1.006	0.972	0.000
	5L81&5L82	1.000	0.998	0.002	1.017	1.016	0.002	1.039	1.039	0.001	0.971	0.970	0.002
	5L96&5L98	1.000	1.000	0.000	1.017	1.015	0.003	1.040	1.041	0.000	0.971	0.972	0.000
	5L51&5L52	1.029	1.009	-0.009	1.050	1.040	-0.022	1.071	1.049	-0.008	0.998	0.980	-0.008
	2L288&2L295	0.999	0.999	0.002	1.016	1.016	0.002	1.040	1.040	0.001	0.971	0.971	0.001
	2L289&2L295	1.003	0.999	0.002	1.021	1.017	0.000	1.041	1.040	0.001	0.974	0.970	0.001
	2L295&2L299	1.001	1.000	0.000	1.019	1.017	0.001	1.041	1.041	0.000	0.972	0.971	0.000

D.7.2 **y17c32**

y17c32		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	1.013	1.012	0.002	1.028	1.027	0.000	1.024	1.022	0.001	0.998	0.996	0.002
N-1	SEL T1	1.013	1.013	0.000	1.027	1.027	0.000	1.023	1.023	0.000	0.997	0.997	0.000
	CBK T2+T6	1.019	1.017	-0.004	1.027	1.026	0.002	1.027	1.025	-0.001	1.003	1.001	-0.003
	SEL Shaft Trip T1	1.013	1.011	0.003	1.027	1.026	0.002	1.022	1.022	0.002	0.997	0.996	0.002
	5L75 REV-ACK	1.013	1.013	0.000	1.027	1.027	0.000	1.023	1.023	0.000	0.997	0.997	0.000
	5L91 ACK-SEL	0.996	1.001	0.013	1.009	1.012	0.016	1.009	1.016	0.007	0.982	0.988	0.010
	5L92 CBK-SEL	1.086	1.018	-0.004	1.111	1.042	-0.015	1.120	1.048	-0.024	1.073	1.005	-0.007
	5L94 CBK-LGN	1.038	1.011	0.002	1.057	1.036	-0.008	1.069	1.041	-0.017	1.025	0.998	0.000
	5L96 VAS-SEL	1.004	1.013	0.000	1.017	1.026	0.002	1.014	1.024	0.000	0.989	0.998	0.000
	5L98 NIC-VAS	1.011	1.014	0.000	1.024	1.027	0.000	1.020	1.024	0.000	0.995	0.998	0.000
	2L112 NLY-BDY	1.013	1.011	0.002	1.027	1.027	0.001	1.023	1.022	0.002	0.998	0.996	0.002
	2L222 SEV-SEL	1.012	1.014	0.000	1.026	1.029	-0.002	1.021	1.024	0.000	0.997	0.998	0.000
	2L258 CBK-INV	1.004	1.010	0.004	1.023	1.026	0.002	1.018	1.022	0.002	0.990	0.995	0.003
	2L277 WAN-NLY	1.013	1.011	0.002	1.027	1.026	0.001	1.023	1.022	0.002	0.998	0.996	0.002
	2L288 KCL-BTS	1.013	1.012	0.002	1.027	1.027	0.001	1.024	1.022	0.001	0.998	0.996	0.002
	2L289 SEL-BTS	1.013	1.013	0.000	1.027	1.027	0.000	1.023	1.023	0.000	0.997	0.997	0.000
	2L293 SEL-NLY	1.014	1.012	0.001	1.028	1.027	0.000	1.024	1.023	0.000	0.998	0.997	0.001
	2L294 CBK-NLY	1.007	1.013	0.000	1.024	1.027	0.000	1.020	1.024	0.000	0.992	0.998	0.000
	2L295 SEL-KCL	1.013	1.013	0.000	1.027	1.027	0.000	1.023	1.023	0.000	0.997	0.997	0.000
	1L274 NTL-POCATER	1.014	1.013	0.000	1.027	1.027	0.001	1.039	1.031	-0.008	1.005	1.002	-0.004
	1L275 NTL-COLEMAN	1.014	1.013	0.000	1.027	1.026	0.001	1.044	1.042	-0.019	1.001	0.999	-0.001
	5L82 NIC-MDN	1.013	1.013	0.000	1.027	1.027	0.000	1.023	1.023	0.000	0.997	0.997	0.000
N-2	5L76&5L79	1.006	1.010	0.003	1.020	1.024	0.004	1.016	1.021	0.002	0.991	0.995	0.003
	5L91&5L96	1.059	1.018	-0.004	1.077	1.044	-0.017	1.072	1.028	-0.005	1.040	1.002	-0.004
	5L81&5L82	1.012	1.012	0.002	1.026	1.026	0.002	1.023	1.023	0.001	0.997	0.997	0.001
	5L96&5L98	1.007	1.011	0.003	1.020	1.024	0.004	1.017	1.023	0.001	0.991	0.996	0.002
	5L51&5L52	1.050	1.021	-0.007	1.069	1.047	-0.019	1.081	1.026	-0.002	1.036	1.008	-0.010
	2L288&2L295	1.012	1.012	0.002	1.026	1.026	0.002	1.023	1.023	0.000	0.997	0.997	0.001
	2L289&2L295	1.014	1.012	0.002	1.028	1.028	0.000	1.022	1.022	0.001	0.998	0.996	0.002
	2L295&2L299	1.013	1.010	0.003	1.027	1.025	0.003	1.022	1.021	0.002	0.997	0.995	0.003

D.8 2022 AB to BC transfer

D.8.1 y22c31

y22c31		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.998	0.998	0.000	1.024	1.024	0.000	1.038	1.038	0.000	0.970	0.970	0.000
N-1	SEL T1	0.997	0.997	0.000	1.023	1.023	0.000	1.038	1.038	0.000	0.969	0.969	0.000
	CBK T2+T6	1.015	1.013	-0.015	1.030	1.027	-0.003	1.049	1.041	-0.003	0.985	0.984	-0.014
	SEL Shaft Trip T1	0.999	0.997	0.001	1.025	1.023	0.001	1.038	1.038	0.000	0.970	0.969	0.000
	5L75 REV-ACK	0.997	0.997	0.001	1.023	1.023	0.001	1.037	1.037	0.000	0.969	0.969	0.001
	5L91 ACK-SEL	0.992			1.018			1.032			0.965		
	5L92 CBK-SEL	0.960	1.028	-0.030	0.983	1.051	-0.027	1.043	1.119	-0.081	0.943	1.011	-0.041
	5L94 CBK-LGN	1.011	1.003	-0.005	1.039	1.029	-0.005	1.101	1.092	-0.053	0.995	0.986	-0.016
	5L96 VAS-SEL	0.994	0.994	0.005	1.020	1.017	0.007	1.035	1.036	0.002	0.967	0.967	0.003
	5L98 NIC-VAS	0.999	0.997	0.001	1.025	1.023	0.001	1.039	1.037	0.001	0.971	0.969	0.001
	2L112 NLY-BDY	0.998	0.998	0.000	1.024	1.024	0.000	1.038	1.038	0.000	0.970	0.970	0.000
	2L222 SEV-SEL	0.998	0.997	0.001	1.024	1.023	0.002	1.037	1.037	0.001	0.970	0.969	0.001
	2L258 CBK-INV	0.989	0.994	0.004	1.019	1.022	0.003	1.032	1.036	0.002	0.962	0.967	0.003
	2L277 WAN-NLY	0.998	0.998	0.000	1.024	1.024	0.000	1.038	1.038	0.000	0.970	0.970	0.000
	2L288 KCL-BTS	0.998	0.998	0.000	1.024	1.024	0.000	1.038	1.038	0.000	0.970	0.970	0.000
	2L289 SEL-BTS	0.997	0.997	0.000	1.023	1.024	0.000	1.038	1.038	0.000	0.969	0.969	0.000
	2L293 SEL-NLY	0.998	0.998	0.000	1.024	1.024	0.000	1.039	1.038	0.000	0.970	0.970	0.000
	2L294 CBK-NLY	0.990	0.995	0.004	1.020	1.022	0.002	1.033	1.037	0.001	0.963	0.968	0.002
	2L295 SEL-KCL	0.997	0.997	0.000	1.023	1.023	0.000	1.038	1.038	0.000	0.969	0.969	0.000
	1L274 NTL-POCATER	0.999	0.998	0.000	1.024	1.024	0.000	1.054	1.040	-0.002	0.977	0.977	-0.007
	1L275 NTL-COLEMAN	1.002	1.002	-0.003	1.025	1.025	0.000	1.091	1.040	-0.002	0.985	0.986	-0.016
	5L82 NIC-MDN	0.998	0.997	0.000	1.024	1.023	0.000	1.038	1.038	0.000	0.970	0.969	0.000
N-2	5L76&5L79	1.015	1.005	-0.006	1.043	1.031	-0.007	1.105	1.094	-0.055	0.998	0.988	-0.018
	5L91&5L96	1.032	1.014	-0.016	1.062	1.044	-0.019	1.077	1.049	-0.011	1.001	0.984	-0.014
	5L81&5L82	0.996	0.996	0.002	1.022	1.022	0.002	1.035	1.037	0.001	0.968	0.969	0.001
	5L96&5L98	0.997	0.994	0.005	1.022	1.019	0.005	1.037	1.035	0.003	0.969	0.966	0.004
	5L51&5L52	1.024	1.019	-0.021	1.054	1.050	-0.026	1.067	1.053	-0.015	0.994	0.988	-0.018
	2L288&2L295	0.997	0.997	0.001	1.023	1.023	0.001	1.037	1.037	0.000	0.969	0.969	0.001
	2L289&2L295	1.000	0.998	0.000	1.027	1.024	0.000	1.039	1.039	0.000	0.972	0.970	0.000
	2L295&2L299	0.999	0.996	0.002	1.025	1.022	0.002	1.038	1.037	0.001	0.970	0.969	0.001

D.8.2 **y22c32**

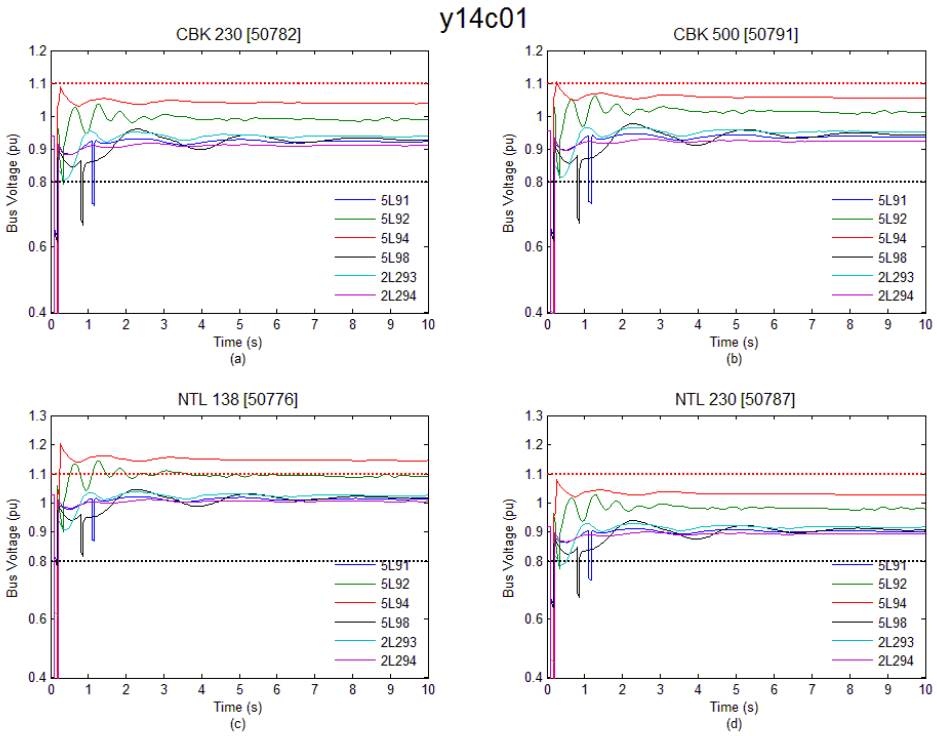
y22c32		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	1.013	1.013	0.000	1.028	1.028	0.000	1.022	1.022	0.000	0.993	0.993	0.000
N-1	SEL T1	1.012	1.013	0.000	1.027	1.028	0.000	1.022	1.023	0.000	0.992	0.994	0.000
	CBK T2+T6	1.019	1.017	-0.005	1.028	1.027	0.001	1.026	1.025	-0.002	0.999	0.997	-0.004
	SEL Shaft Trip T1	1.012	1.012	0.001	1.027	1.027	0.001	1.020	1.022	0.000	0.992	0.992	0.000
	5L75 REV-ACK	1.012	1.013	0.000	1.027	1.028	0.000	1.022	1.023	0.000	0.992	0.994	0.000
	5L91 ACK-SEL	1.000	1.008	0.005	1.015	1.020	0.008	1.011	1.027	-0.005	0.982	0.988	0.005
	5L92 CBK-SEL	1.080	1.007	0.005	1.104	1.032	-0.004	1.128	1.027	-0.004	1.067	0.995	-0.002
	5L94 CBK-LGN	1.037	1.010	0.002	1.056	1.035	-0.007	1.082	1.030	-0.008	1.024	0.998	-0.005
	5L96 VAS-SEL	1.003	1.013	0.000	1.018	1.027	0.002	1.013	1.023	-0.001	0.985	0.994	0.000
	5L98 NIC-VAS	1.010	1.014	-0.001	1.025	1.028	0.000	1.019	1.024	-0.001	0.990	0.994	-0.001
	2L112 NLY-BDY	1.012	1.014	0.000	1.028	1.029	0.000	1.022	1.023	0.000	0.993	0.994	0.000
	2L222 SEV-SEL	1.011	1.014	-0.002	1.027	1.030	-0.002	1.020	1.023	-0.001	0.992	0.995	-0.002
	2L258 CBK-INV	1.003	1.011	0.002	1.023	1.027	0.001	1.016	1.022	0.000	0.985	0.992	0.001
	2L277 WAN-NLY	1.012	1.012	0.000	1.028	1.028	0.000	1.022	1.022	0.000	0.993	0.993	0.000
	2L288 KCL-BTS	1.012	1.012	0.000	1.028	1.028	0.000	1.022	1.022	0.000	0.993	0.993	0.000
	2L289 SEL-BTS	1.012	1.012	0.000	1.028	1.028	0.000	1.022	1.022	0.000	0.993	0.993	0.000
	2L293 SEL-NLY	1.012	1.013	0.000	1.028	1.028	0.000	1.022	1.023	0.000	0.993	0.993	0.000
	2L294 CBK-NLY	1.005	1.014	0.000	1.024	1.028	0.000	1.018	1.023	-0.001	0.987	0.994	-0.001
	2L295 SEL-KCL	1.012	1.013	0.000	1.027	1.028	0.000	1.022	1.023	0.000	0.993	0.994	0.000
	1L274 NTL-POCATER	1.013	1.013	0.000	1.028	1.028	0.000	1.037	1.030	-0.008	1.000	0.998	-0.005
	1L275 NTL-COLEMAN	1.015	1.013	0.000	1.029	1.028	0.000	1.060	1.032	-0.010	1.003	1.001	-0.008
	5L82 NIC-MDN	1.012	1.013	0.000	1.028	1.028	0.000	1.022	1.023	0.000	0.993	0.994	0.000
N-2	5L76&5L79	1.007	1.012	0.000	1.022	1.027	0.001	1.015	1.022	0.000	0.987	0.993	0.000
	5L91&5L96	1.055	1.015	-0.002	1.074	1.042	-0.014	1.068	1.025	-0.002	1.032	0.995	-0.002
	5L81&5L82	1.012	1.013	0.000	1.027	1.027	0.000	1.022	1.022	0.000	0.992	0.993	0.000
	5L96&5L98	1.006	1.014	-0.001	1.021	1.026	0.002	1.016	1.024	-0.002	0.987	0.995	-0.002
	5L51&5L52	1.048	1.021	-0.008	1.068	1.047	-0.019	1.095	1.041	-0.018	1.036	1.009	-0.016
	2L288&2L295	1.011	1.013	0.000	1.027	1.028	0.000	1.021	1.023	0.000	0.992	0.993	0.000
	2L289&2L295	1.013	1.014	0.000	1.029	1.029	0.000	1.021	1.023	0.000	0.993	0.994	0.000
	2L295&2L299	1.012	1.011	0.001	1.028	1.027	0.002	1.021	1.021	0.000	0.993	0.992	0.001

E. TRANSIENT STABILITY PERFORMANCE PLOTS - VOLTAGES

Selected transient stability responses to single and double contingencies listed in Appendix B are displayed below.

E.1 Y14 Cases

E.1.1 **y14c01**



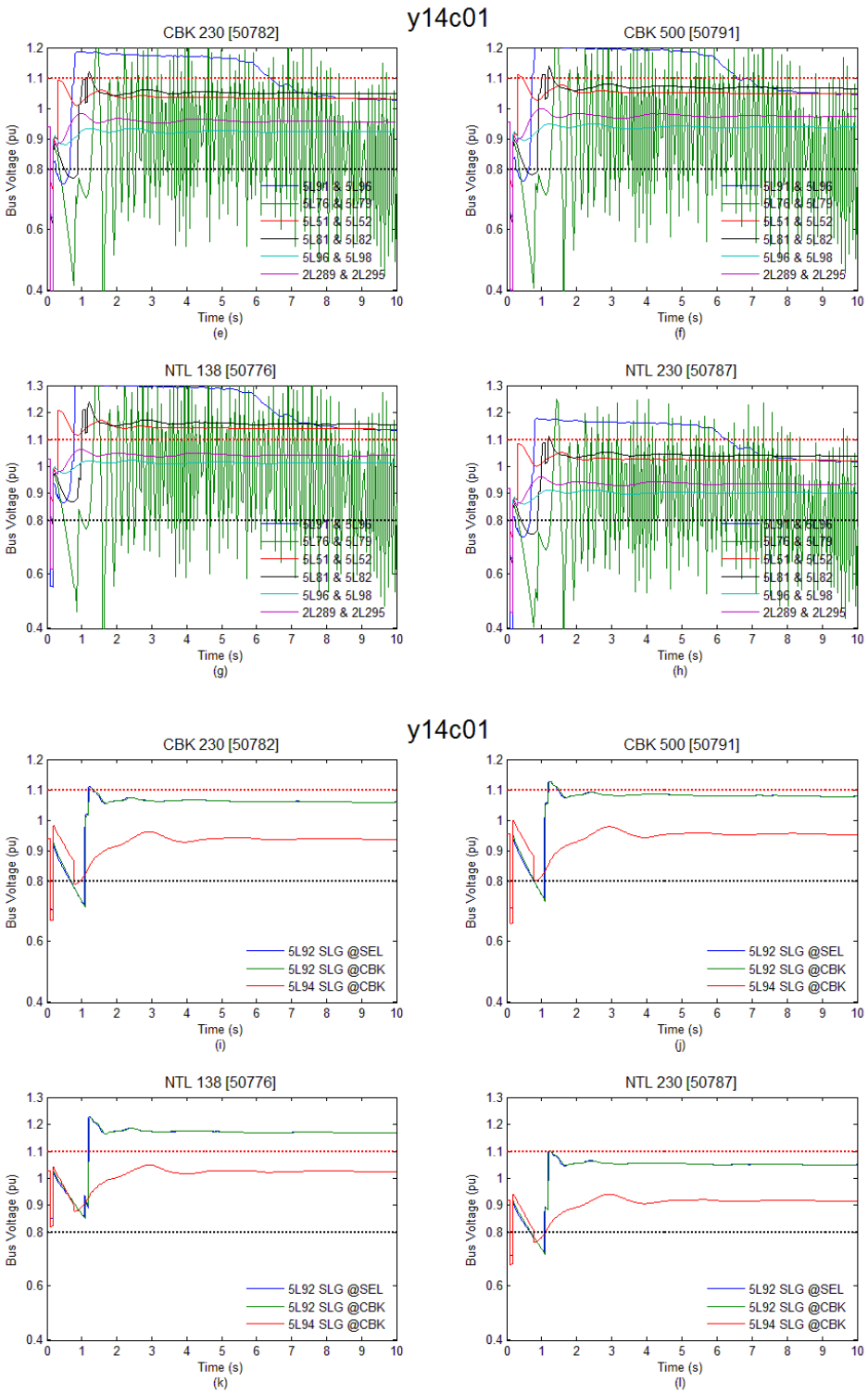
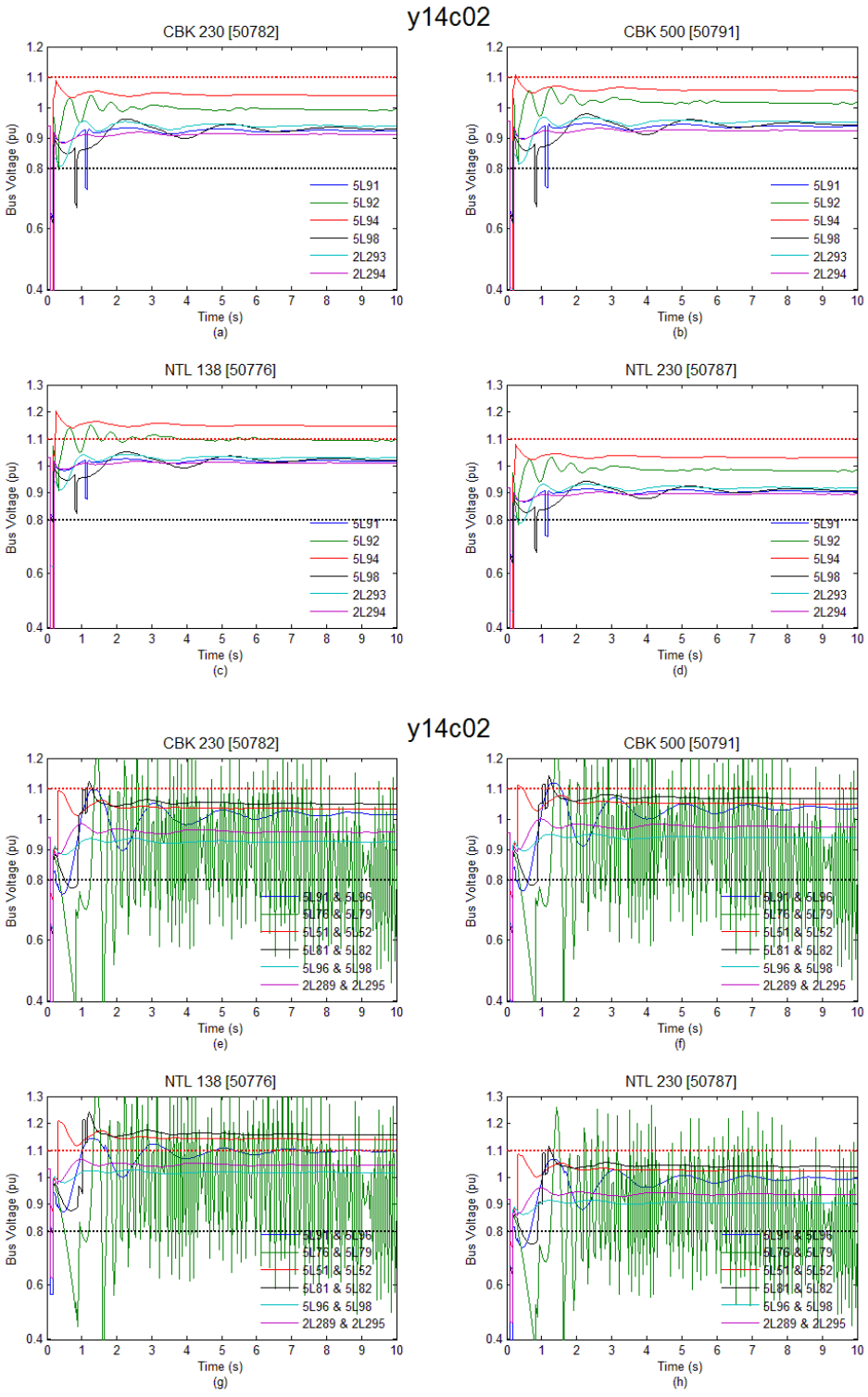


Figure E-1 y14c01 N-1, N-2 and Single Pole Reclose Contingency

E.1.2 **y14c02**



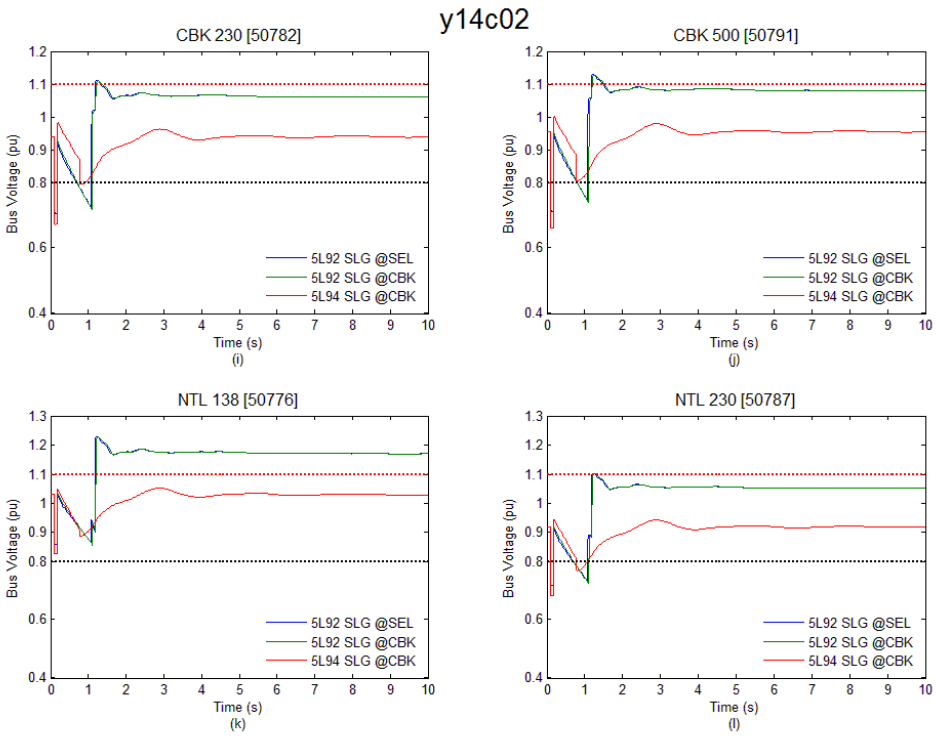
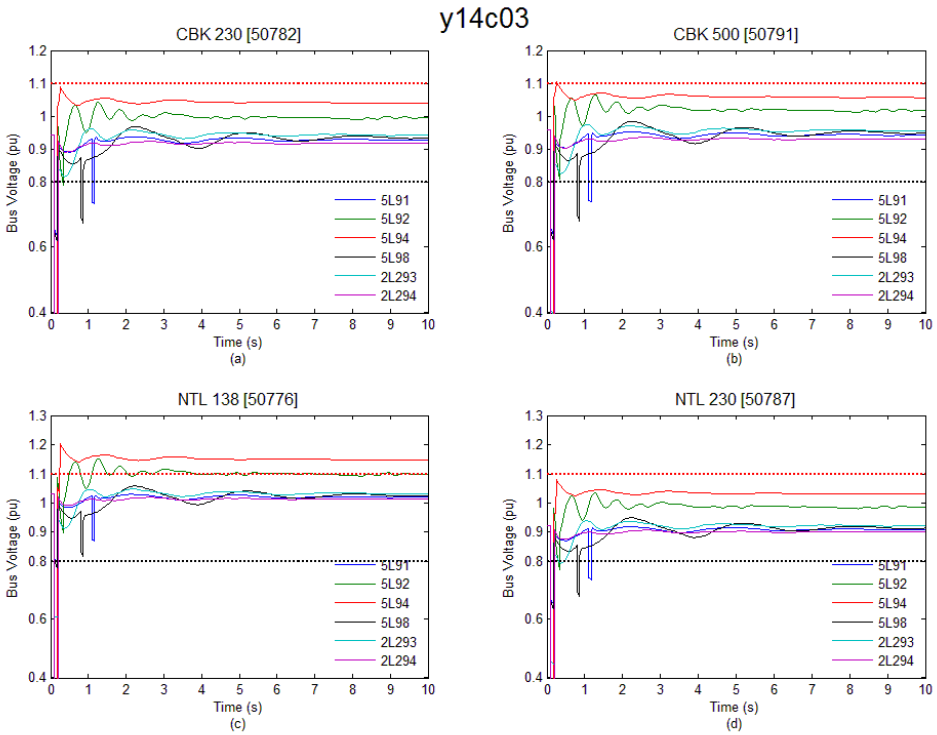


Figure E-2 y14c02 N-1, N-2 and Single Pole Reclose Contingency

E.1.3 **y14c03**



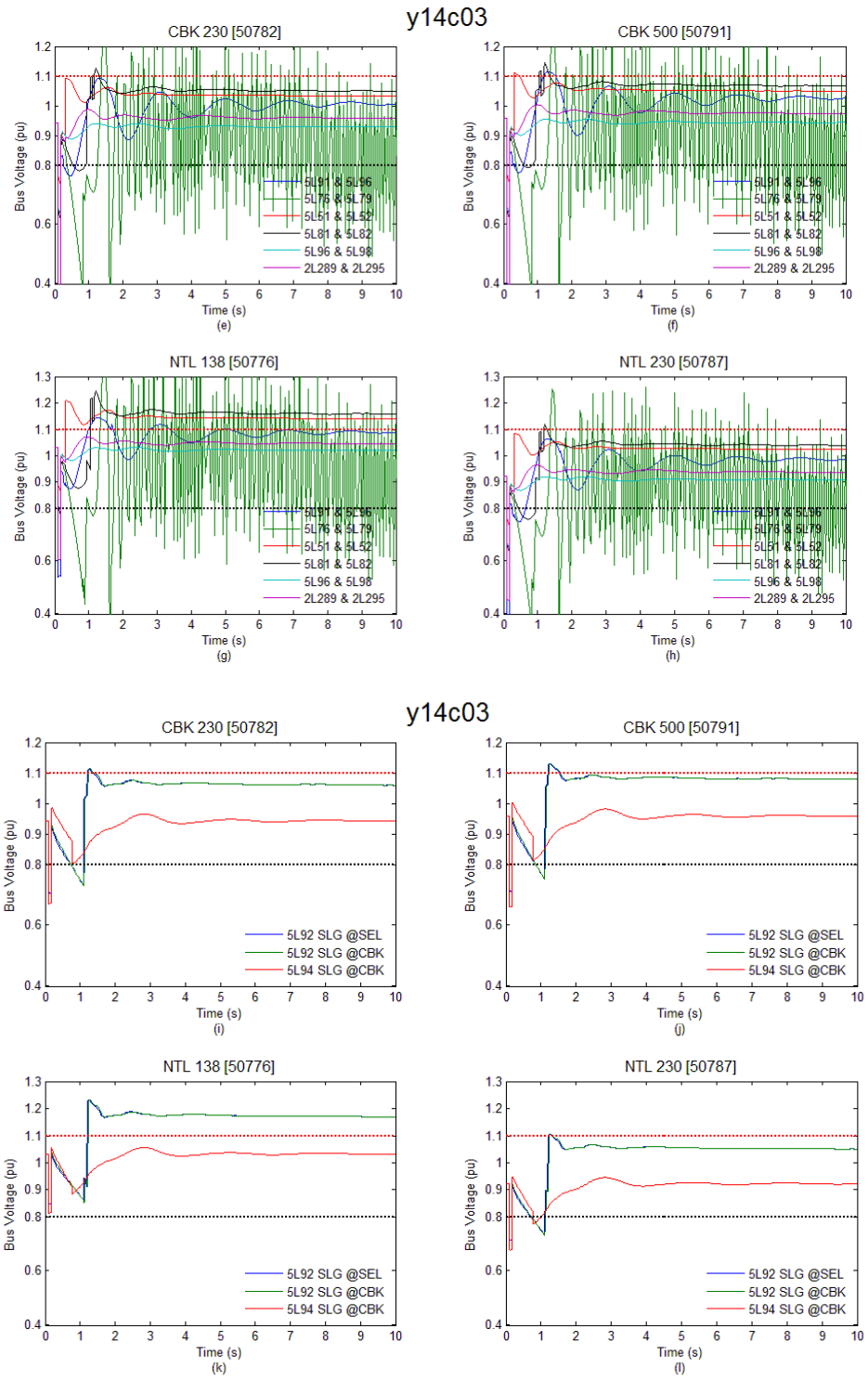
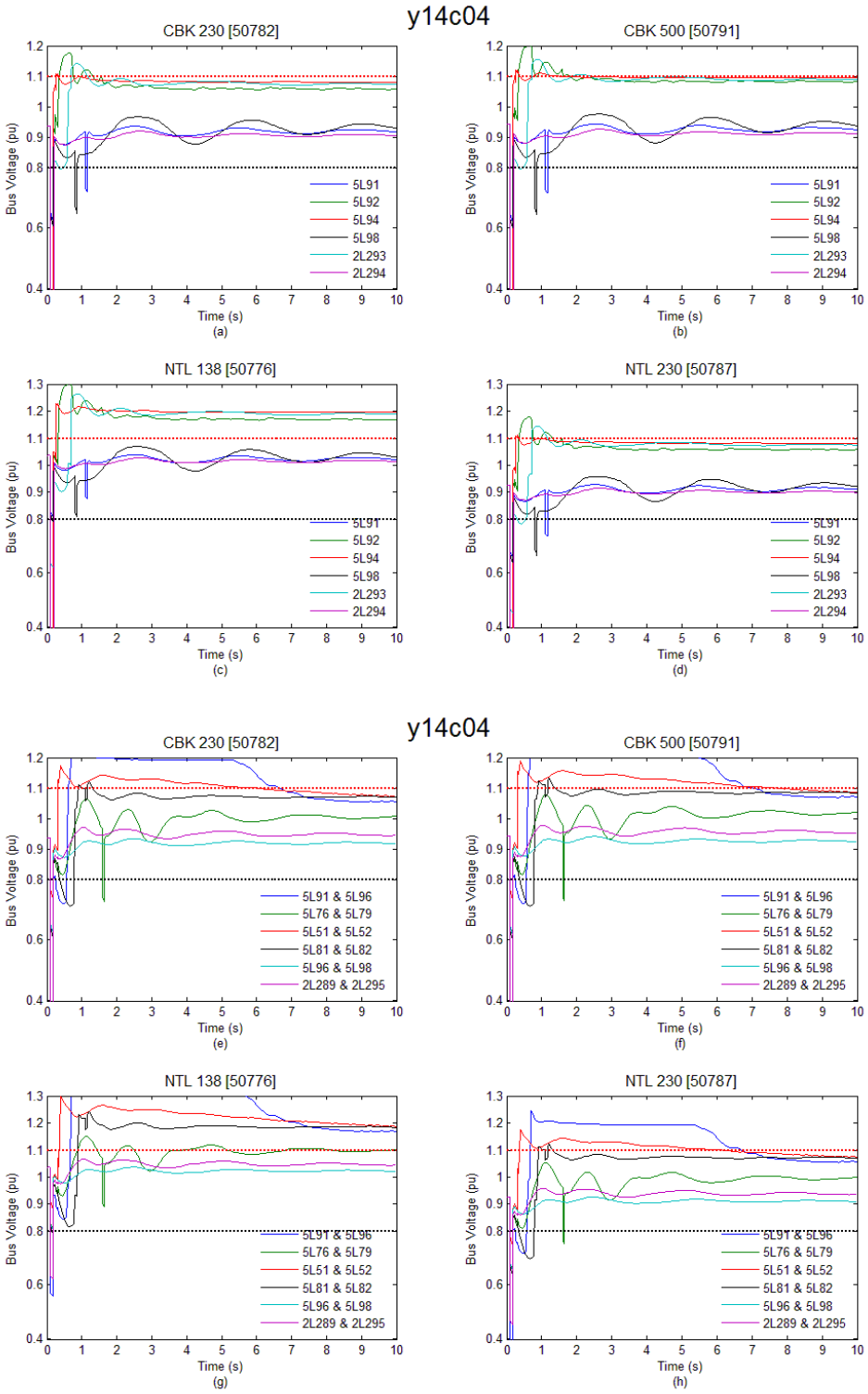


Figure E-3 y14c03 N-1, N-2 and Single Pole Reclose Contingency

E.1.4 **y14c04**



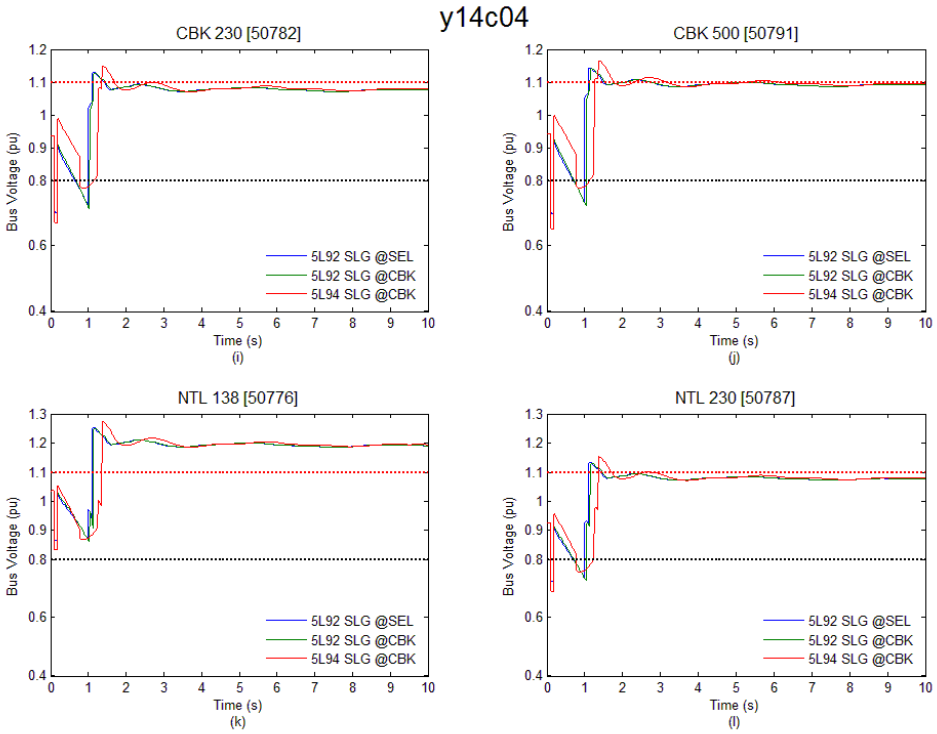
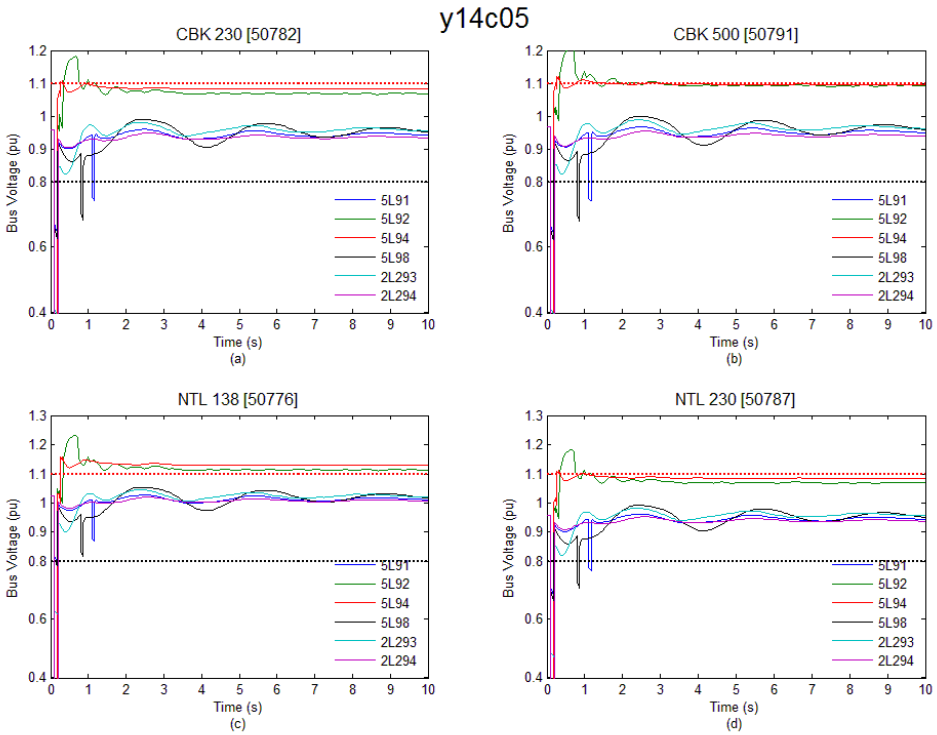


Figure E-4 y14c04 N-1, N-2 and Single Pole Reclose Contingency

E.1.5 **y14c05**



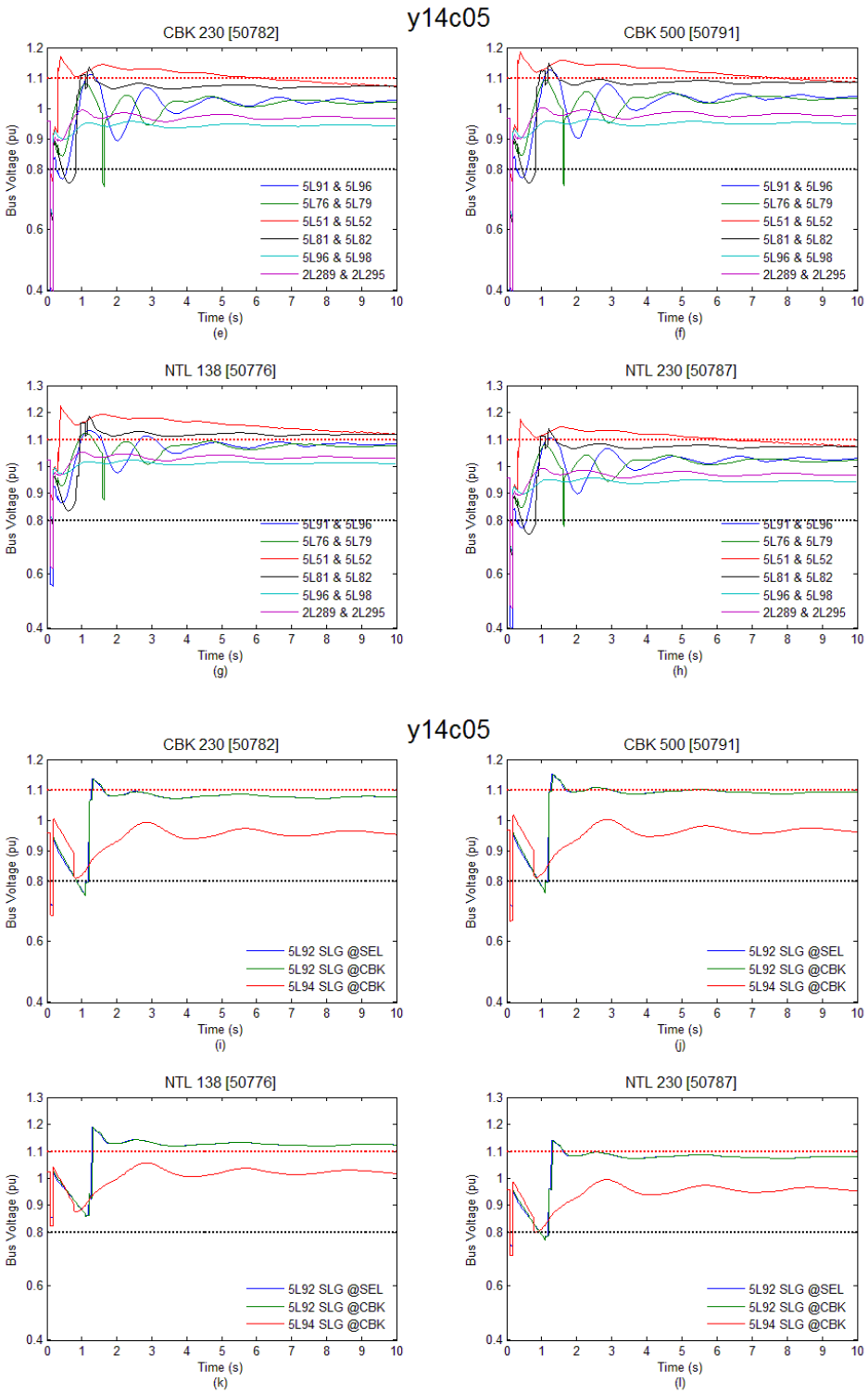
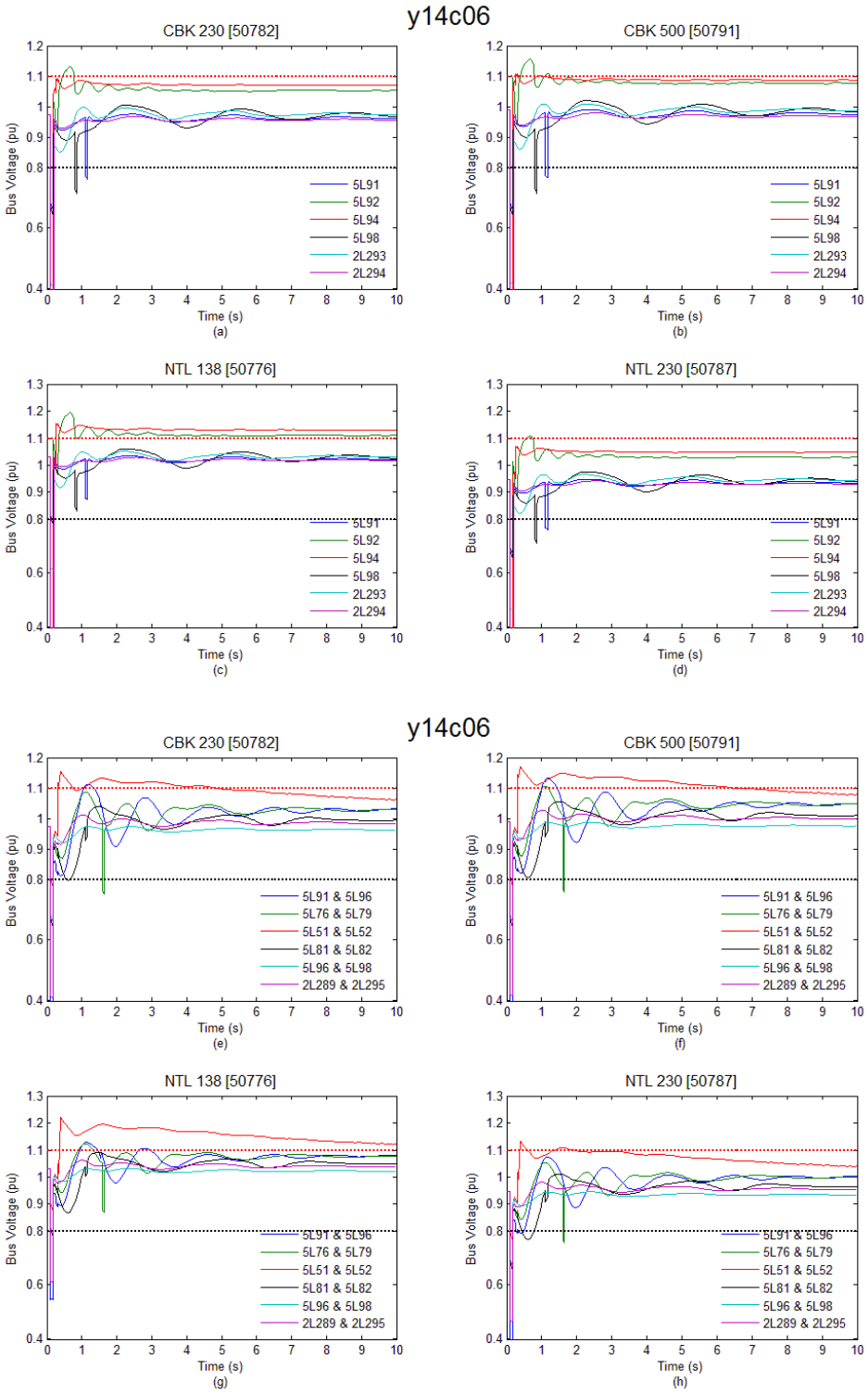


Figure E-5 y14c05 N-1, N-2 and Single Pole Reclose Contingency

E.1.6 **y14c06**



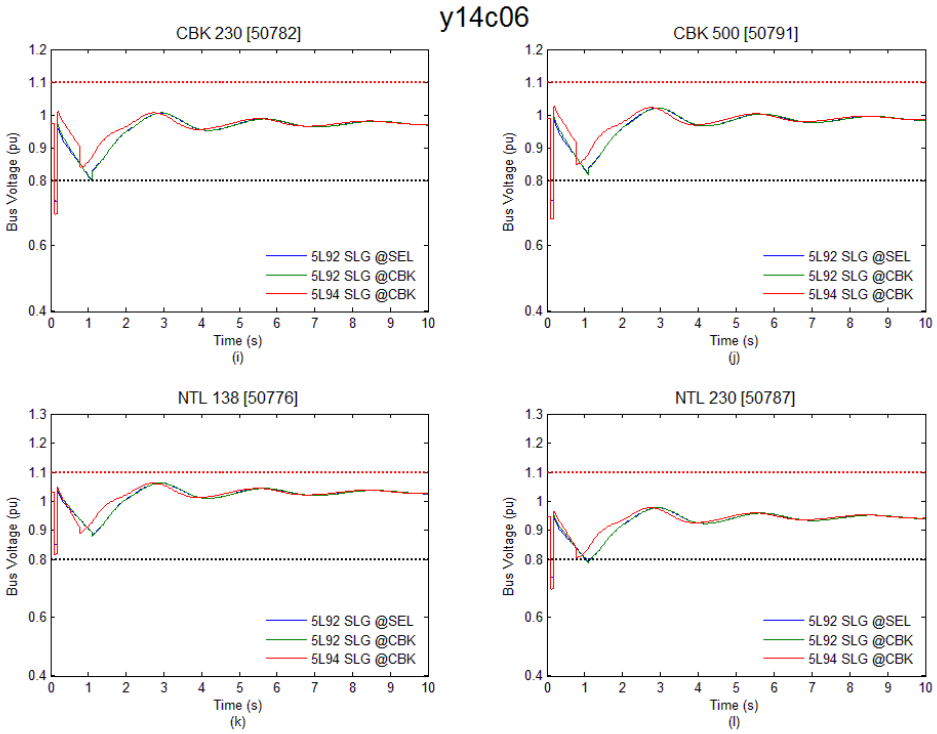
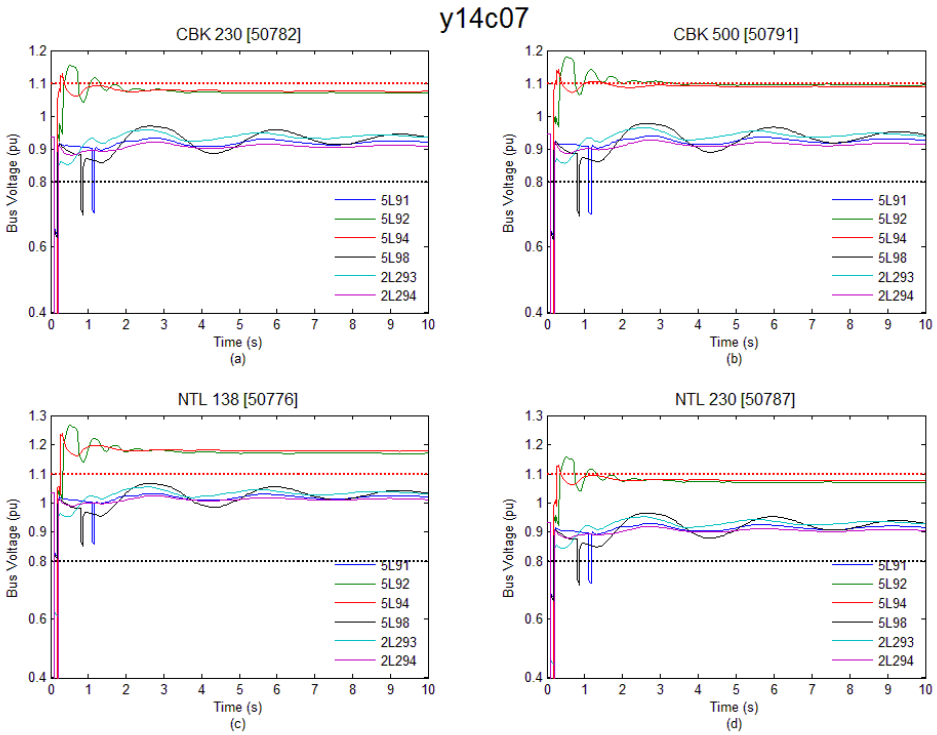


Figure E-6 y14c06 N-1, N-2 and Single Pole Reclose Contingency

E.1.7 **y14c07**



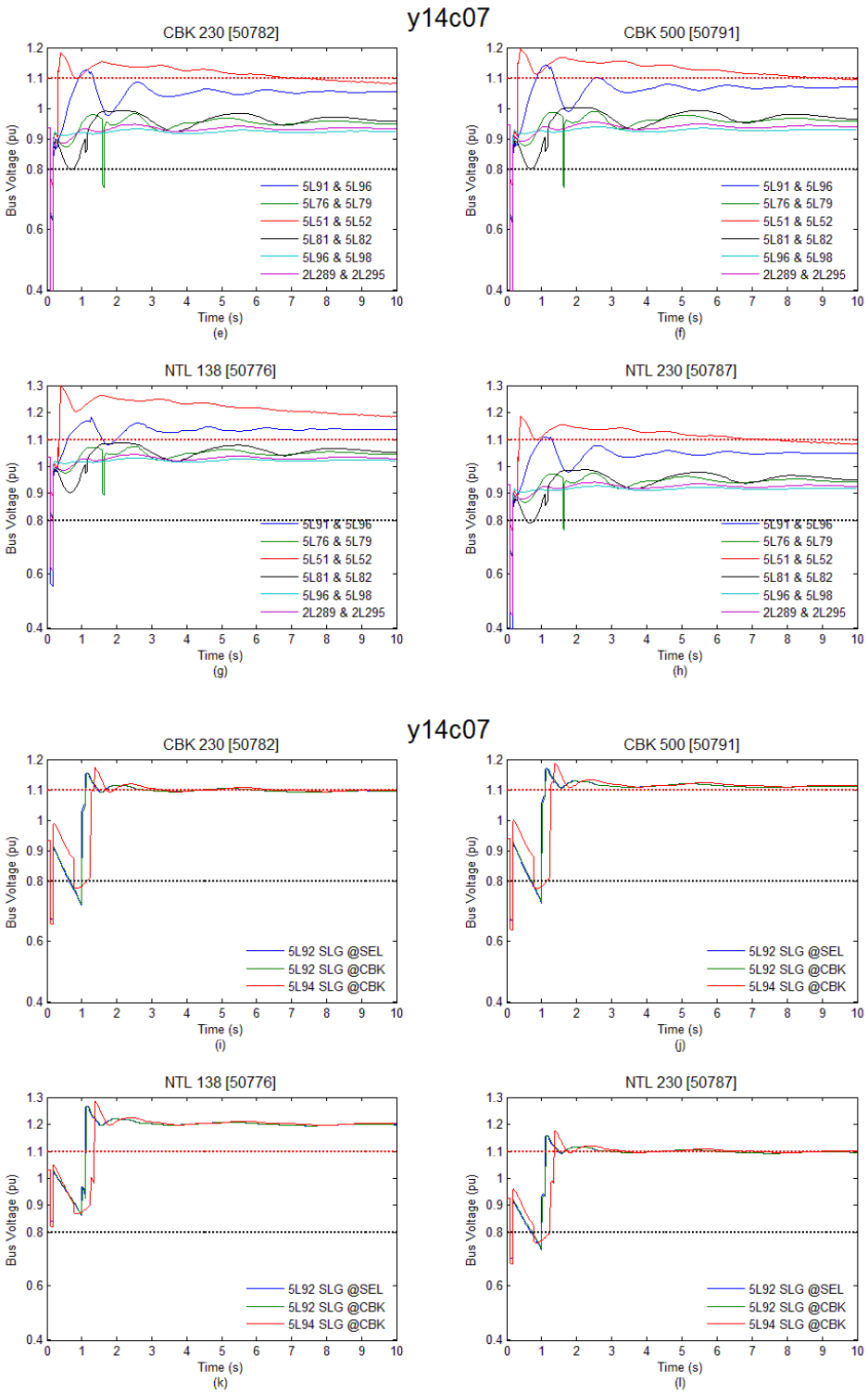
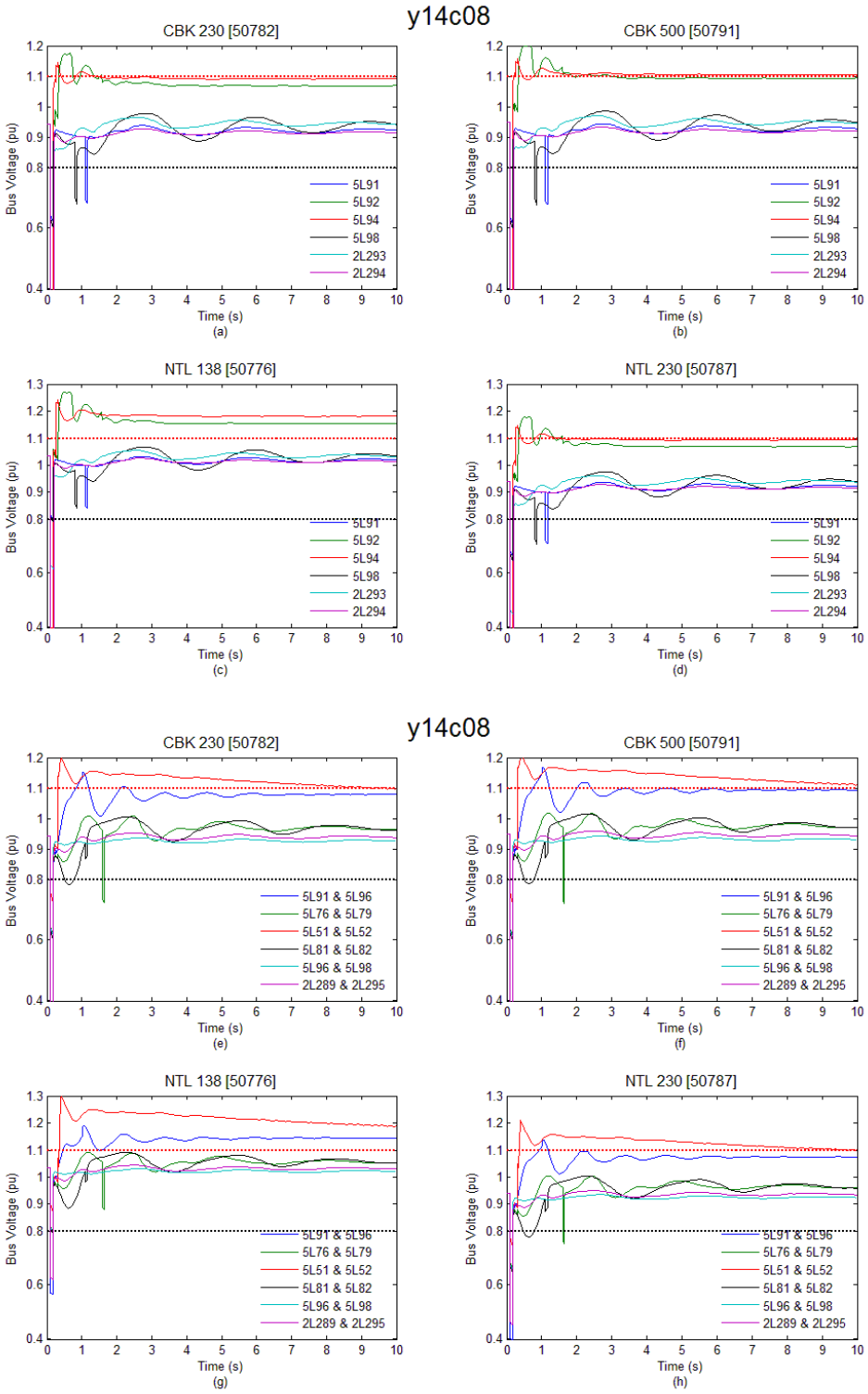


Figure E-7 y14c07 N-1, N-2 and Single Pole Reclose Contingency

E.1.8 **y14c08**



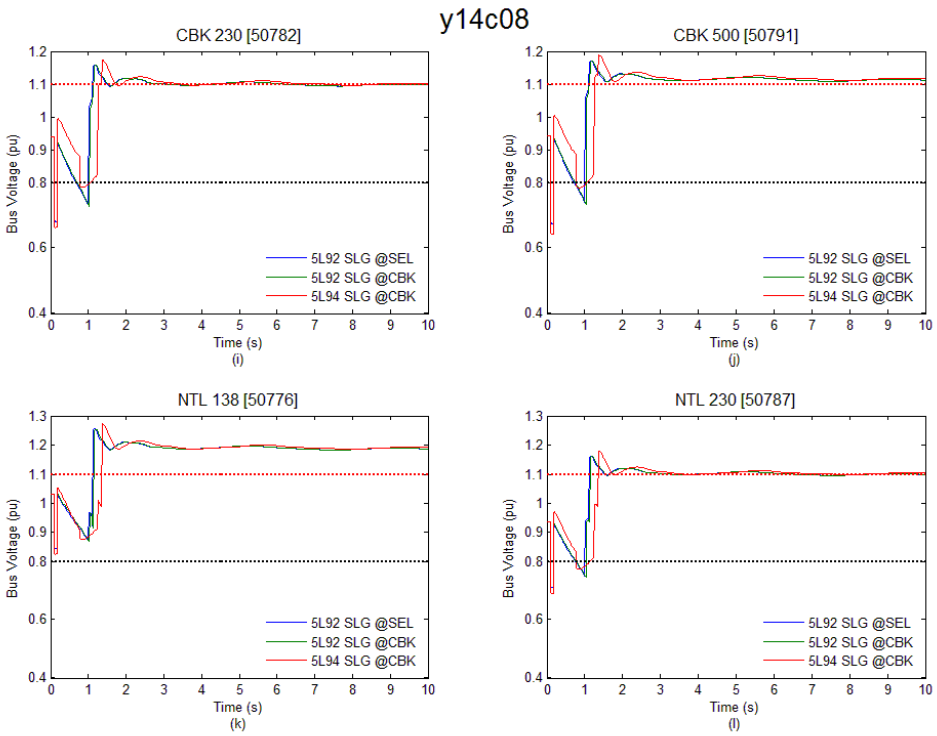
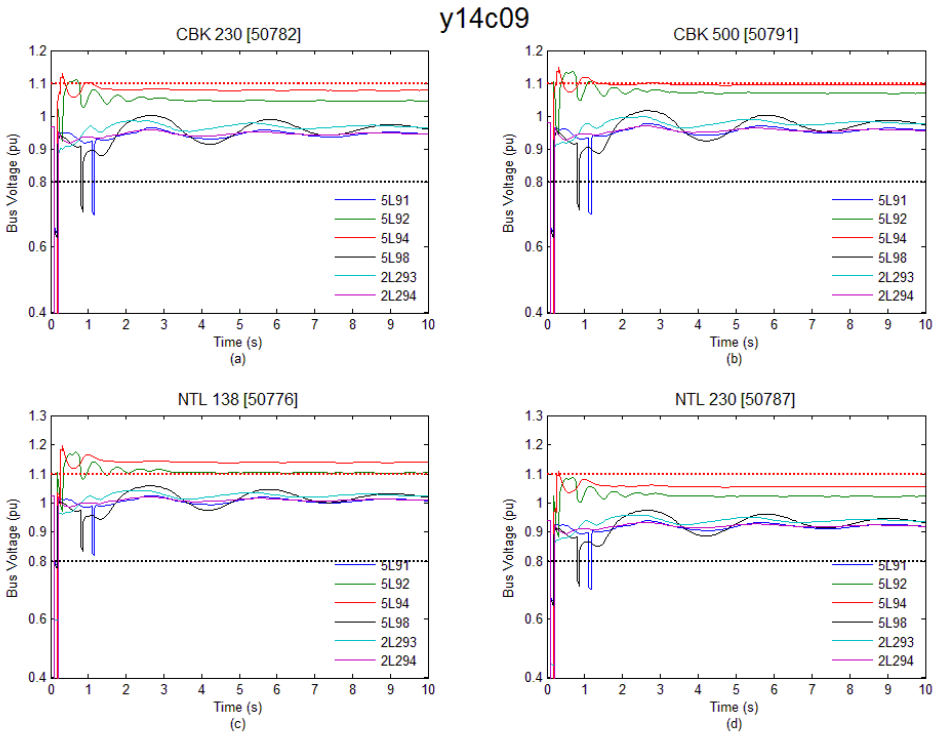


Figure E-8 y14c08 N-1, N-2 and Single Pole Reclose Contingency

E.1.9 **y14c09**



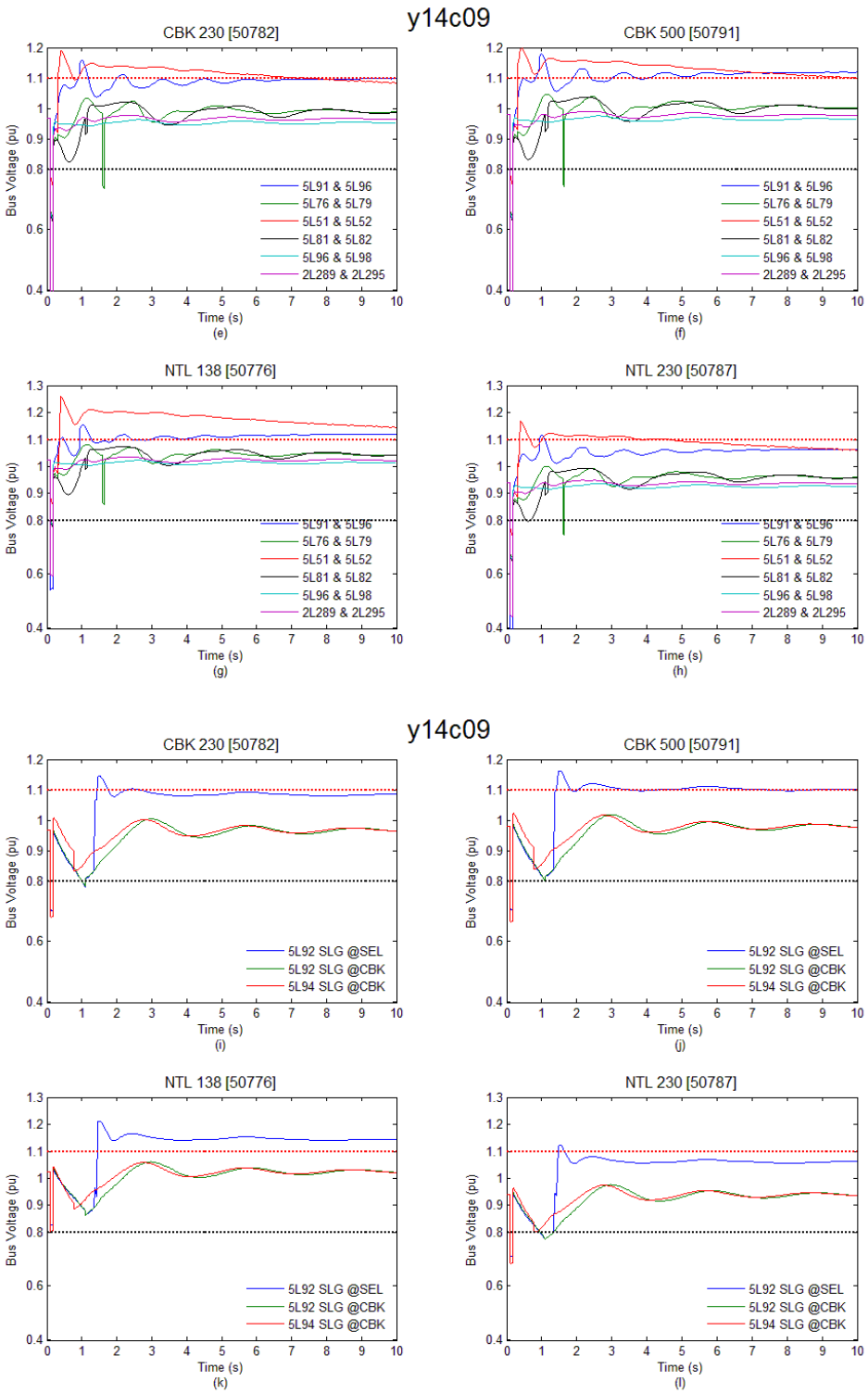
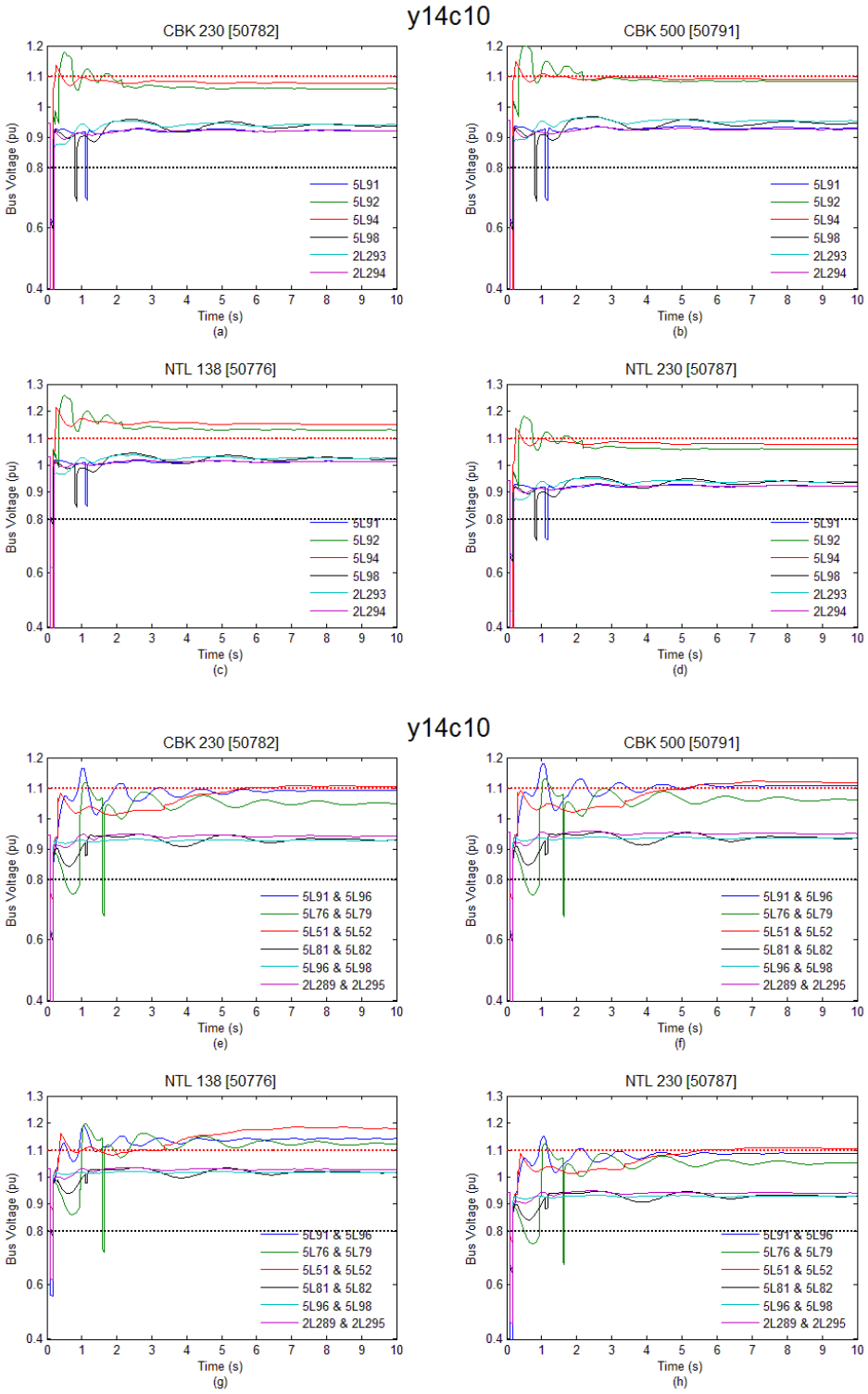


Figure E-9 y14c09 N-1, N-2 and Single Pole Reclose Contingency

E.1.10 **y14c10**



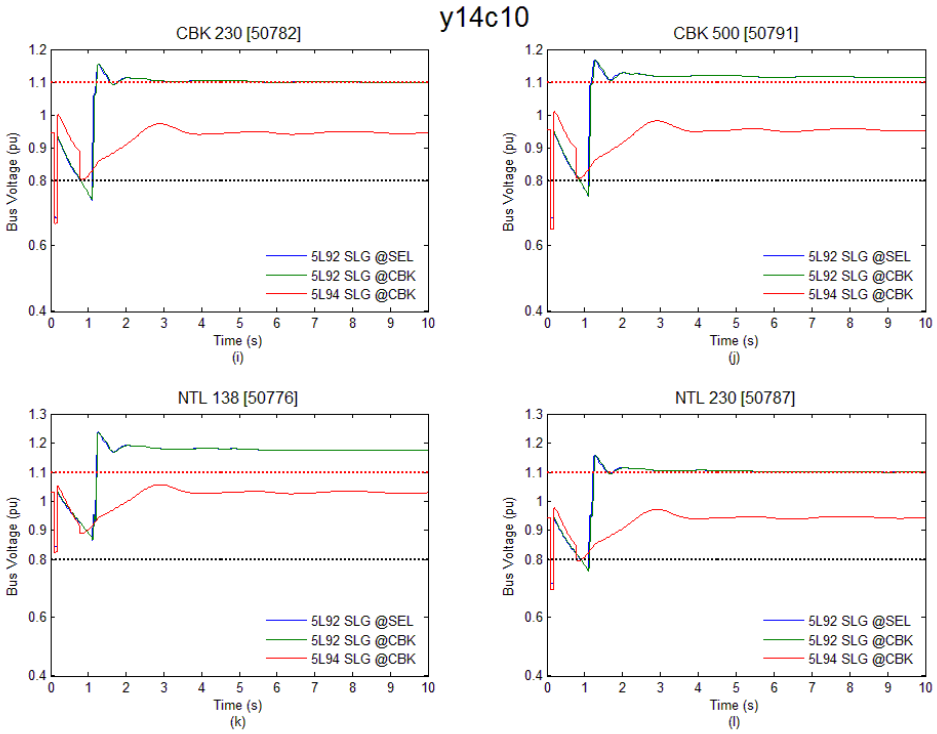
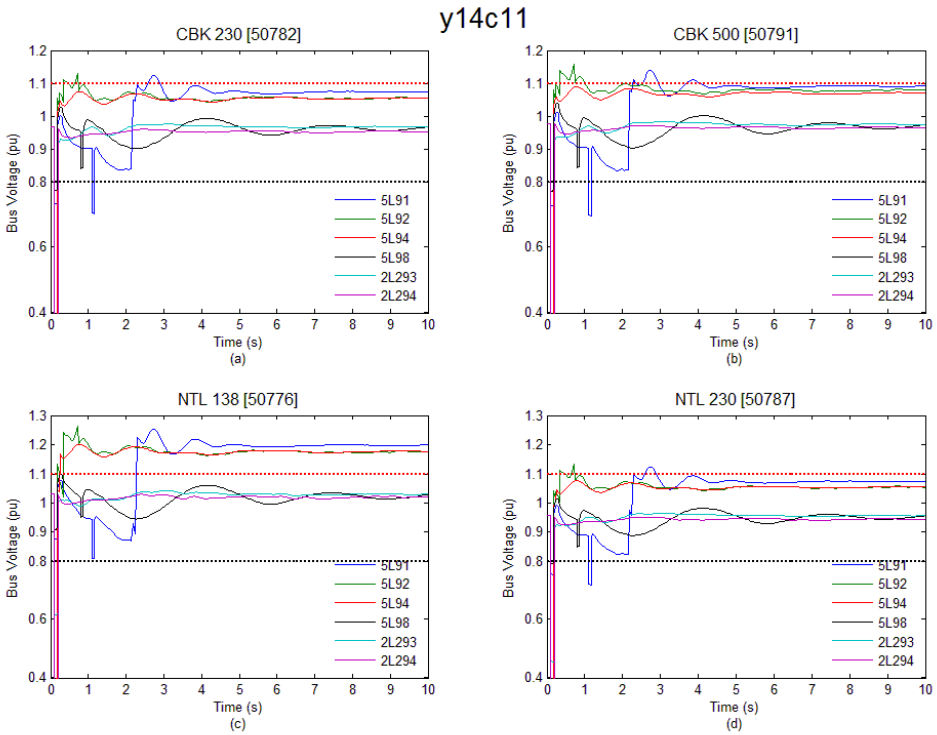


Figure E-10 y14c10 N-1, N-2 and Single Pole Reclose Contingency

E.1.11 **y14c11**



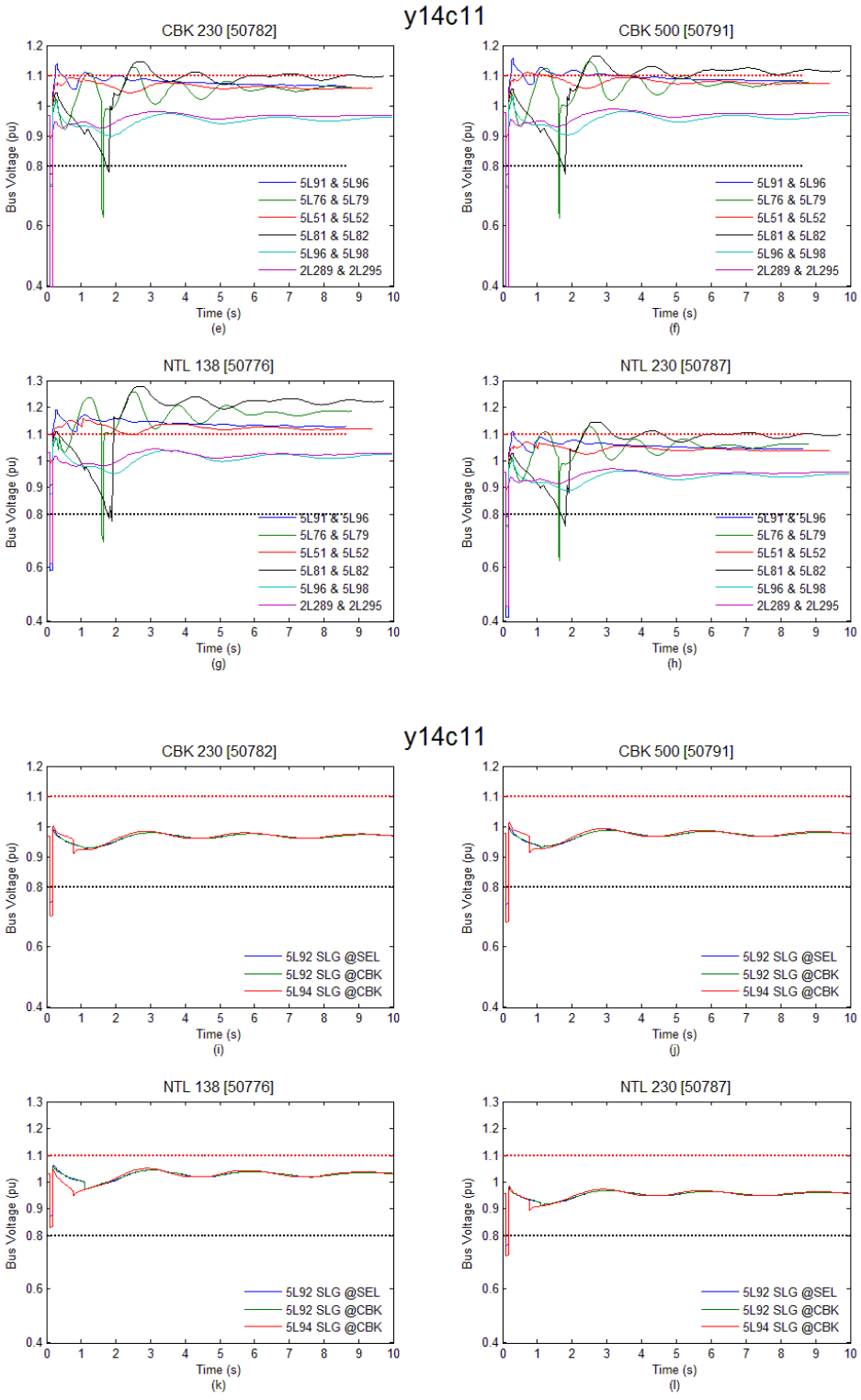
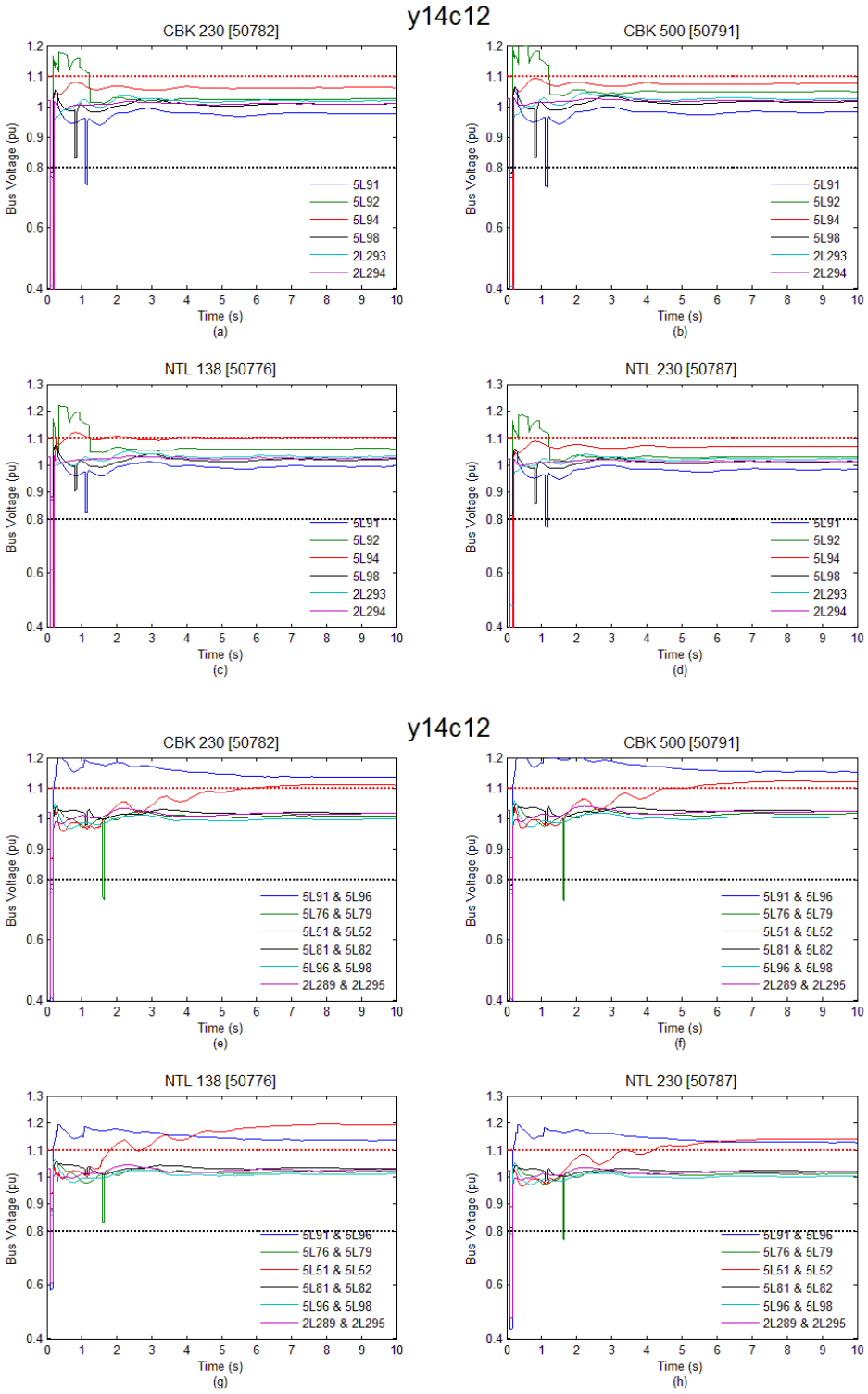


Figure E-11 y14c11 N-1, N-2 and Single Pole Reclose Contingency

E.1.12 **y14c12**



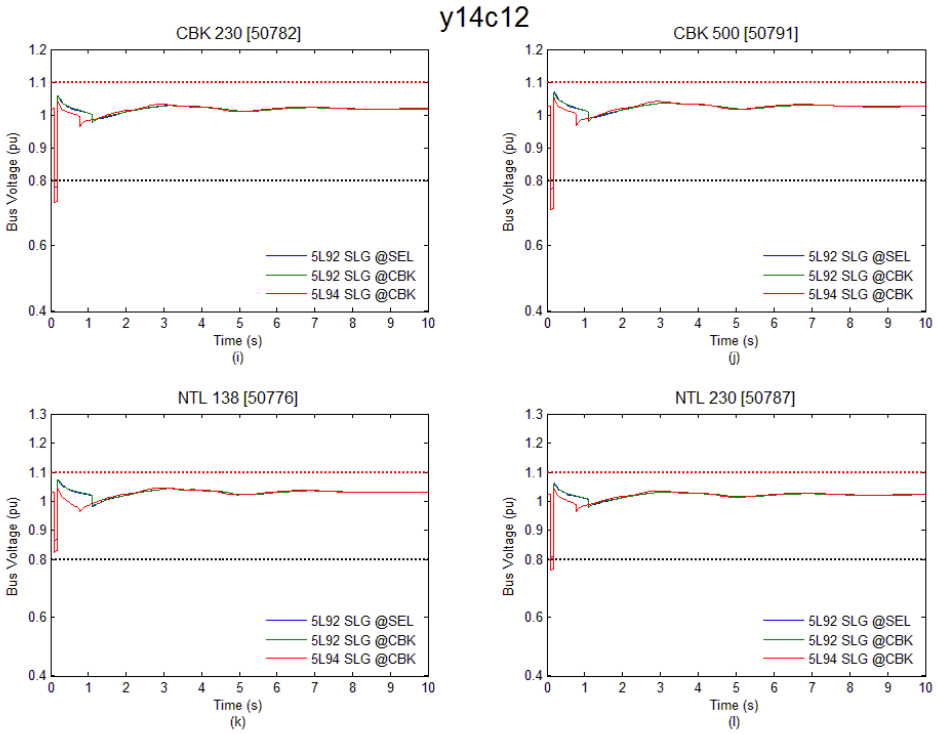
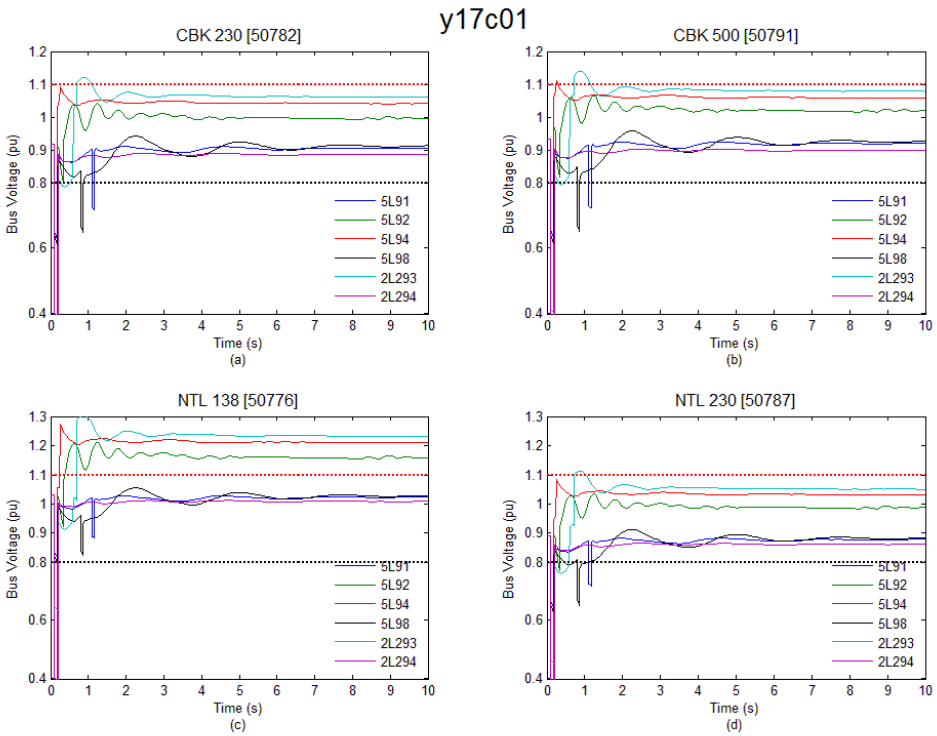


Figure E-12 y14c12 N-1, N-2 and Single Pole Reclose Contingency

E.2 Y17 Cases (No Chapel Rock)

E.2.1 **y17c01**



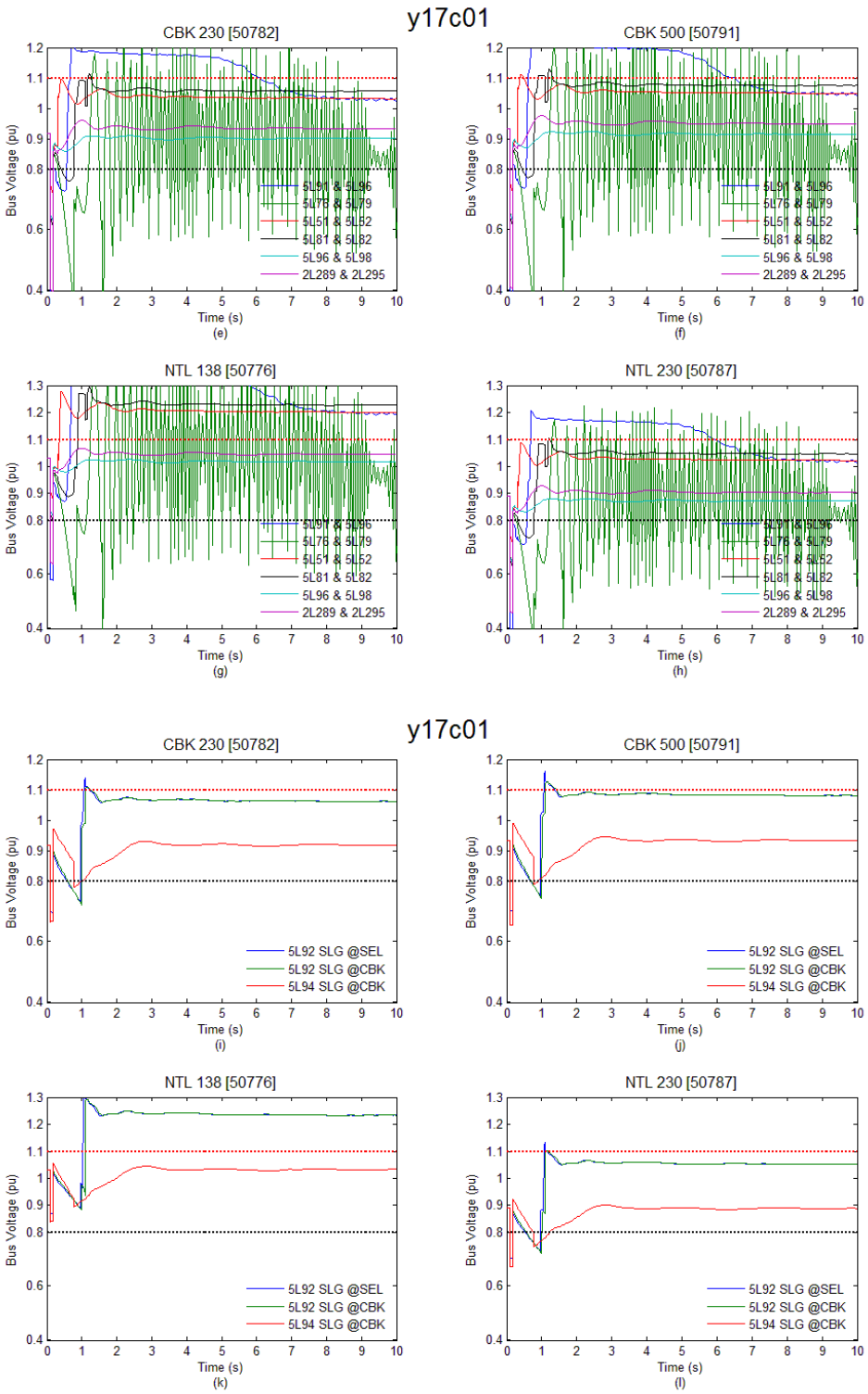
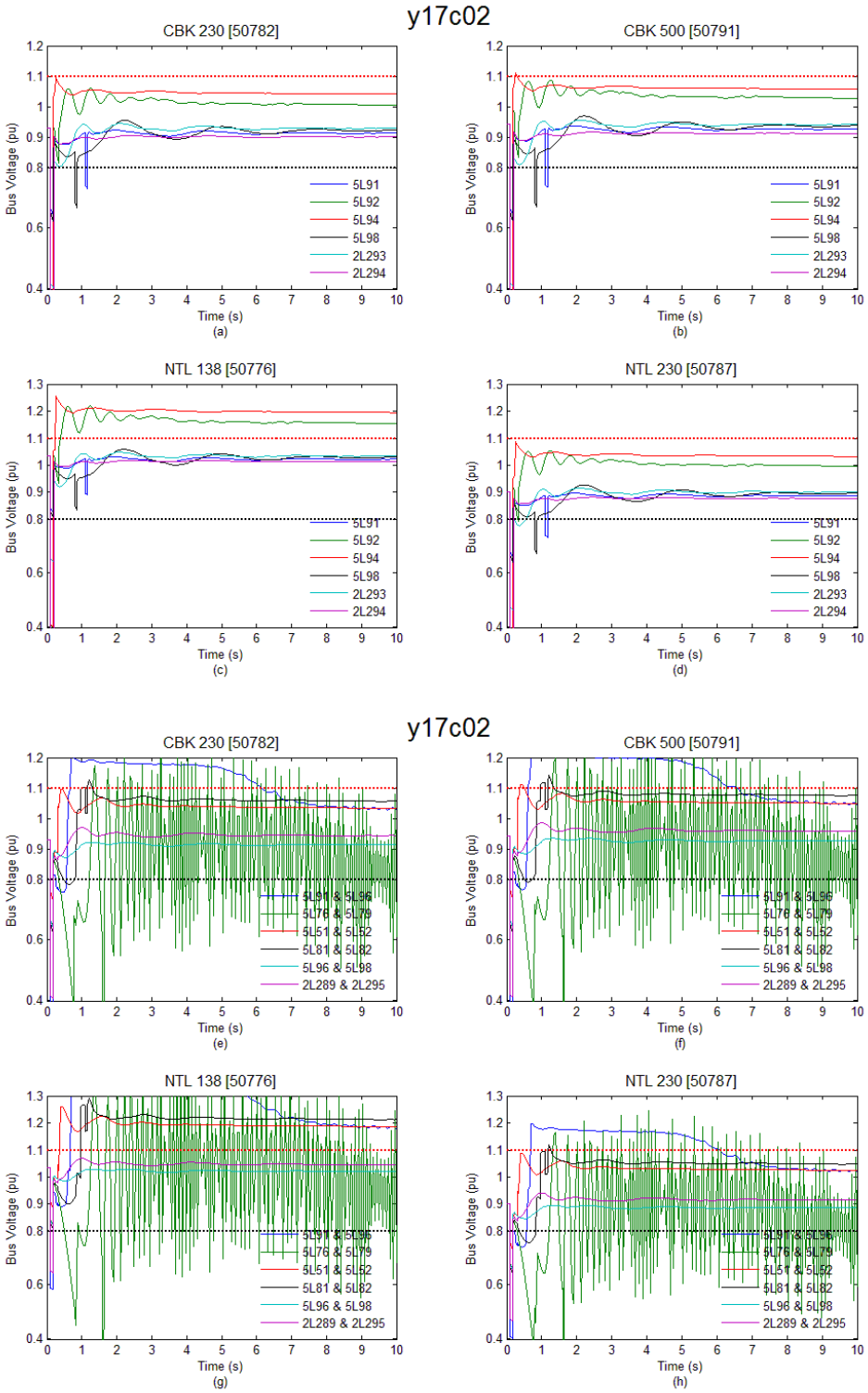


Figure E-13 y17c01 N-1, N-2 and Single Pole Reclose Contingency

E.2.2 **y17c02**



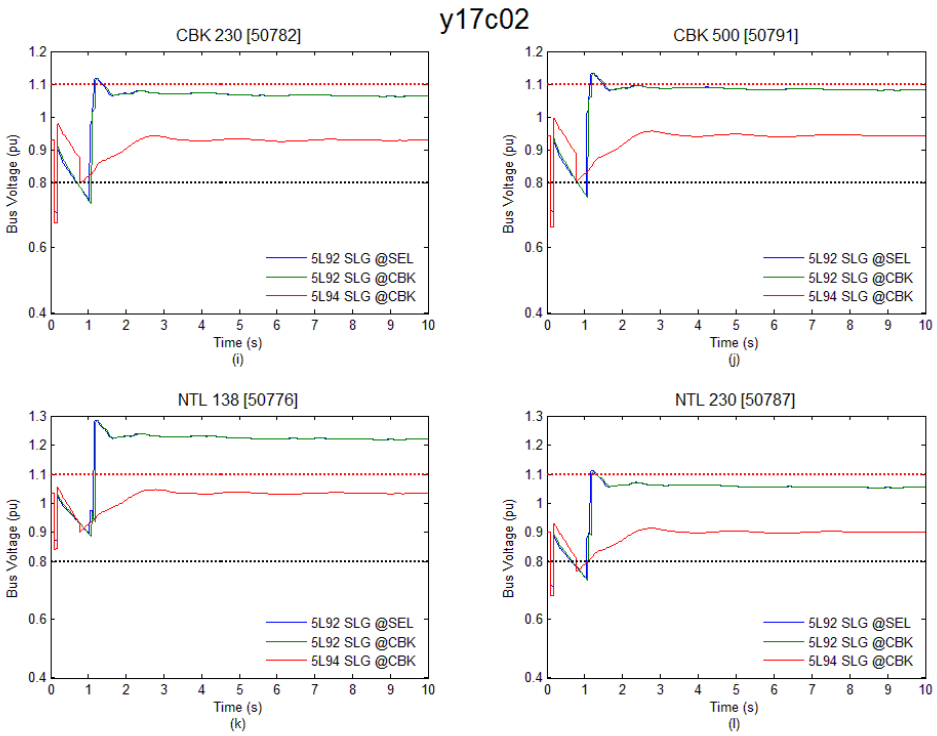
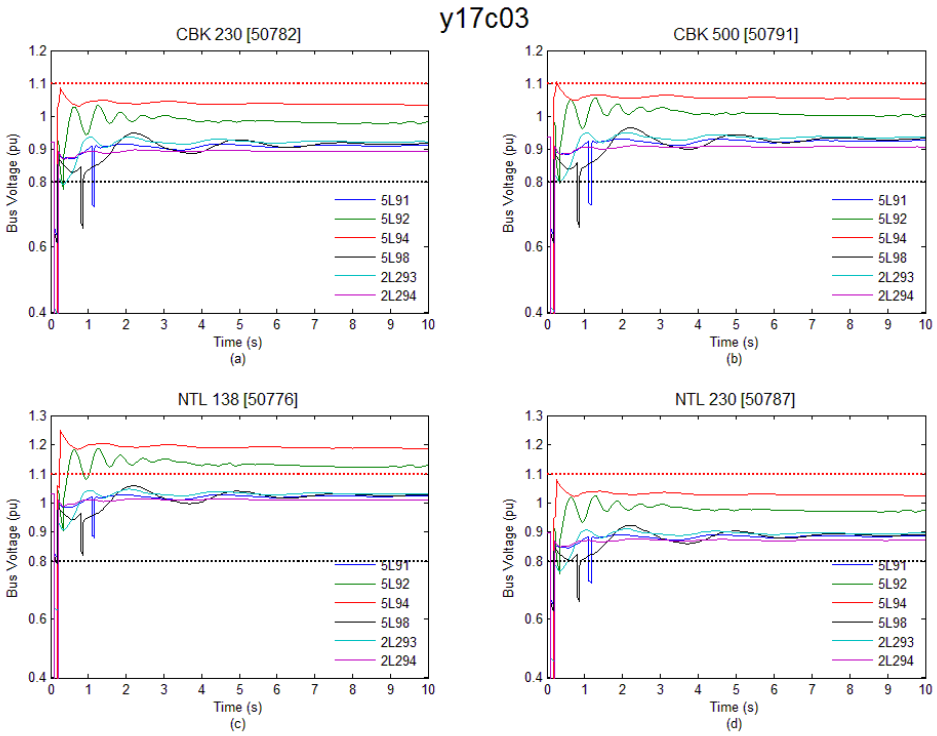


Figure E-14 y17c02 N-1, N-2 and Single Pole Reclose Contingency

E.2.3 **y17c03**



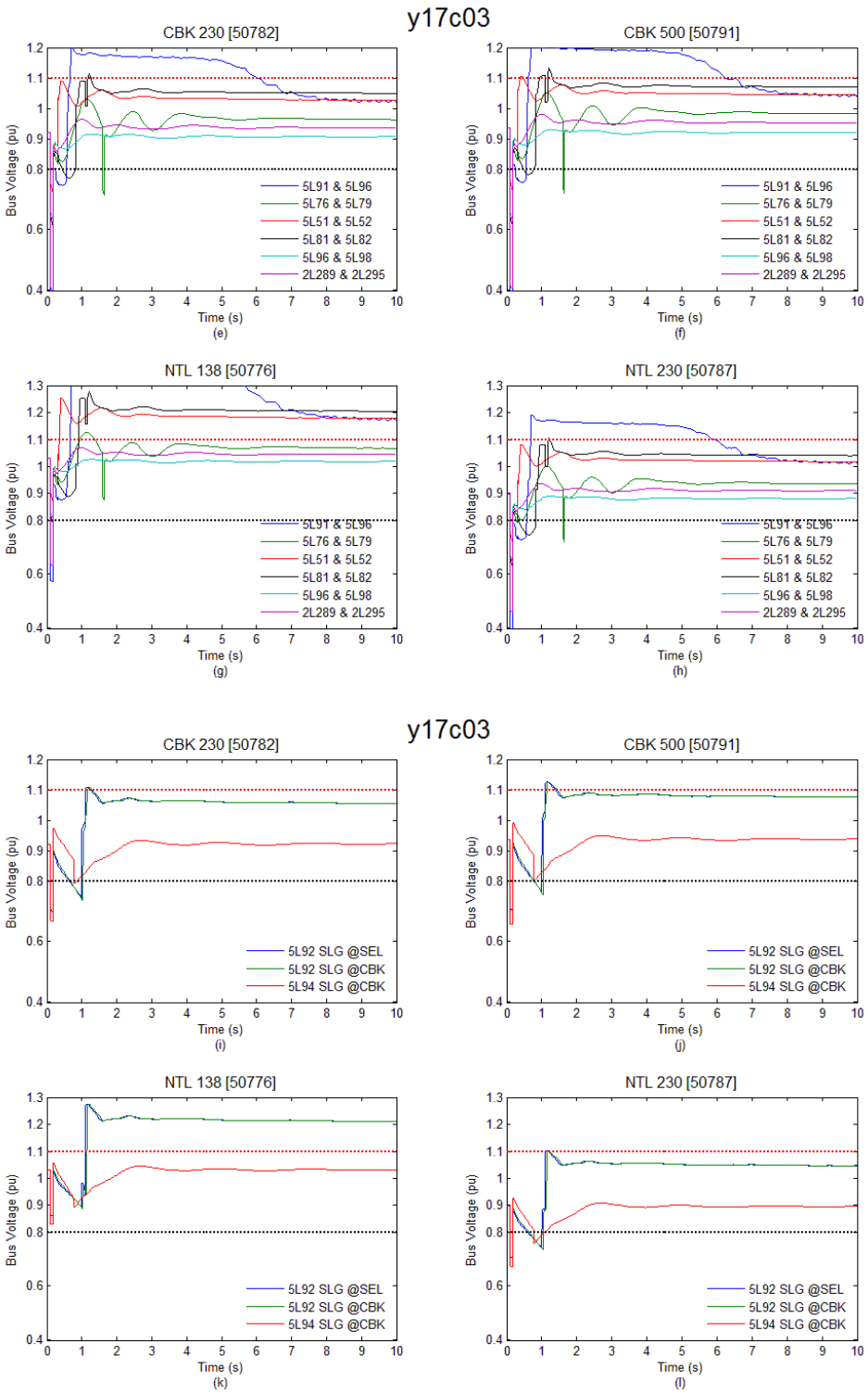
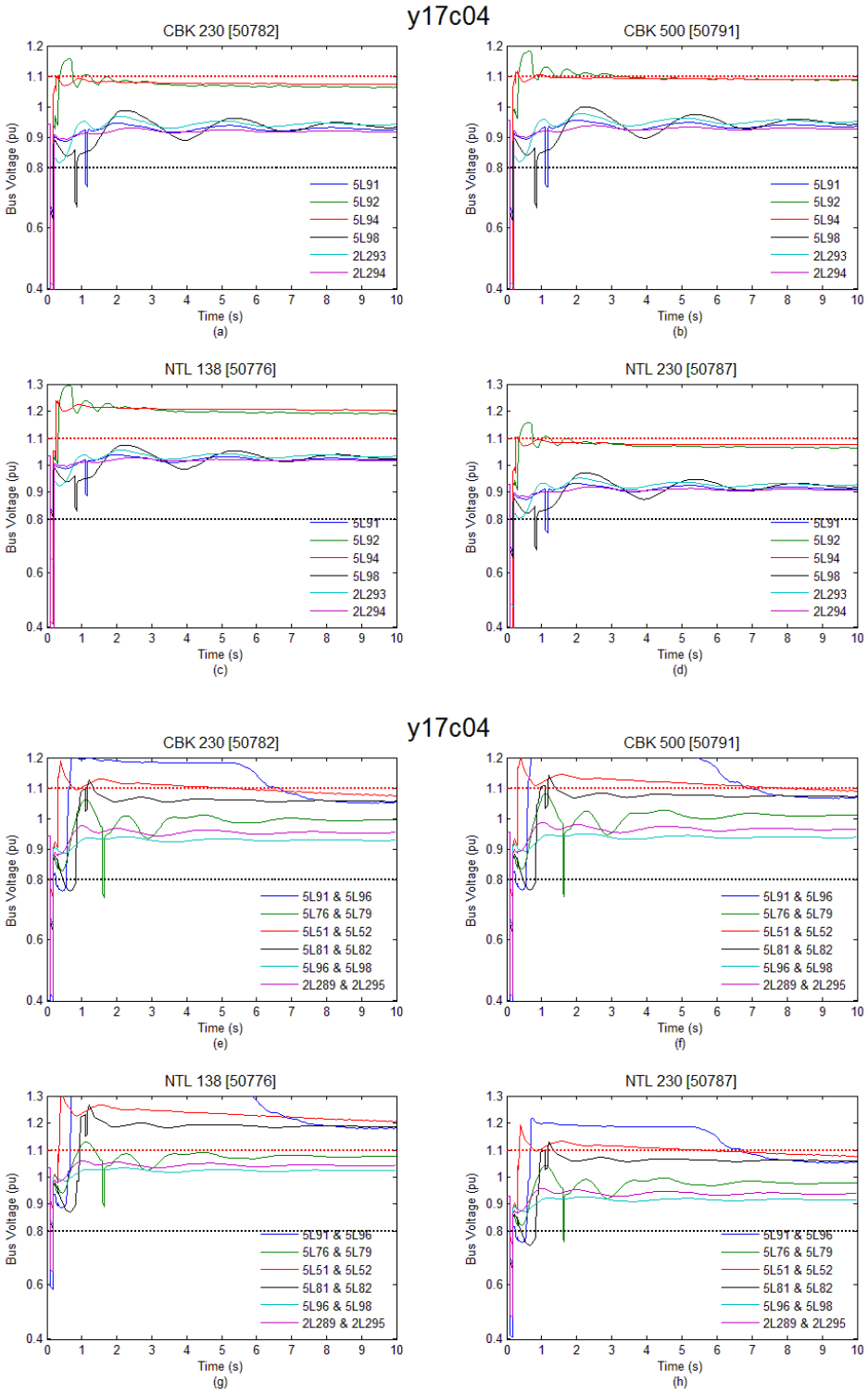


Figure E-15 y17c03 N-1, N-2 and Single Pole Reclose Contingency

E.2.4 **y17c04**



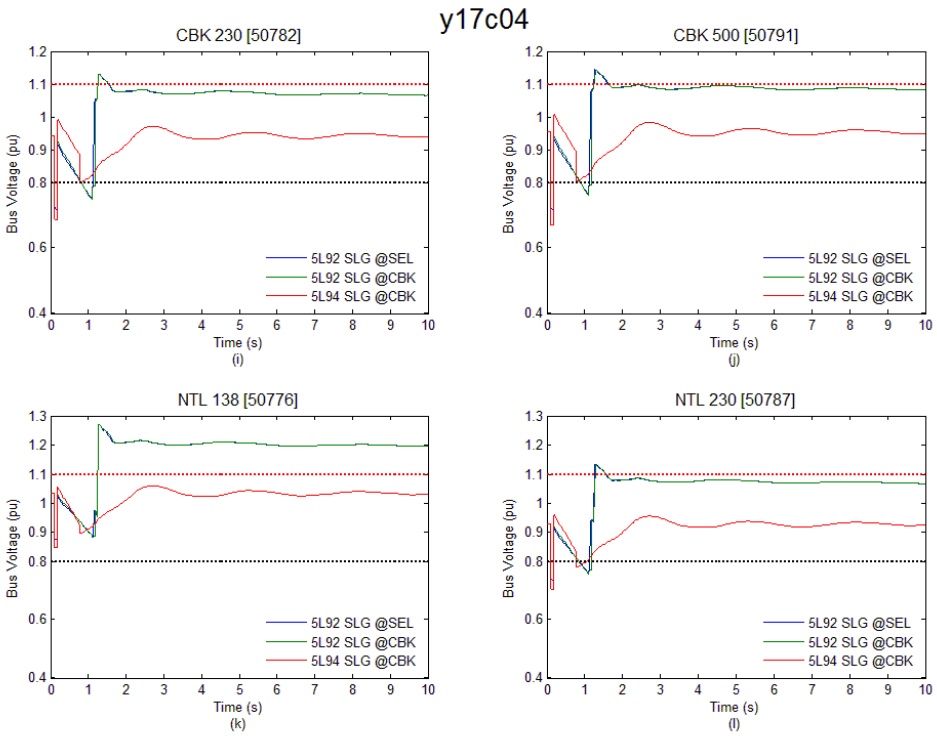
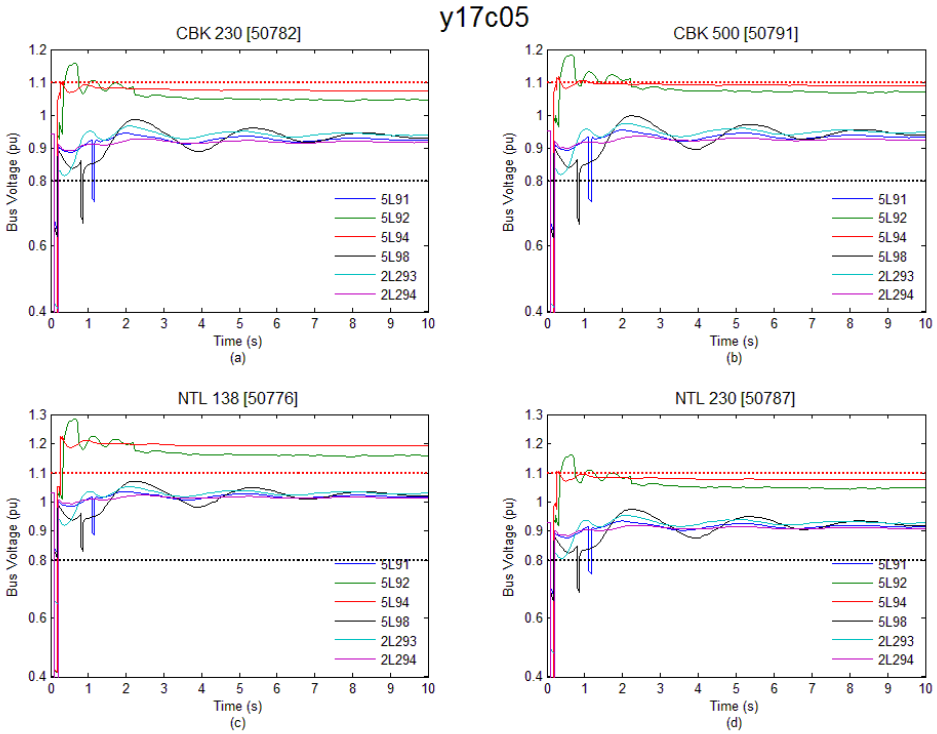


Figure E-16 y17c04 N-1, N-2 and Single Pole Reclose Contingency

E.2.5 **y17c05**



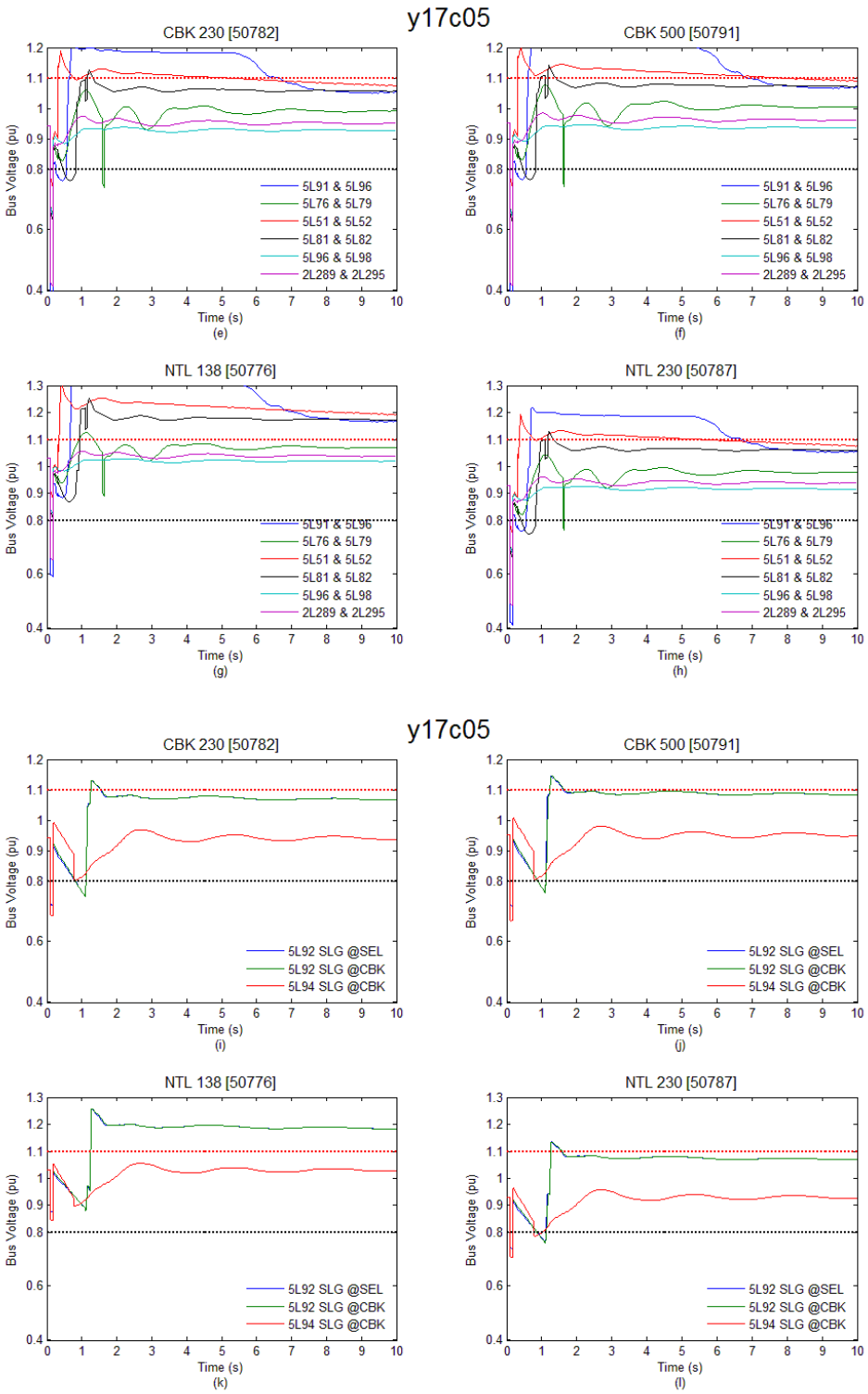
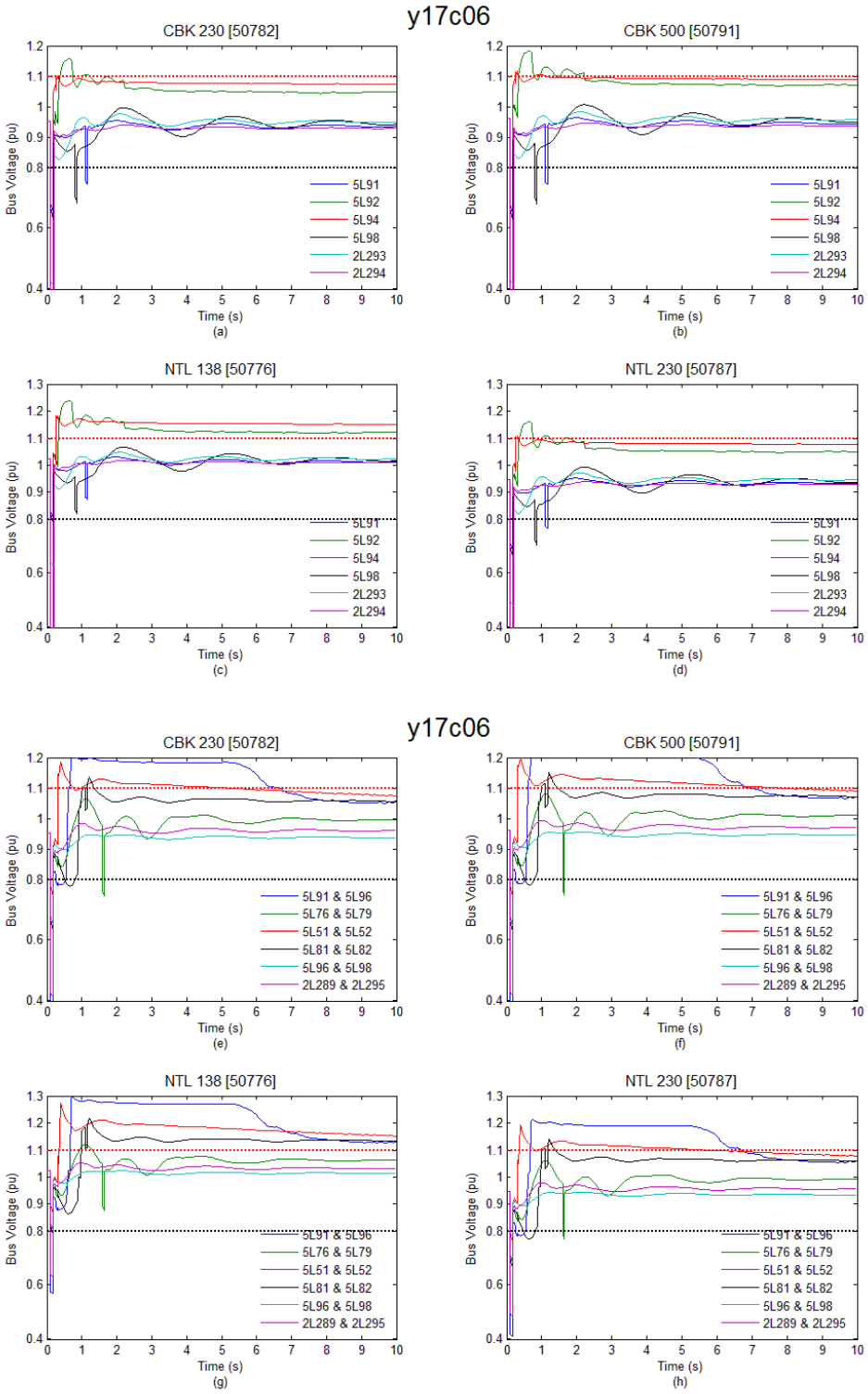


Figure E-17 y17c05 N-1, N-2 and Single Pole Reclose Contingency

E.2.6 **y17c06**



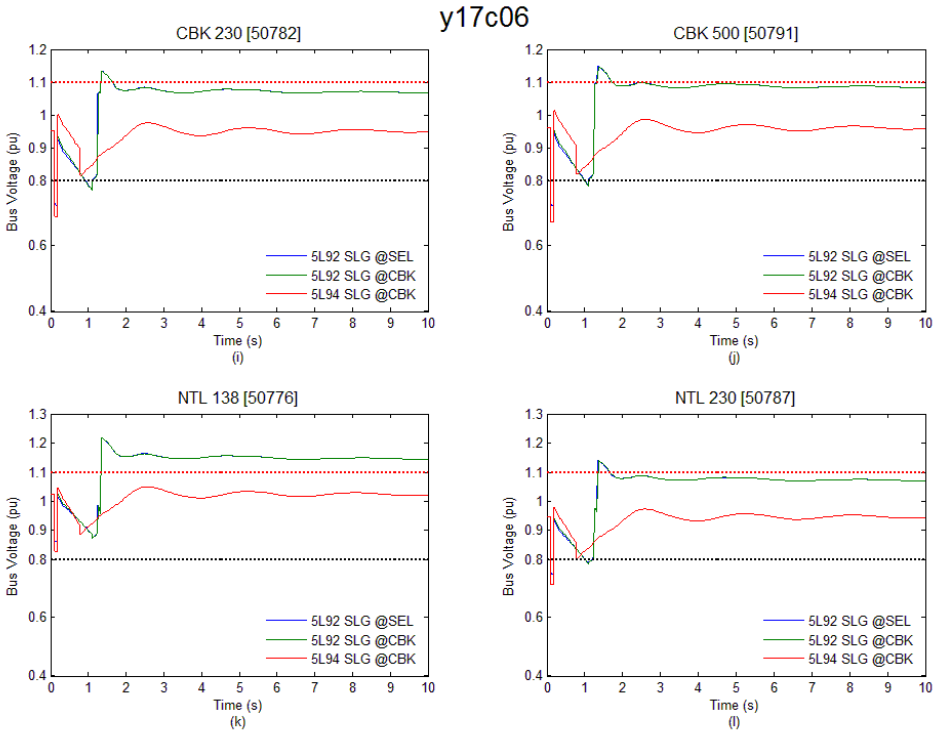
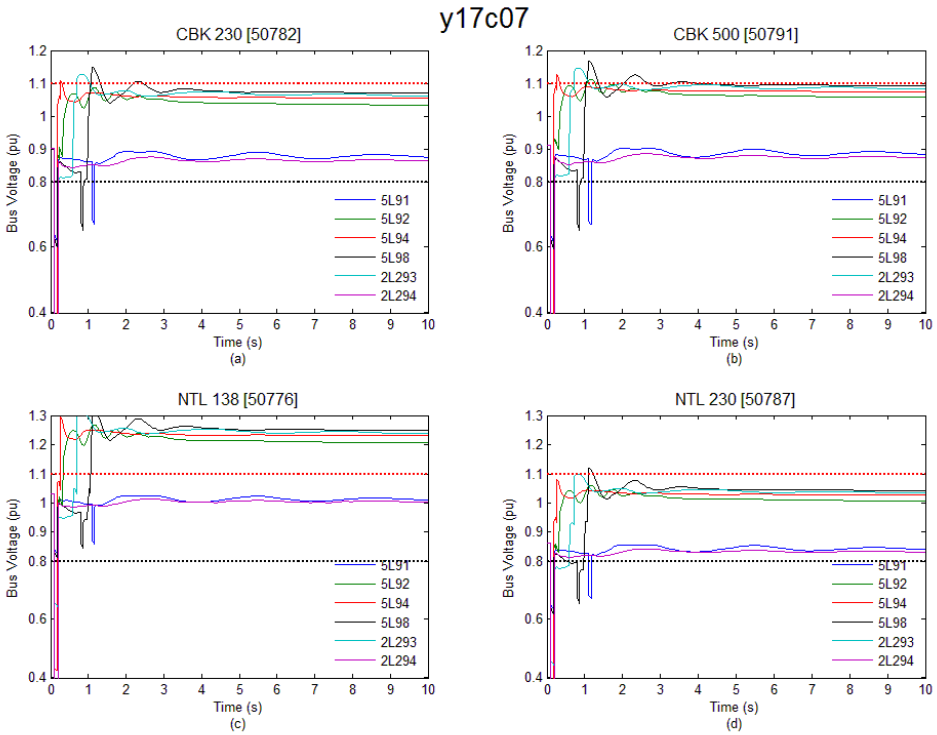


Figure E-18 y17c06 N-1, N-2 and Single Pole Reclose Contingency

E.2.7 **y17c07**



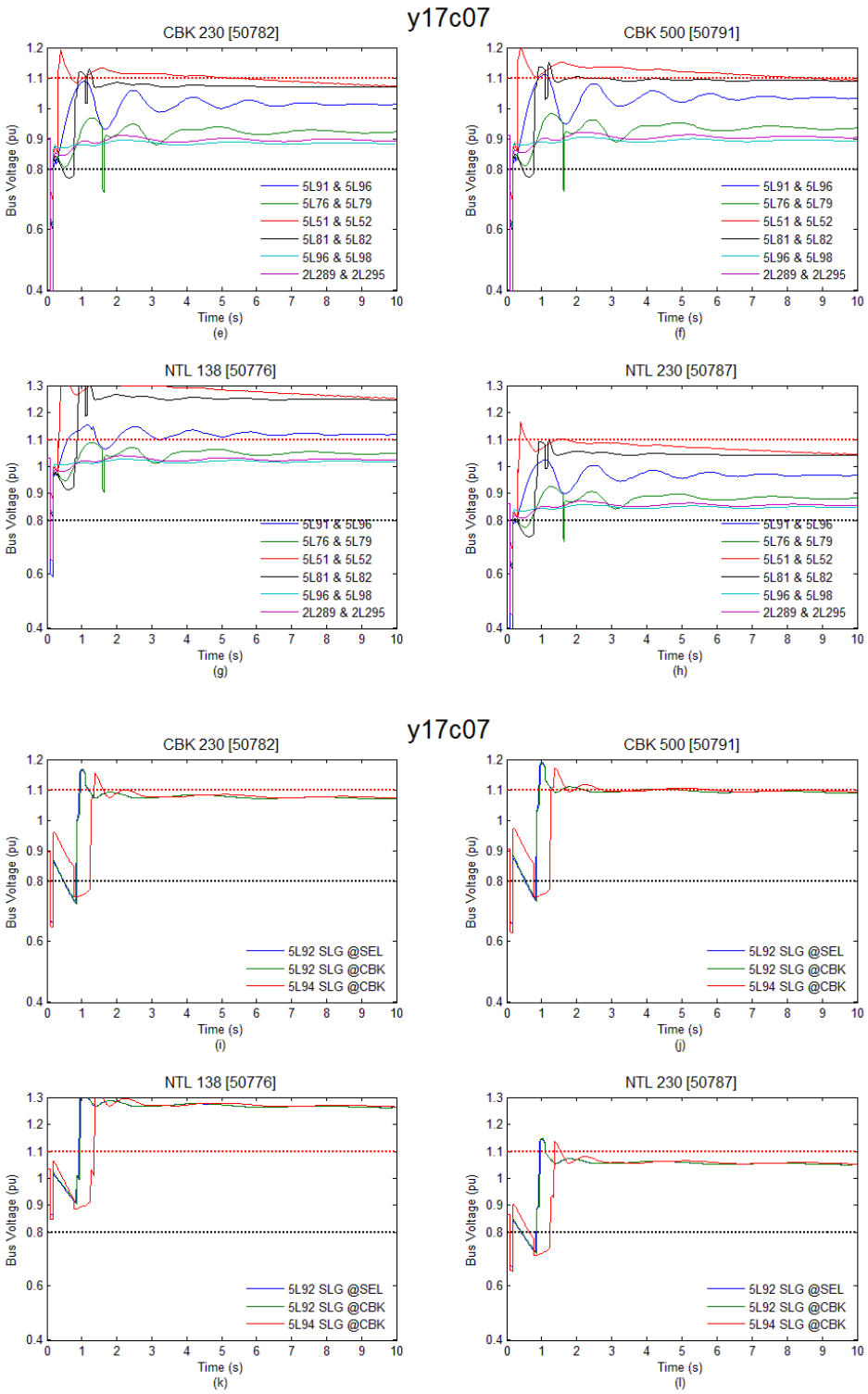
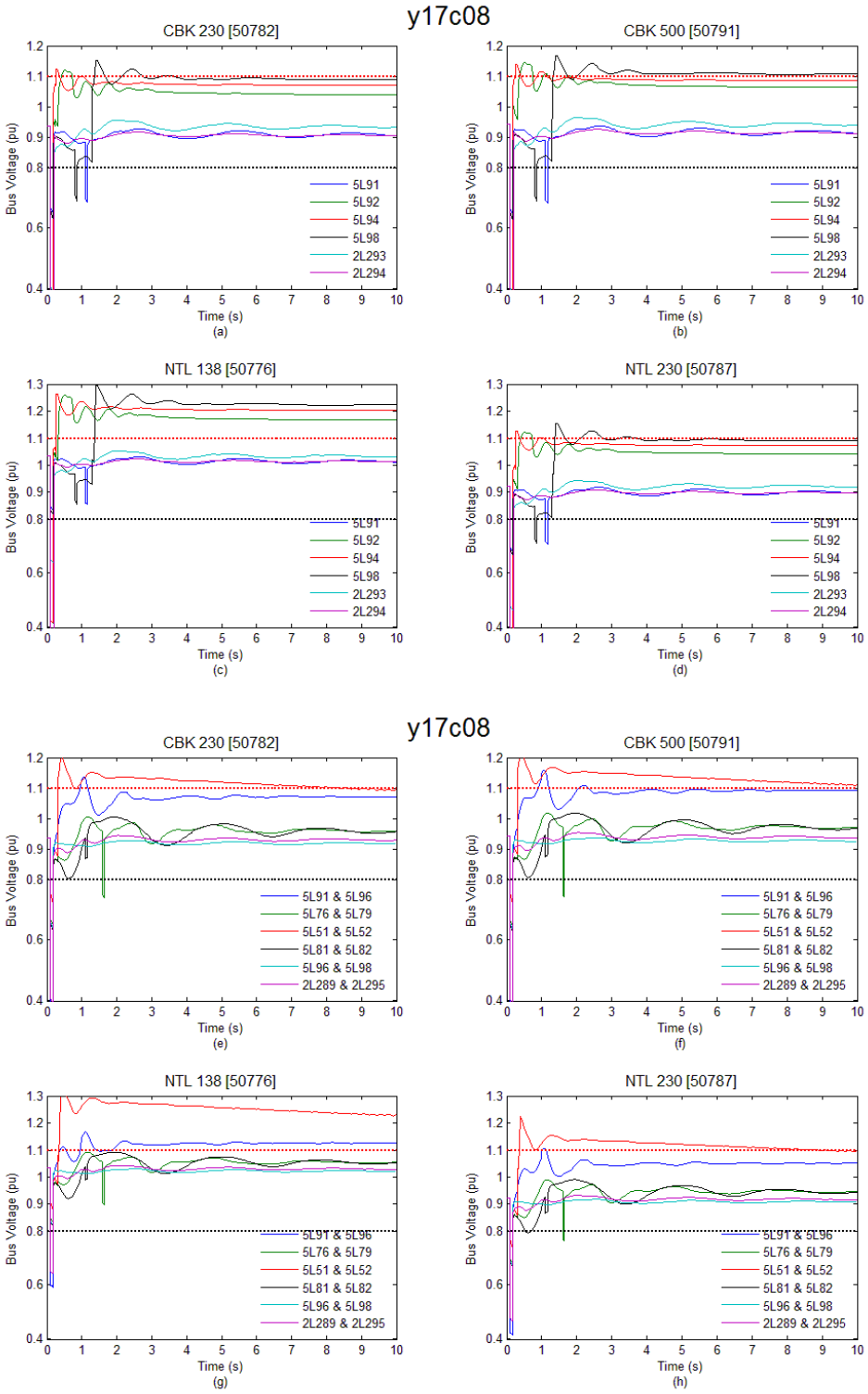


Figure E-19 y17c07 N-1, N-2 and Single Pole Reclose Contingency

E.2.8 **y17c08**



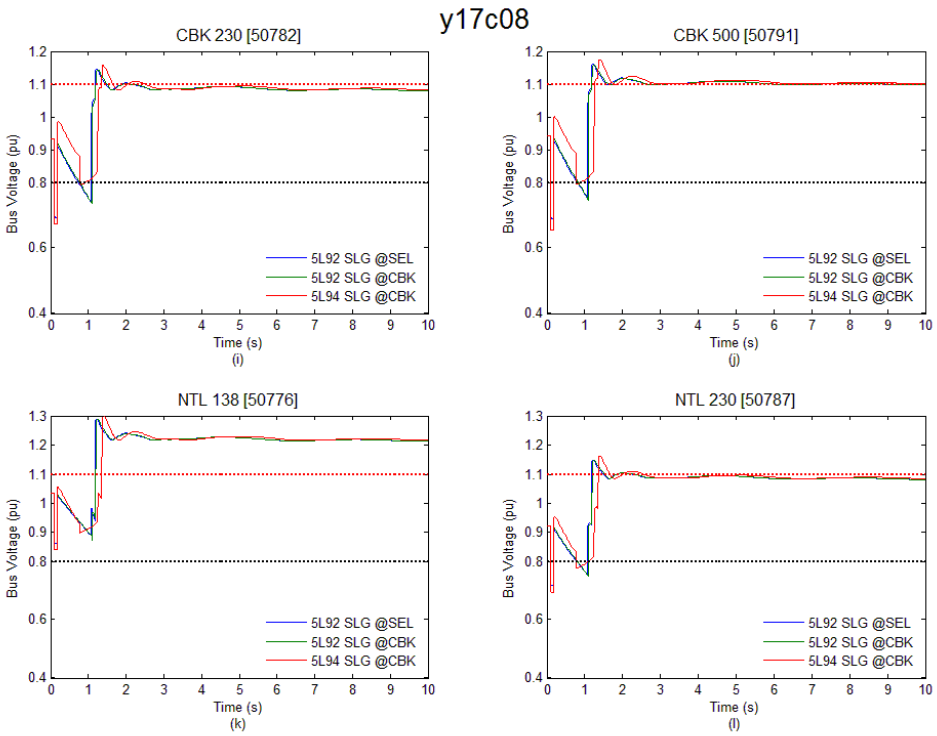
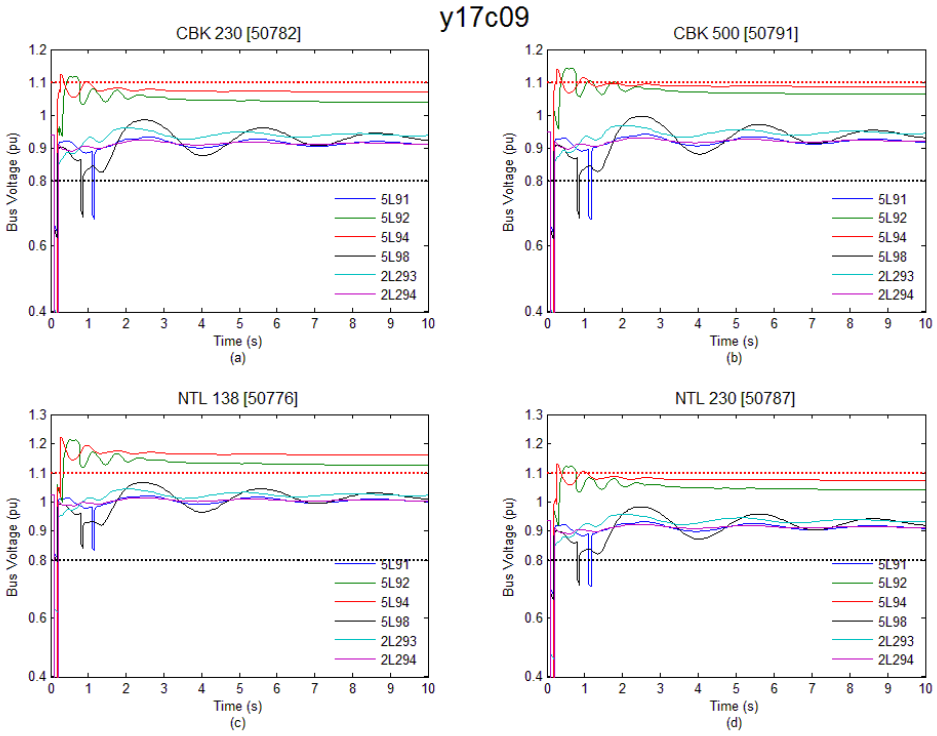


Figure E-20 y17c08 N-1, N-2 and Single Pole Reclose Contingency

E.2.9 **y17c09**



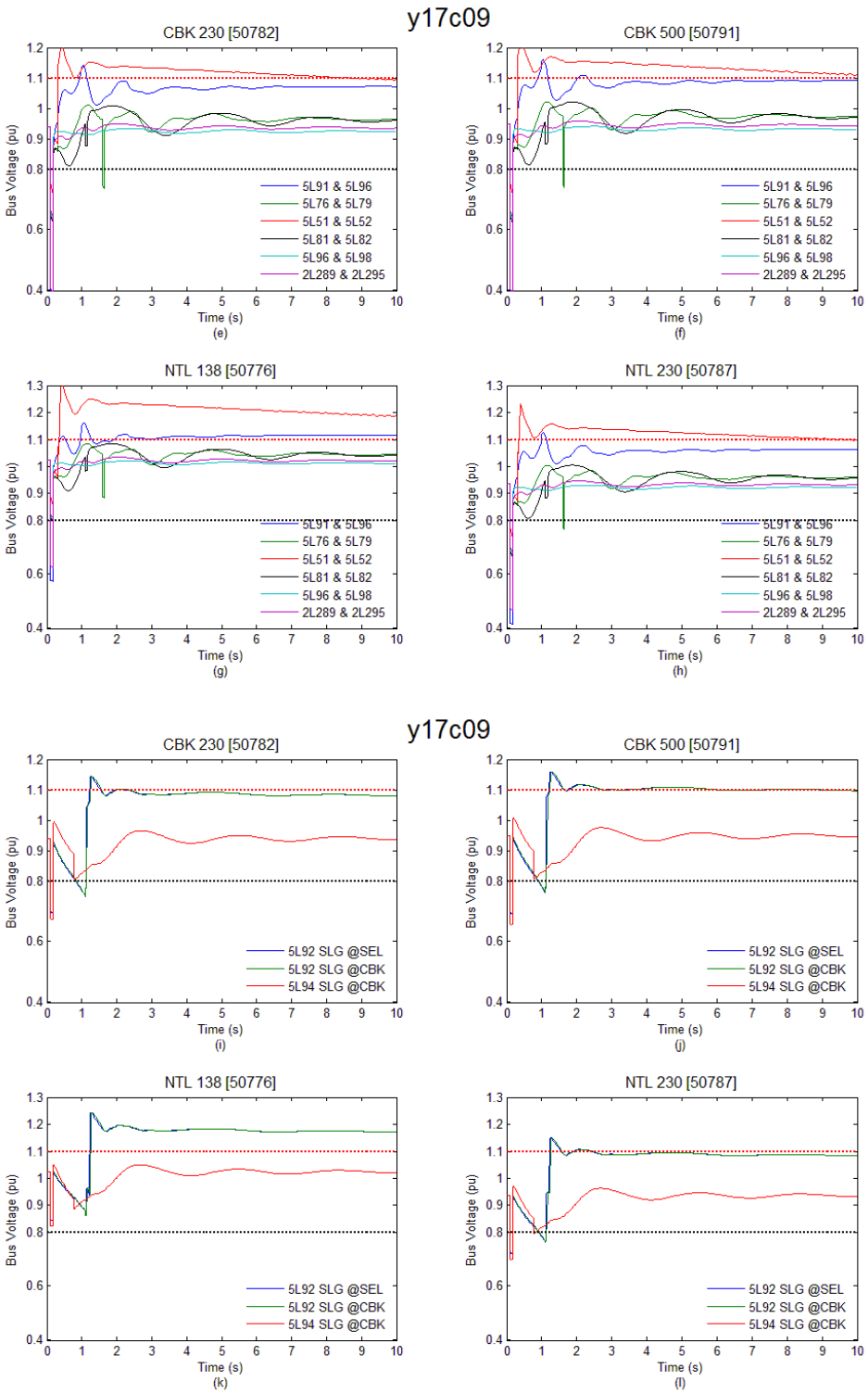
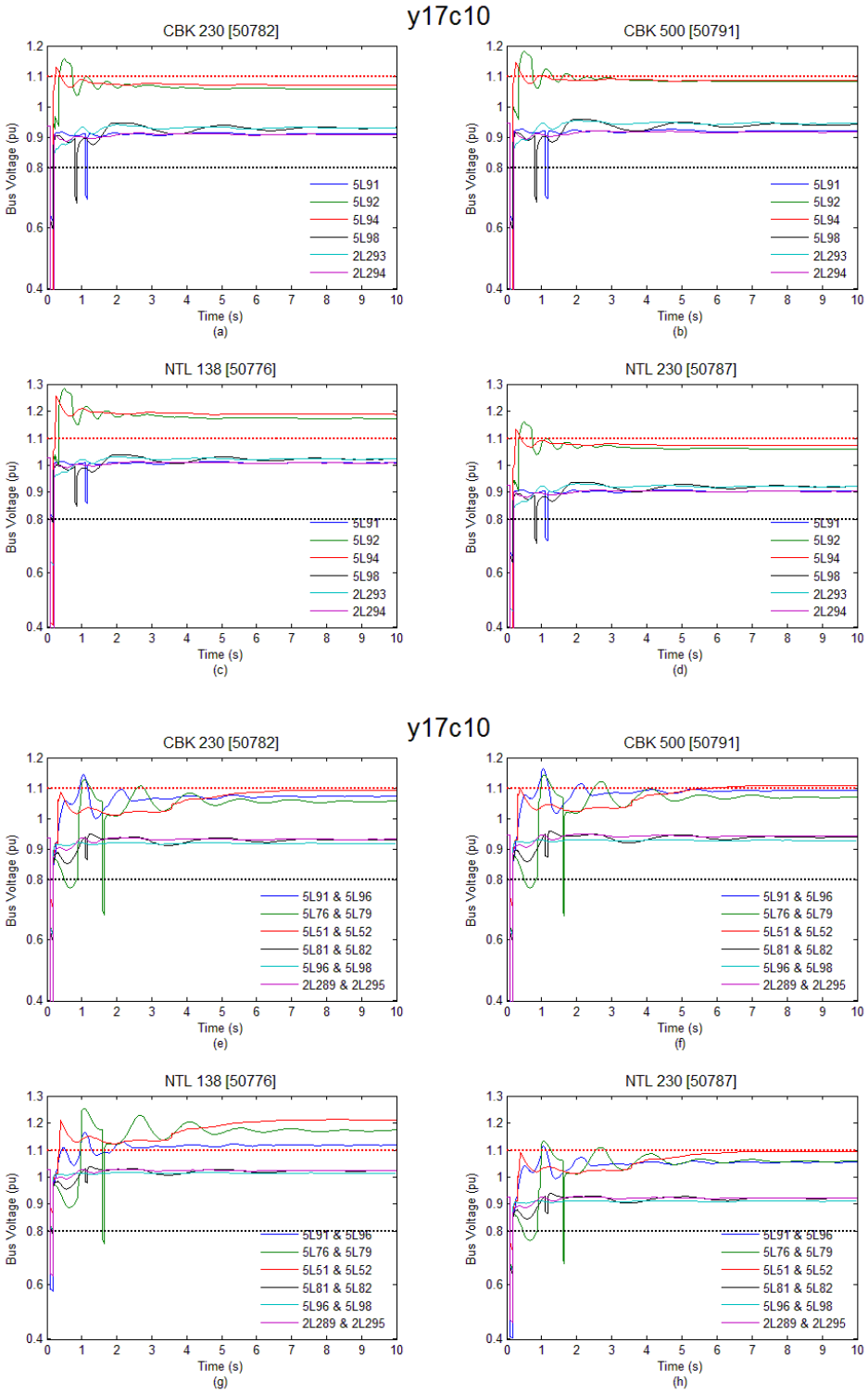


Figure E-21 y17c09 N-1, N-2 and Single Pole Reclose Contingency

E.2.10 **y17c10**



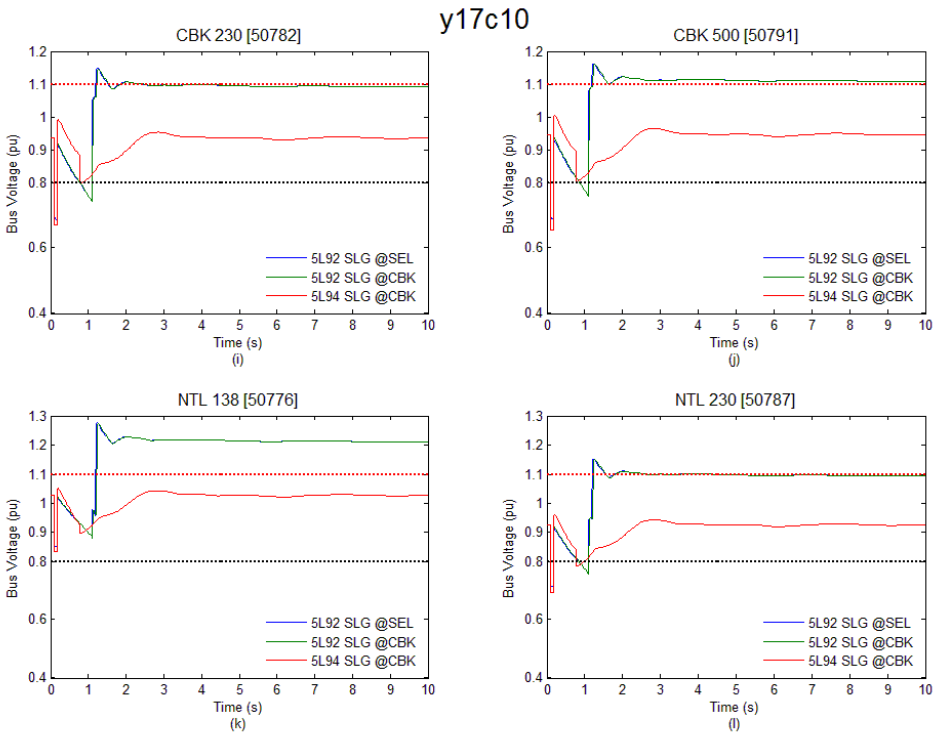
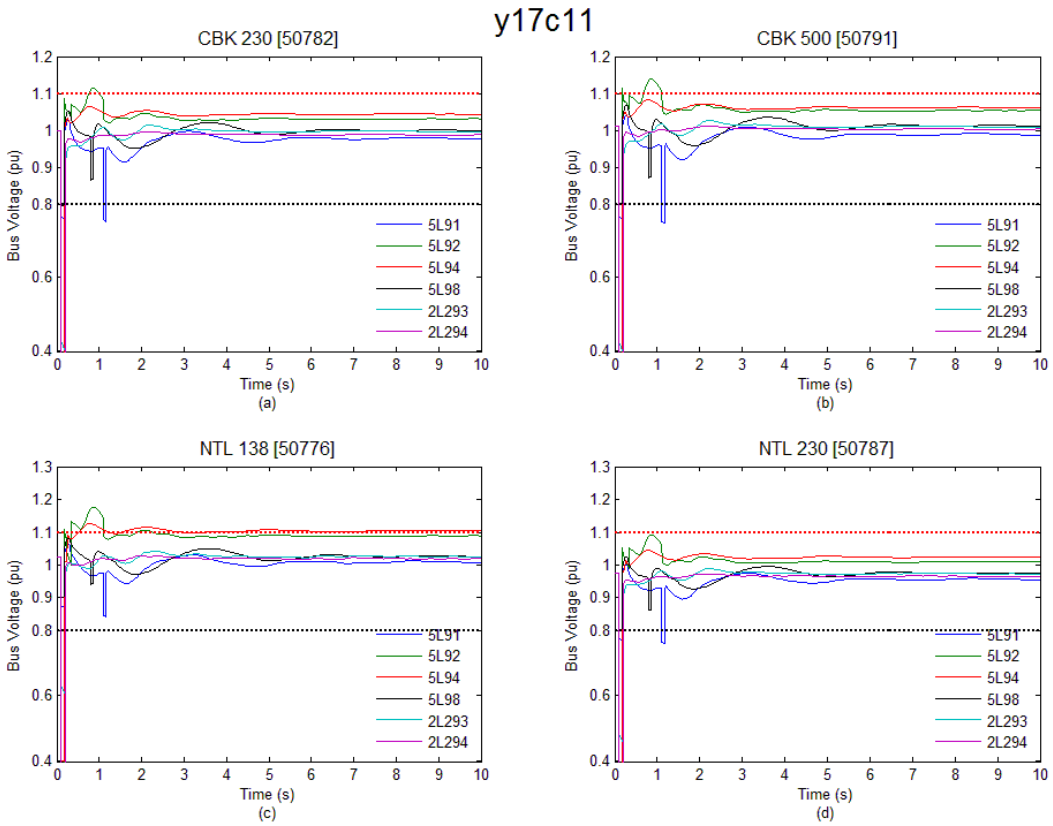


Figure E-22 y17c10 N-1, N-2 and Single Pole Reclose Contingency

E.2.11 **y17c11**



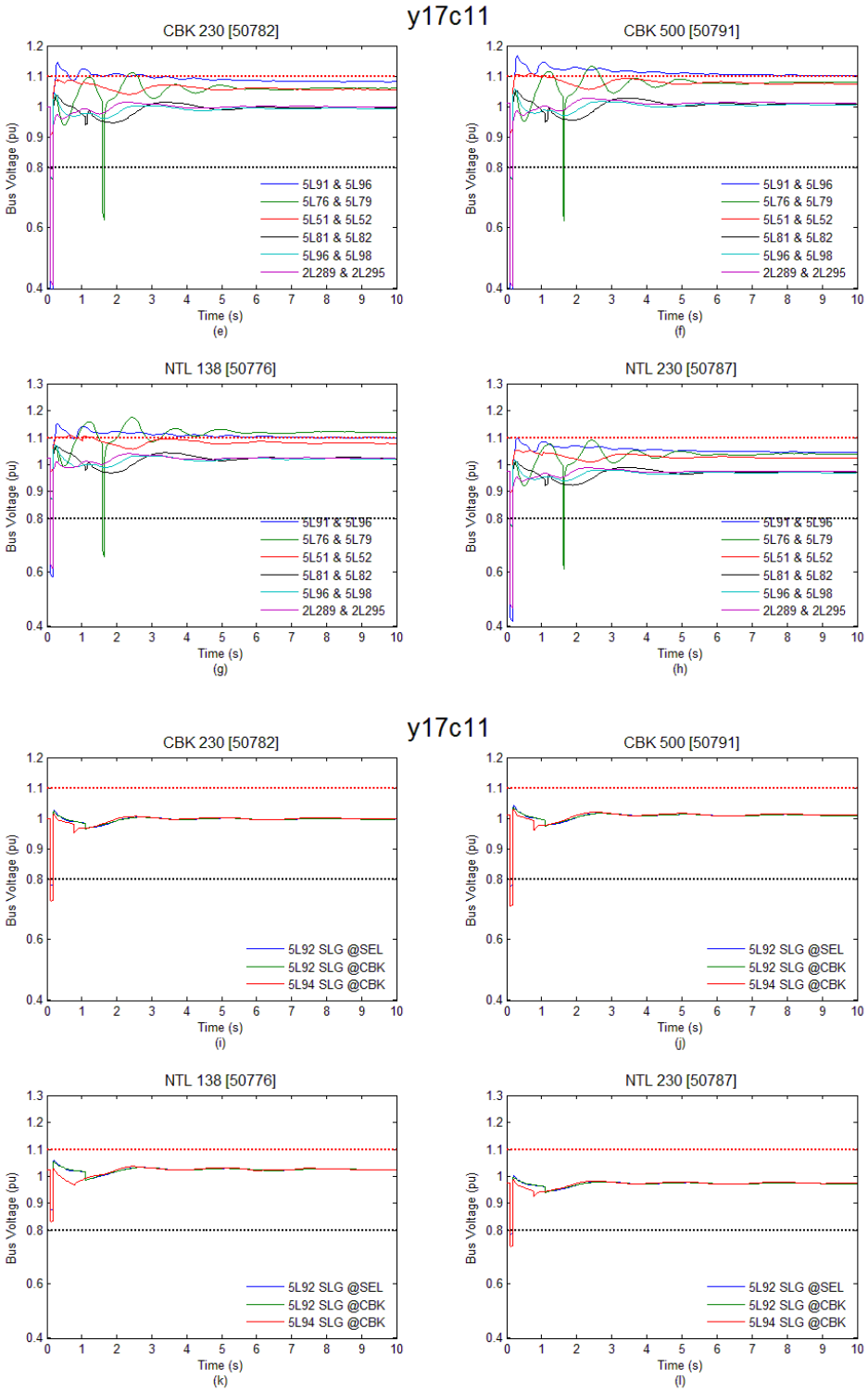
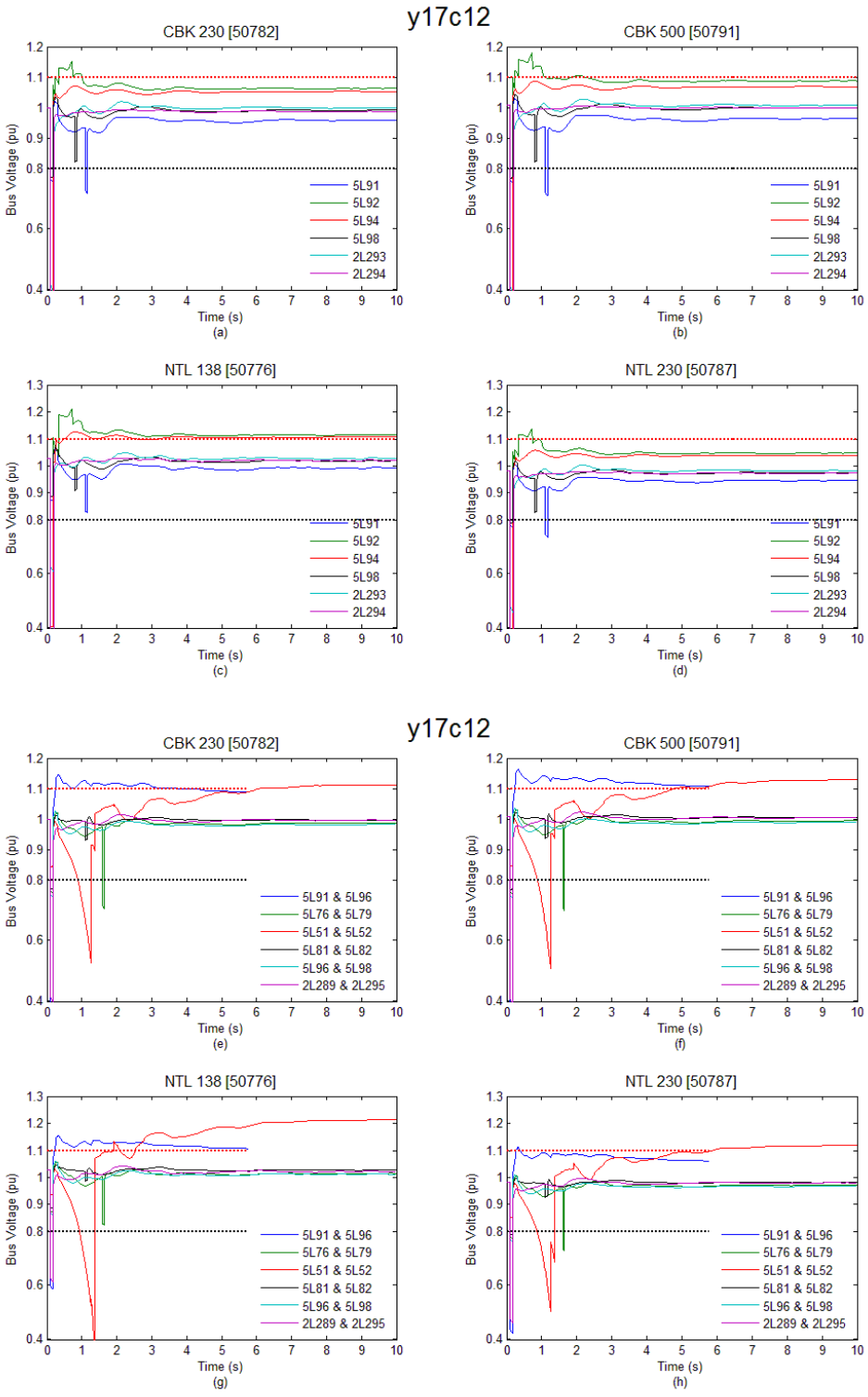


Figure E-23 y17c11 N-1, N-2 and Single Pole Reclose Contingency

E.2.12 **y17c12**



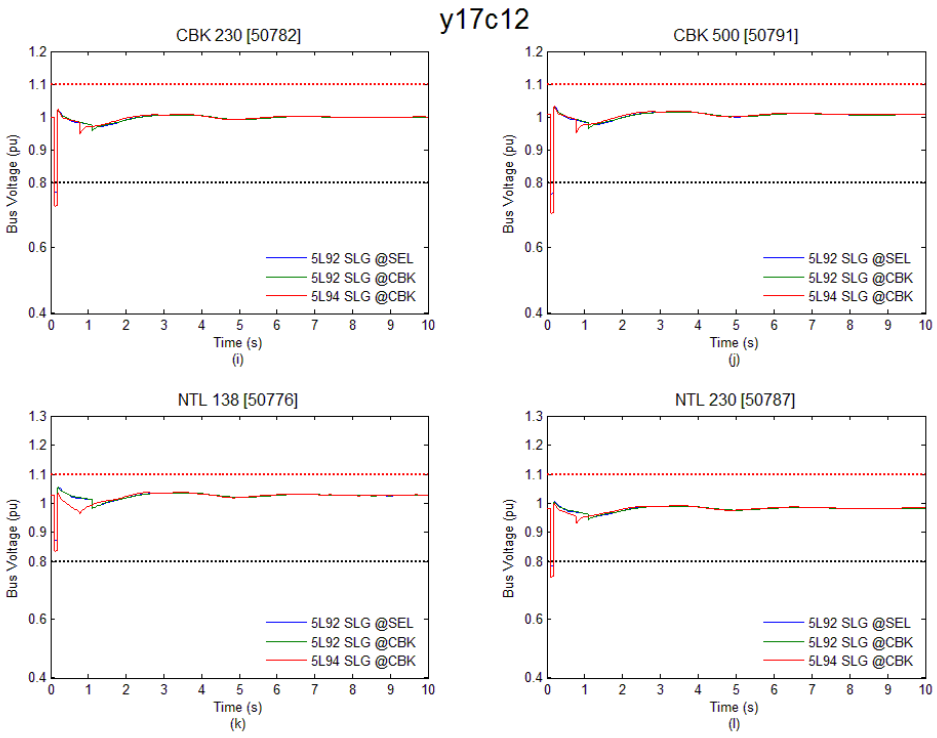
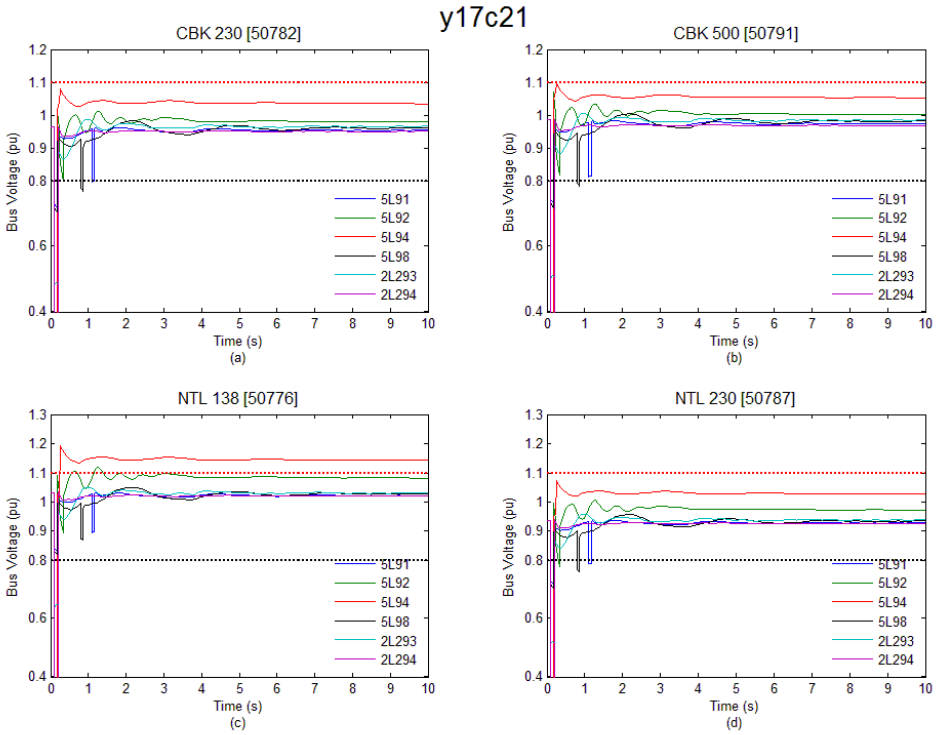


Figure E-24 y17c12 N-1, N-2 and Single Pole Reclose Contingency

E.3 Y17 Cases (Chapel Rock)

E.3.1 **y17c21**



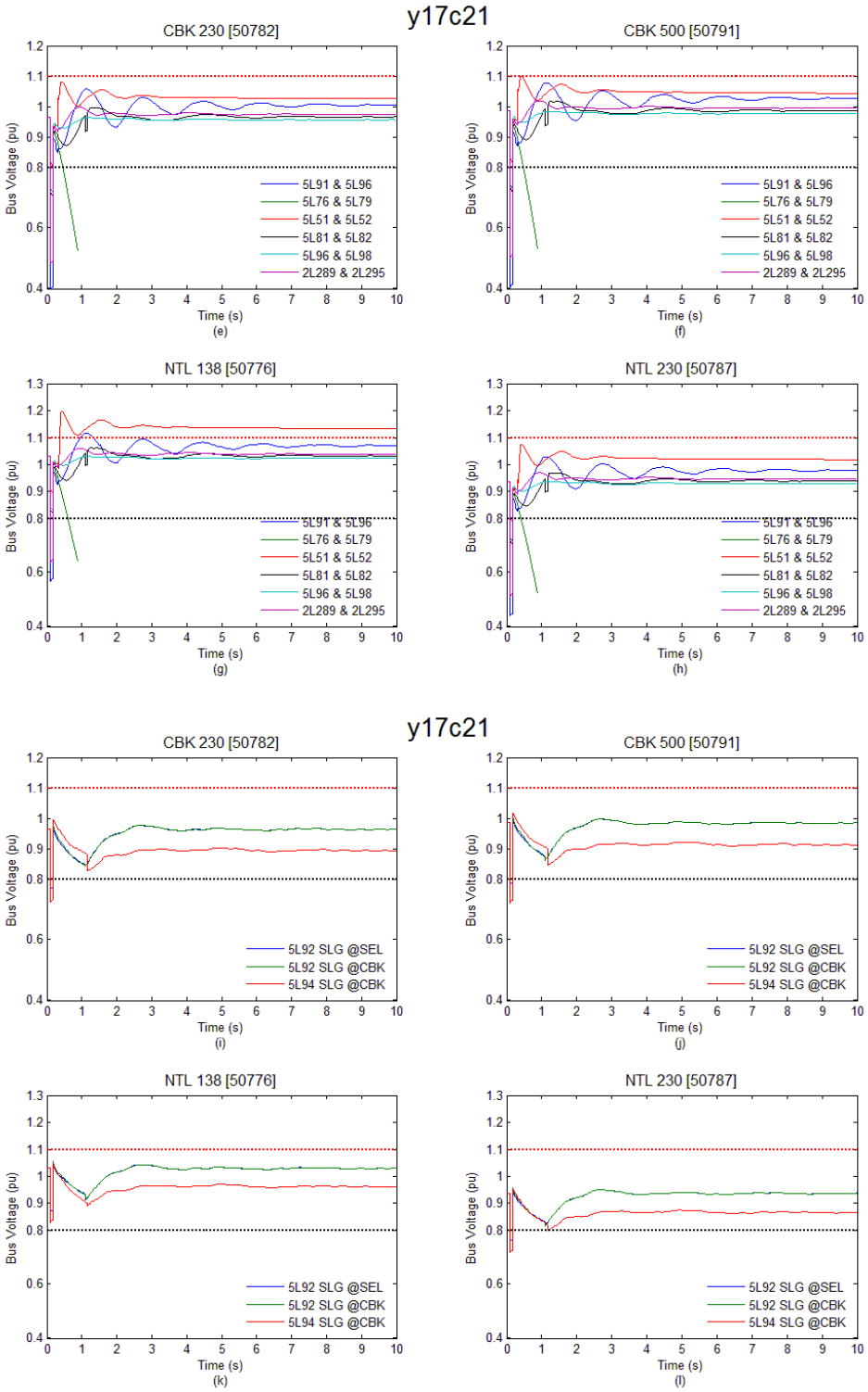
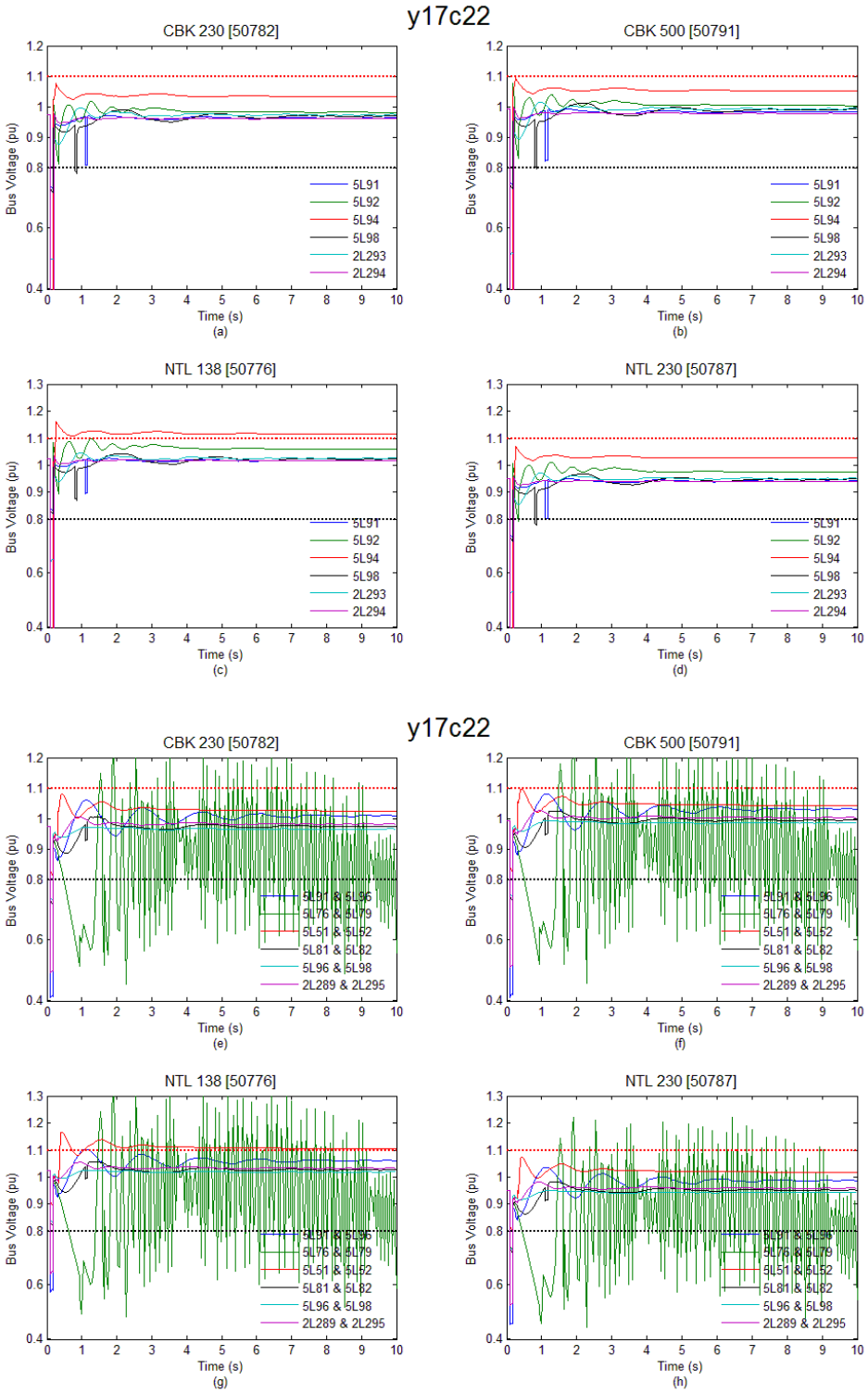


Figure E-25 y17c21 N-1, N-2 and Single Pole Reclose Contingency

E.3.2 **y17c22**



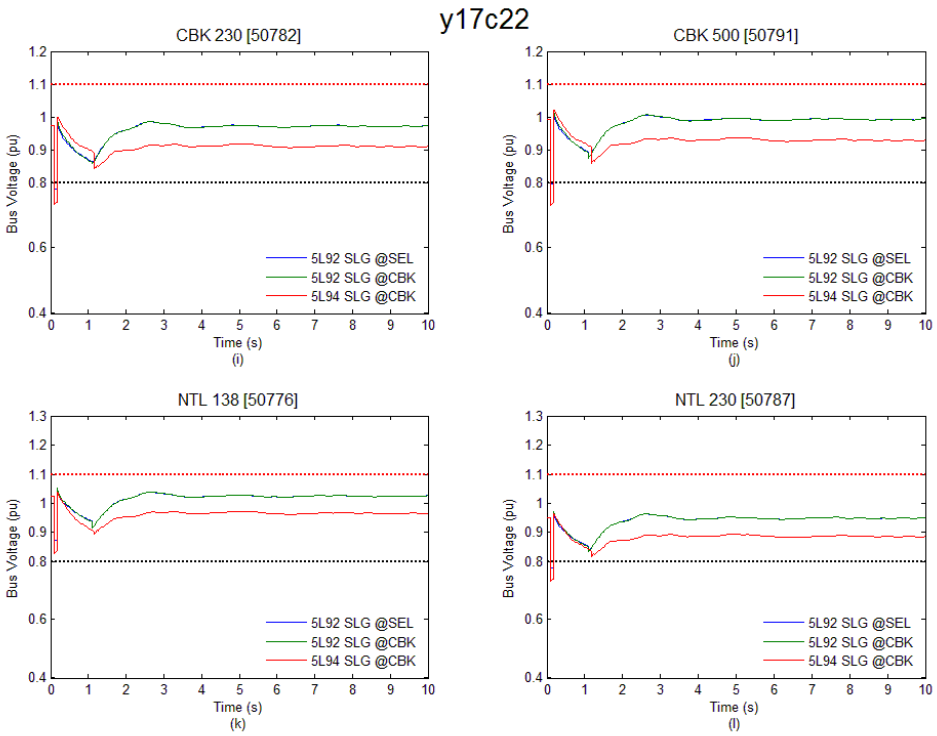
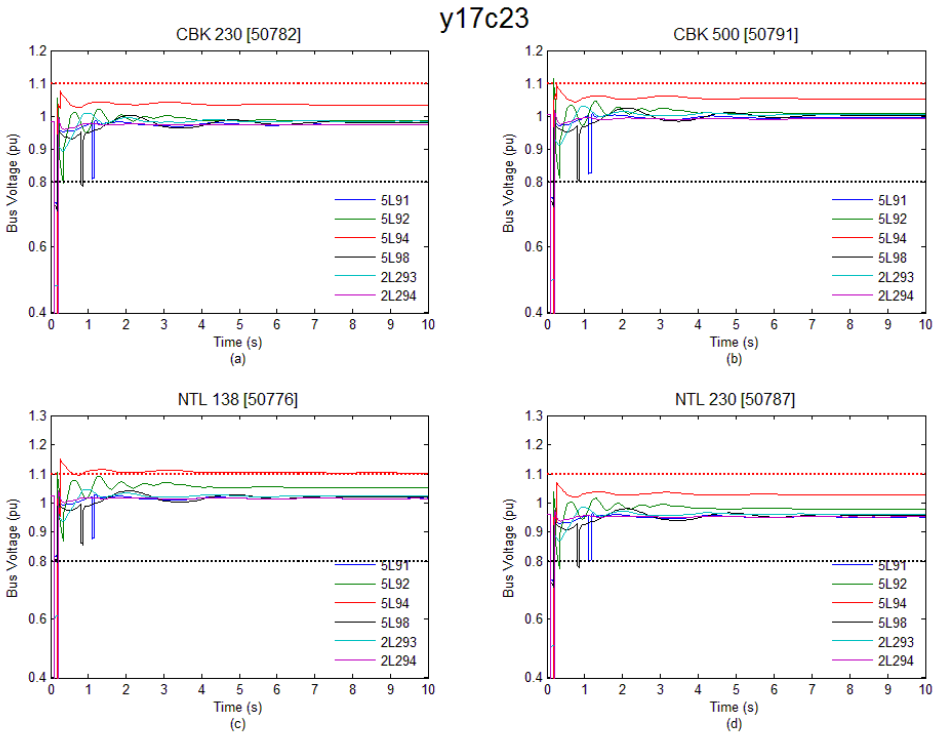


Figure E-26 y17c22 N-1, N-2 and Single Pole Reclose Contingency

E.3.3 **y17c23**



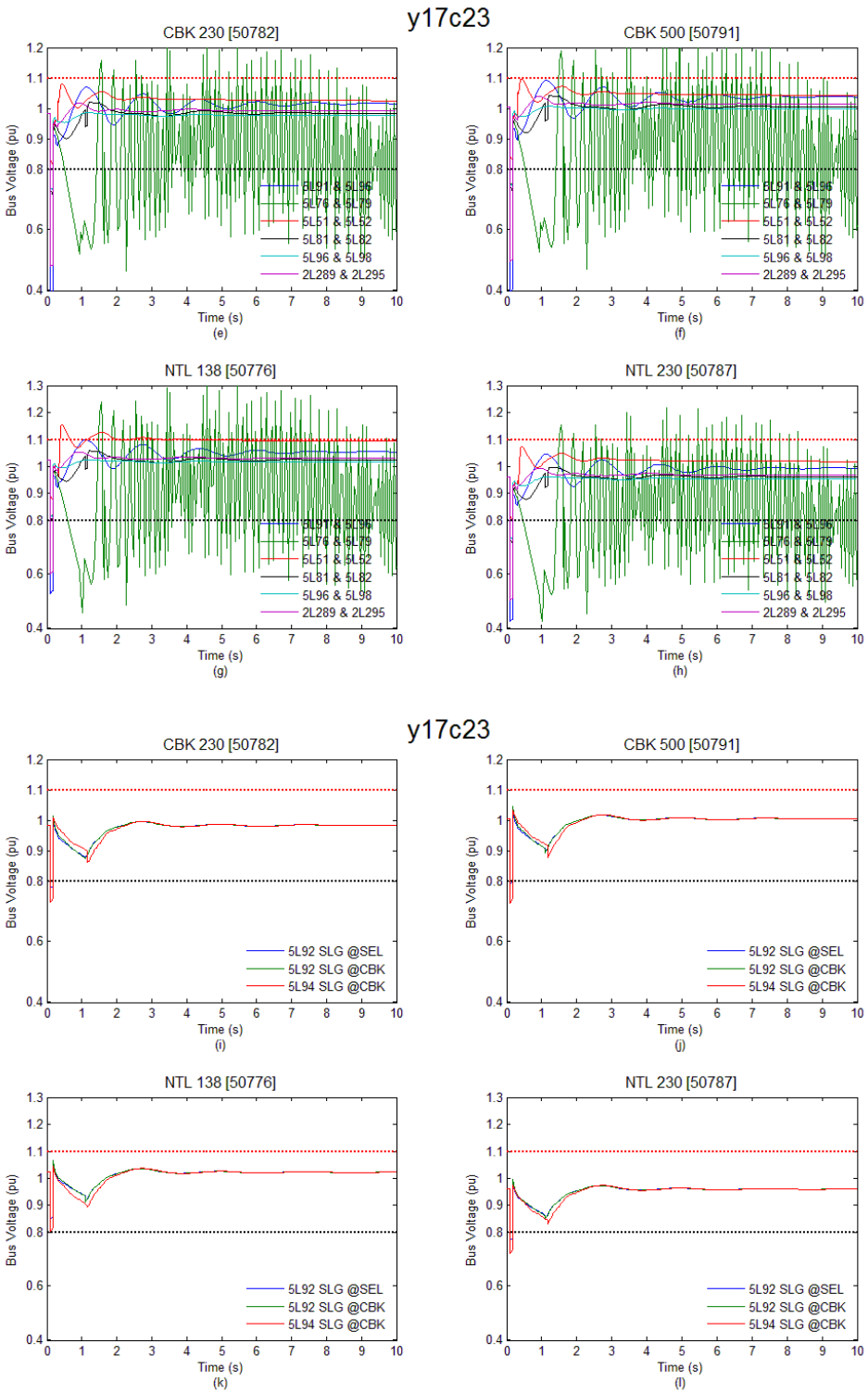
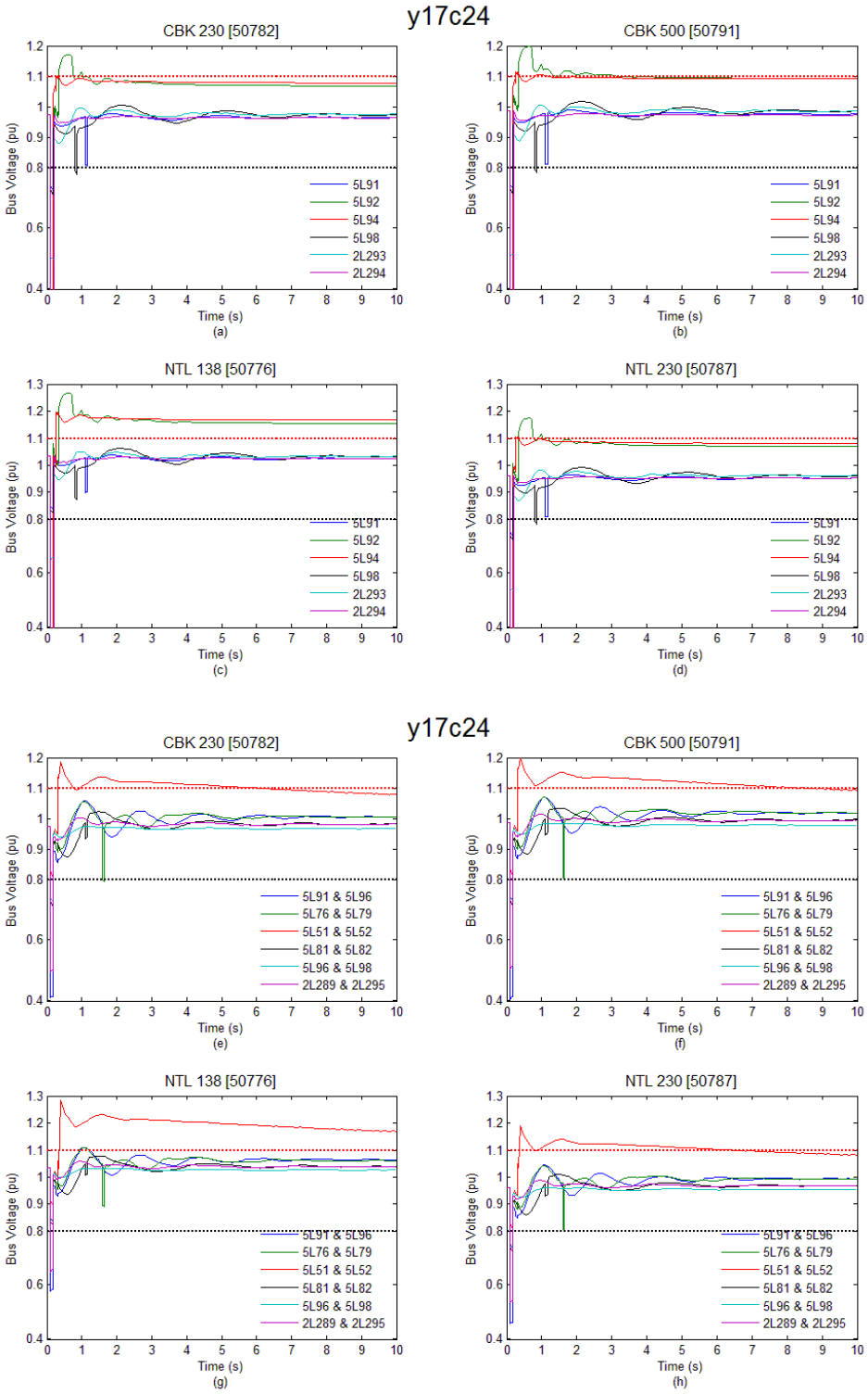


Figure E-27 y17c23 N-1, N-2 and Single Pole Reclose Contingency

E.3.4 **y17c24**



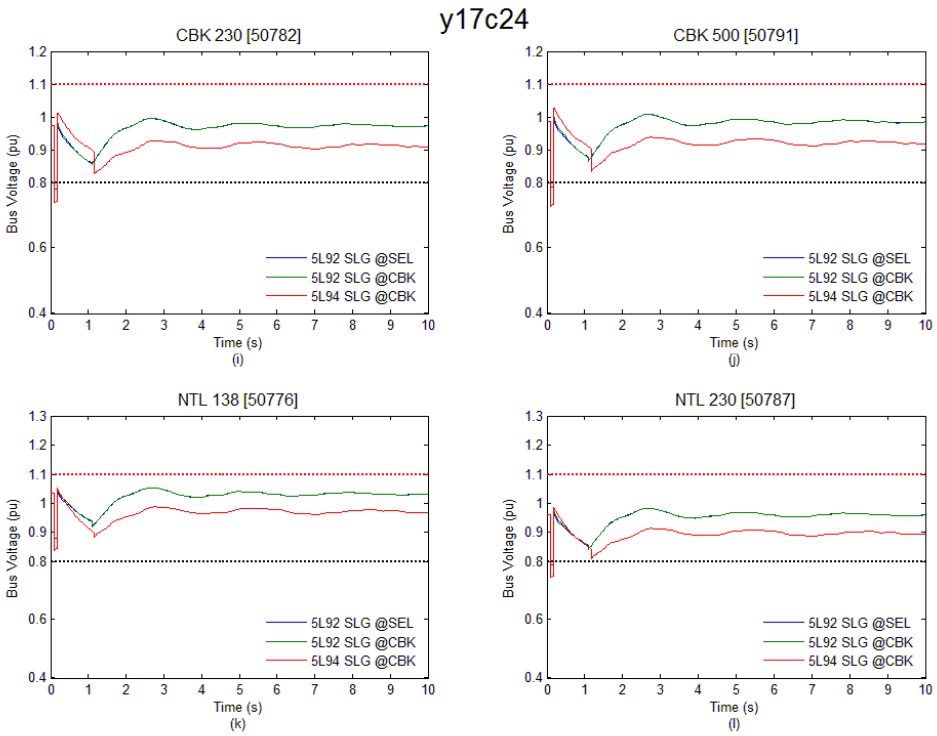
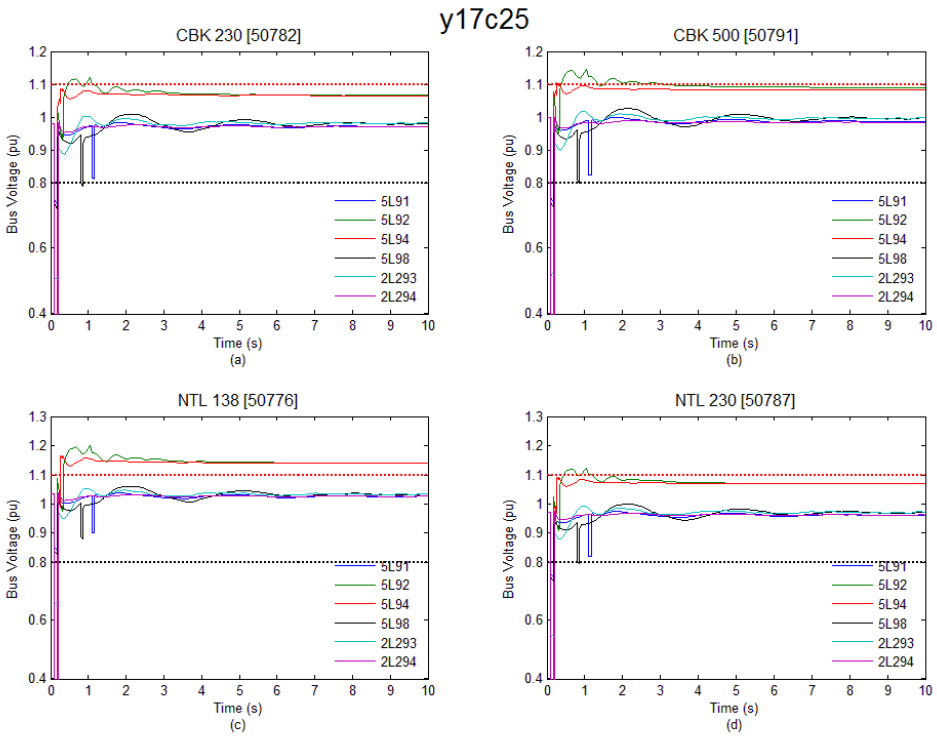


Figure E-28 y17c24 N-1, N-2 and Single Pole Reclose Contingency

E.3.5 **y17c25**



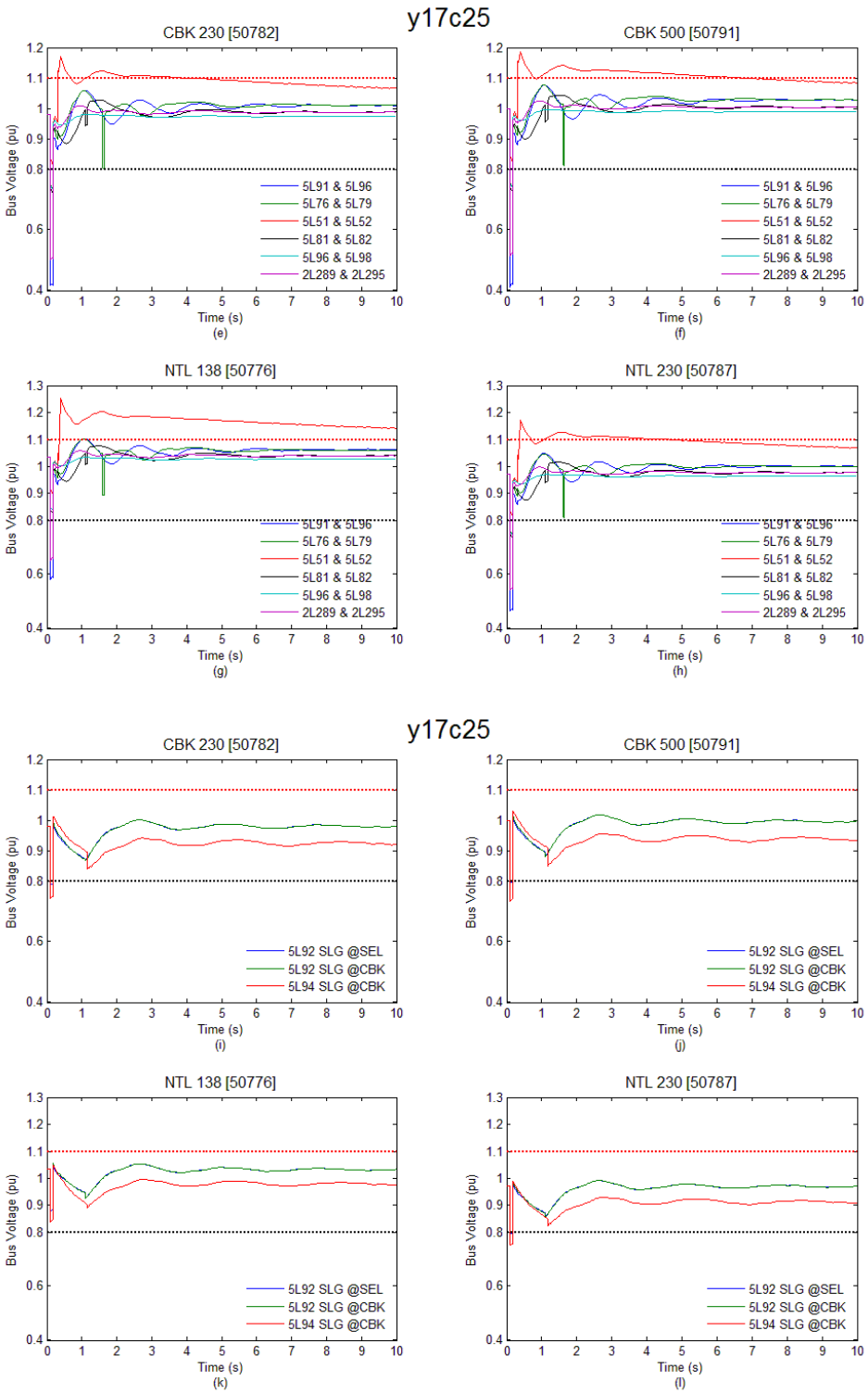
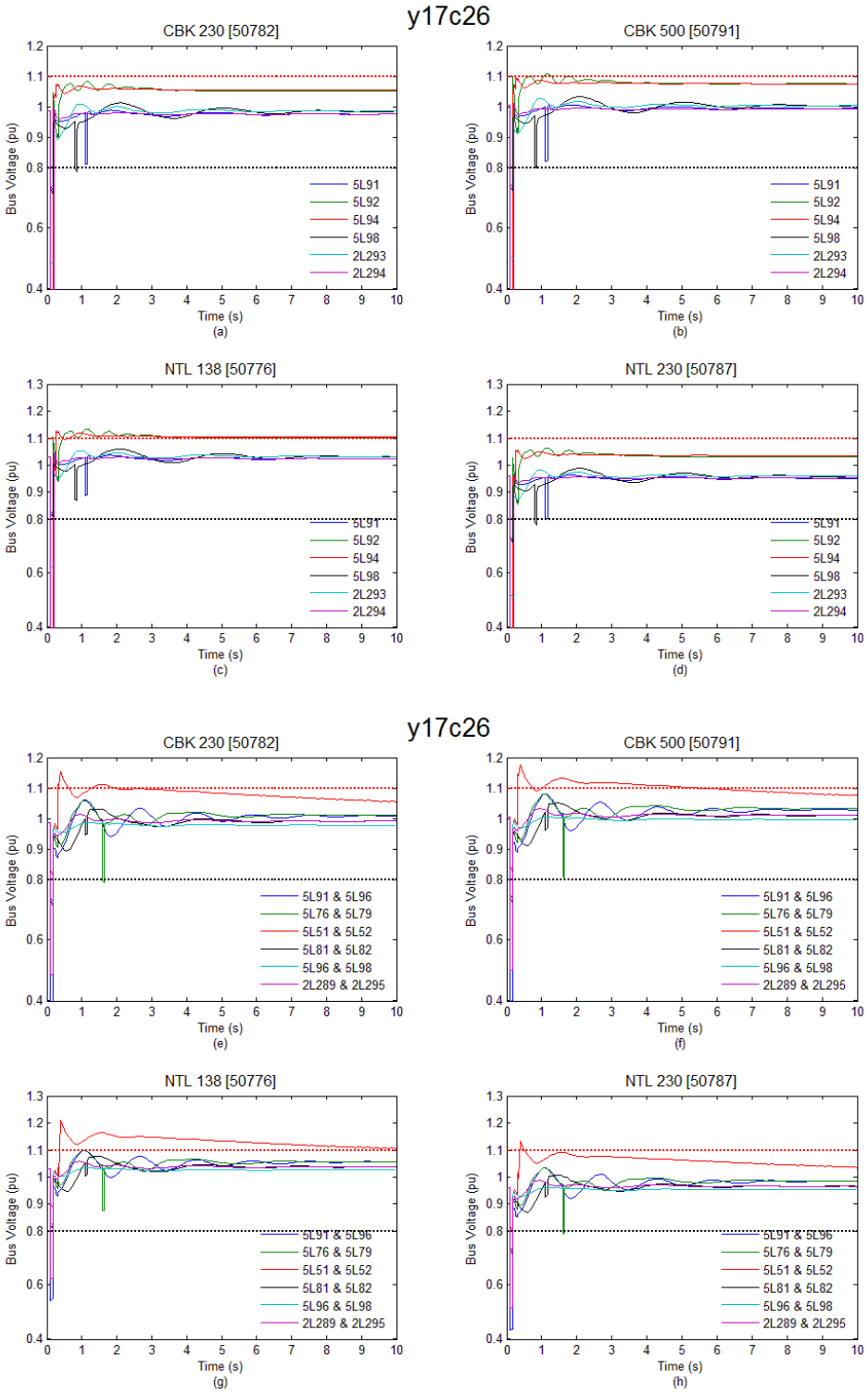


Figure E-29 y17c25 N-1, N-2 and Single Pole Reclose Contingency

E.3.6 **y17c26**



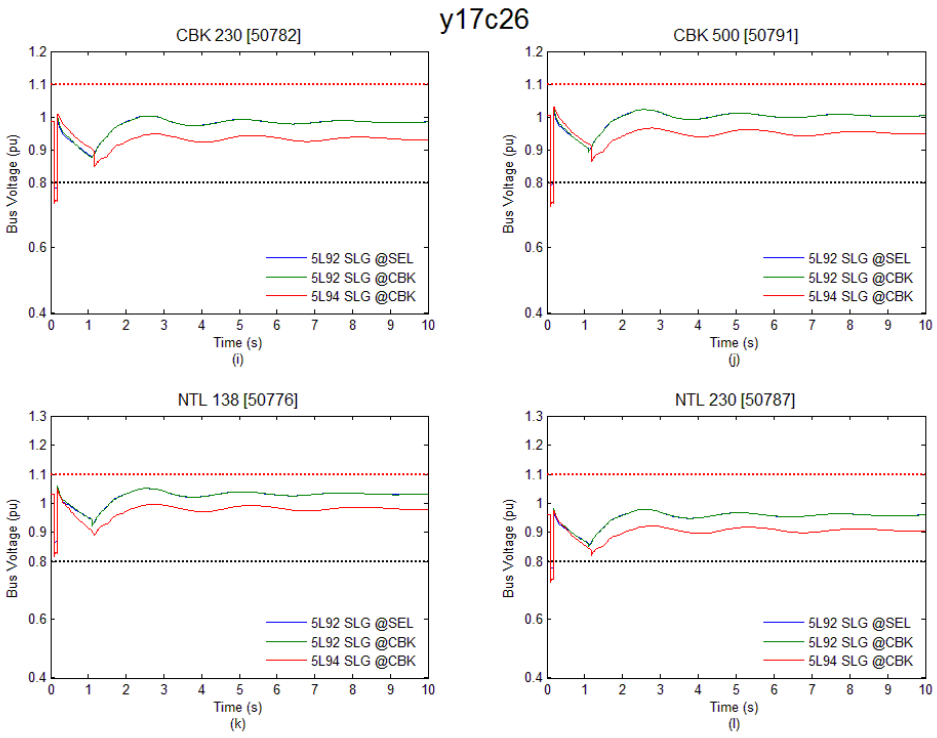
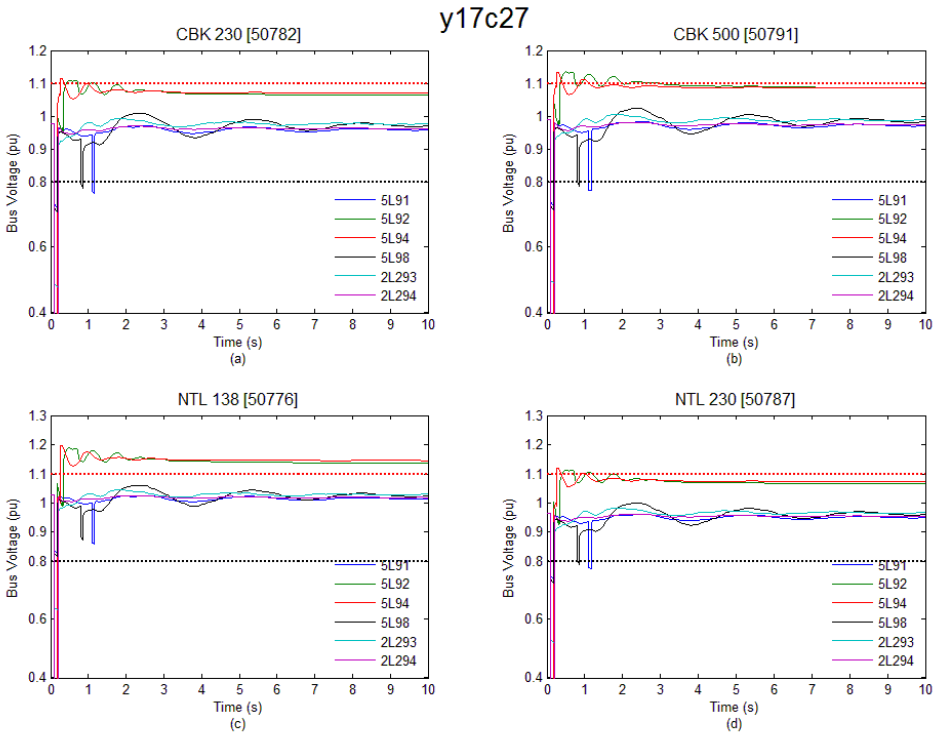


Figure E-30 y17c26 N-1, N-2 and Single Pole Reclose Contingency

E.3.7 **y17c27**



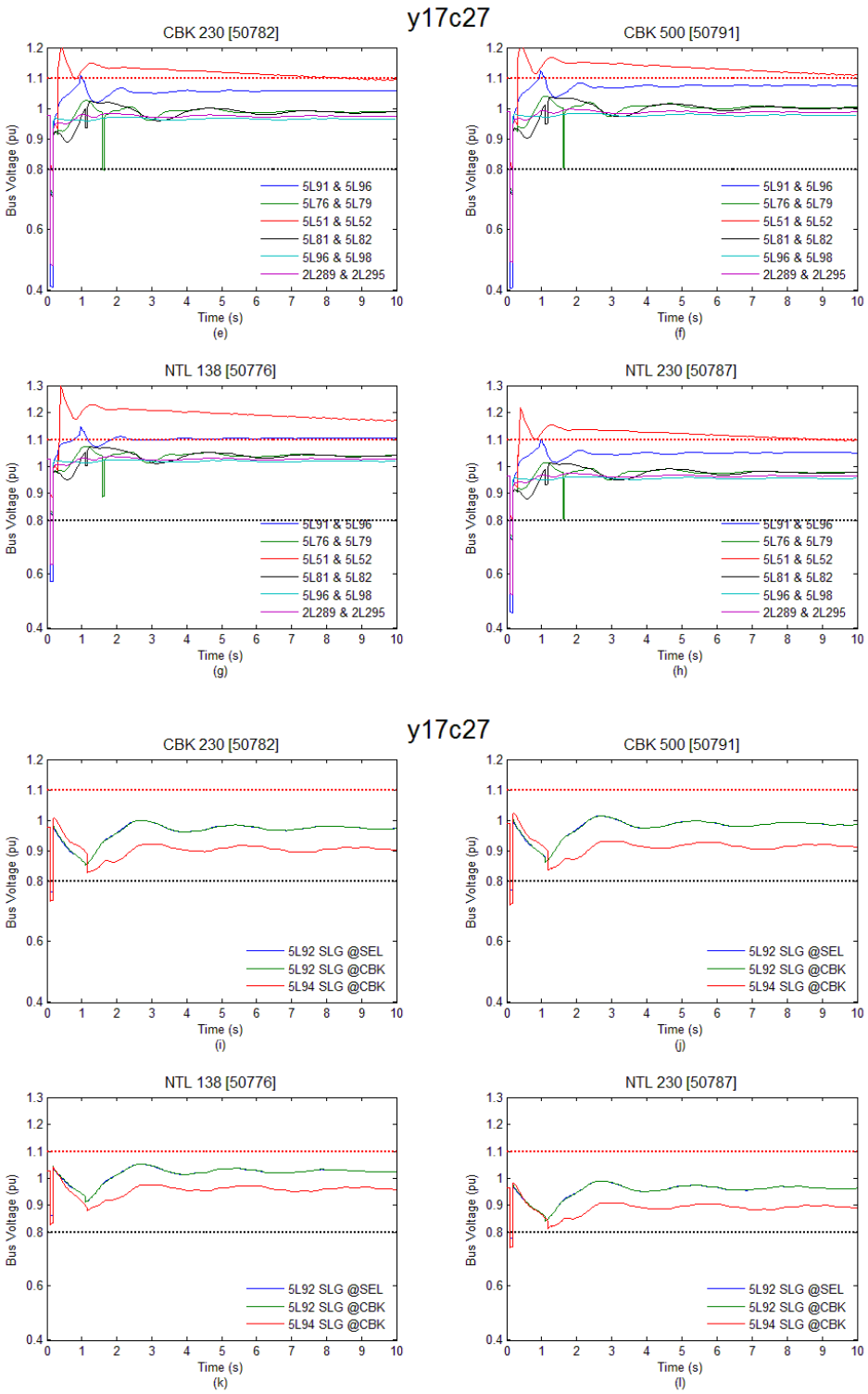
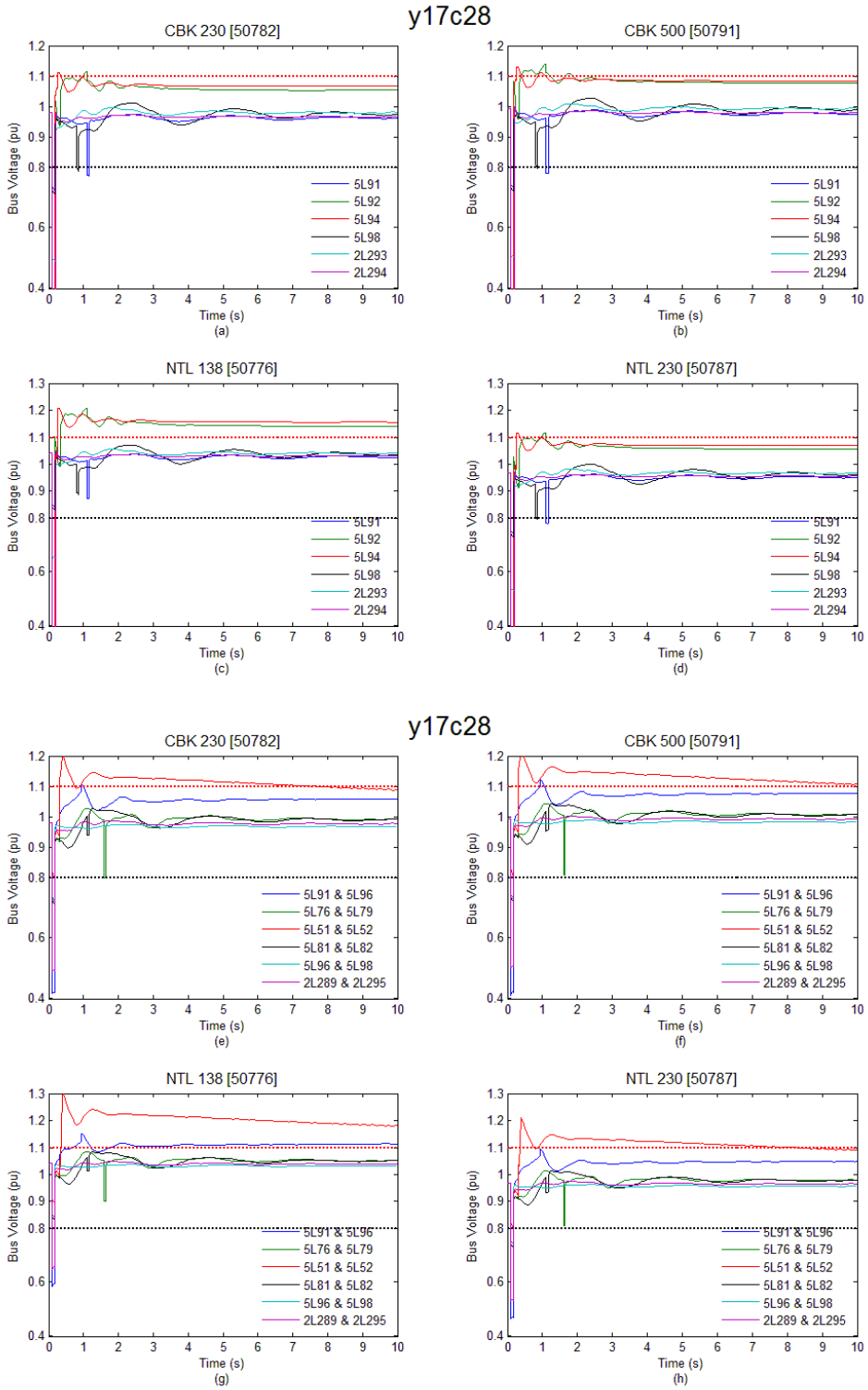


Figure E-31 y17c27 N-1, N-2 and Single Pole Reclose Contingency

E.3.8 **y17c28**



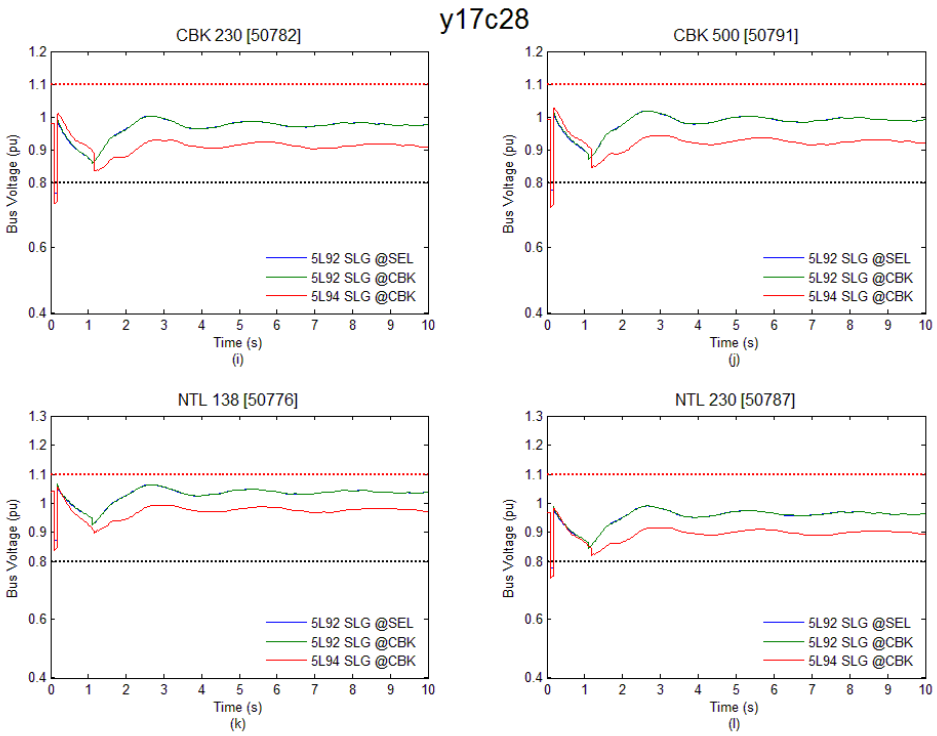
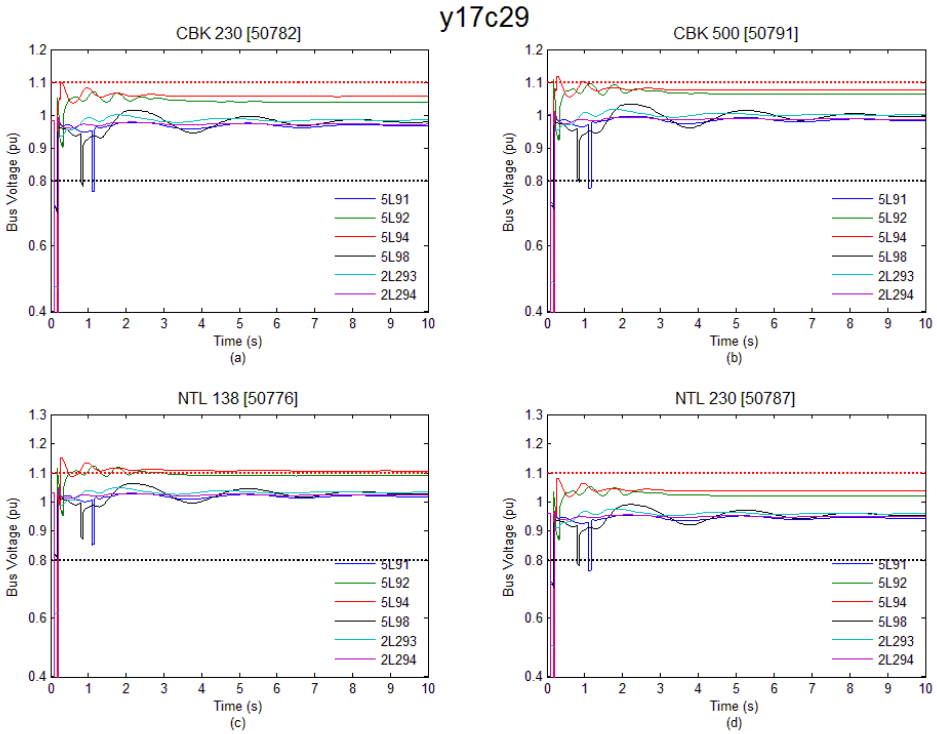


Figure E-32 y17c28 N-1, N-2 and Single Pole Reclose Contingency

E.3.9 **y17c29**



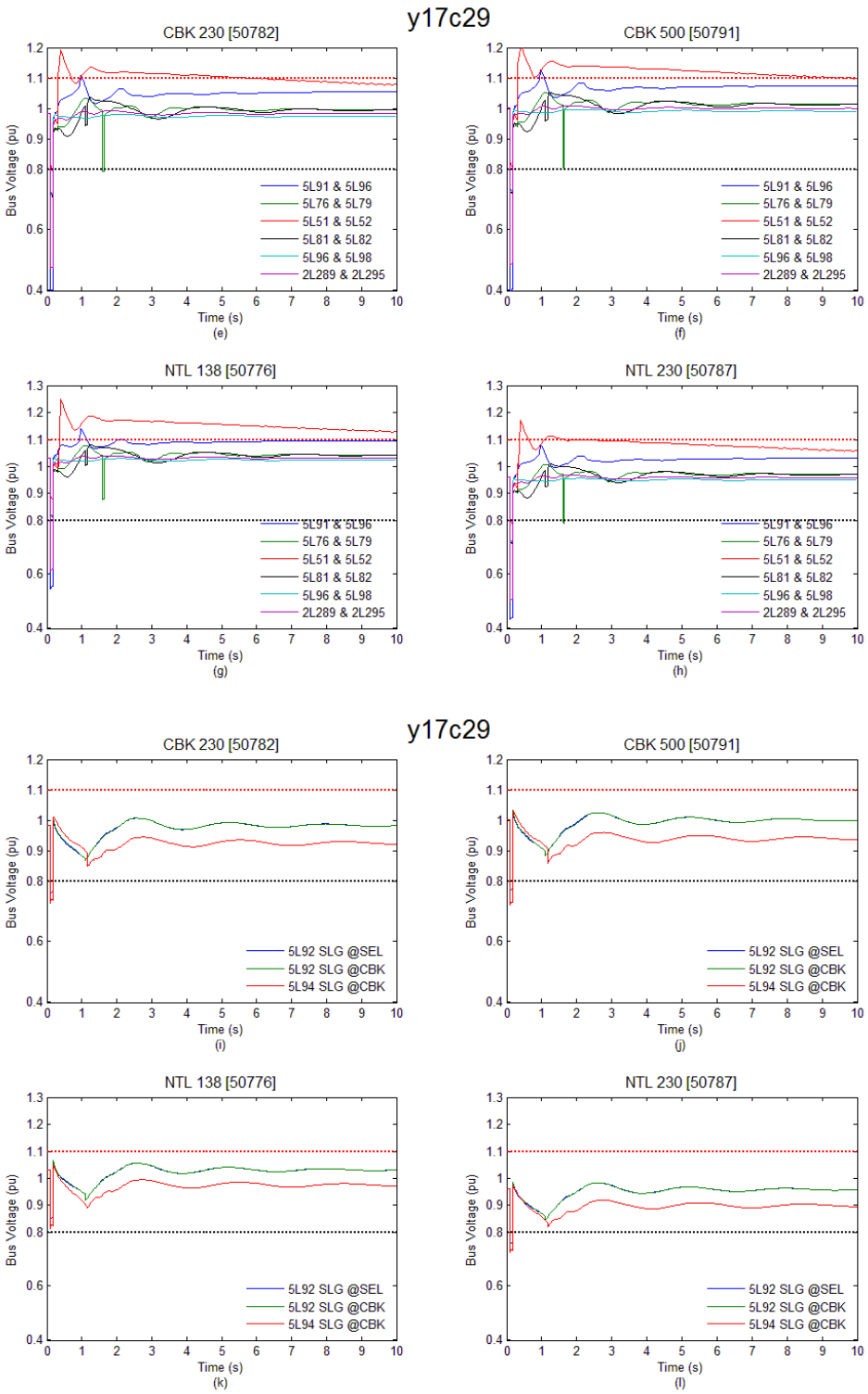
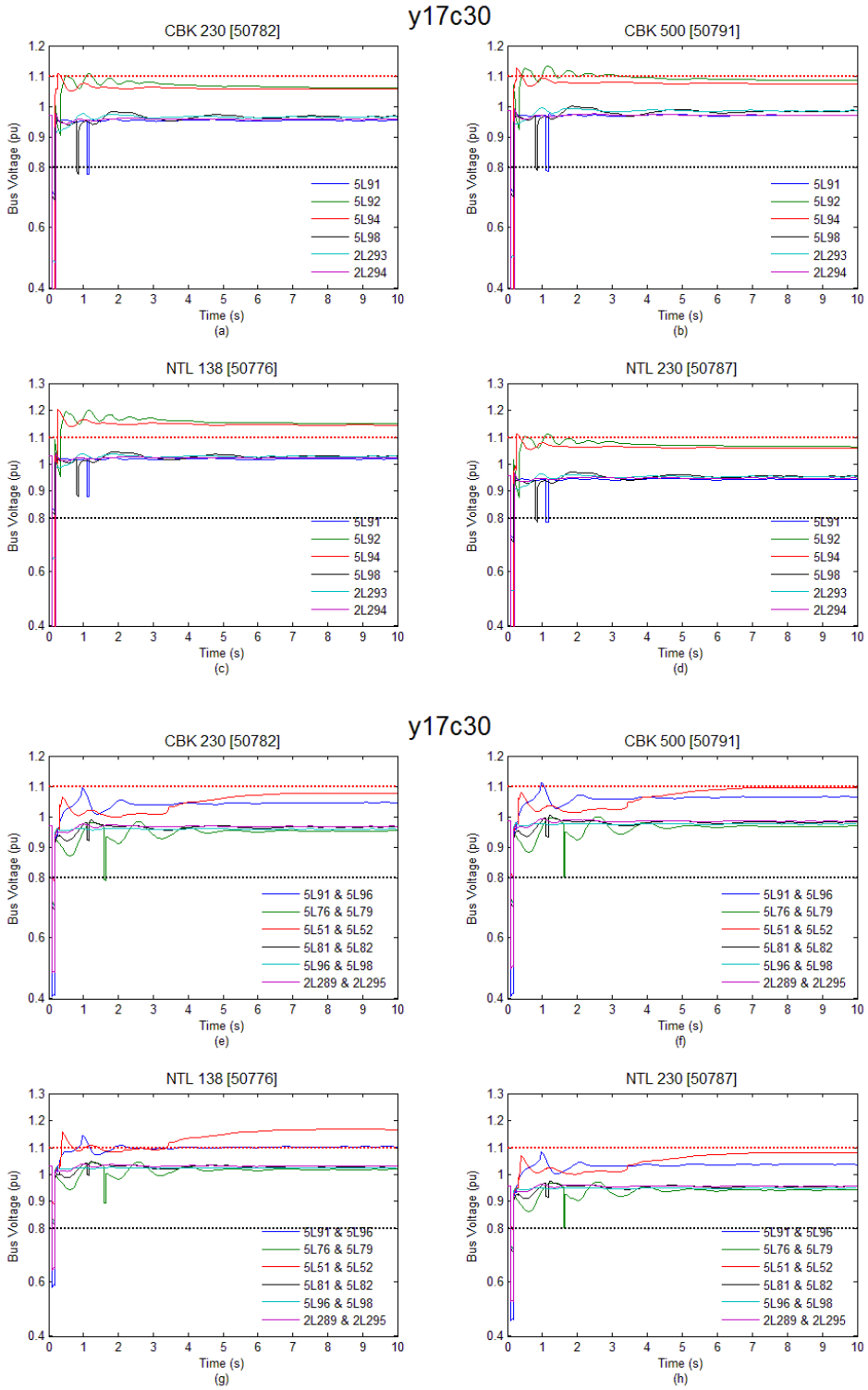


Figure E-33 y17c29 N-1, N-2 and Single Pole Reclose Contingency

E.3.10 **y17c30**



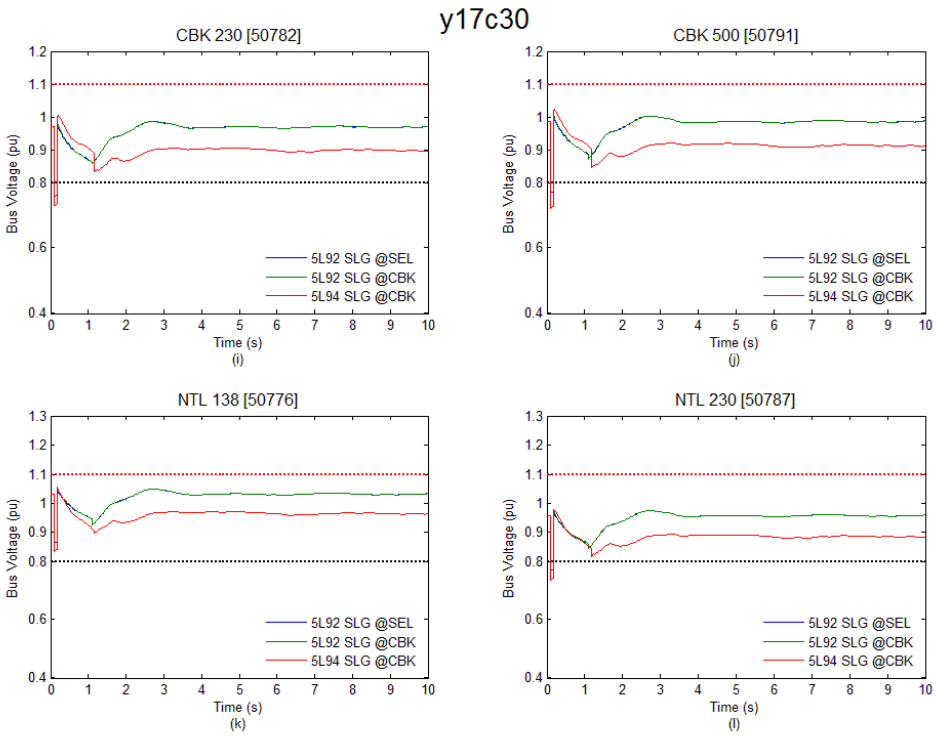
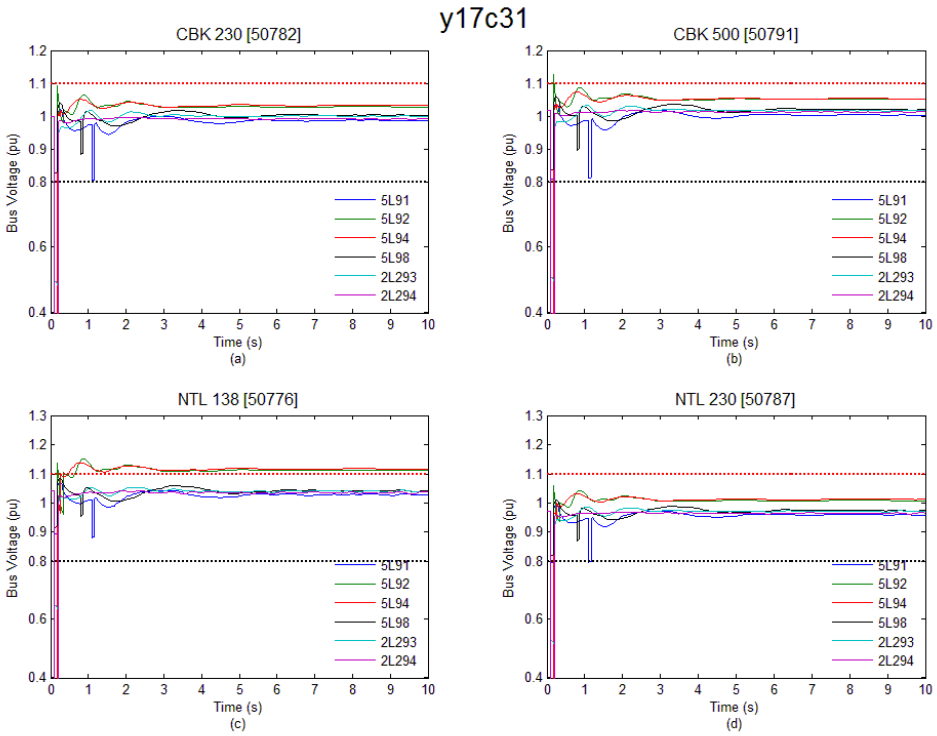


Figure E-34 y17c30 N-1, N-2 and Single Pole Reclose Contingency

E.3.11 **y17c31**



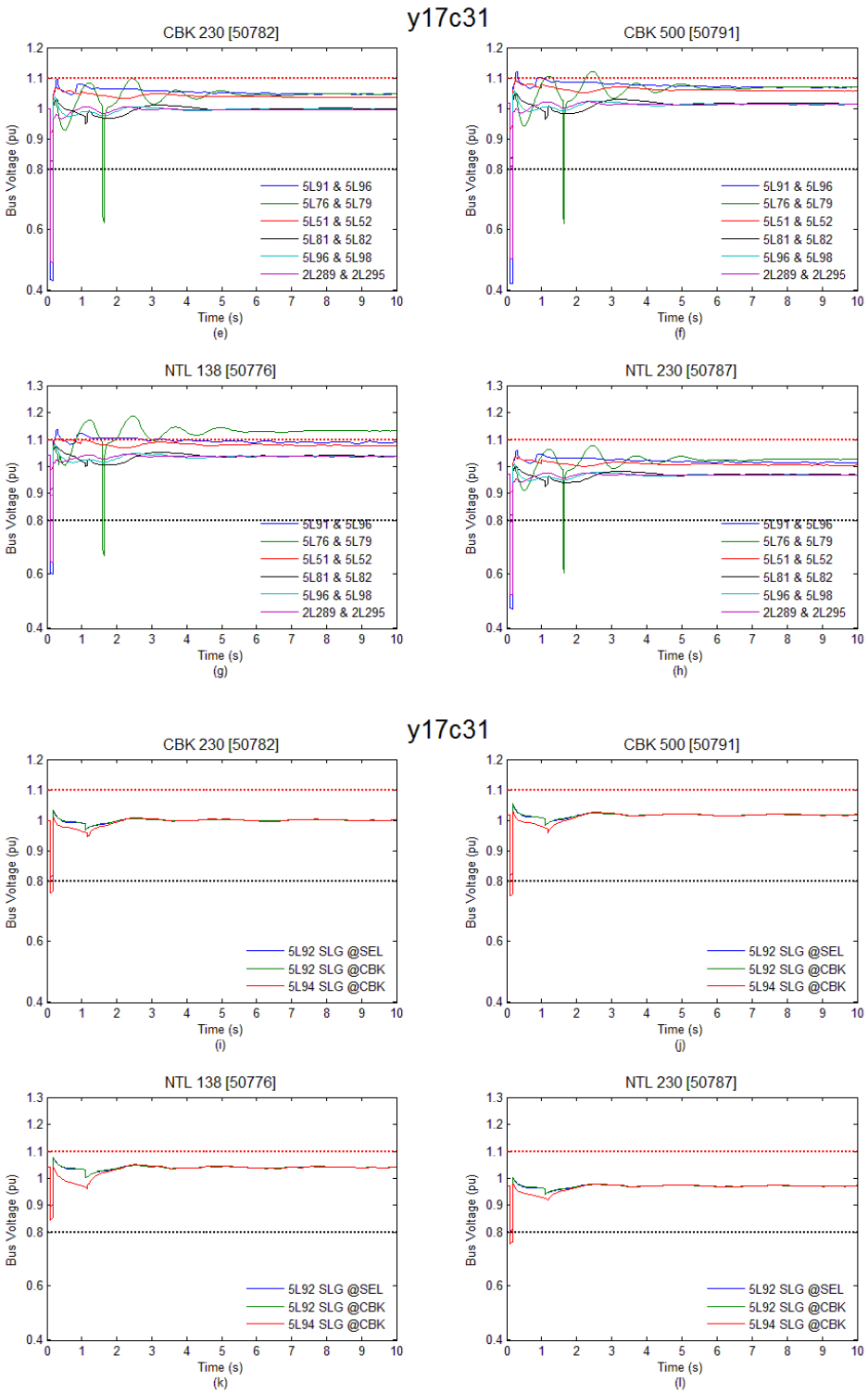
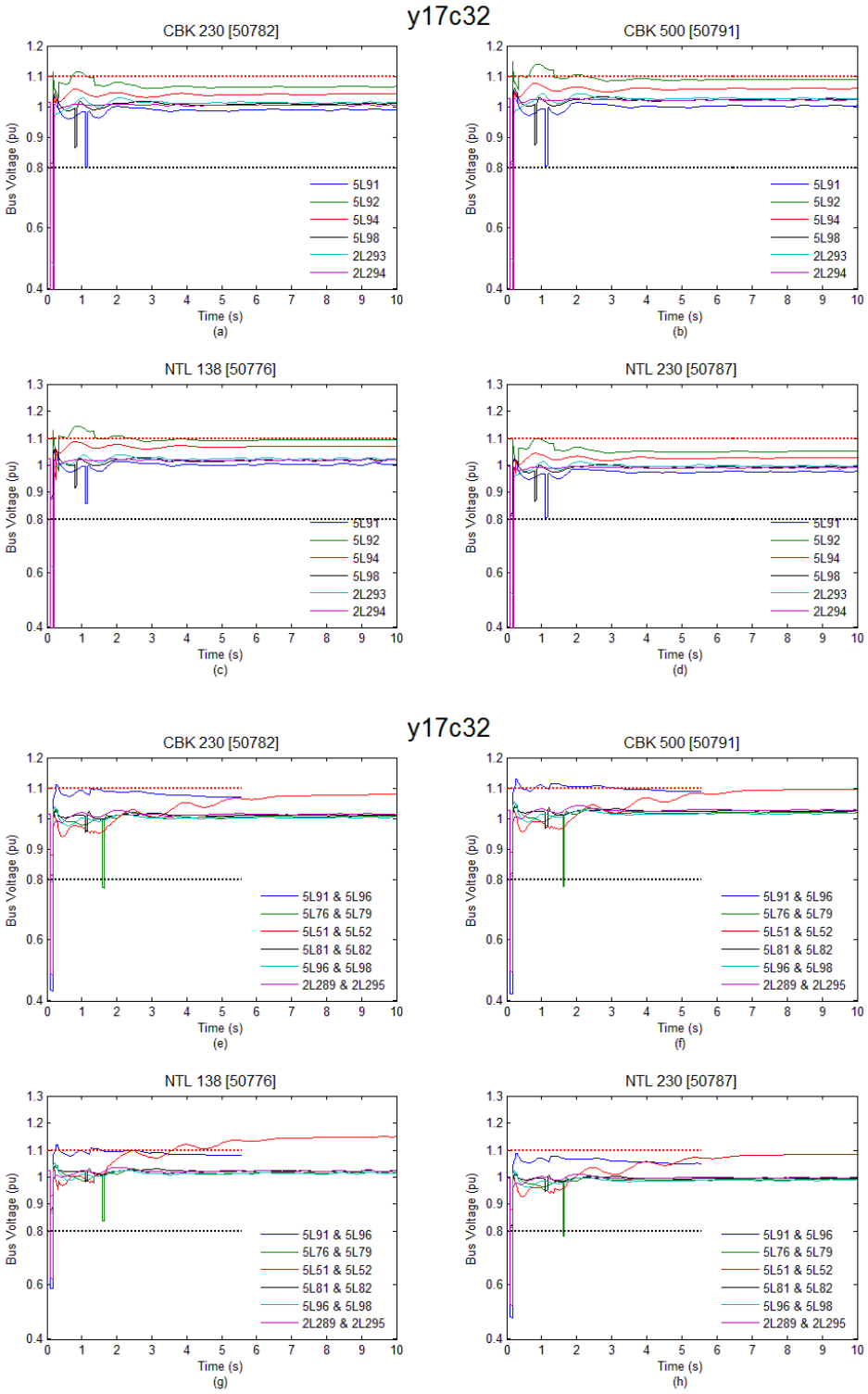


Figure E-35 y17c31 N-1, N-2 and Single Pole Reclose Contingency

E.3.12 **y17c32**



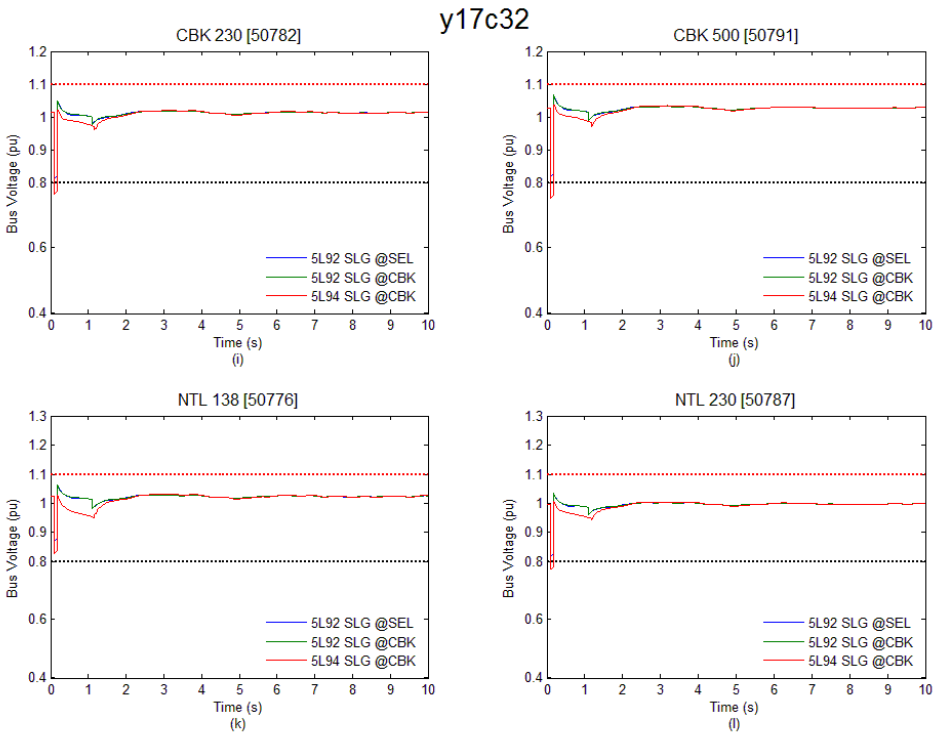
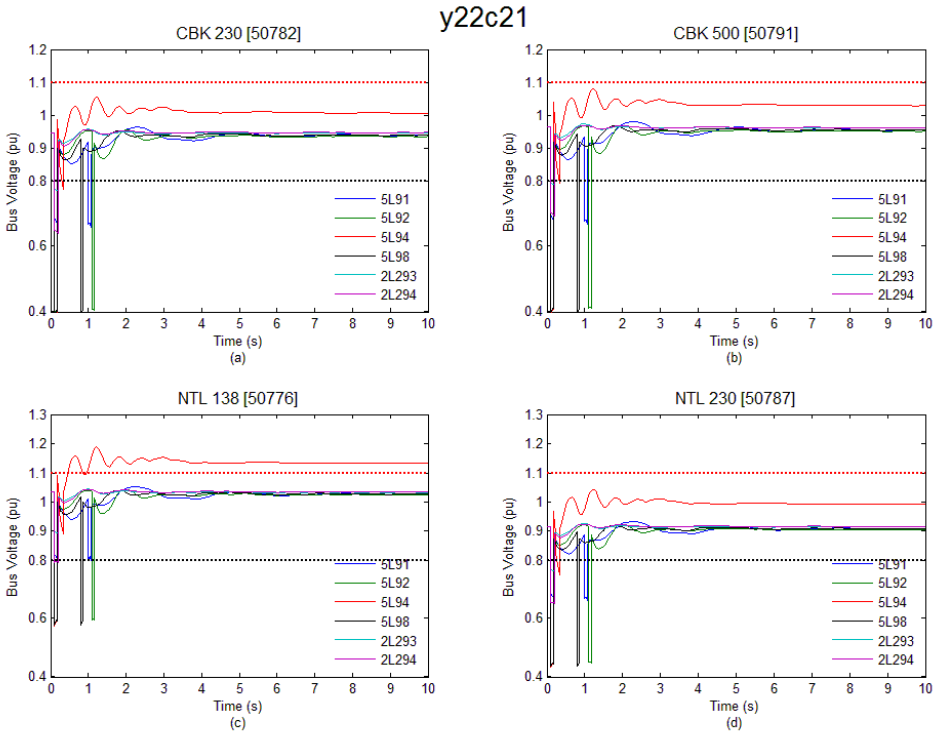


Figure E-36 y17c32 N-1, N-2 and Single Pole Reclose Contingency

E.4 Y22 Cases

E.4.1 **y22c21**



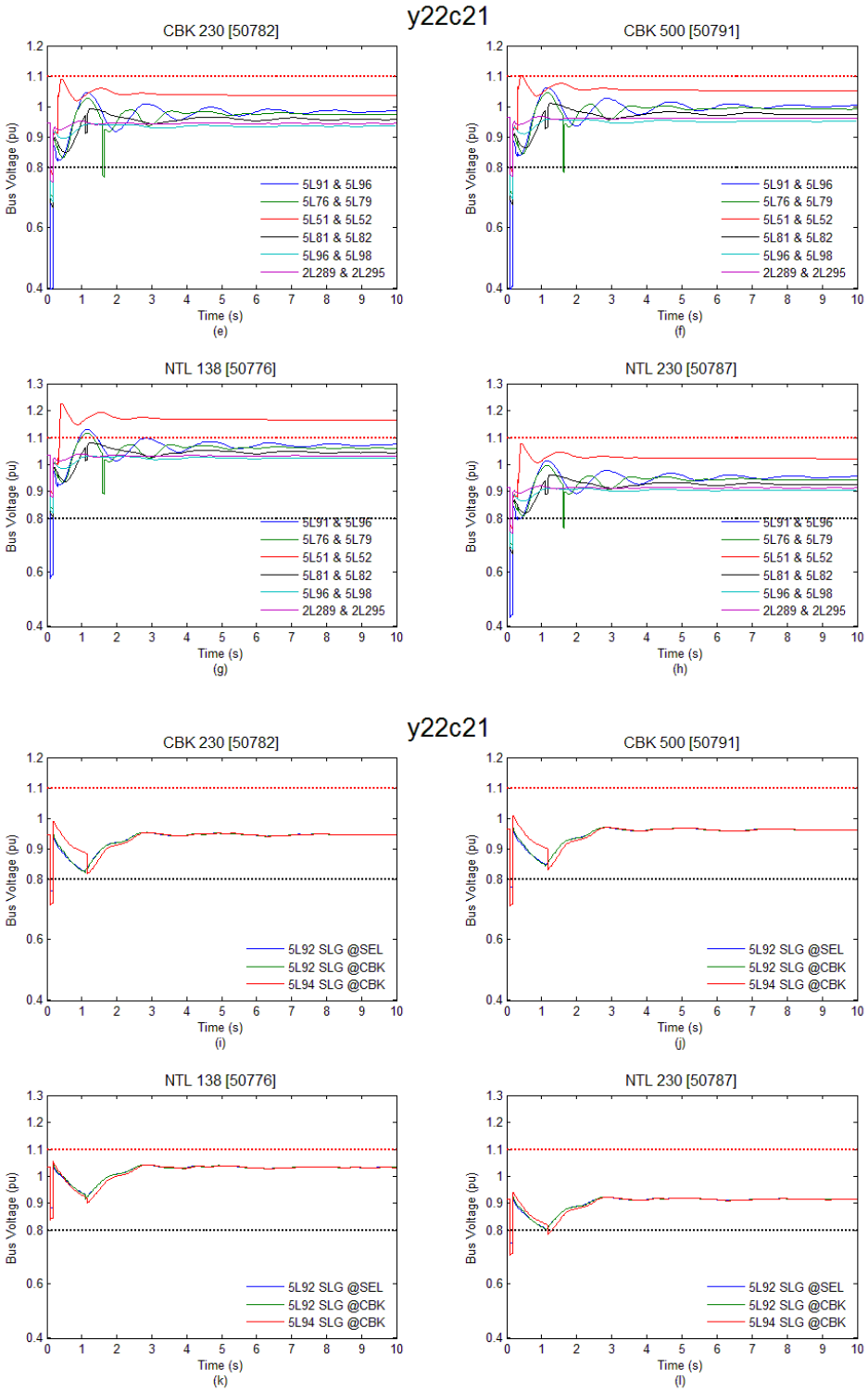
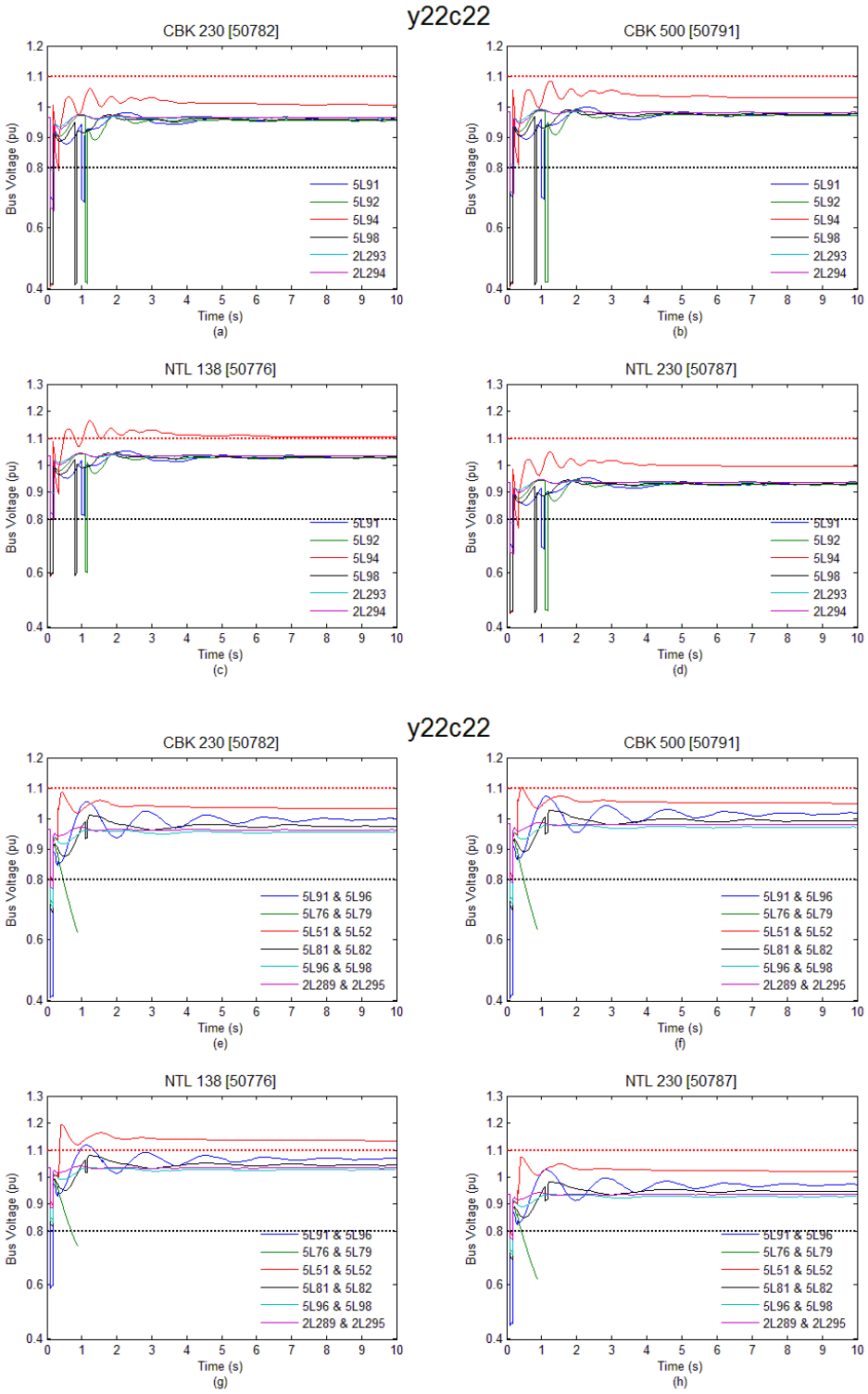


Figure E-37 y22c21 N-1, N-2 and Single Pole Reclose Contingency

E.4.2 **y22c22**



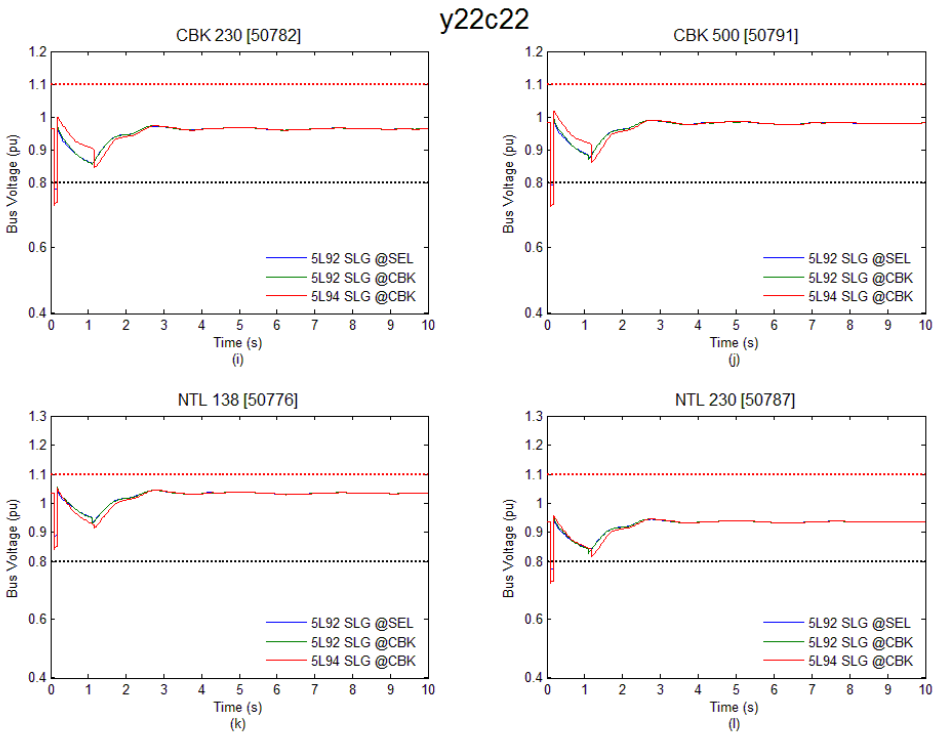
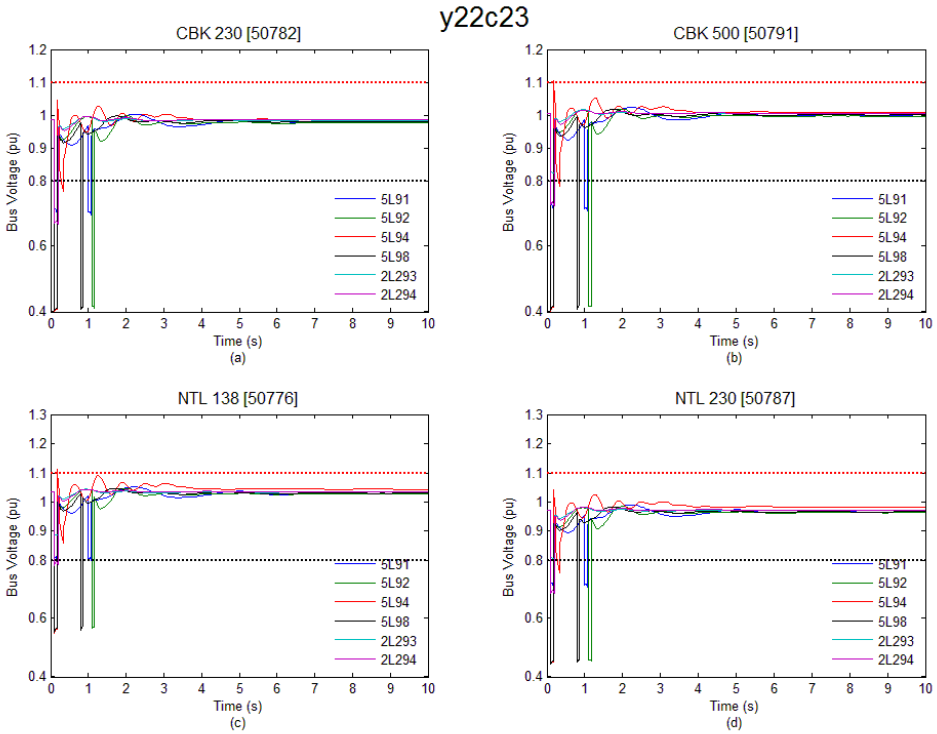


Figure E-38 y22c22 N-1, N-2 and Single Pole Reclose Contingency

E.4.3 **y22c23**



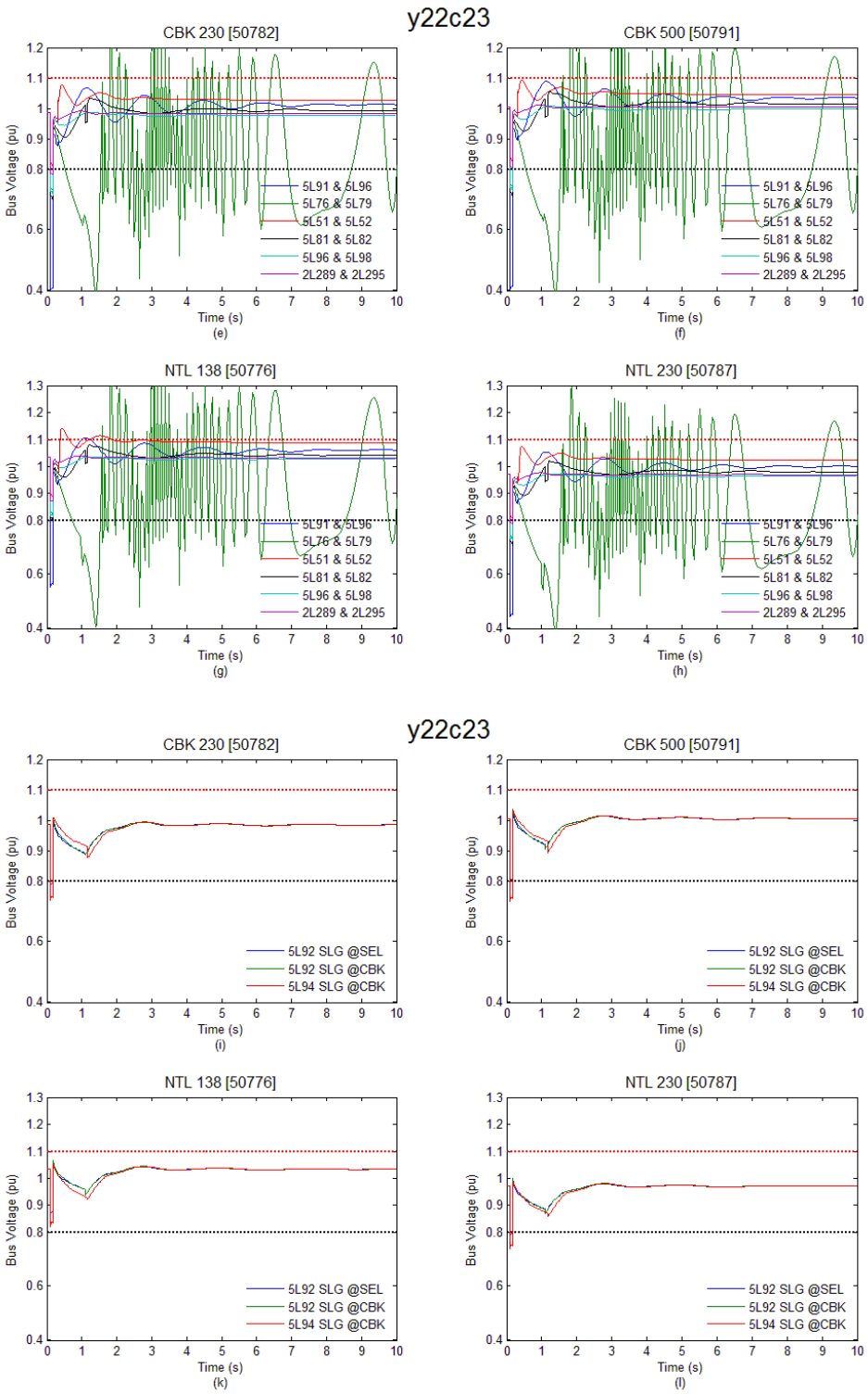
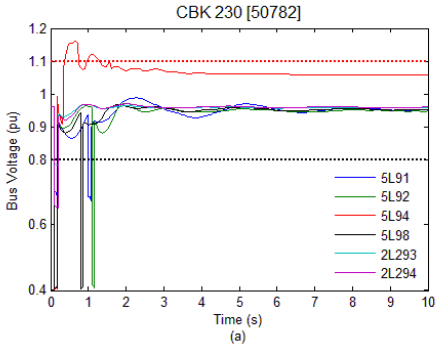
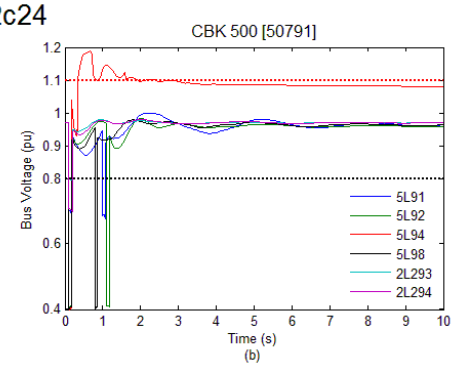


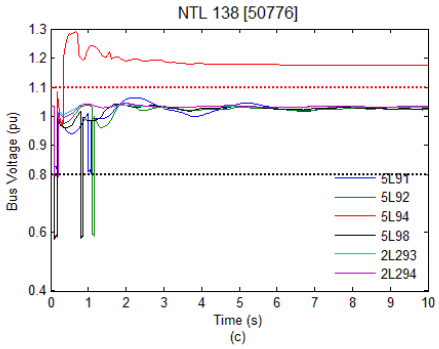
Figure E-39 y22c23 N-1, N-2 and Single Pole Reclose Contingency

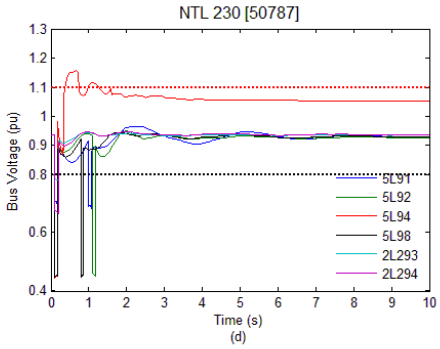
E.4.4 **y22c24**

y22c24

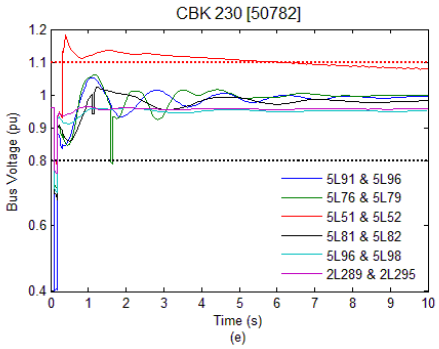


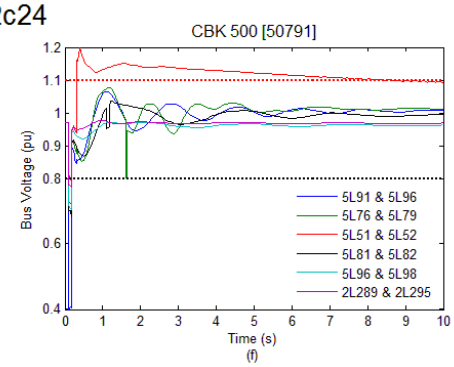


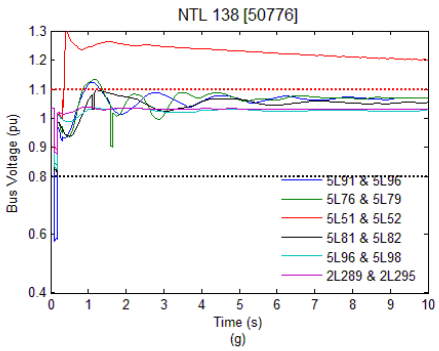


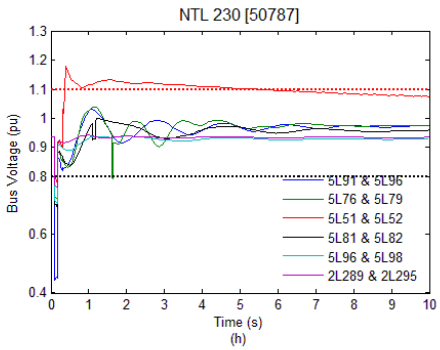


y22c24









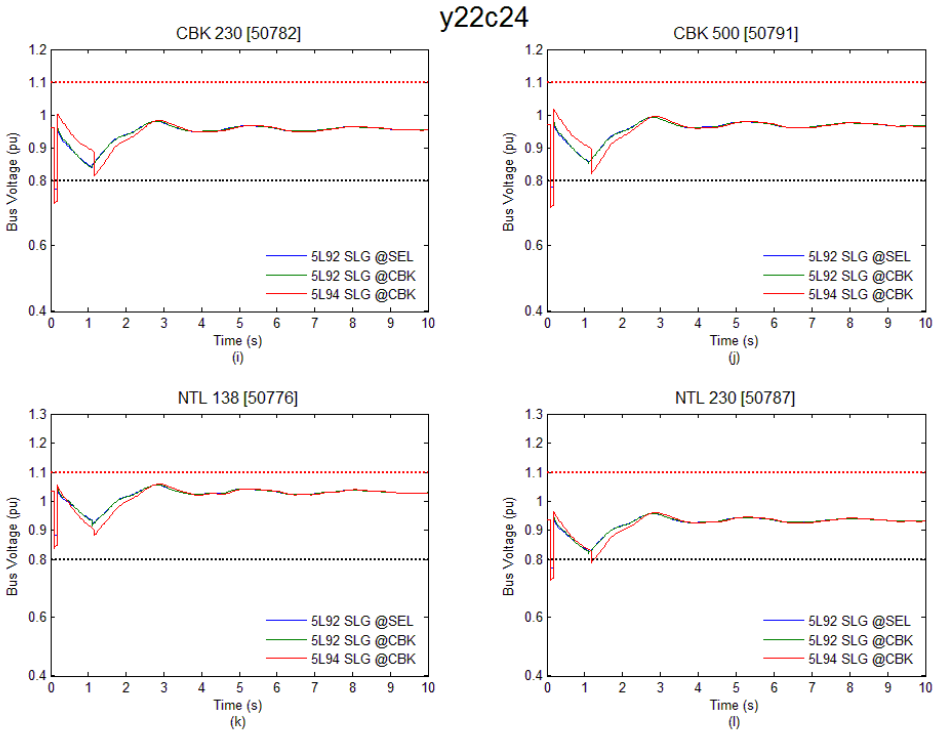
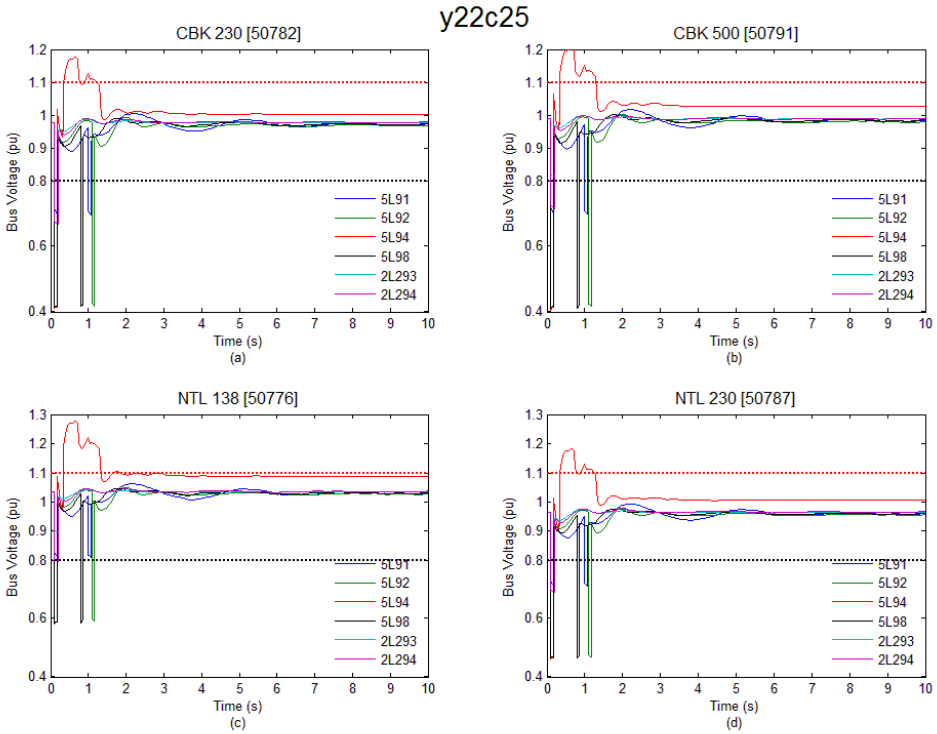


Figure E-40 y22c24 N-1, N-2 and Single Pole Reclose Contingency

E.4.5 **y22c25**



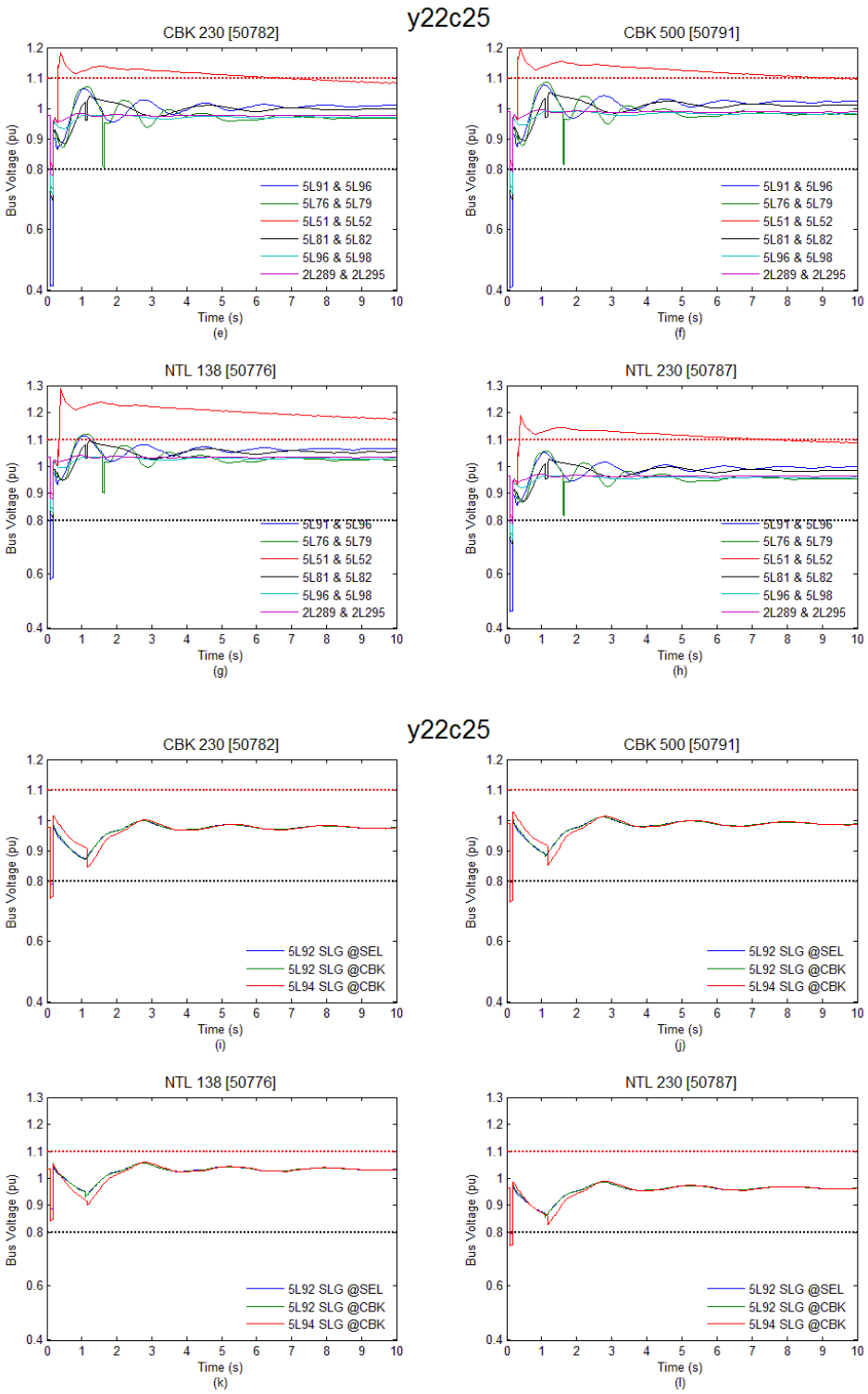
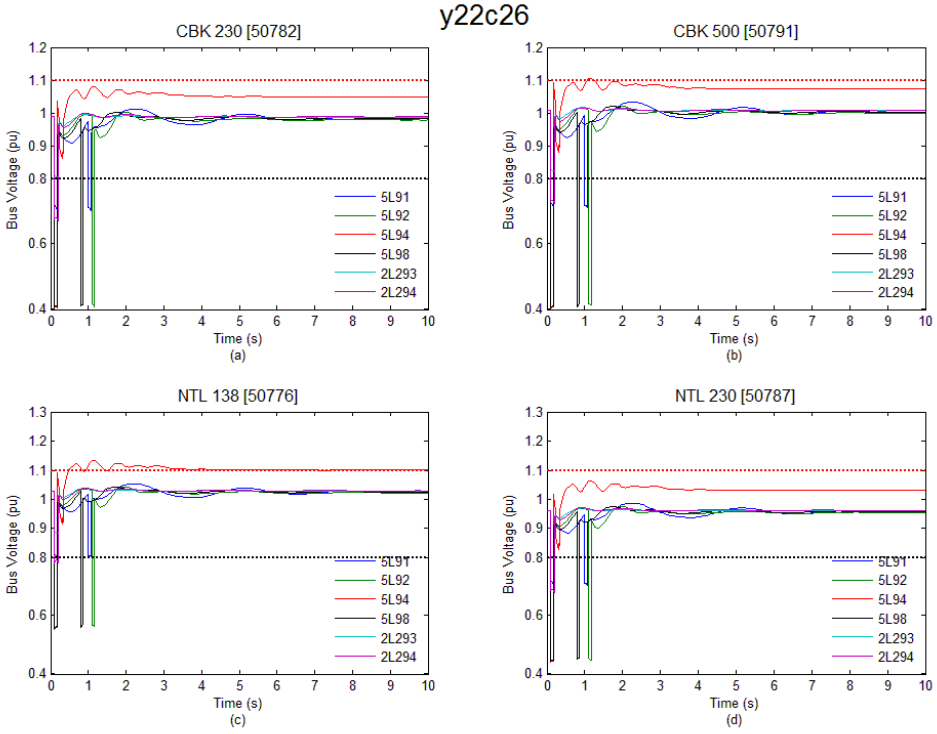


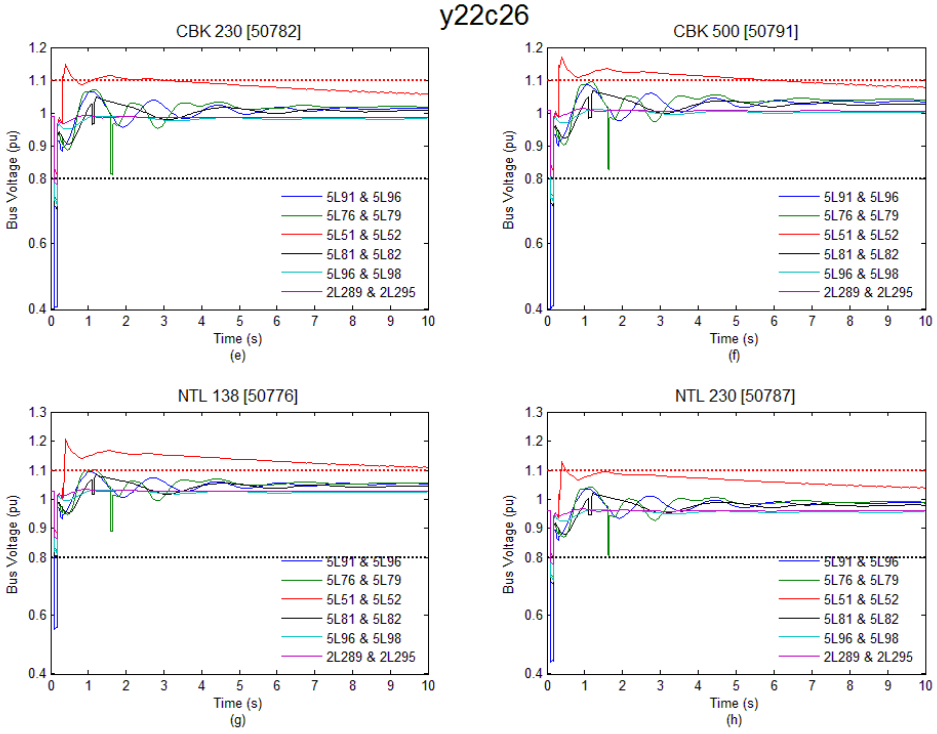
Figure E-41 y22c25 N-1, N-2 and Single Pole Reclose Contingency

E.4.6 **y22c26**

y22c26



y22c26



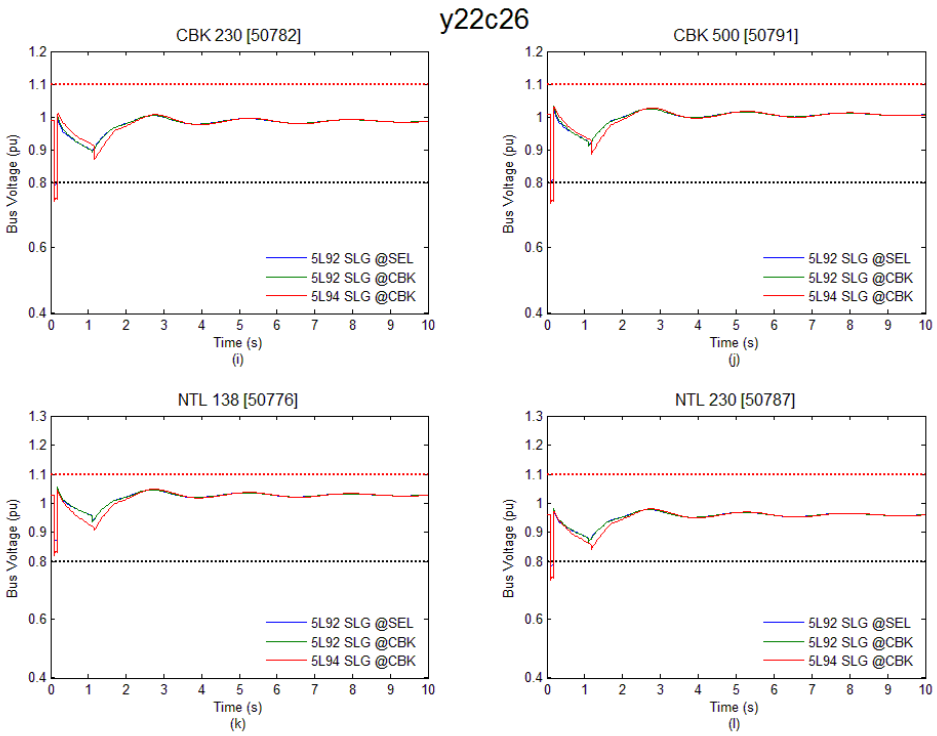
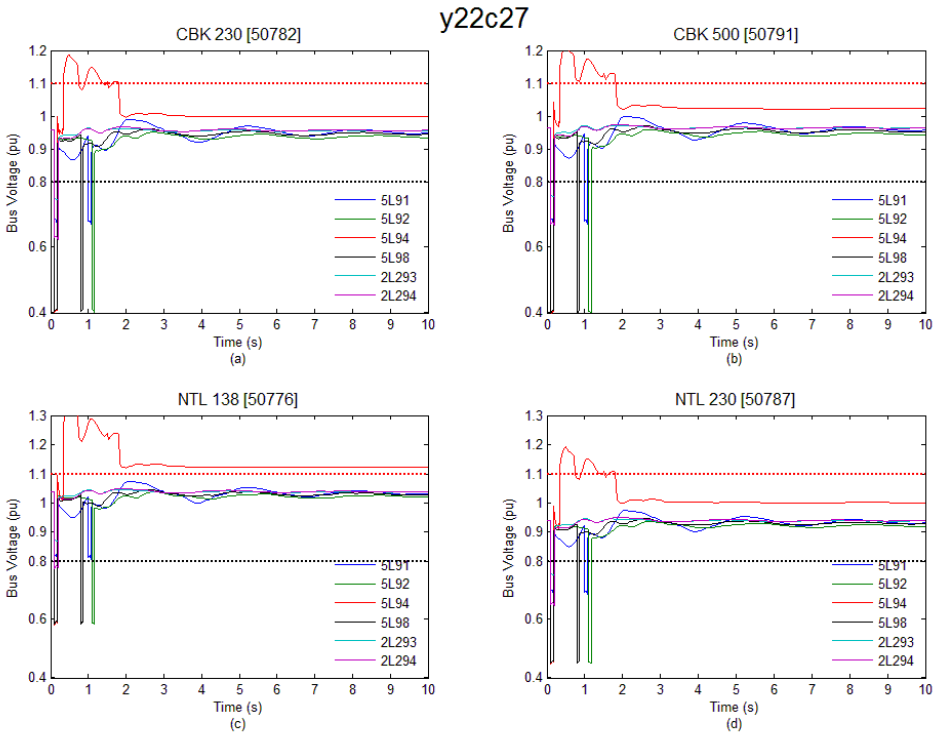


Figure E-42 y22c26 N-1, N-2 and Single Pole Reclose Contingency

E.4.7 **y22c27**



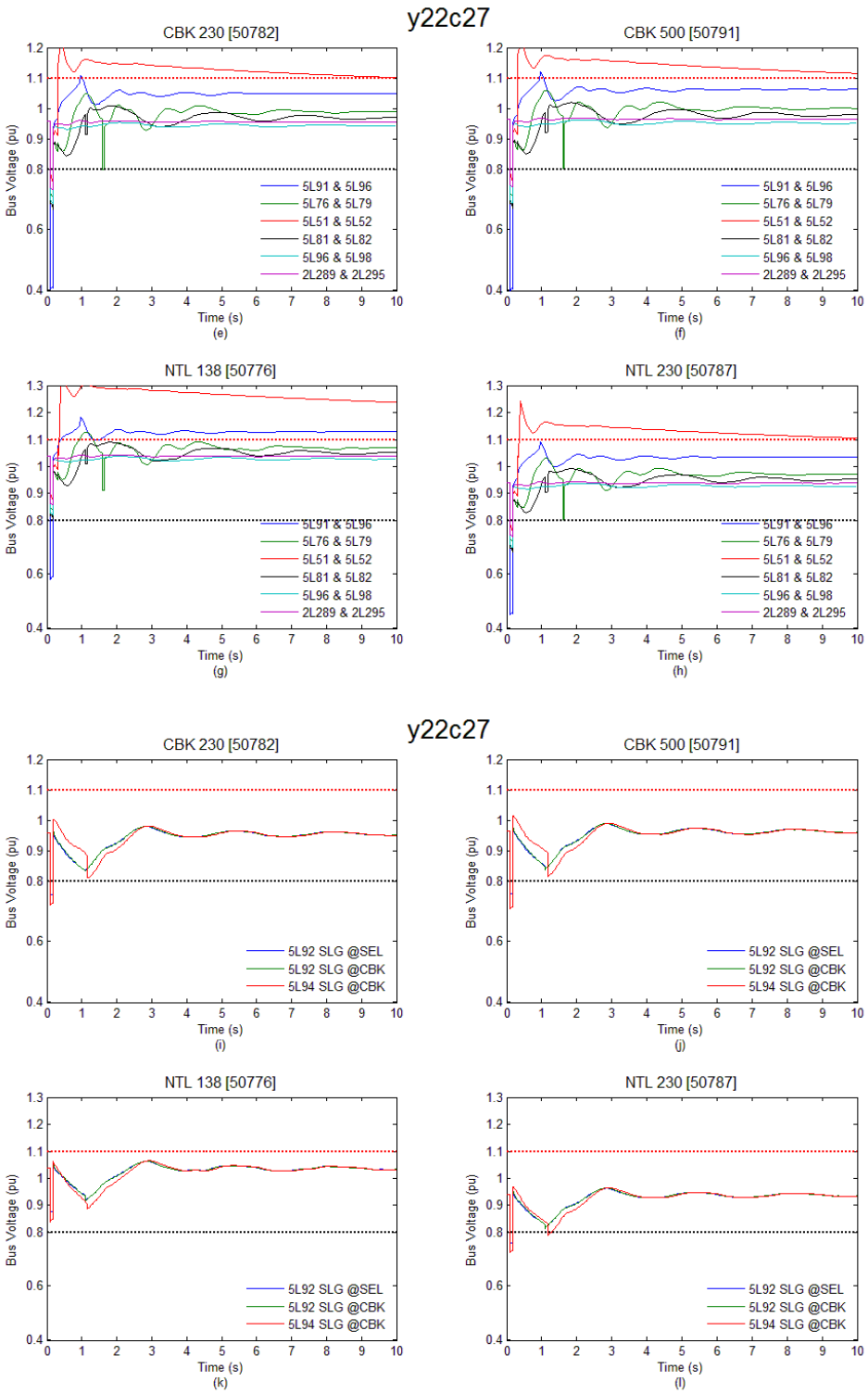
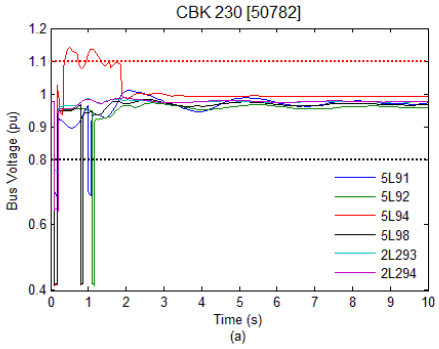
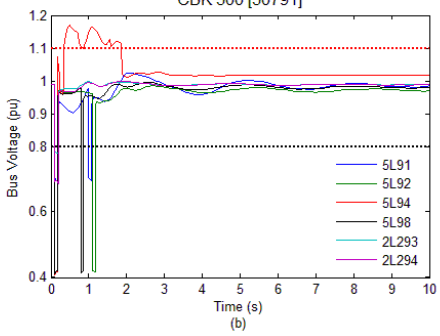


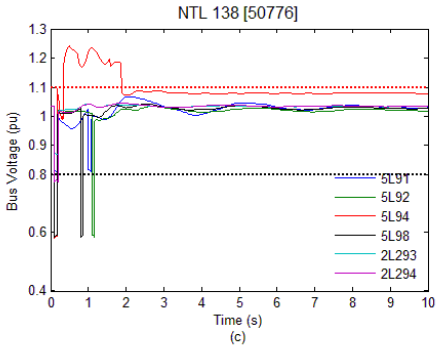
Figure E-43 y22c27 N-1, N-2 and Single Pole Reclose Contingency

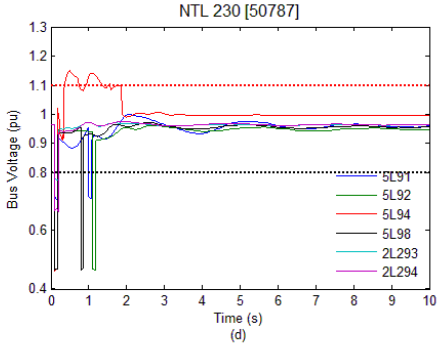
E.4.8 **y22c28**

y22c28

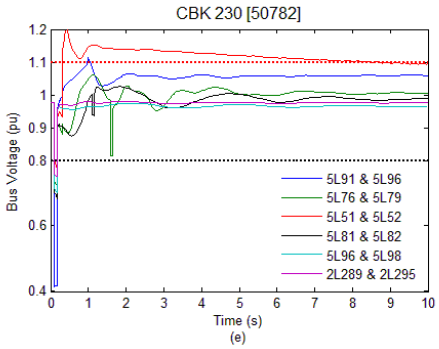


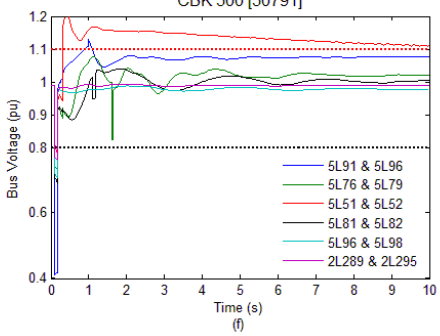


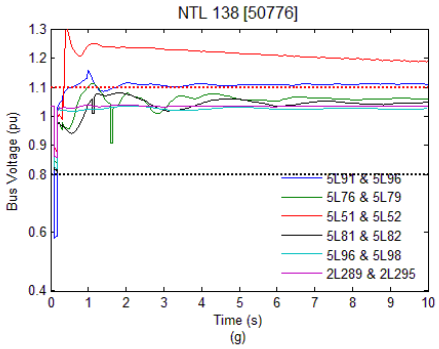


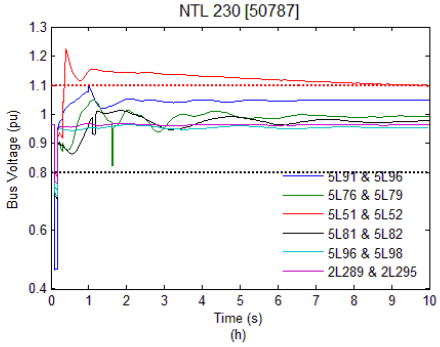


y22c28









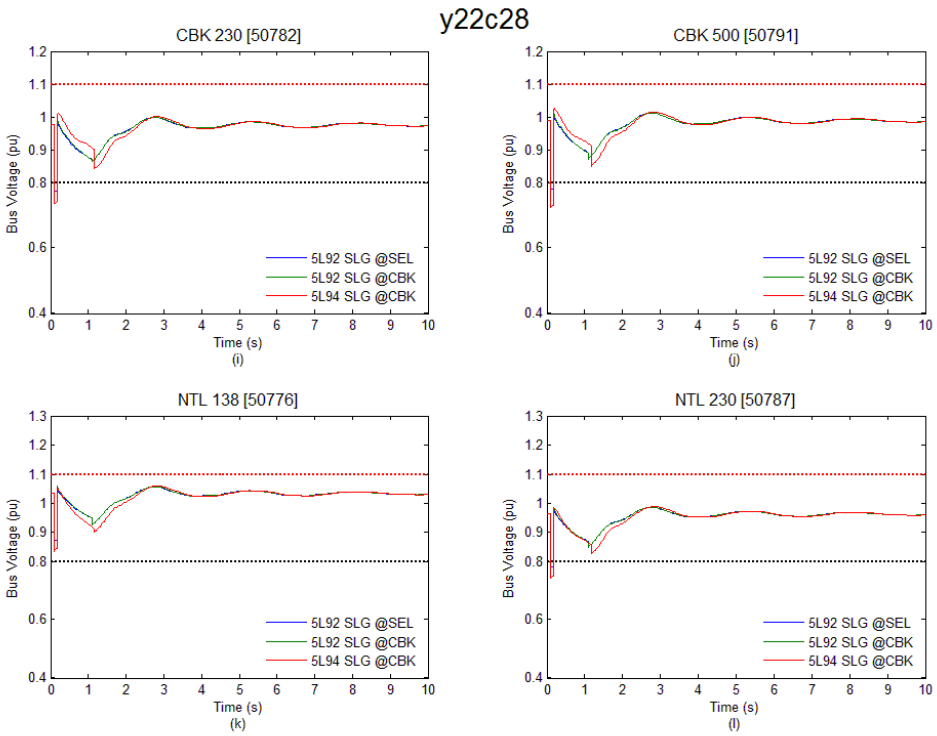
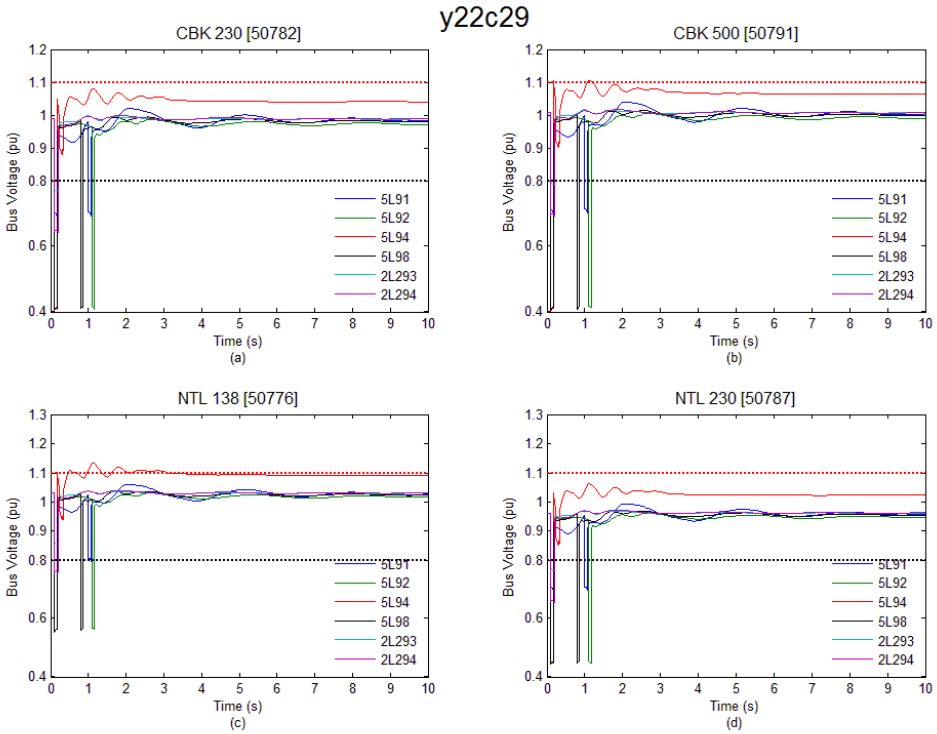


Figure E-44 y22c28 N-1, N-2 and Single Pole Reclose Contingency

E.4.9 **y22c29**



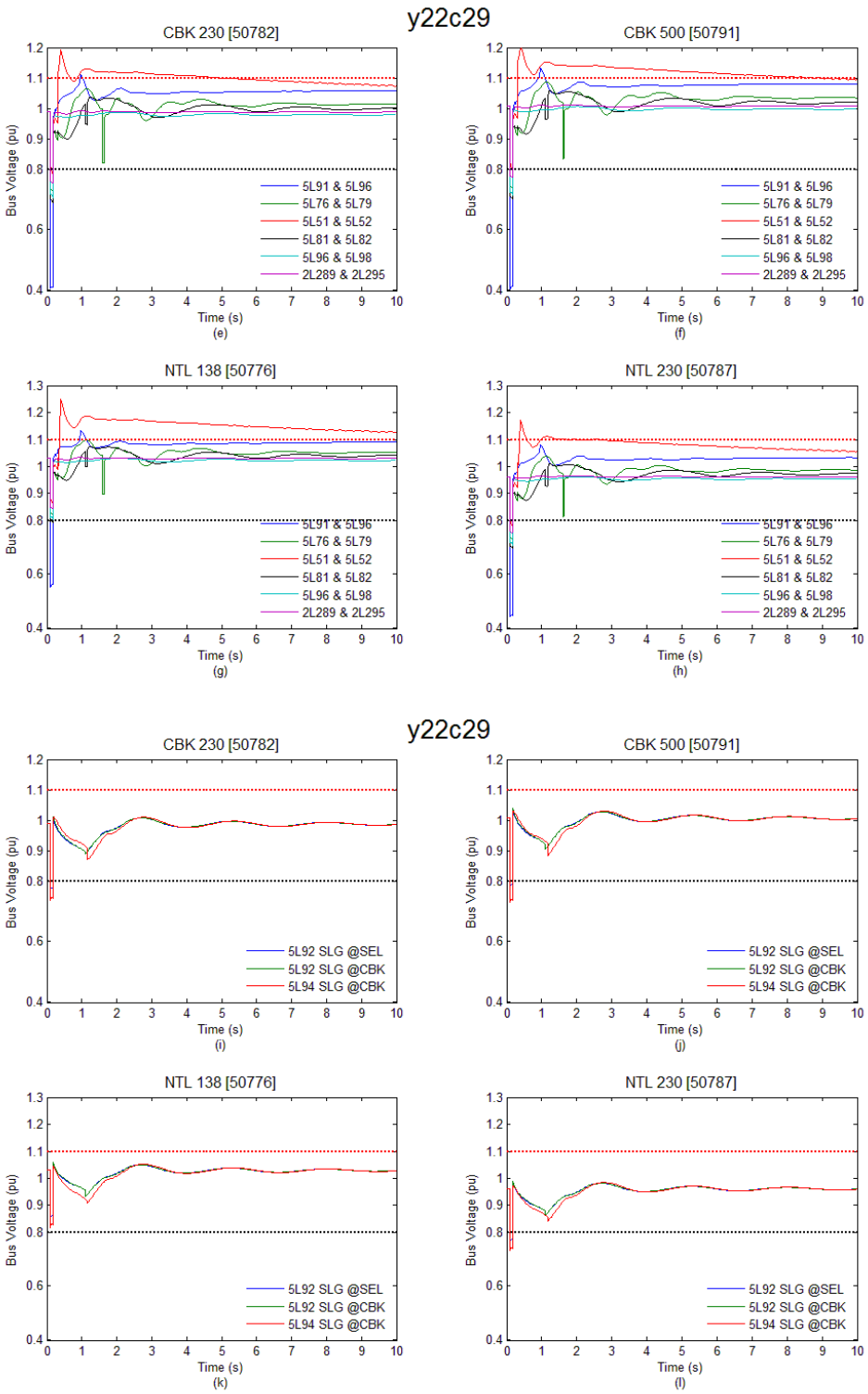
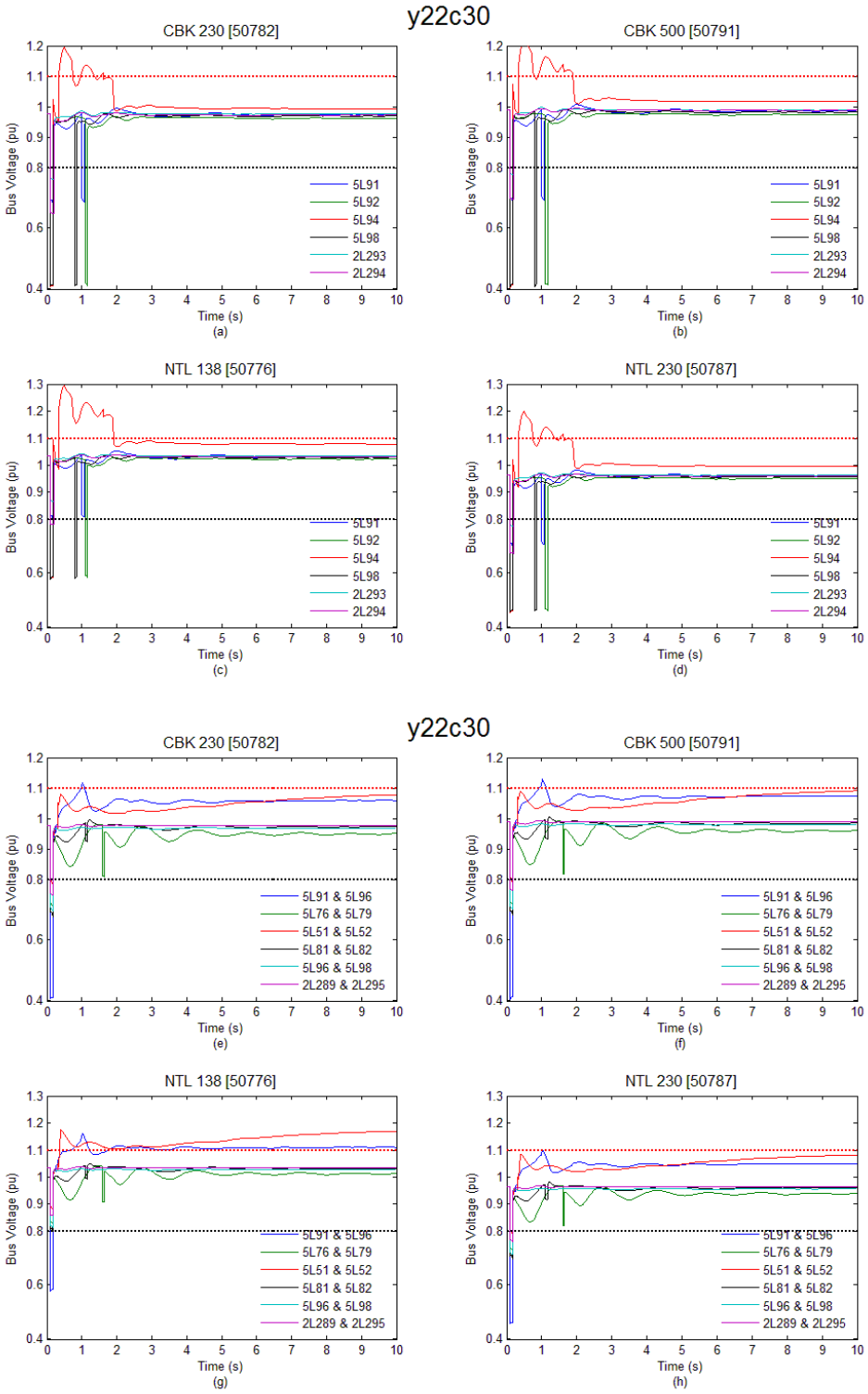


Figure E-45 y22c29 N-1, N-2 and Single Pole Reclose Contingency

E.4.10 **y22c30**



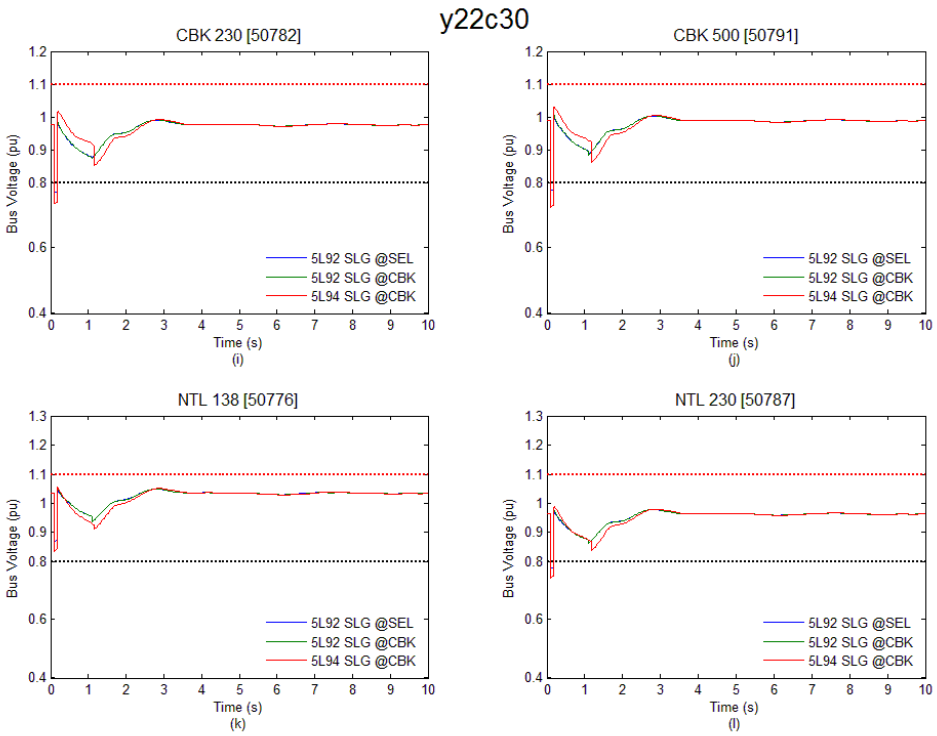
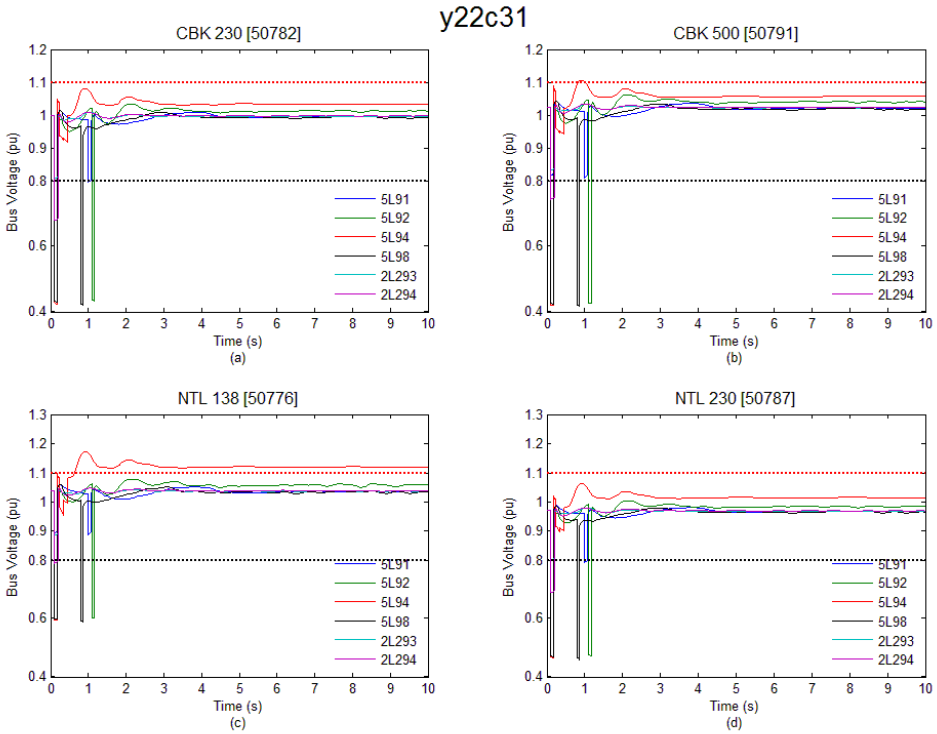


Figure E-46 y22c30 N-1, N-2 and Single Pole Reclose Contingency

E.4.11 **y22c31**



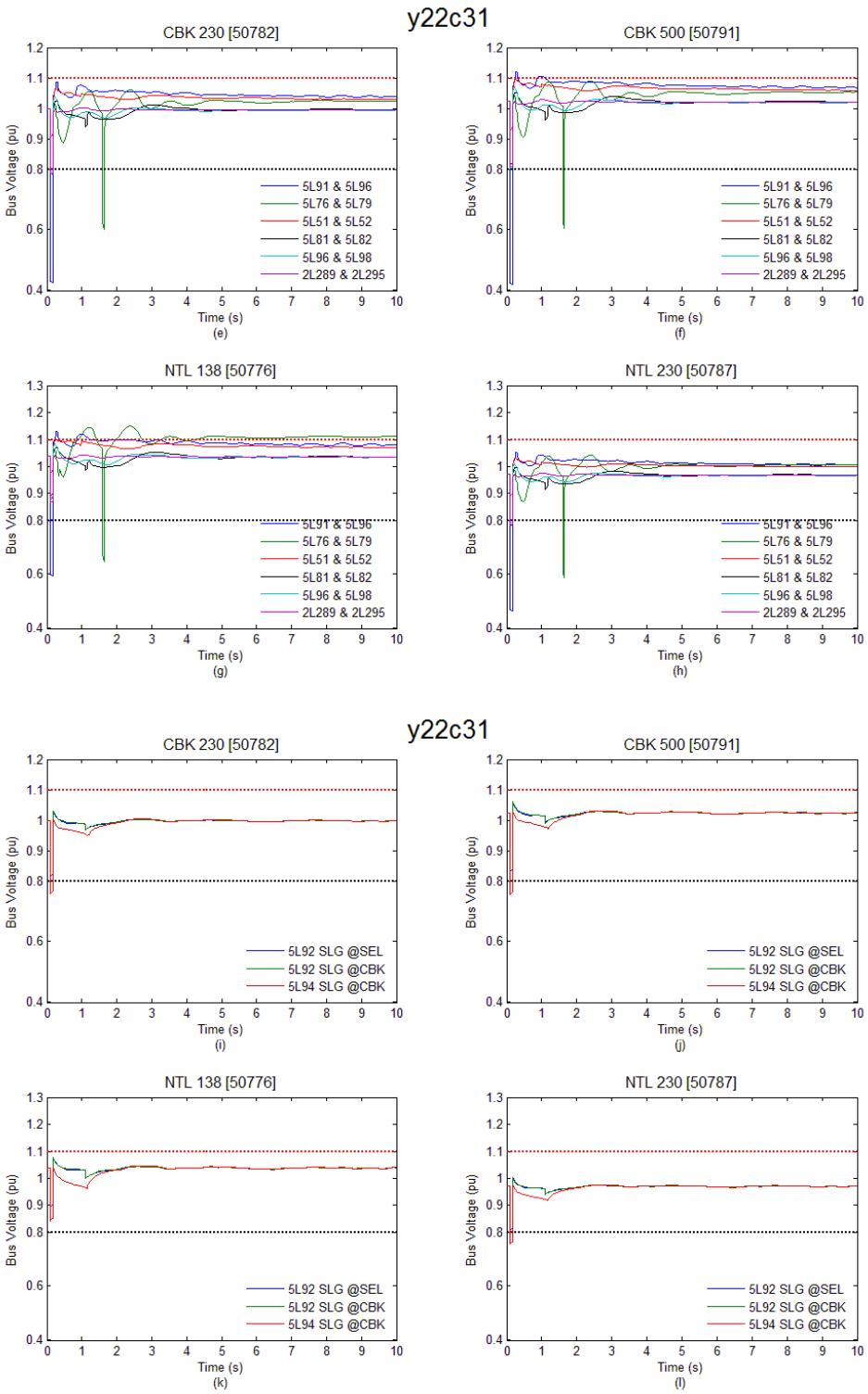
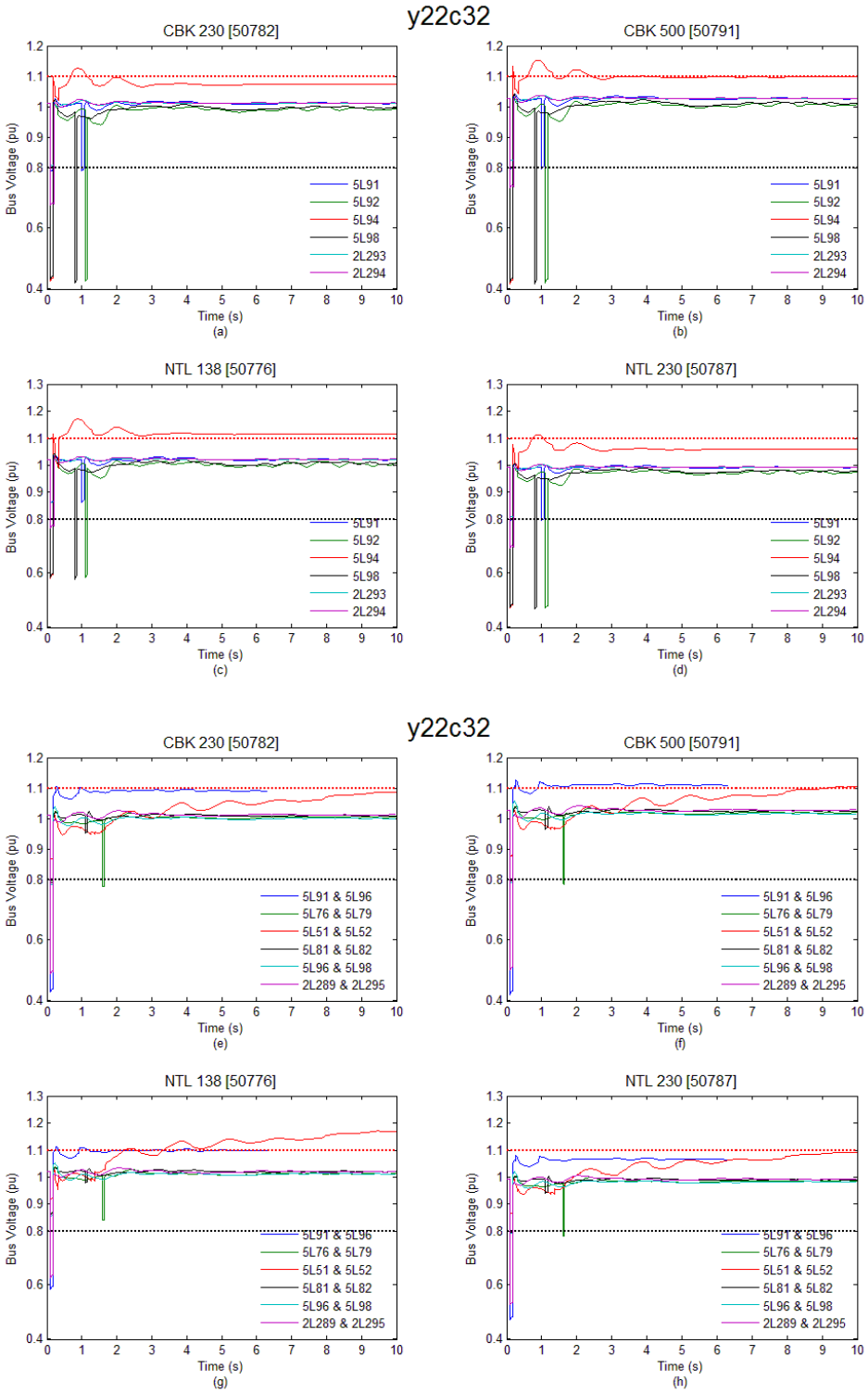


Figure E-47 y22c31 N-1, N-2 and Single Pole Reclose Contingency

E.4.12 **y22c32**



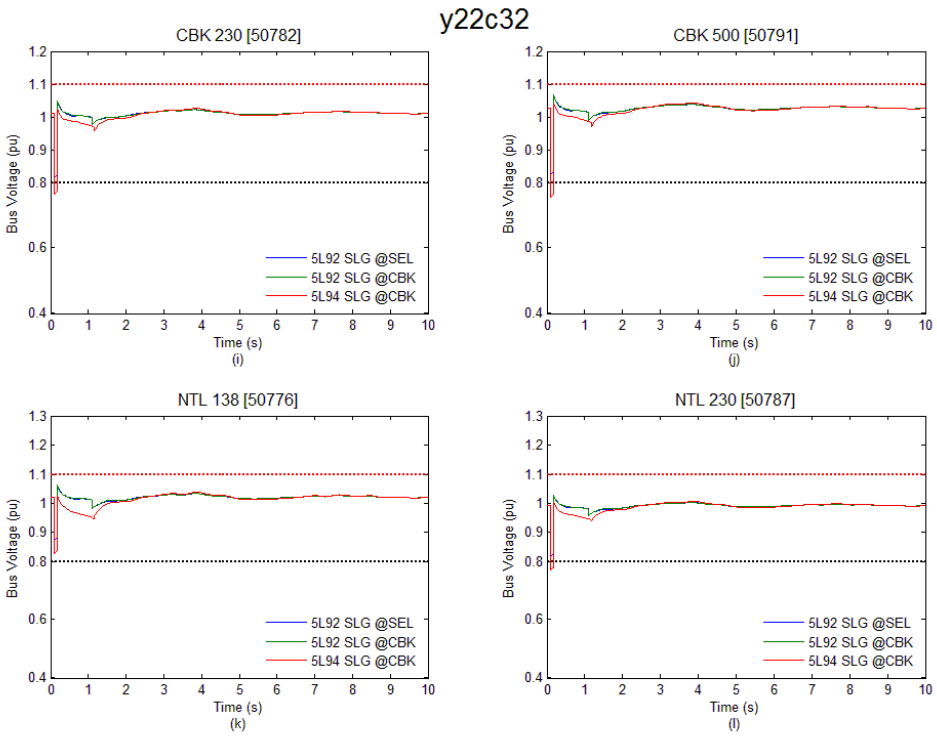
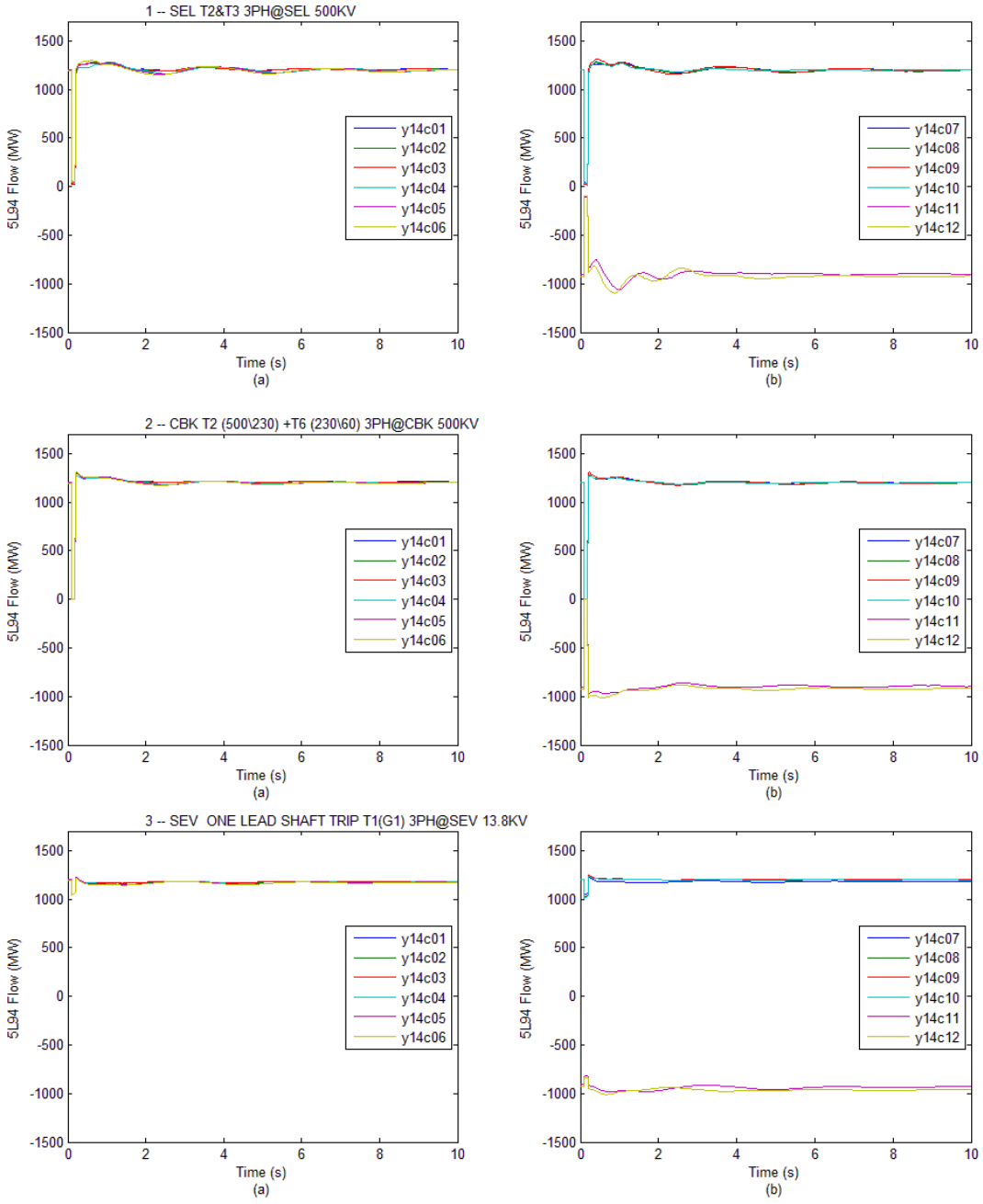


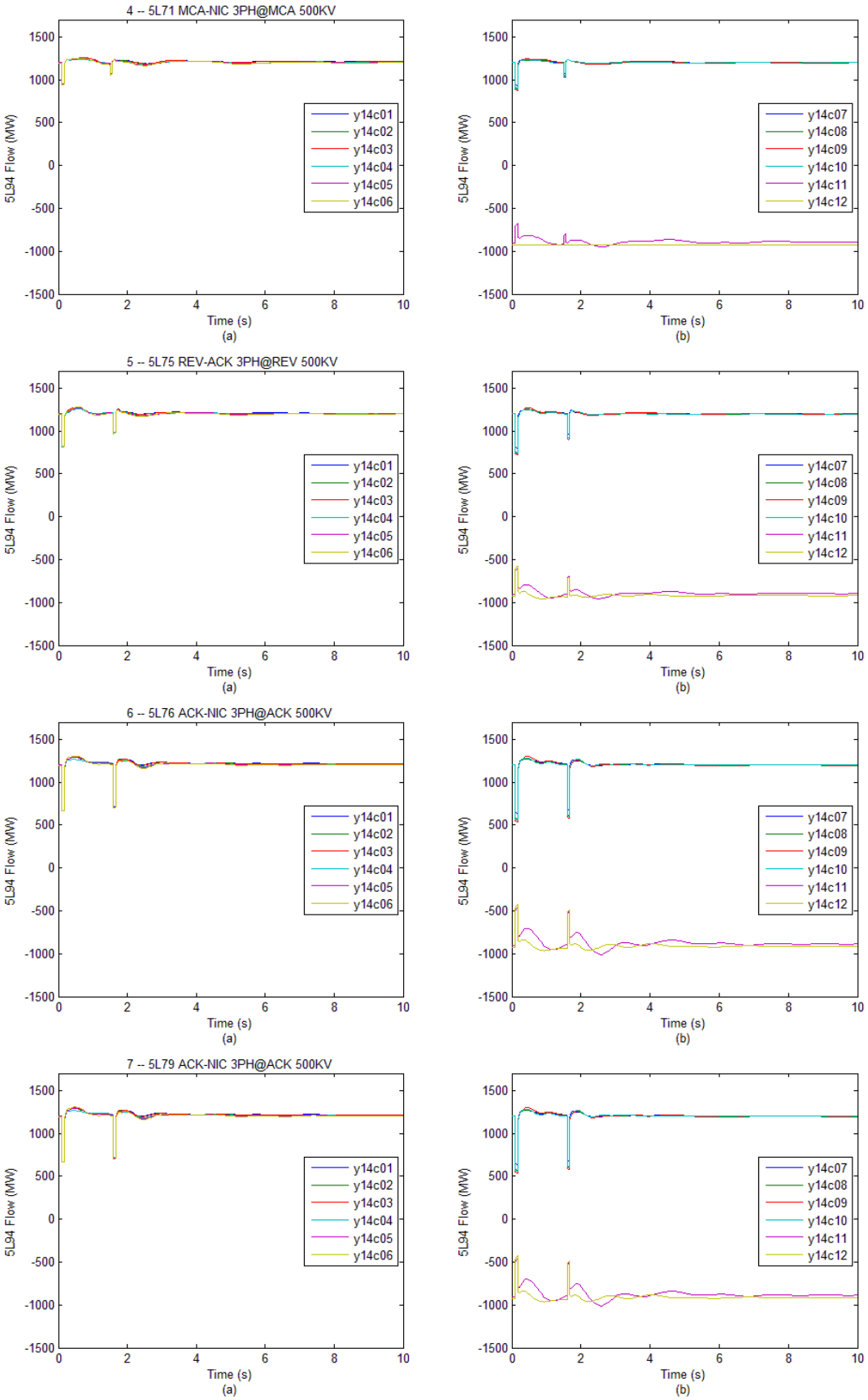
Figure E-48 y22c32 N-1, N-2 and Single Pole Reclose Contingency

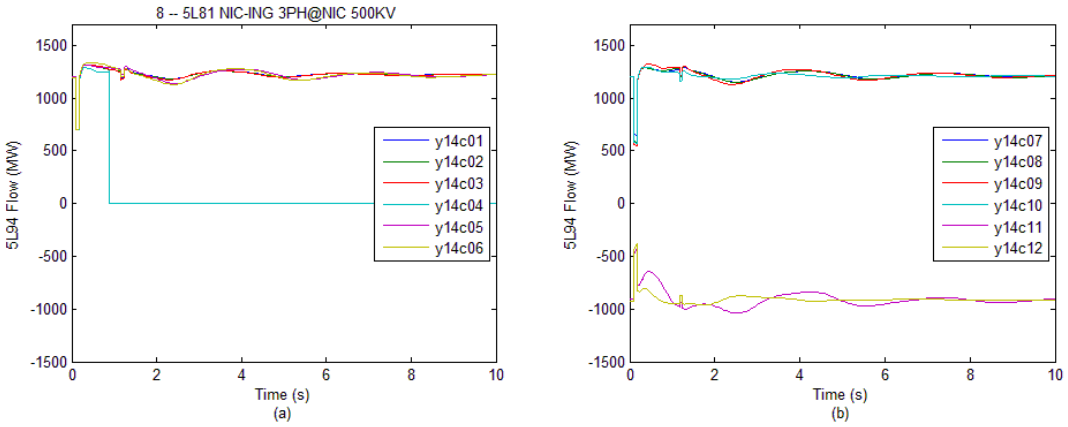
F. TRANSIENT STABILITY PERFORMANCE PLOTS – 5L94 MW FLOW

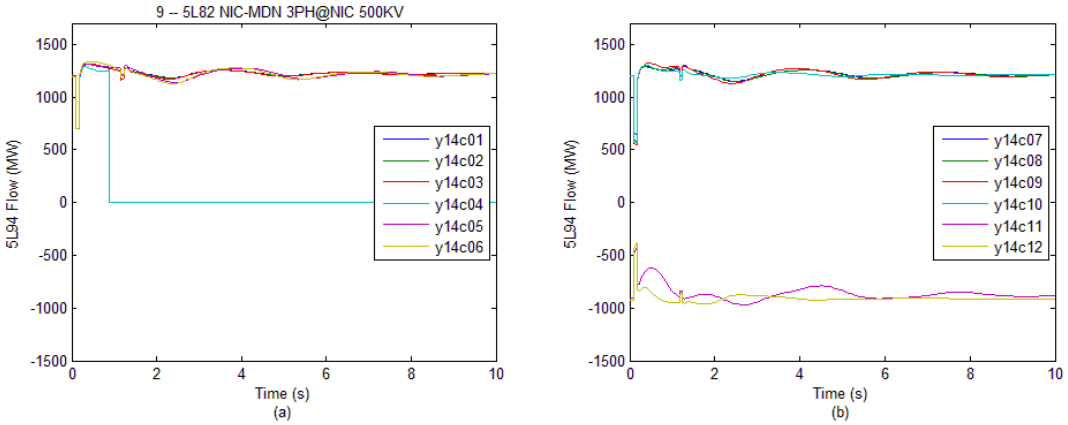
Dynamic power flows from CBK to AB on 5L94 in response to single and double contingencies in BC are displayed below.

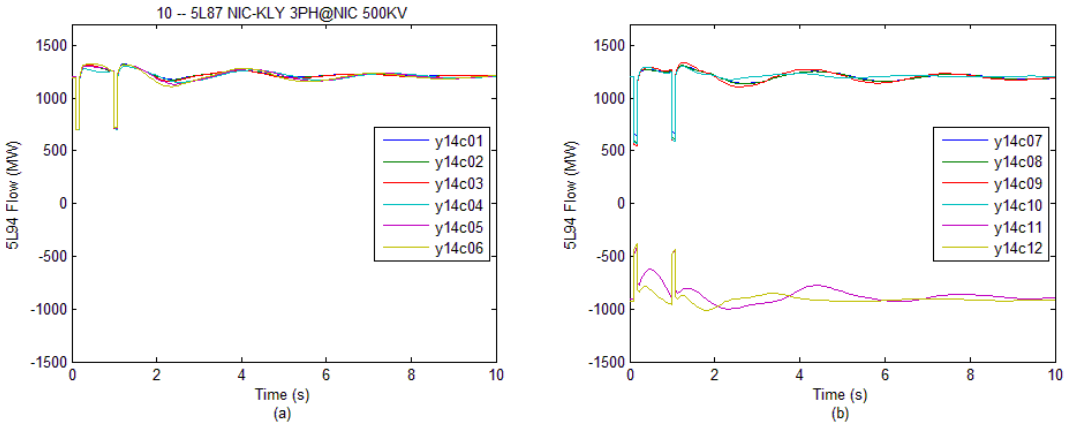
F.1 Y14 cases (N-1 and N-2 Contingency)

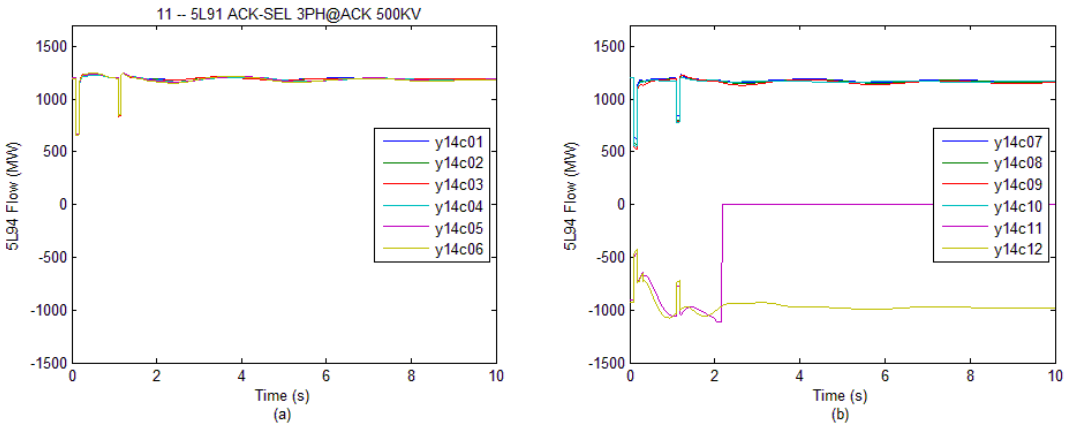


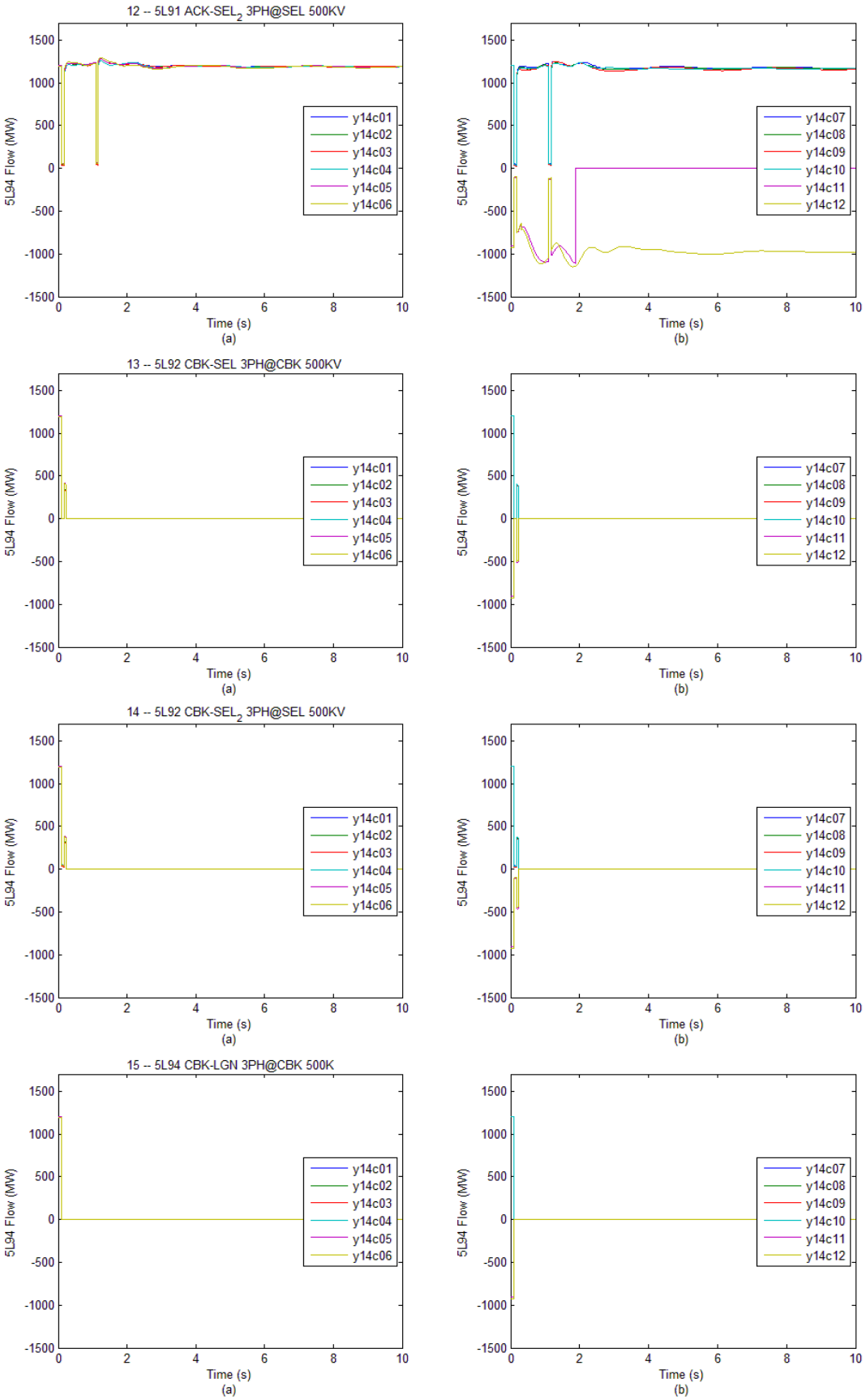


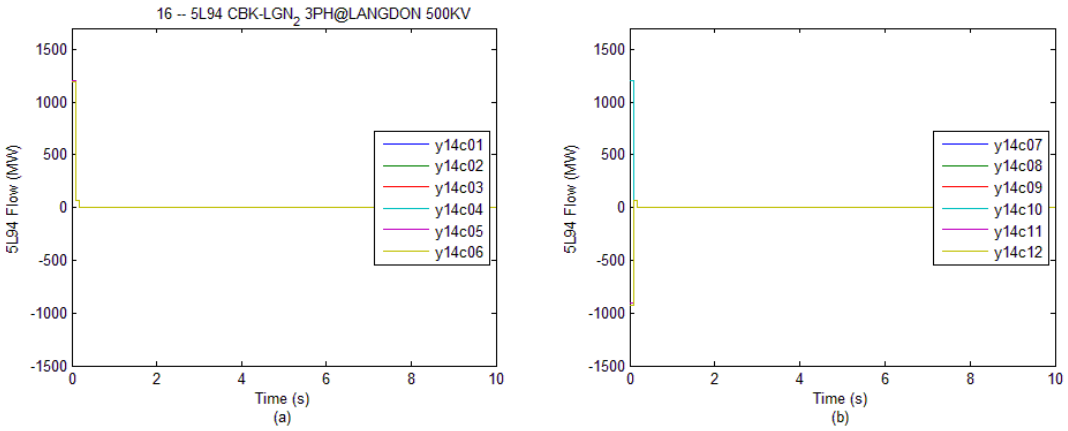


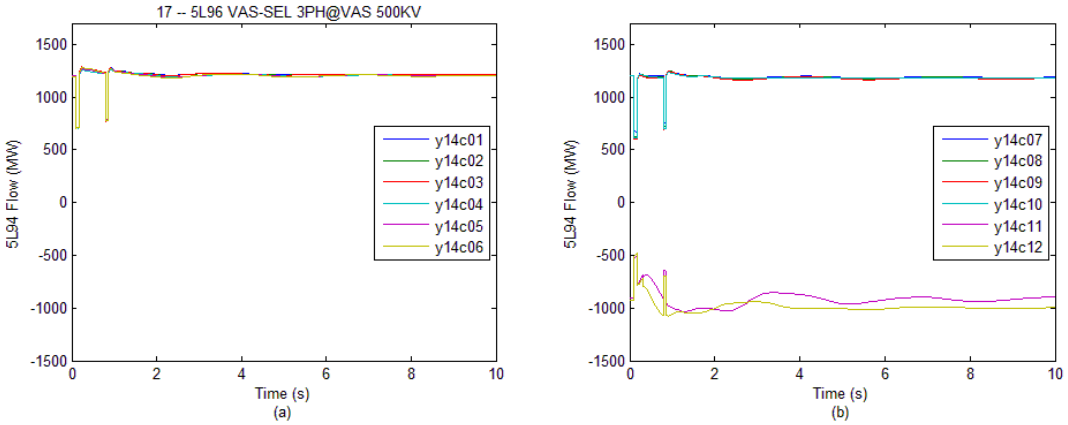


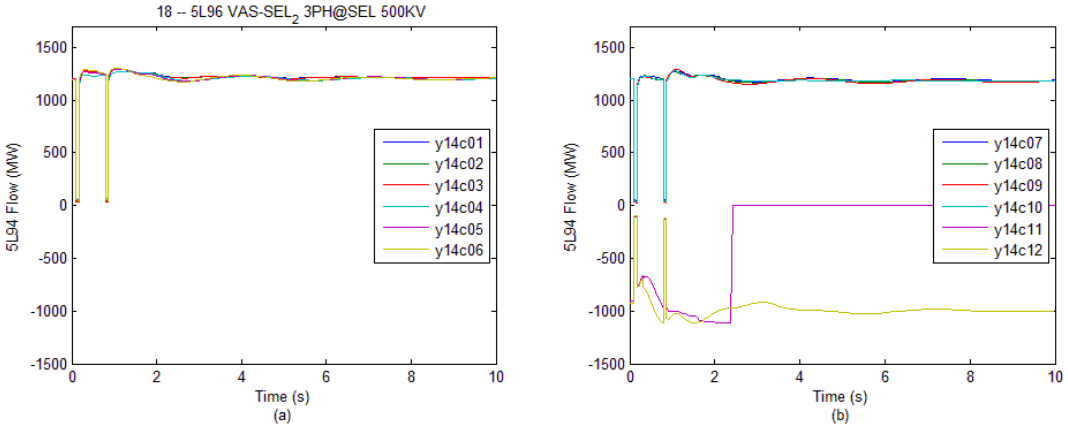


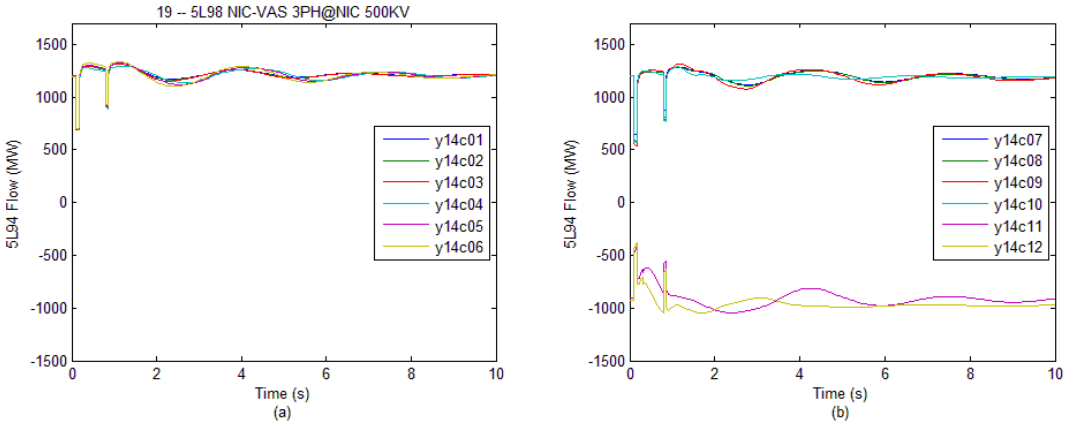


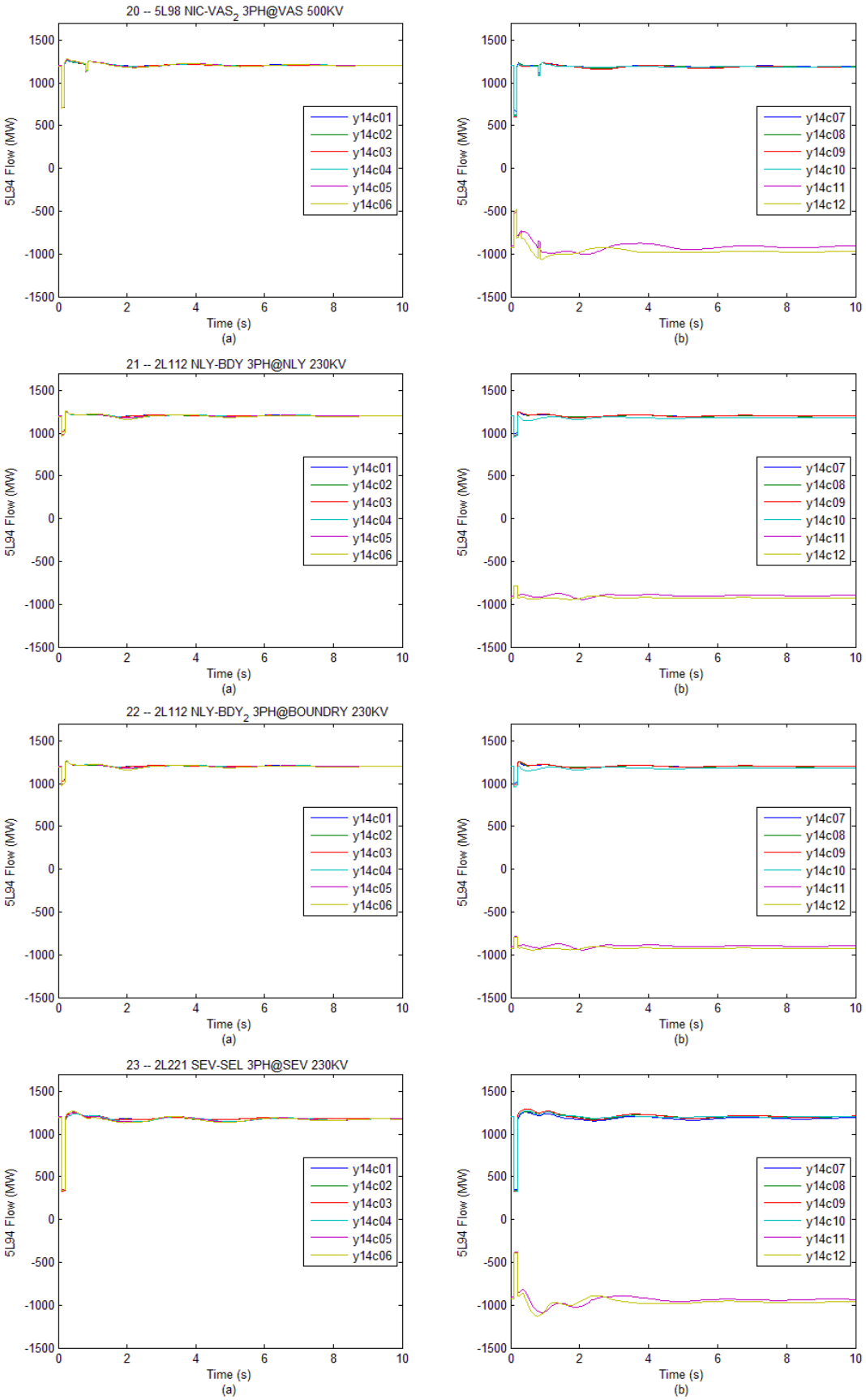


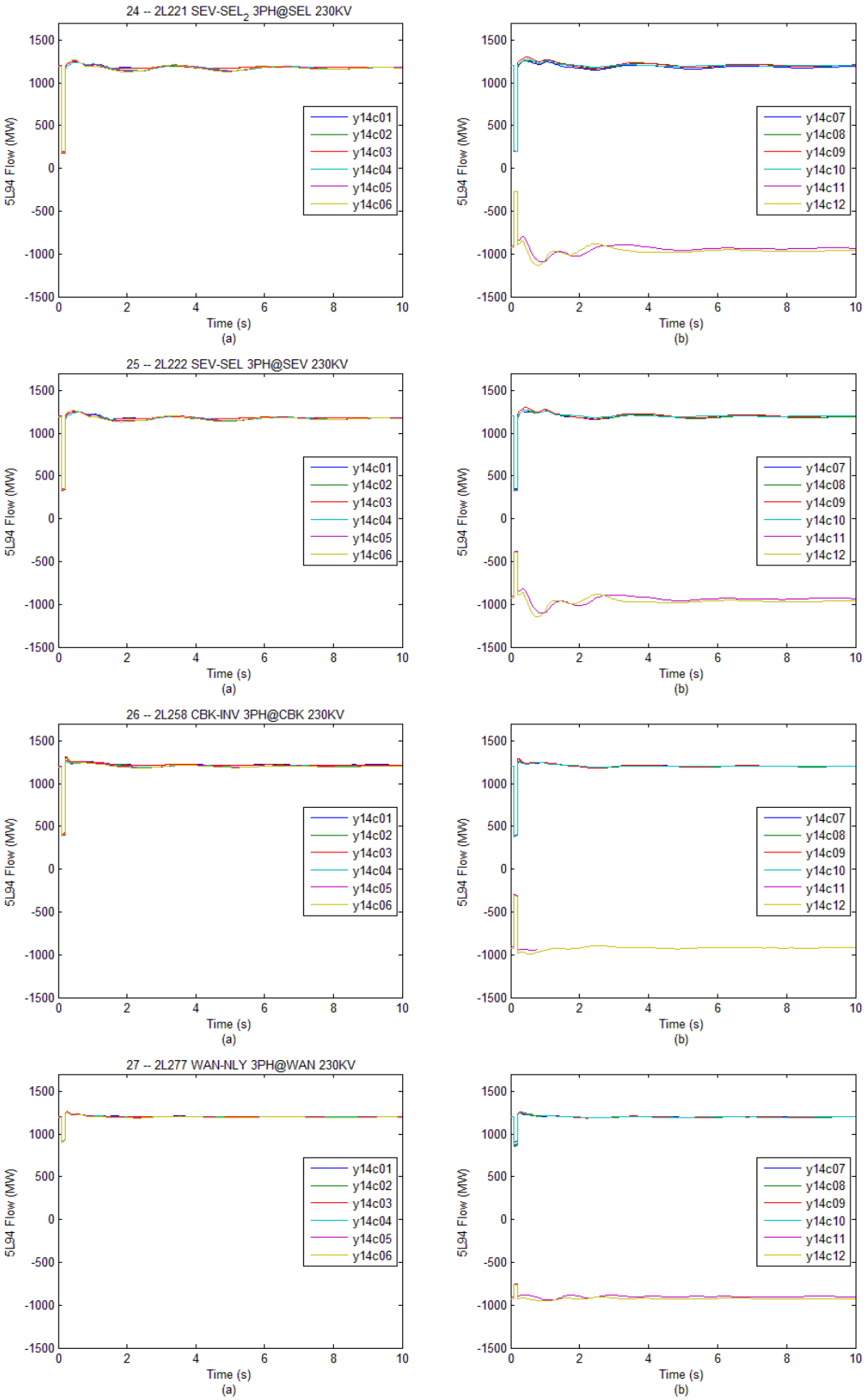


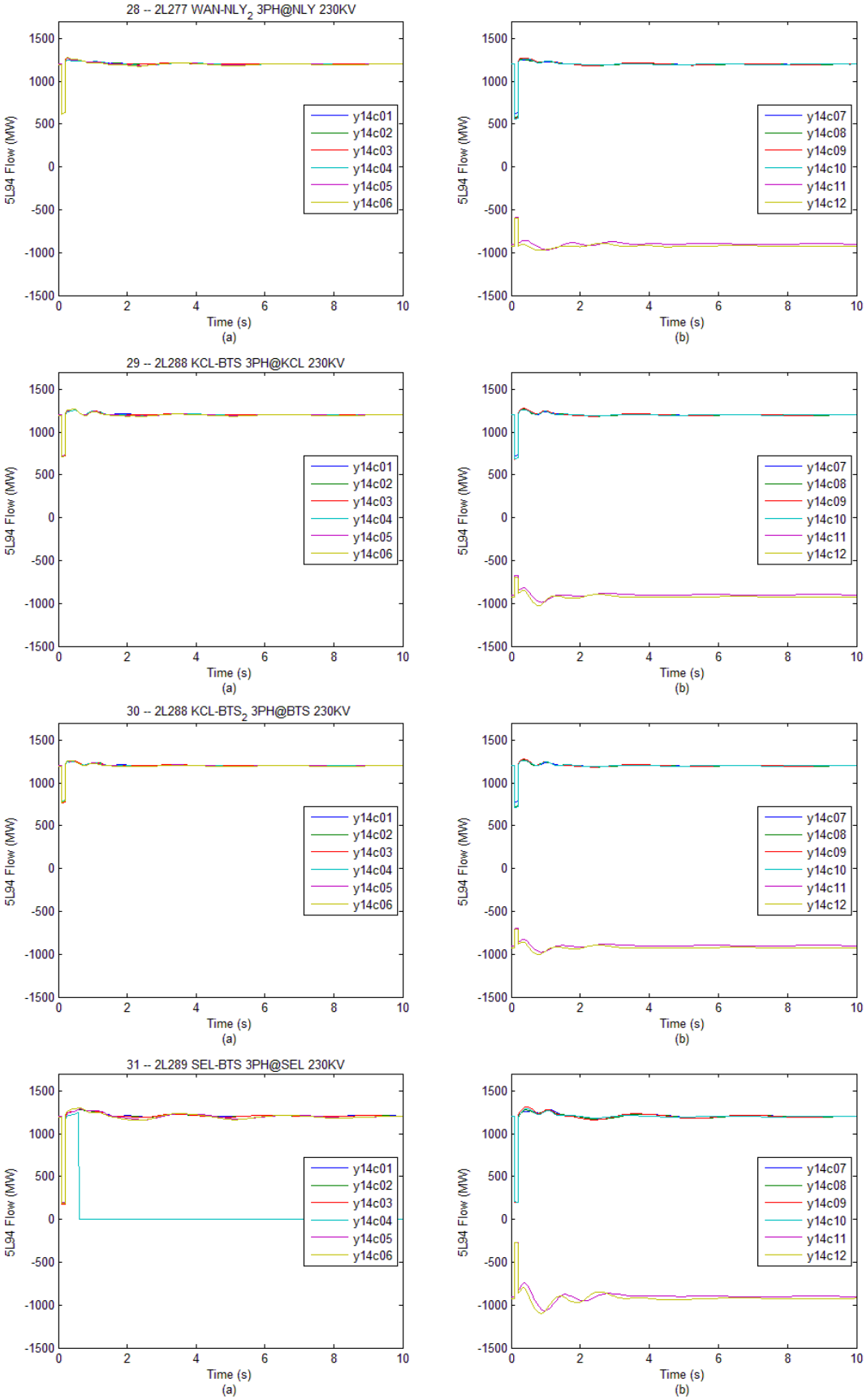


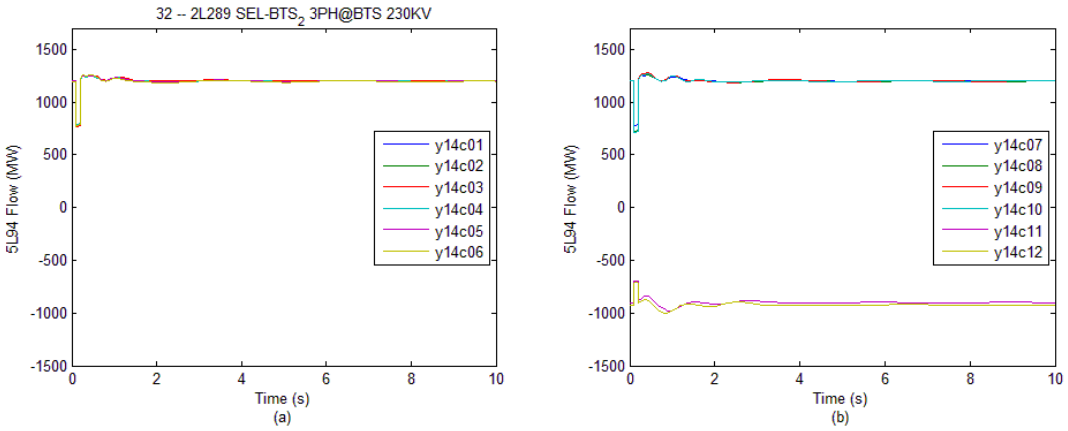


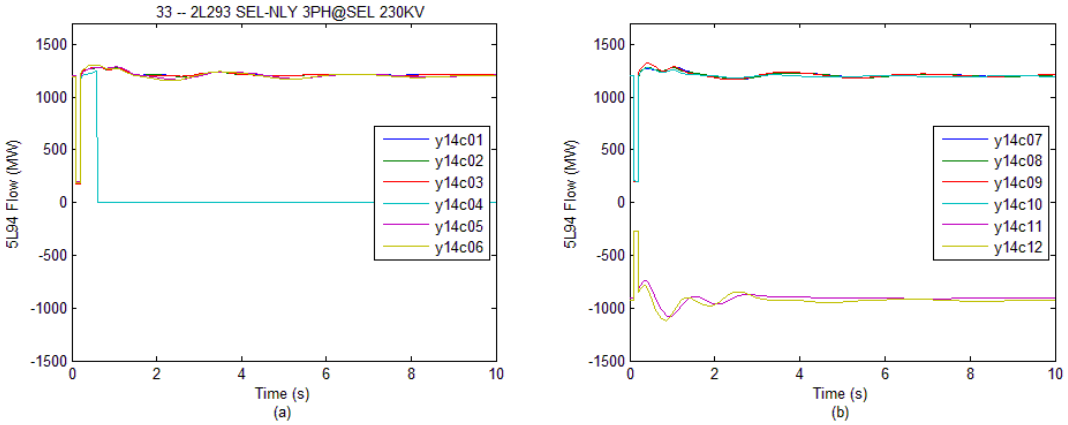


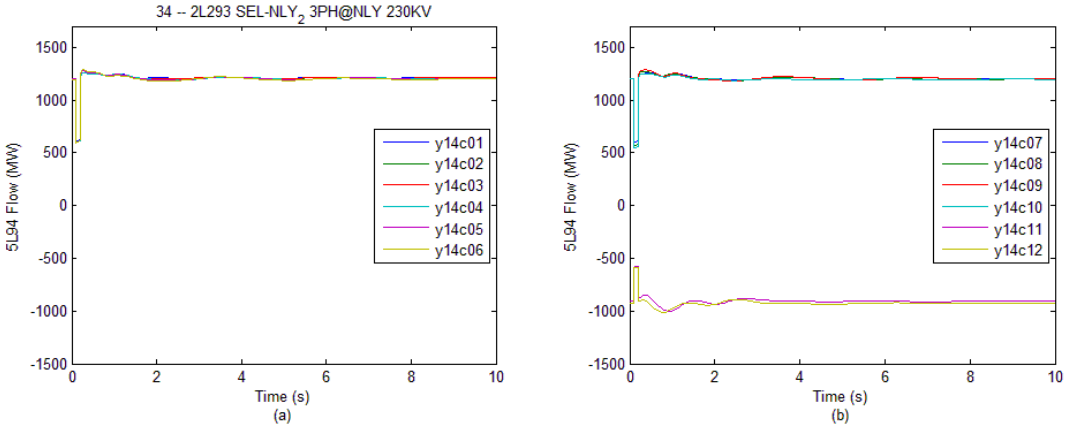


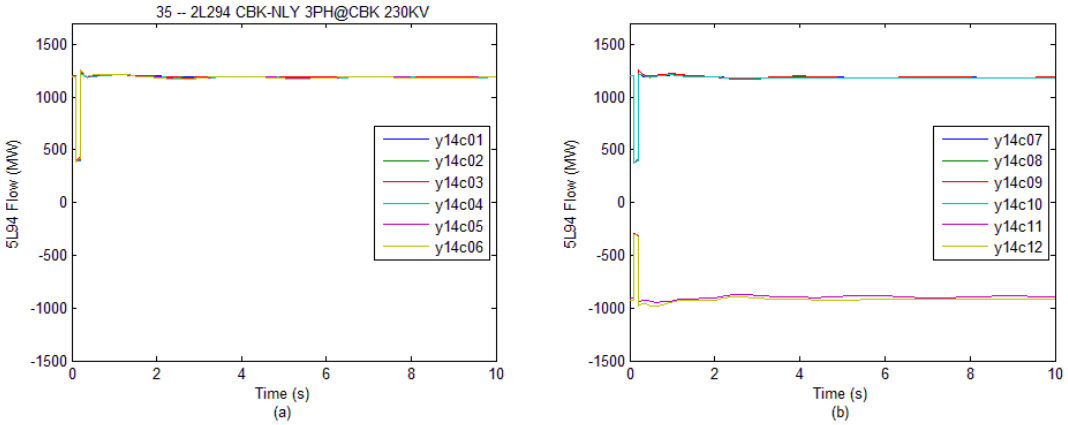


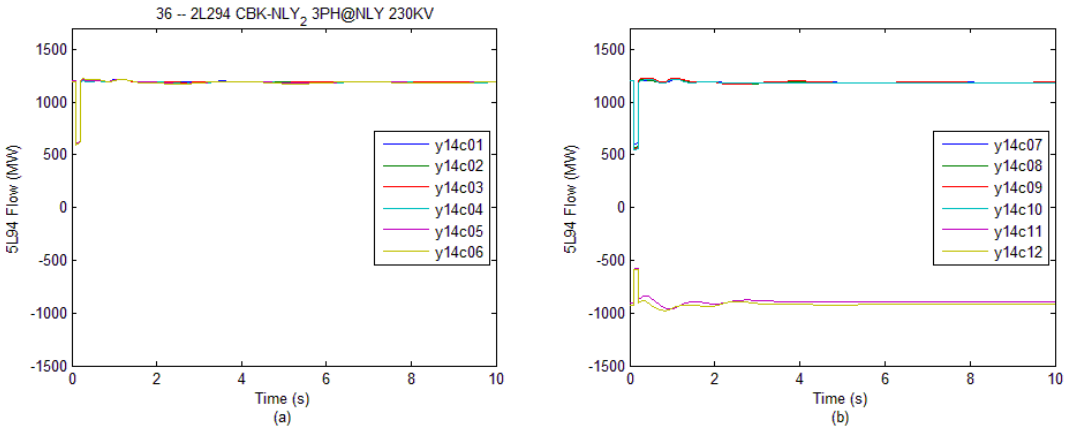


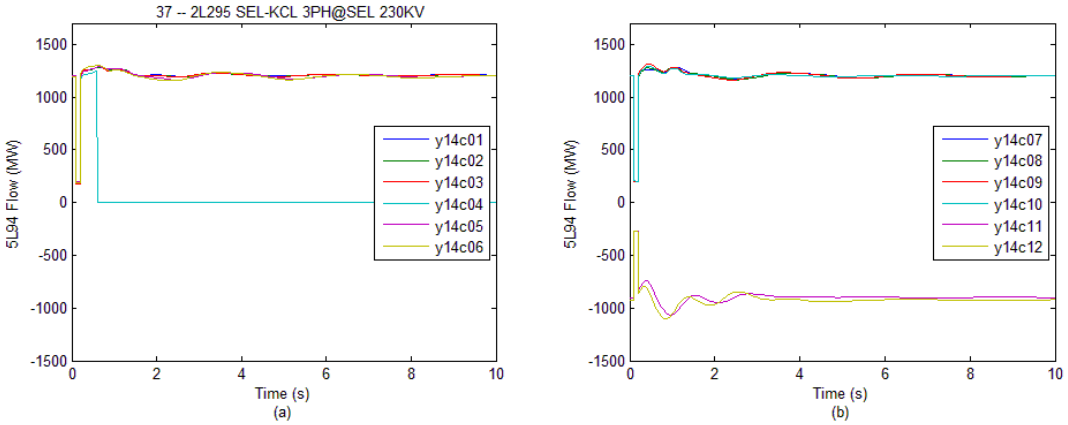


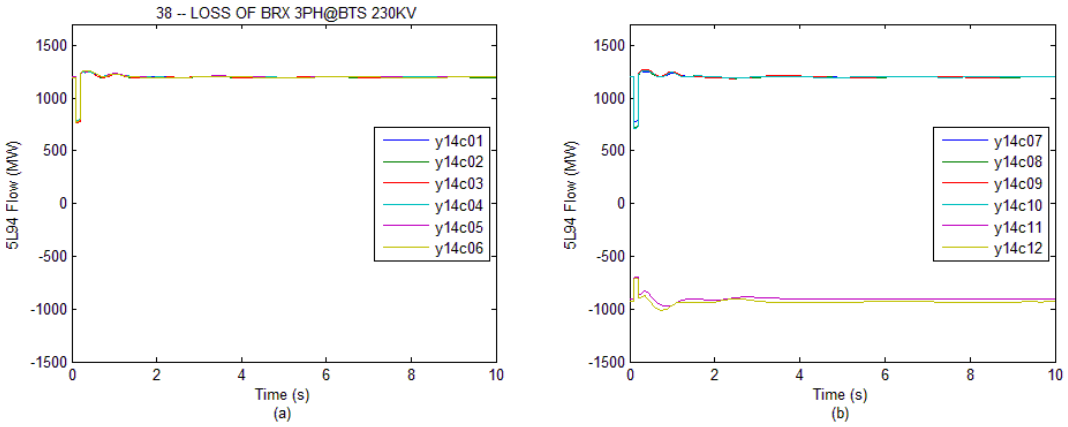


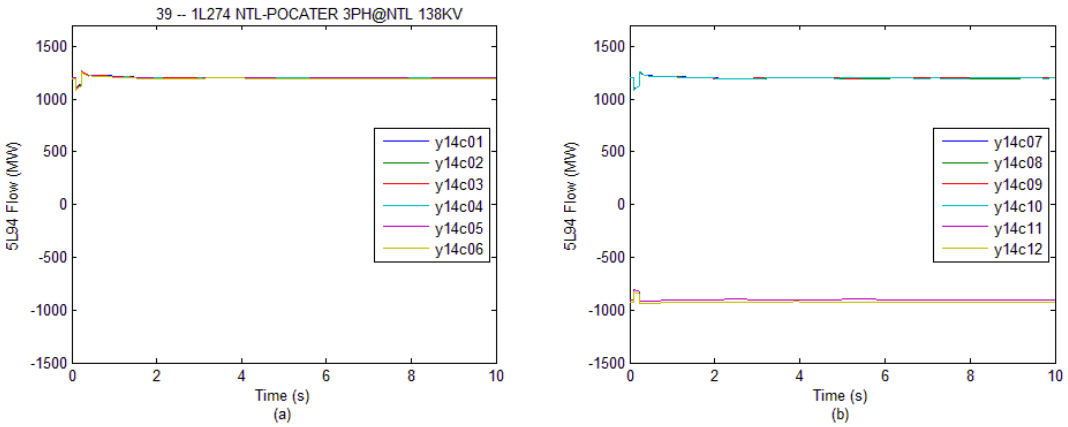


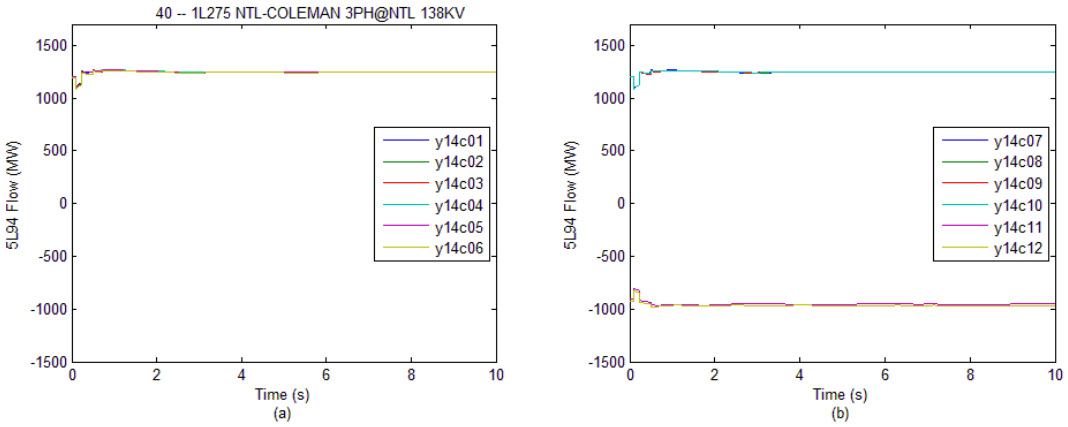


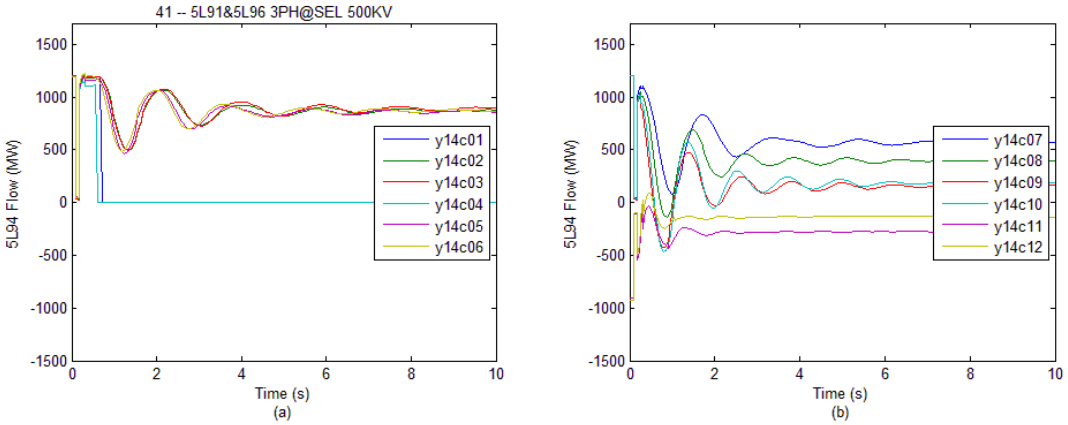


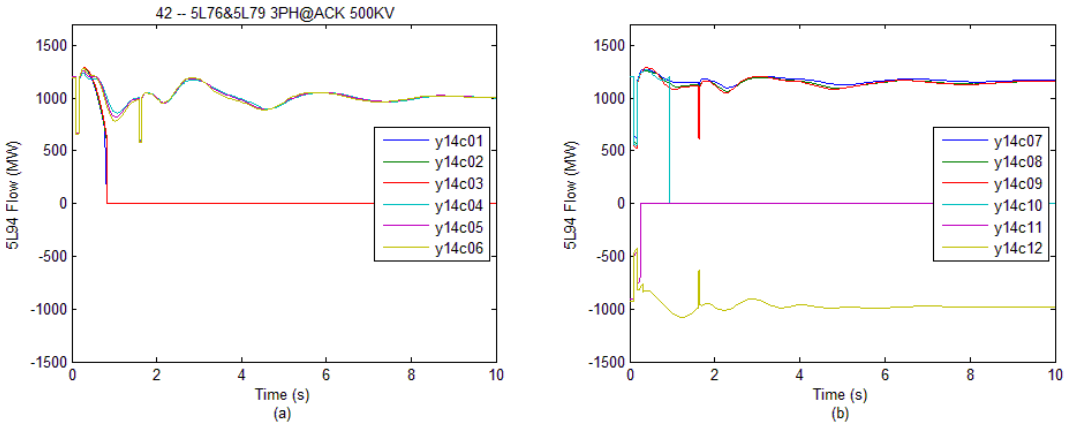


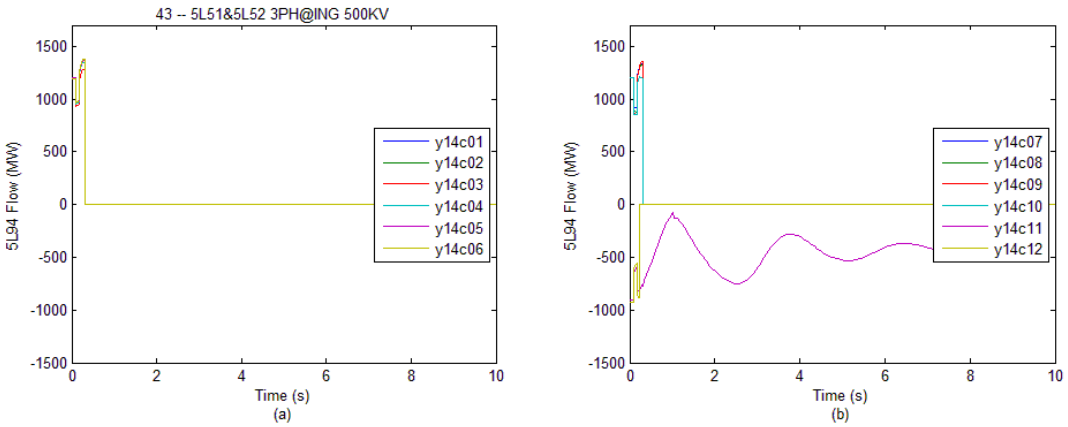


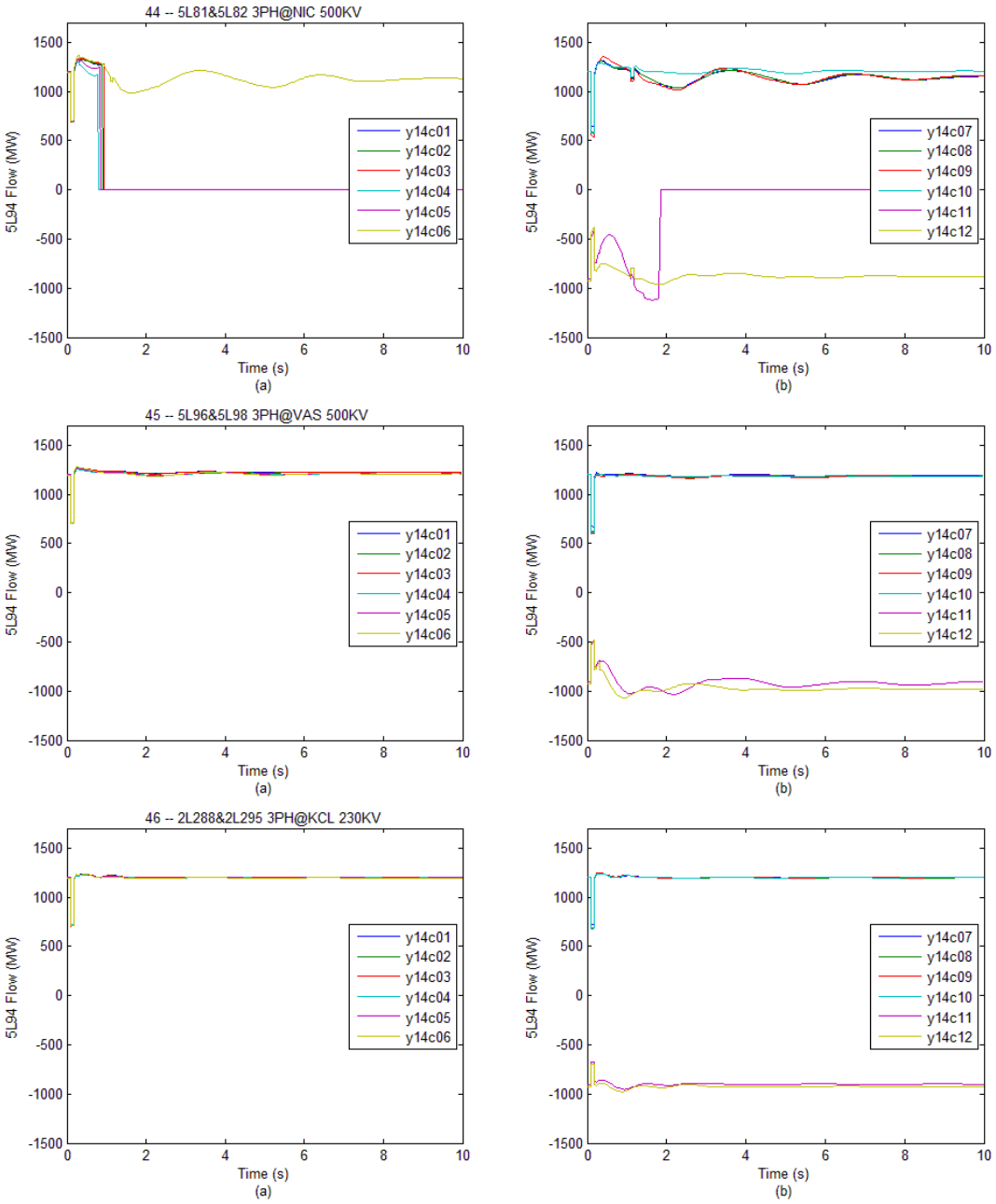


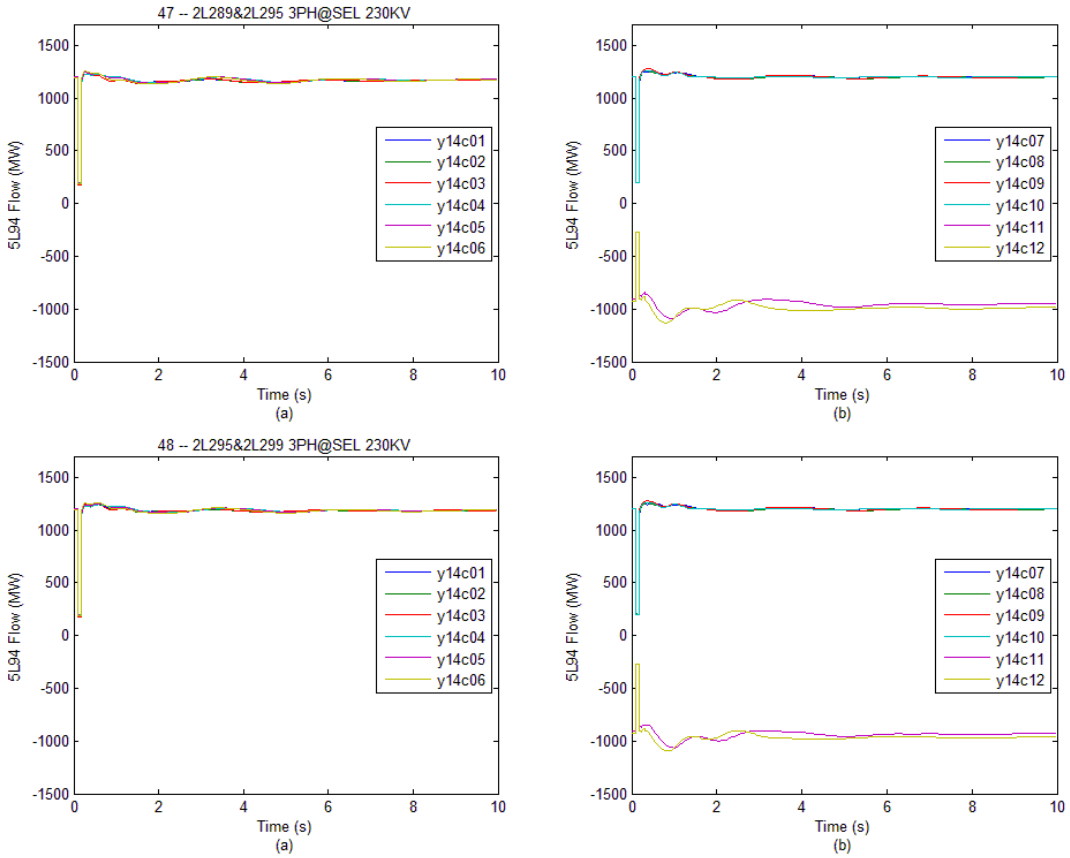




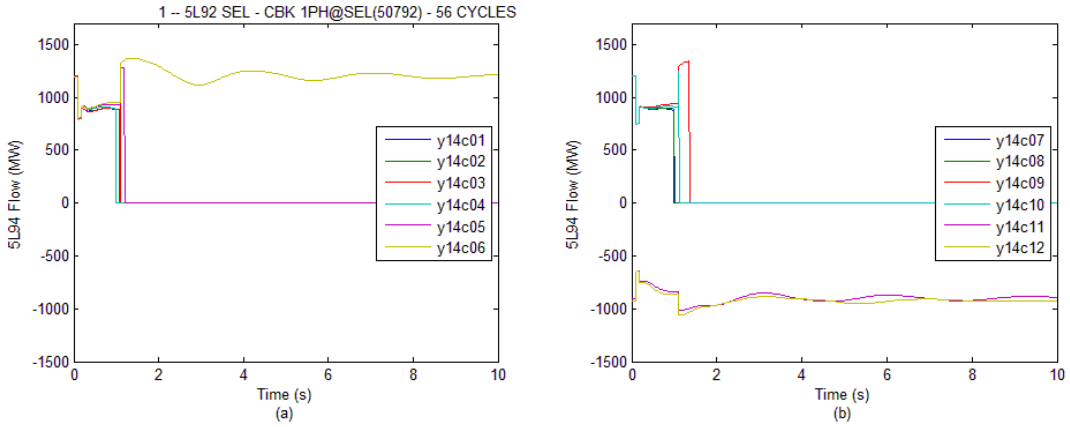


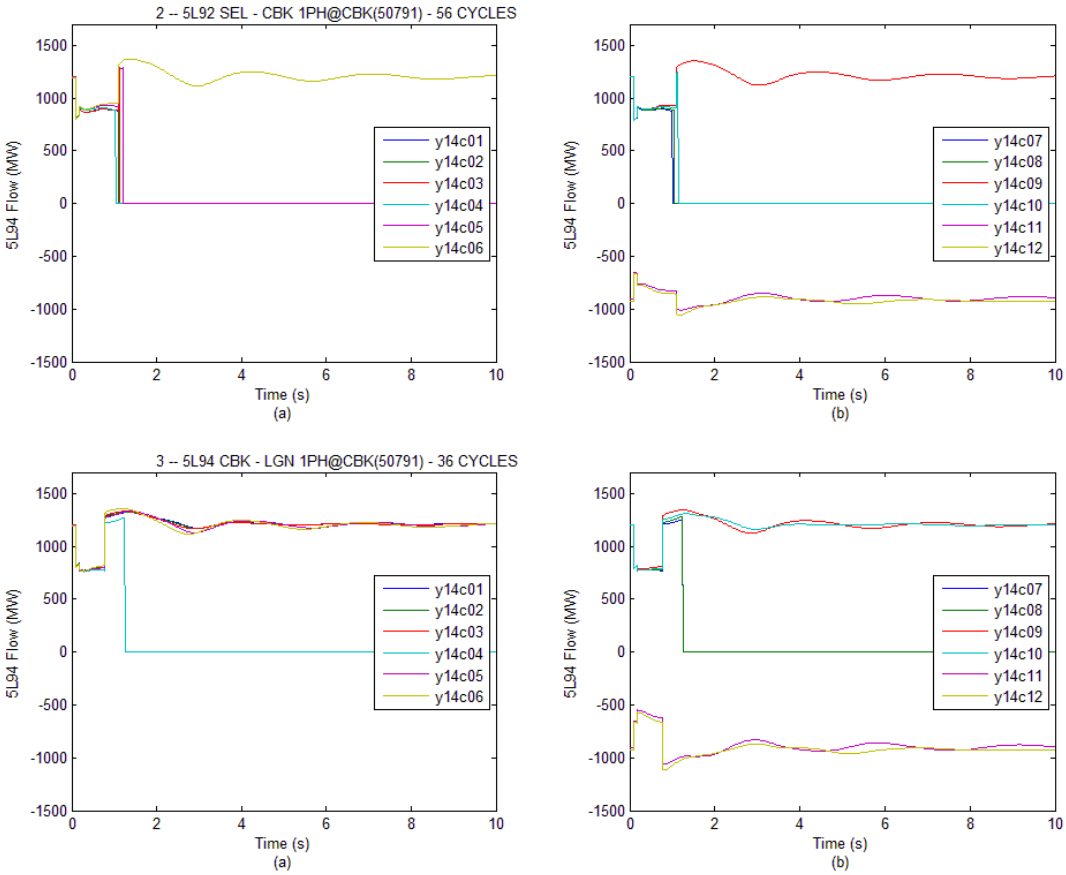




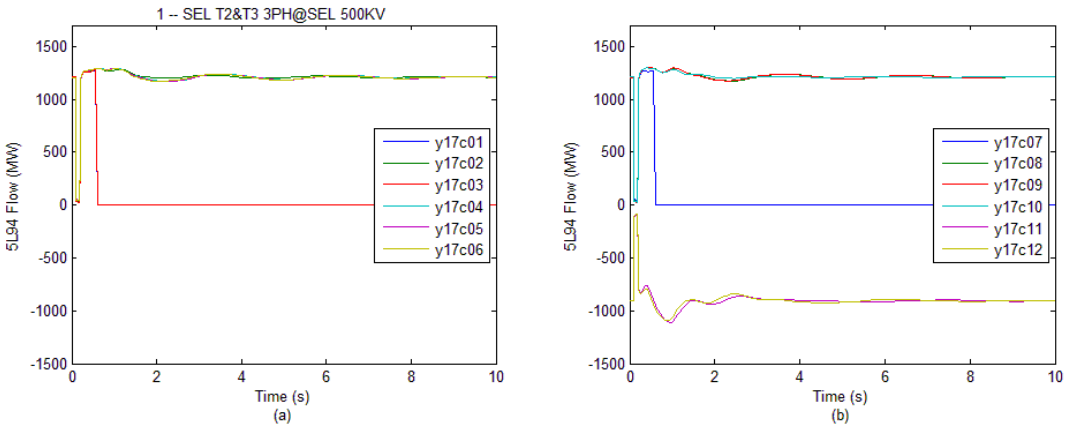


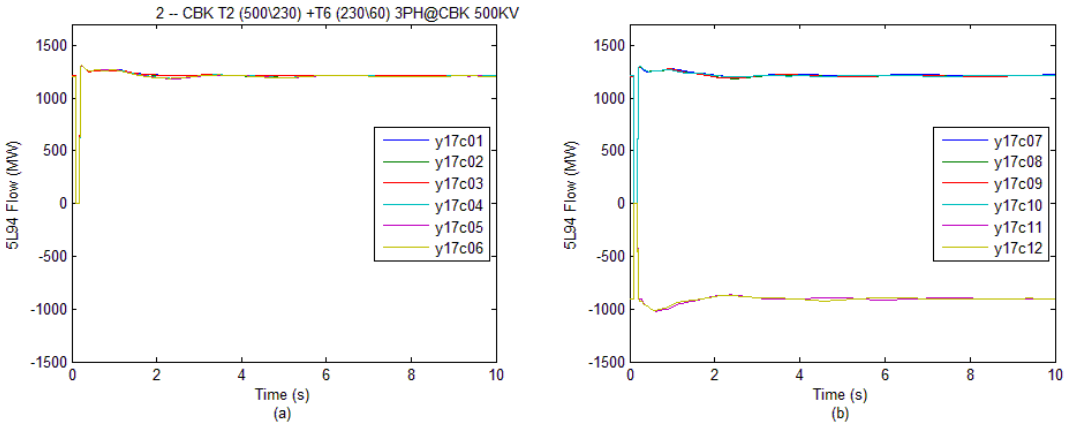
F.2 Y14 cases (SPR Contingency)

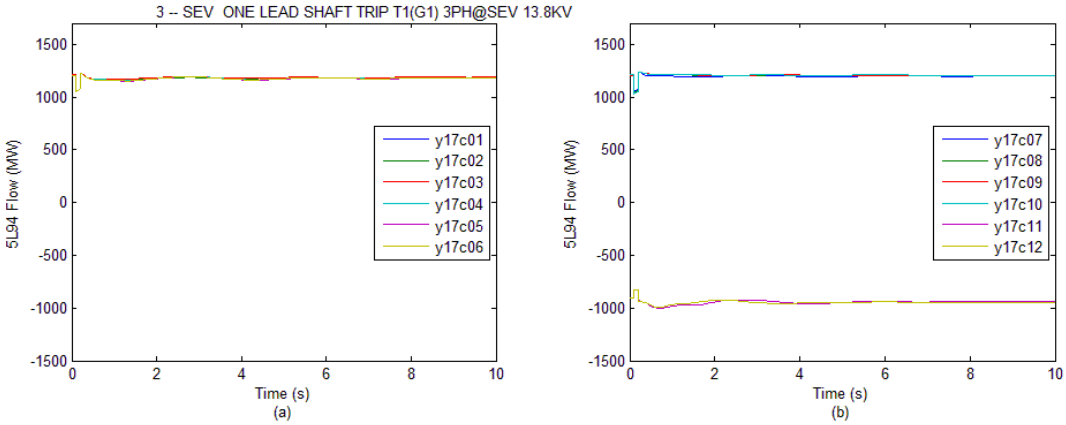


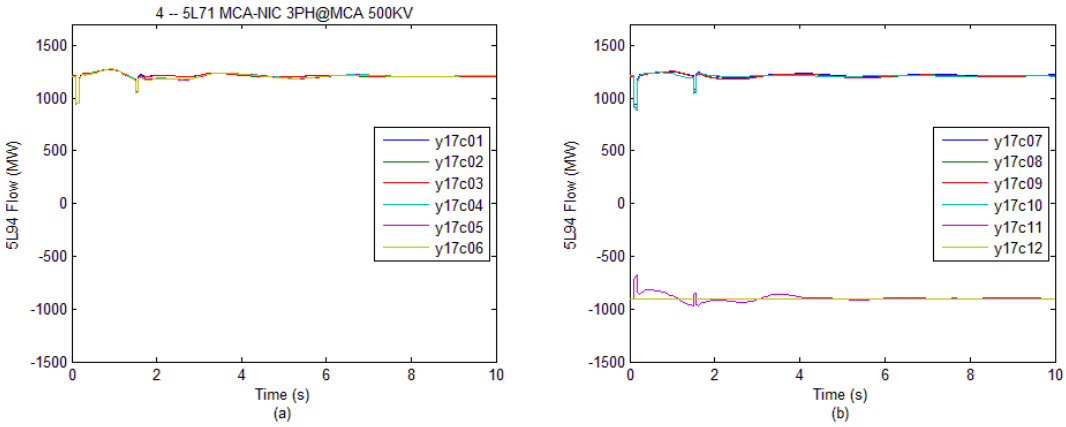


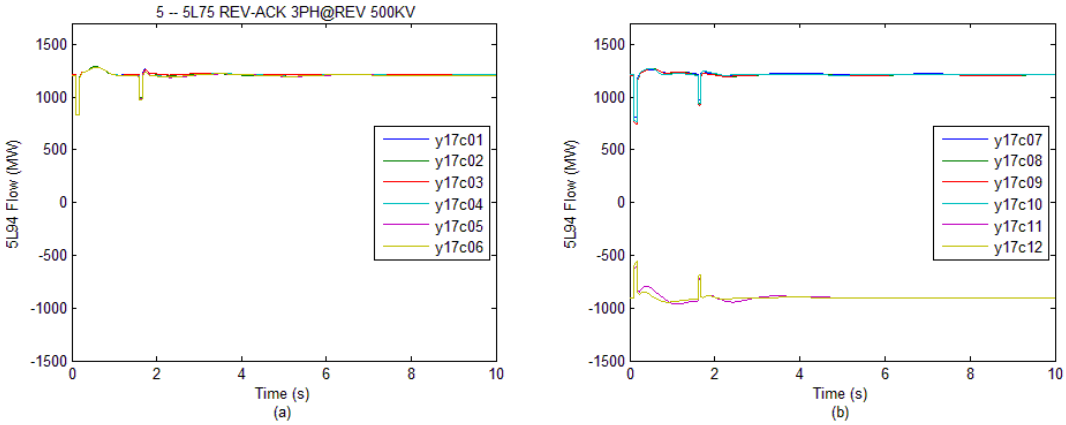
F.3 Y17 cases without Chapel Rock (N-1 and N-2 Contingency)

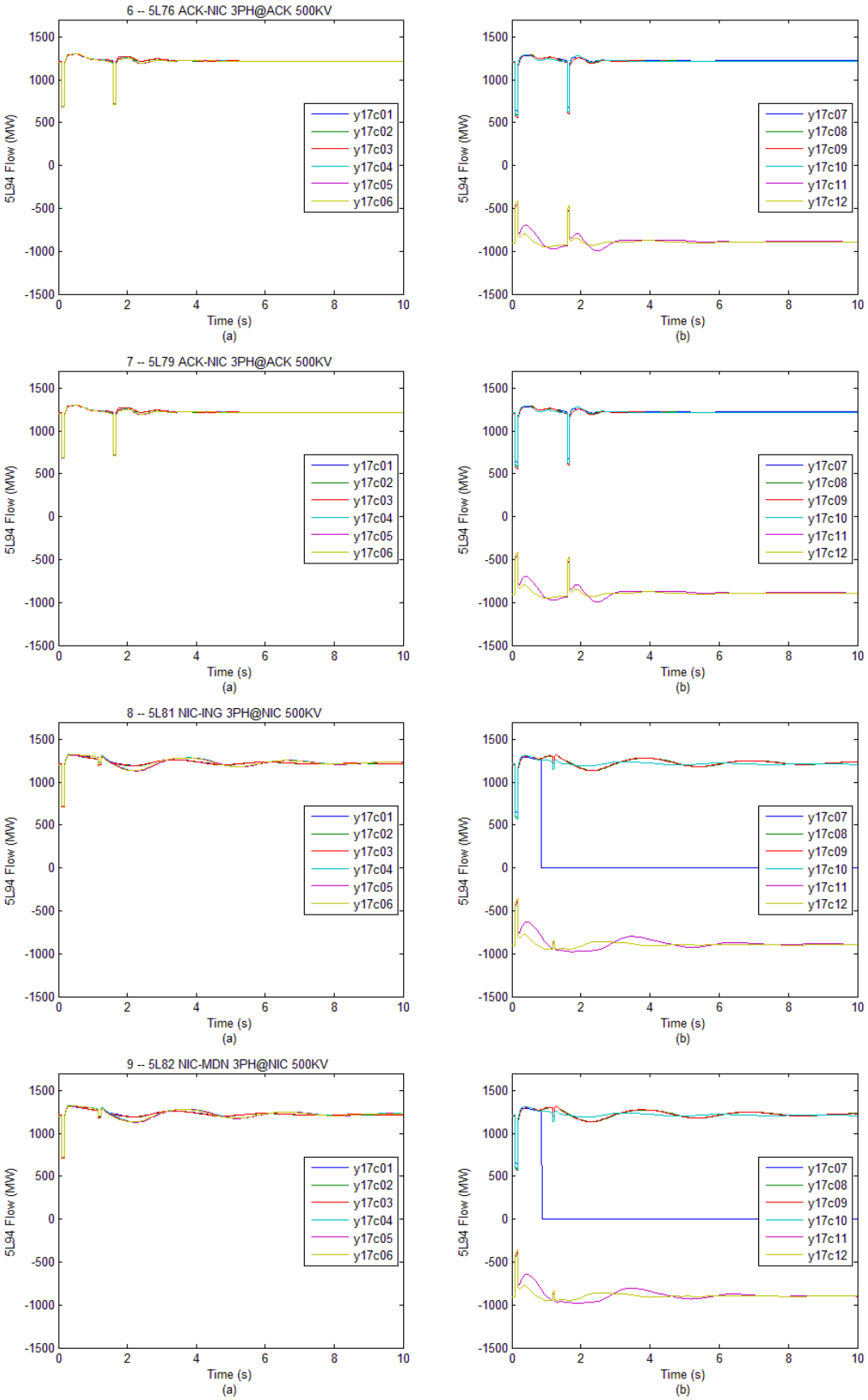


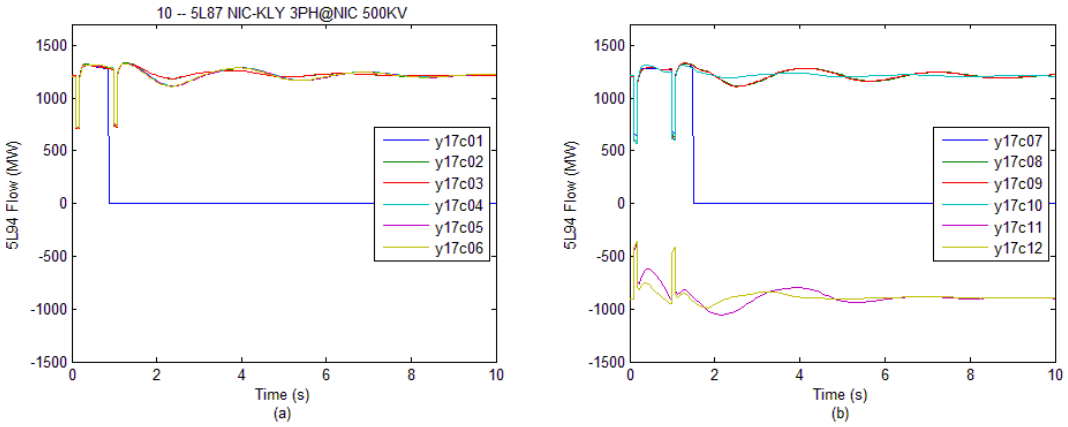


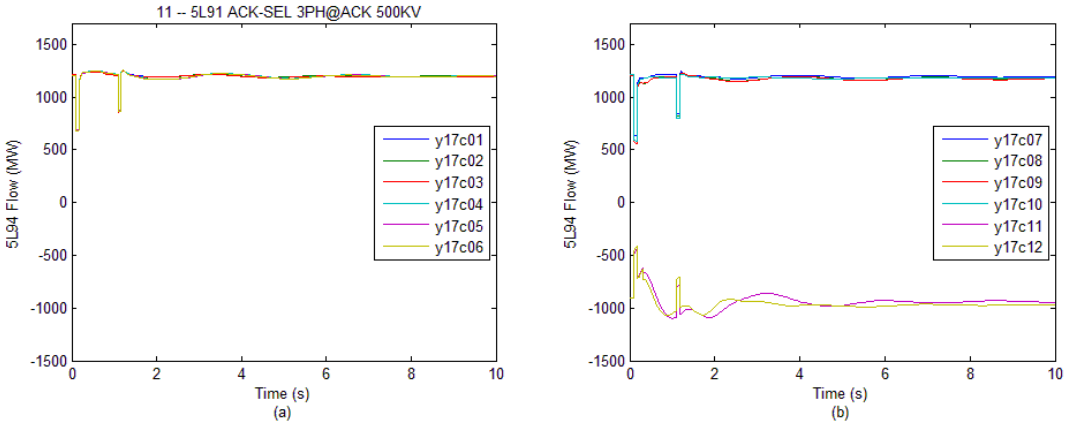


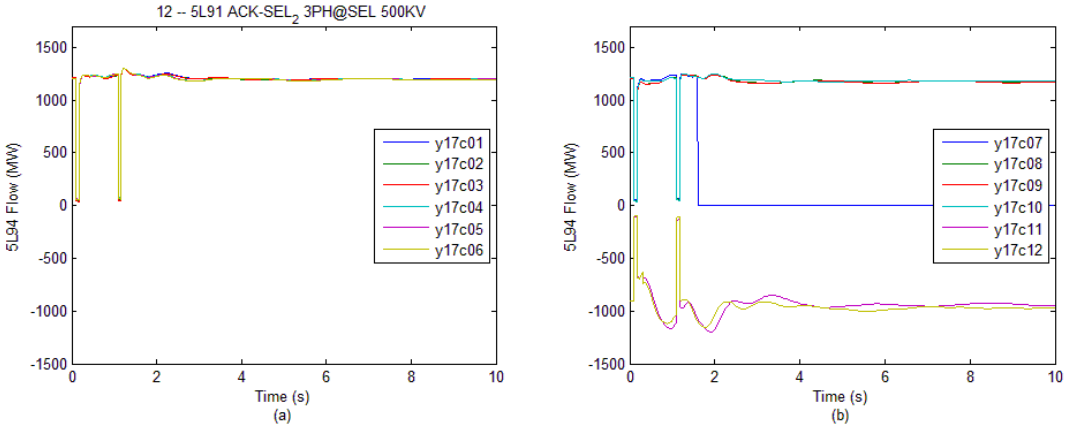


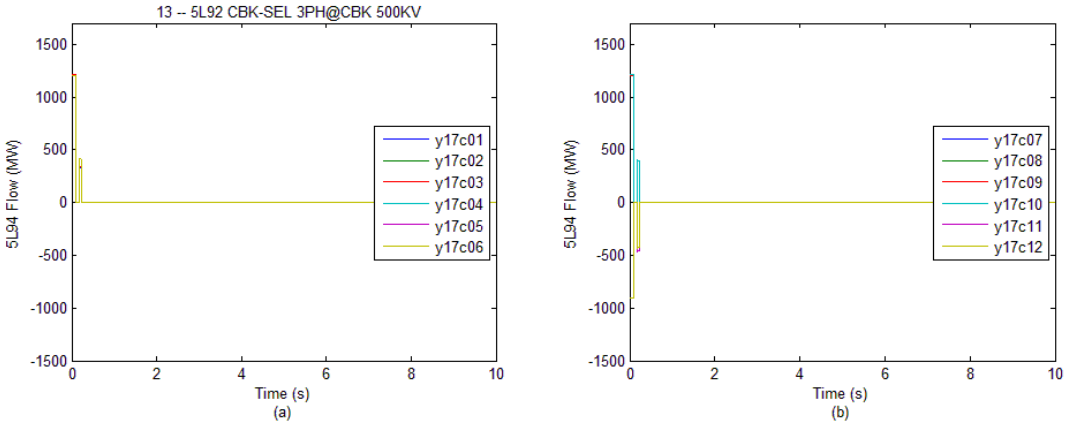


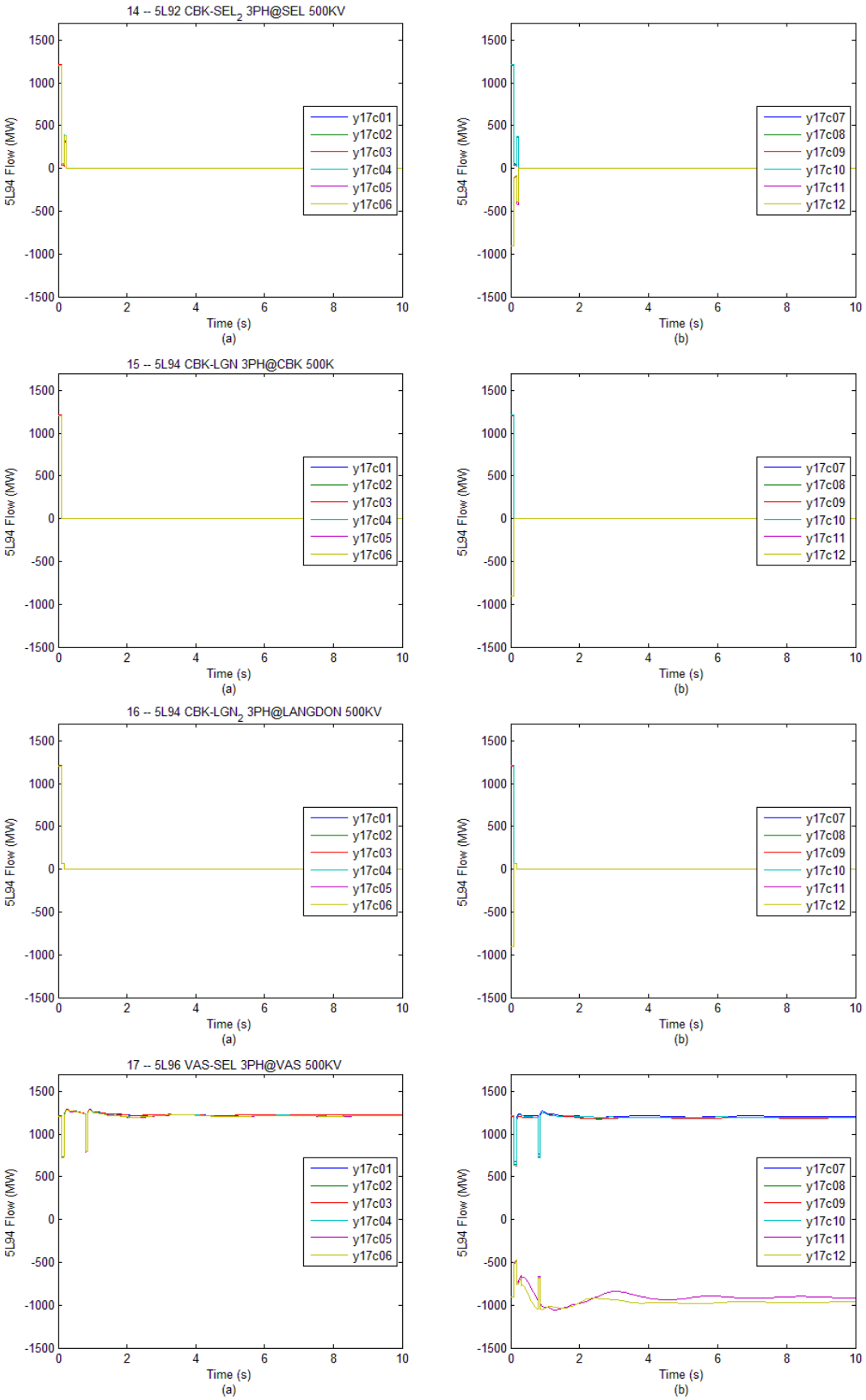


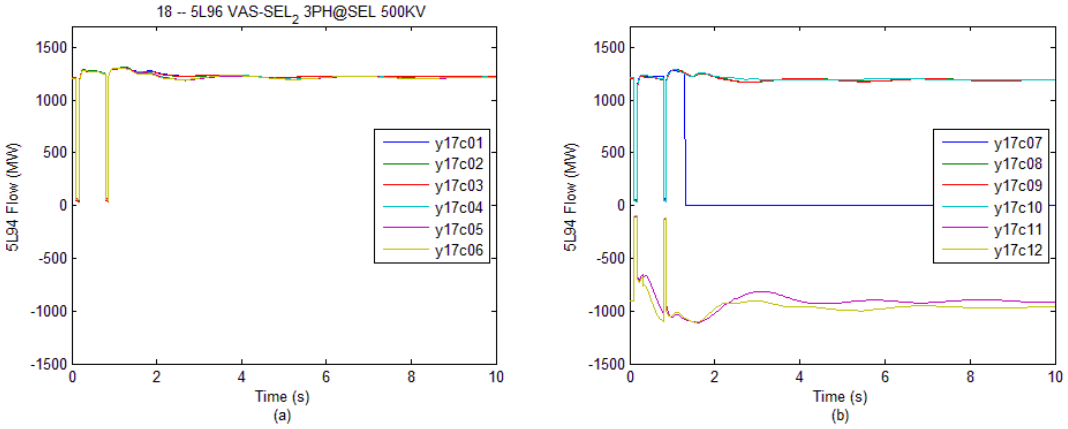


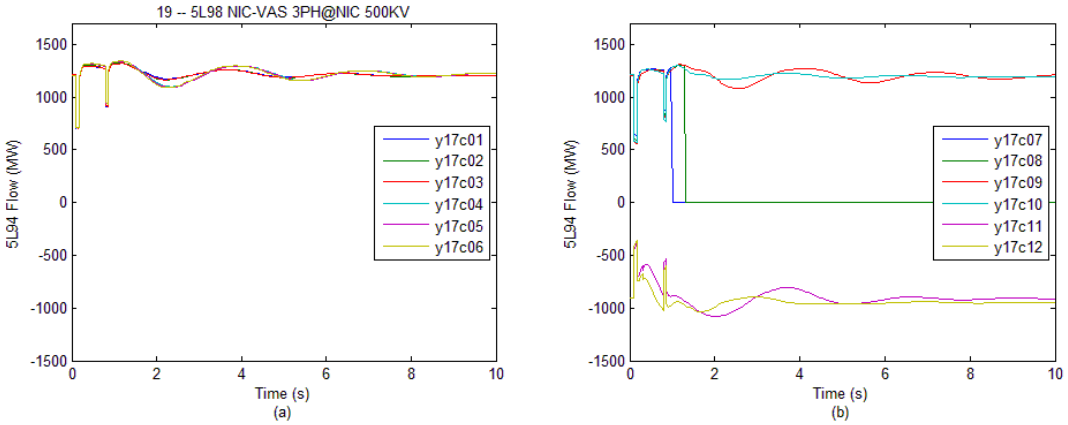


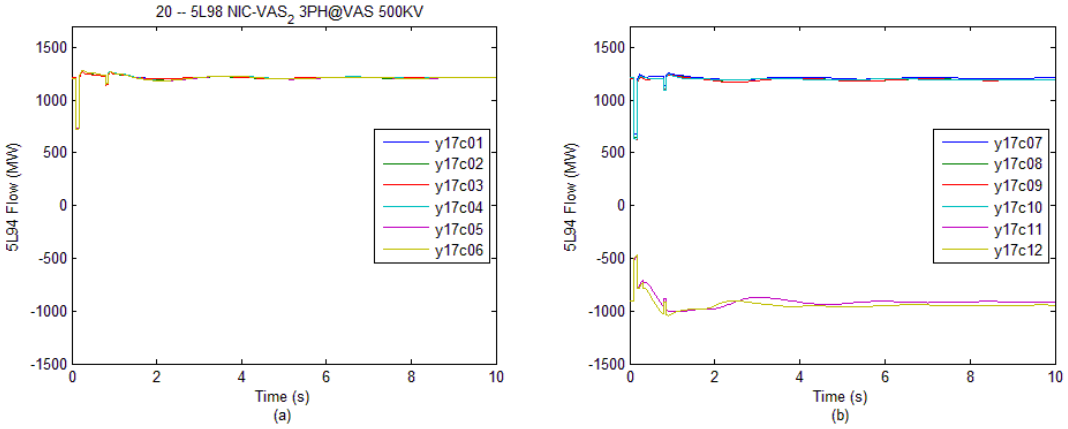


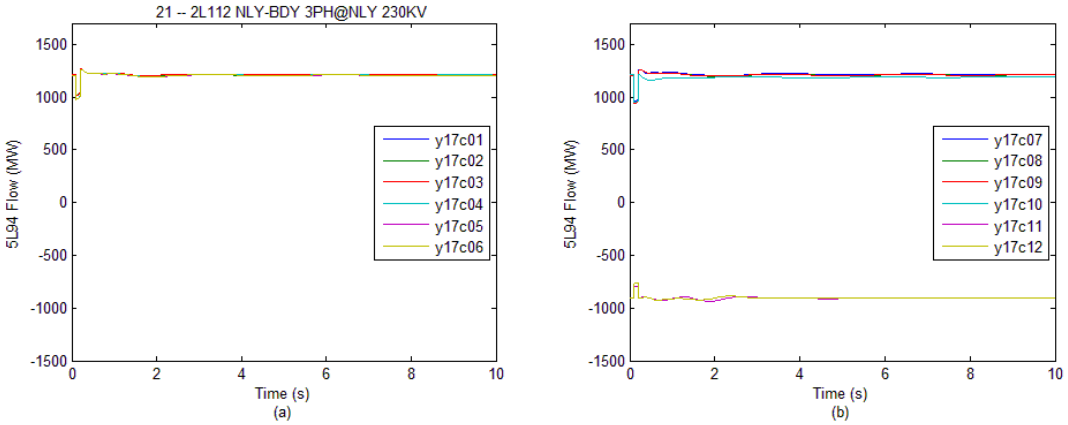


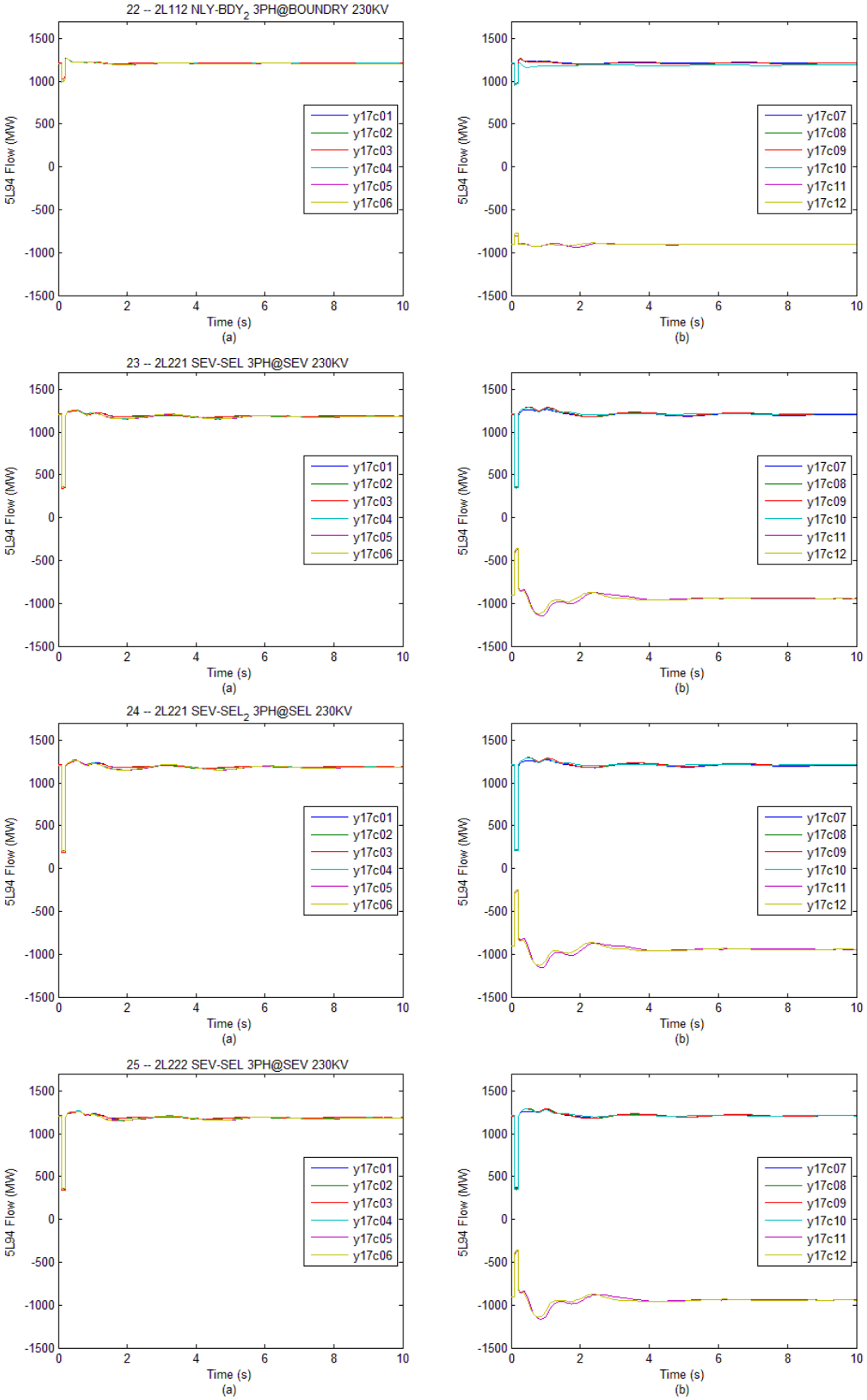


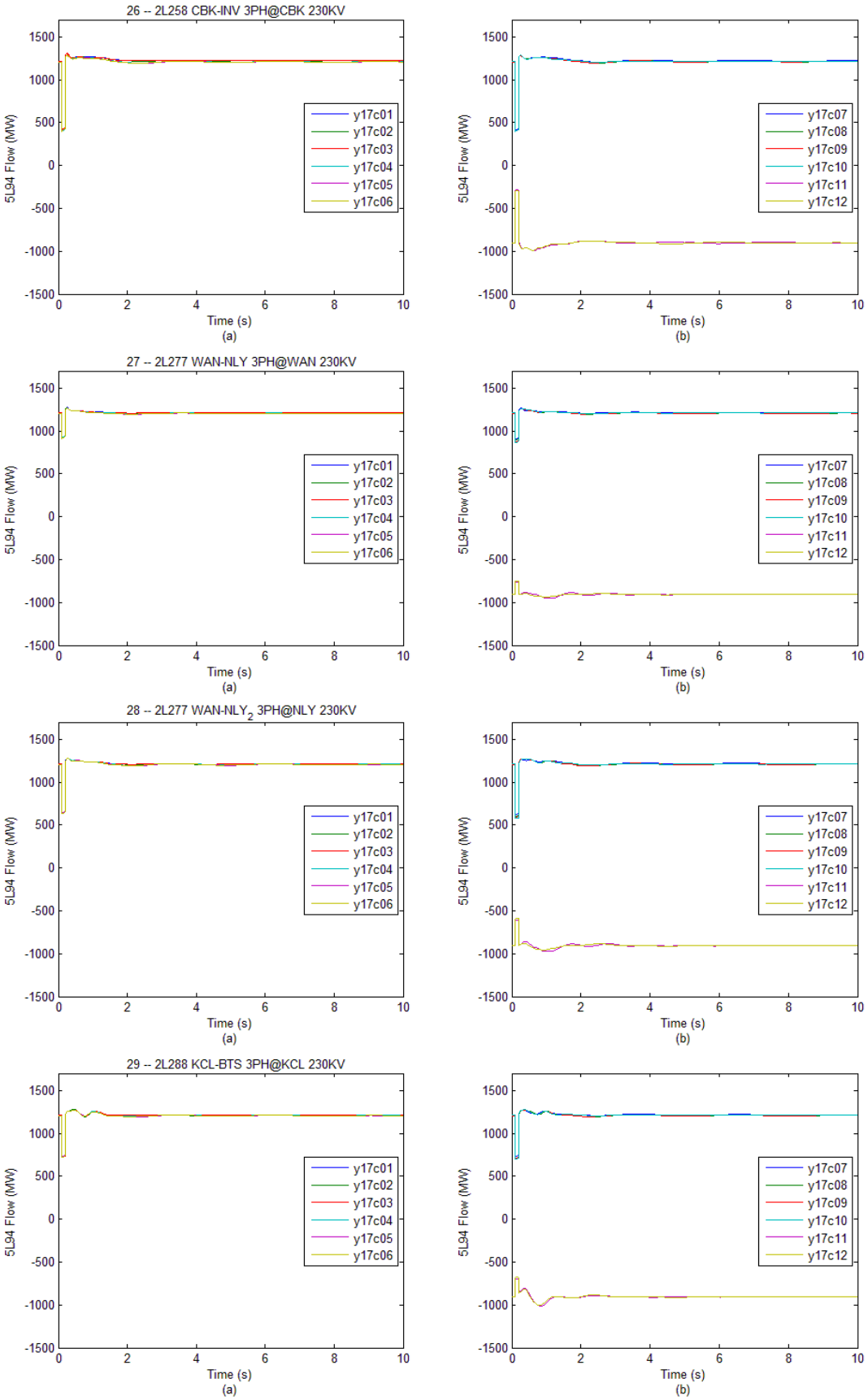


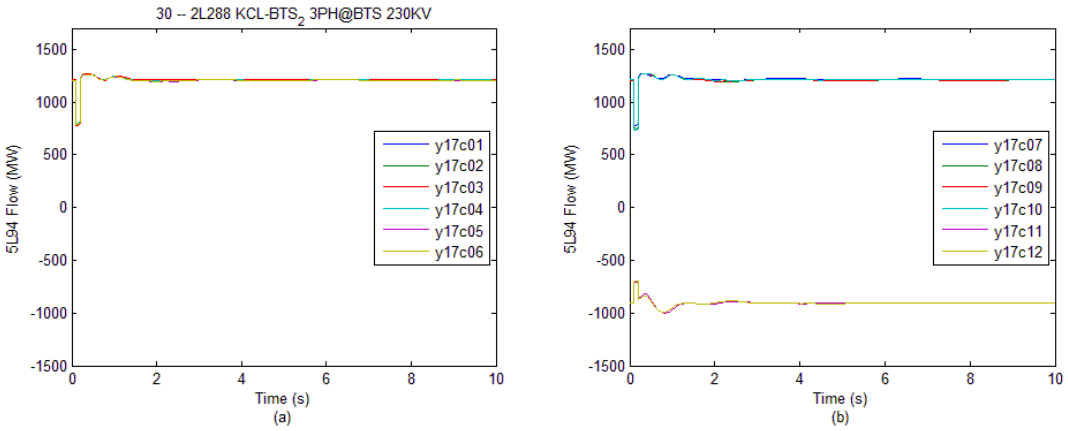


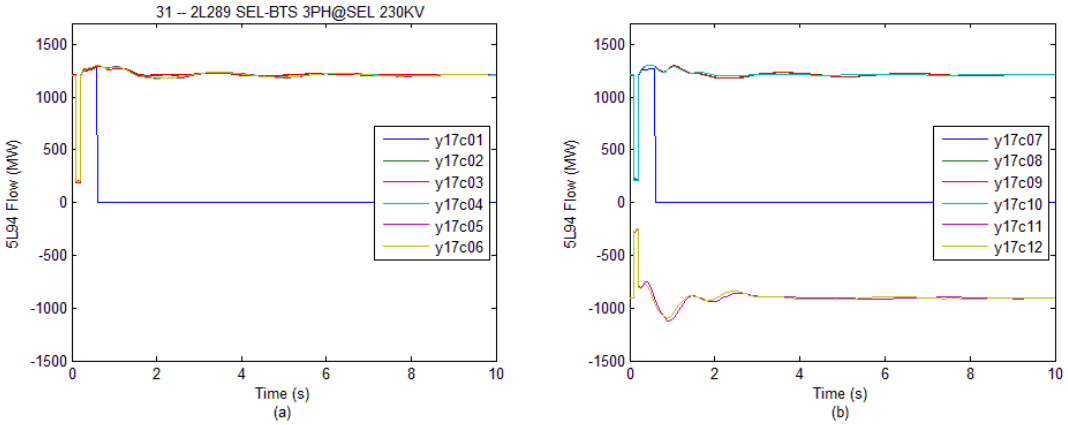


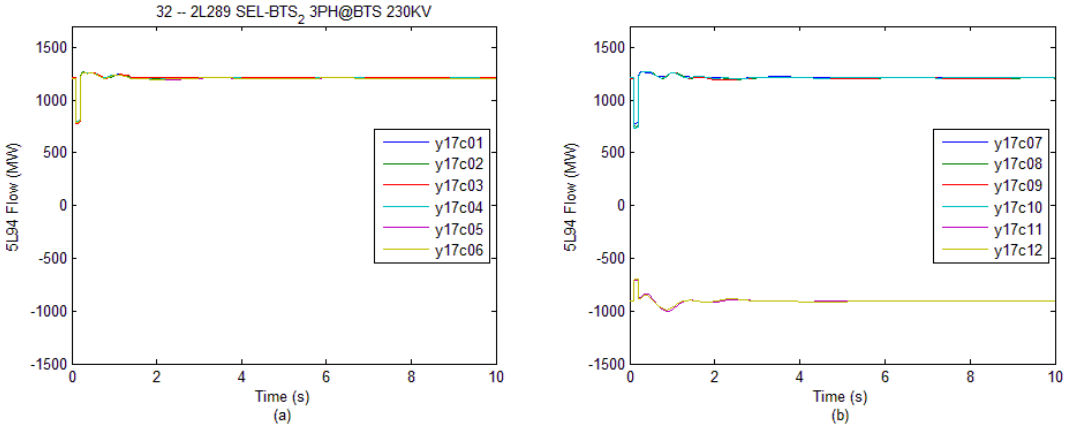


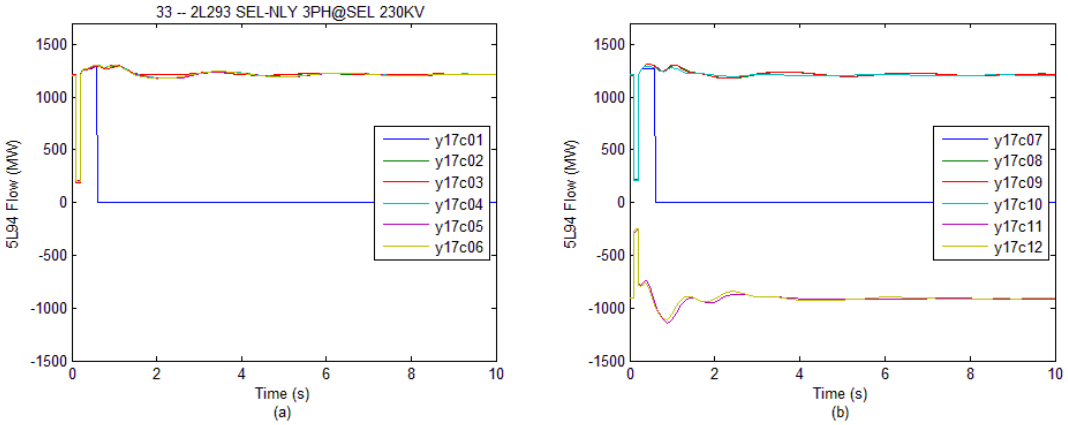


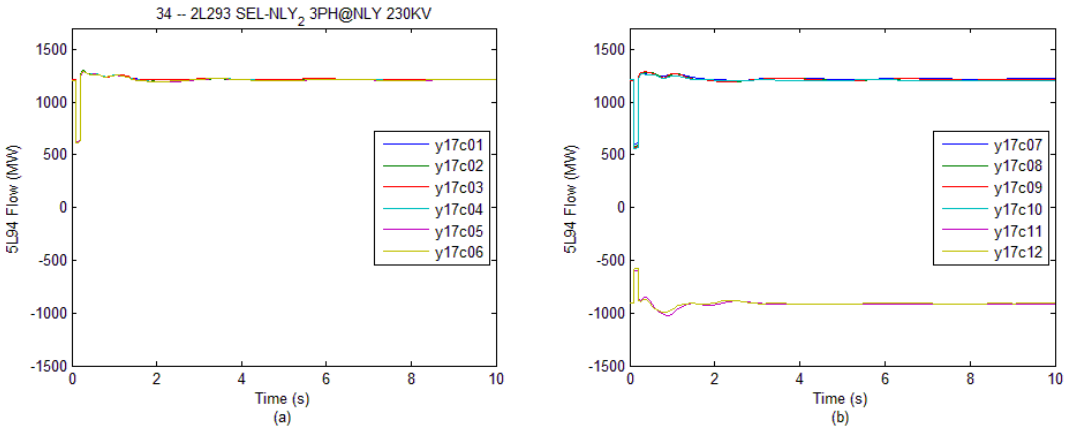


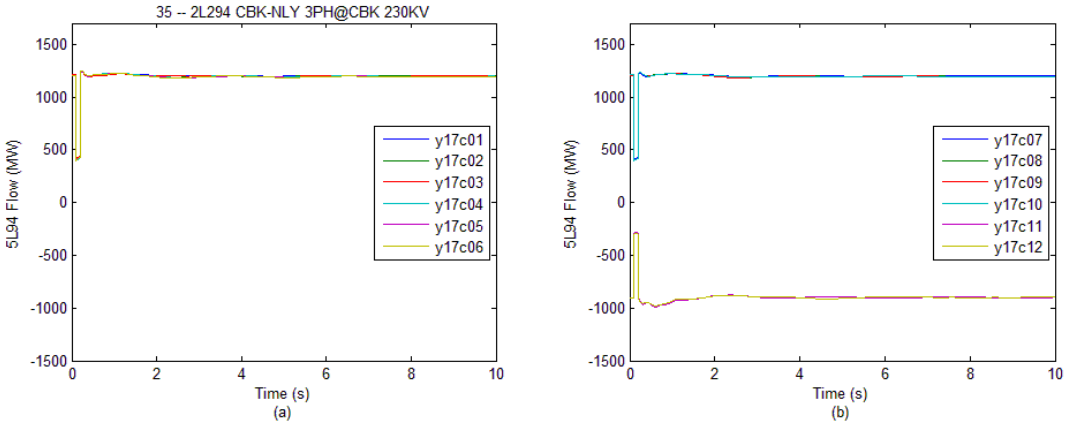


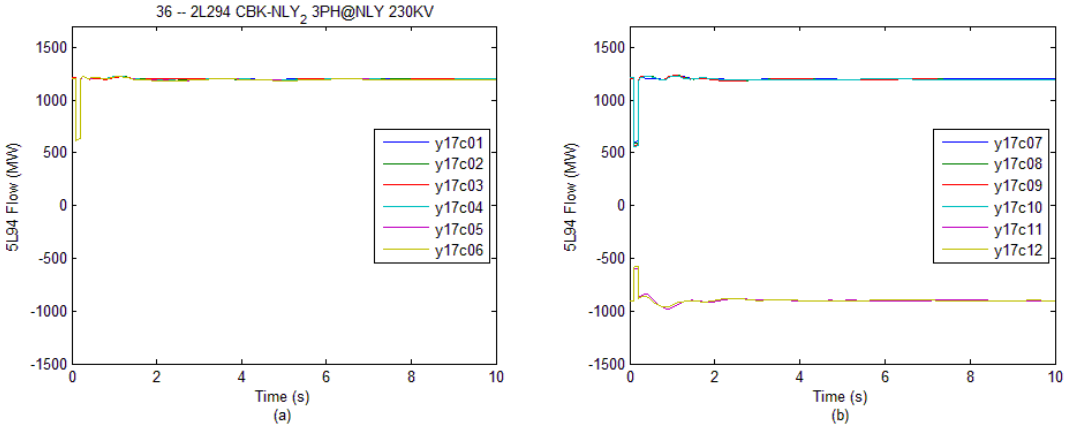


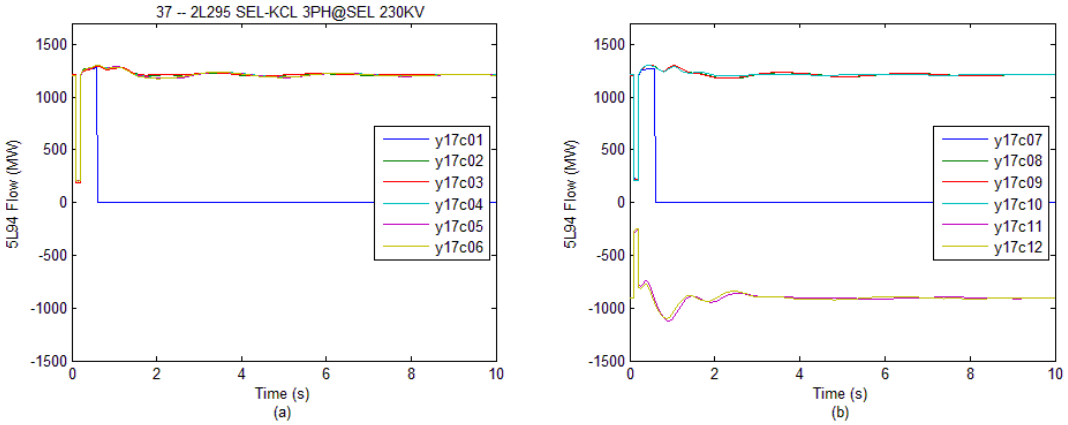


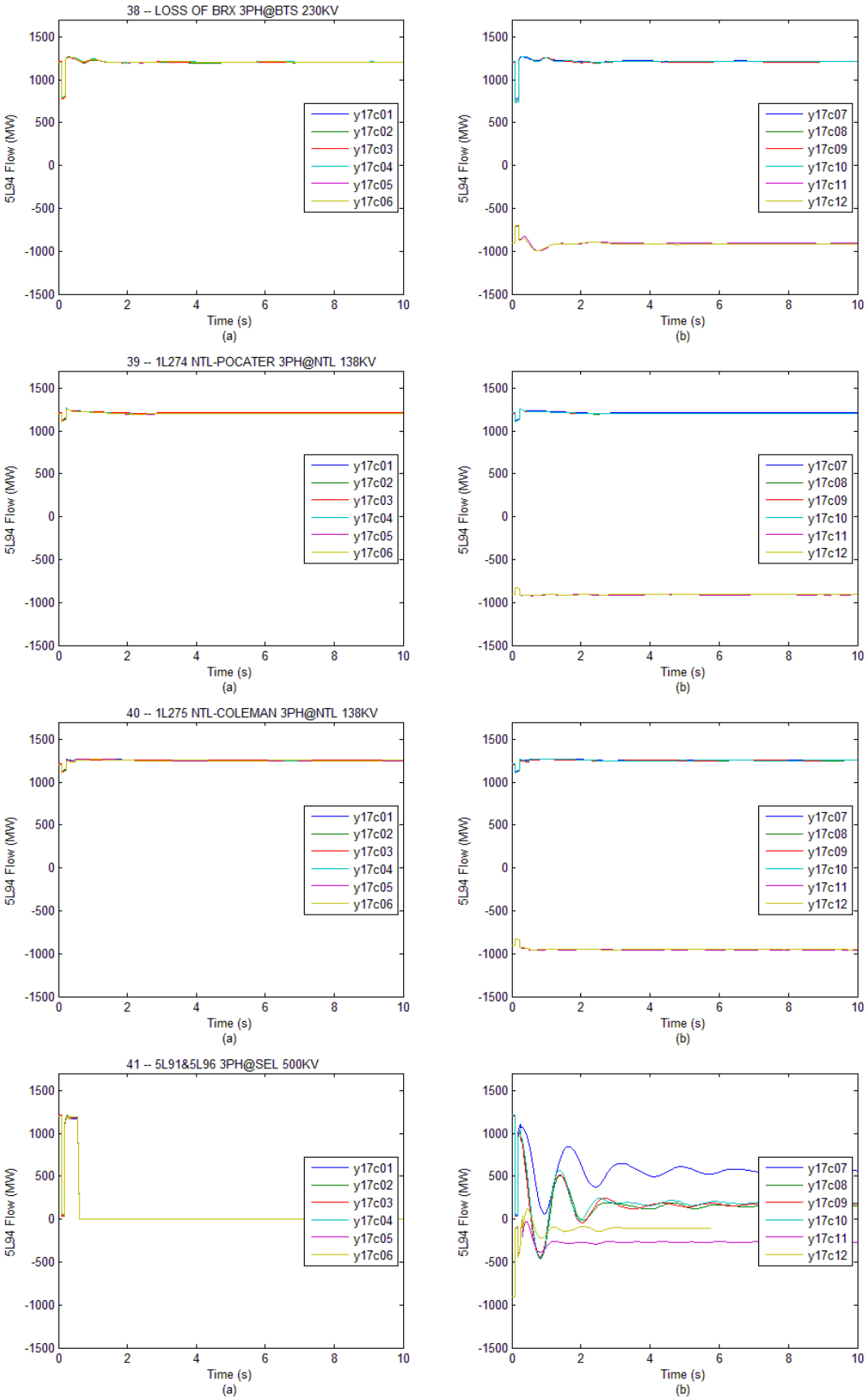


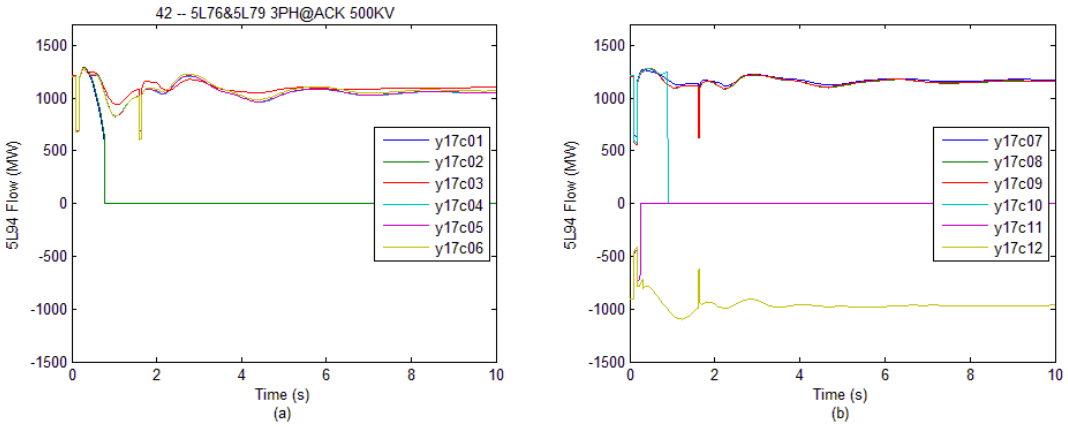


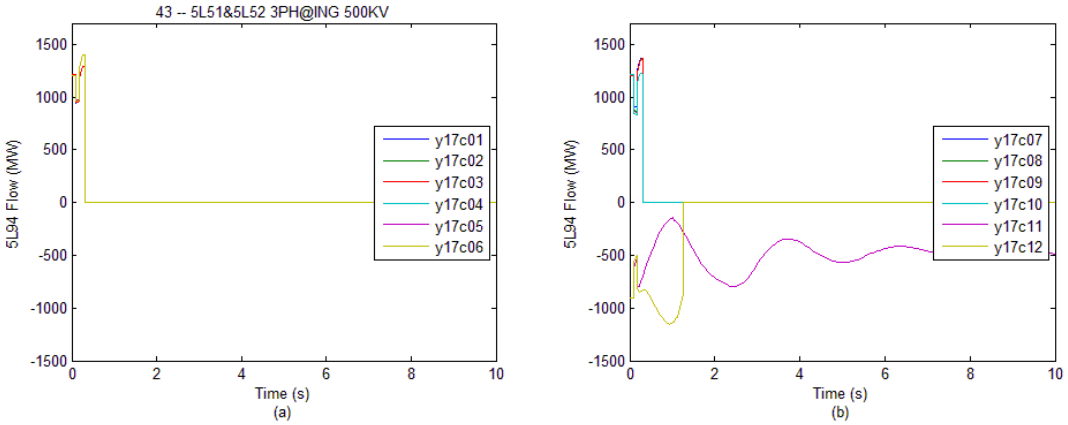


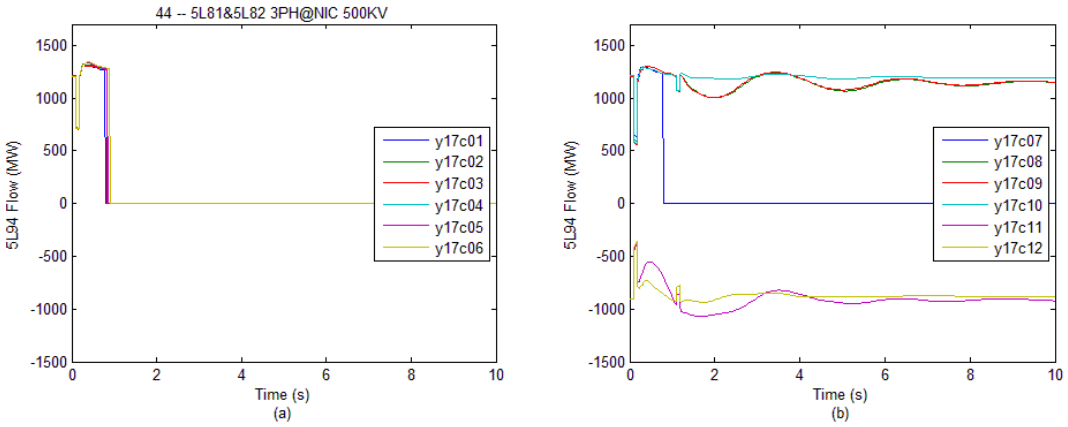


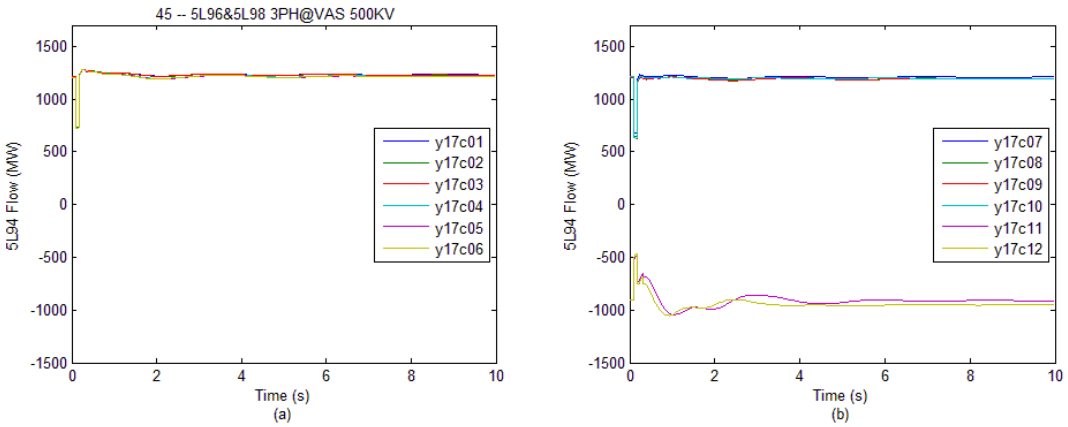


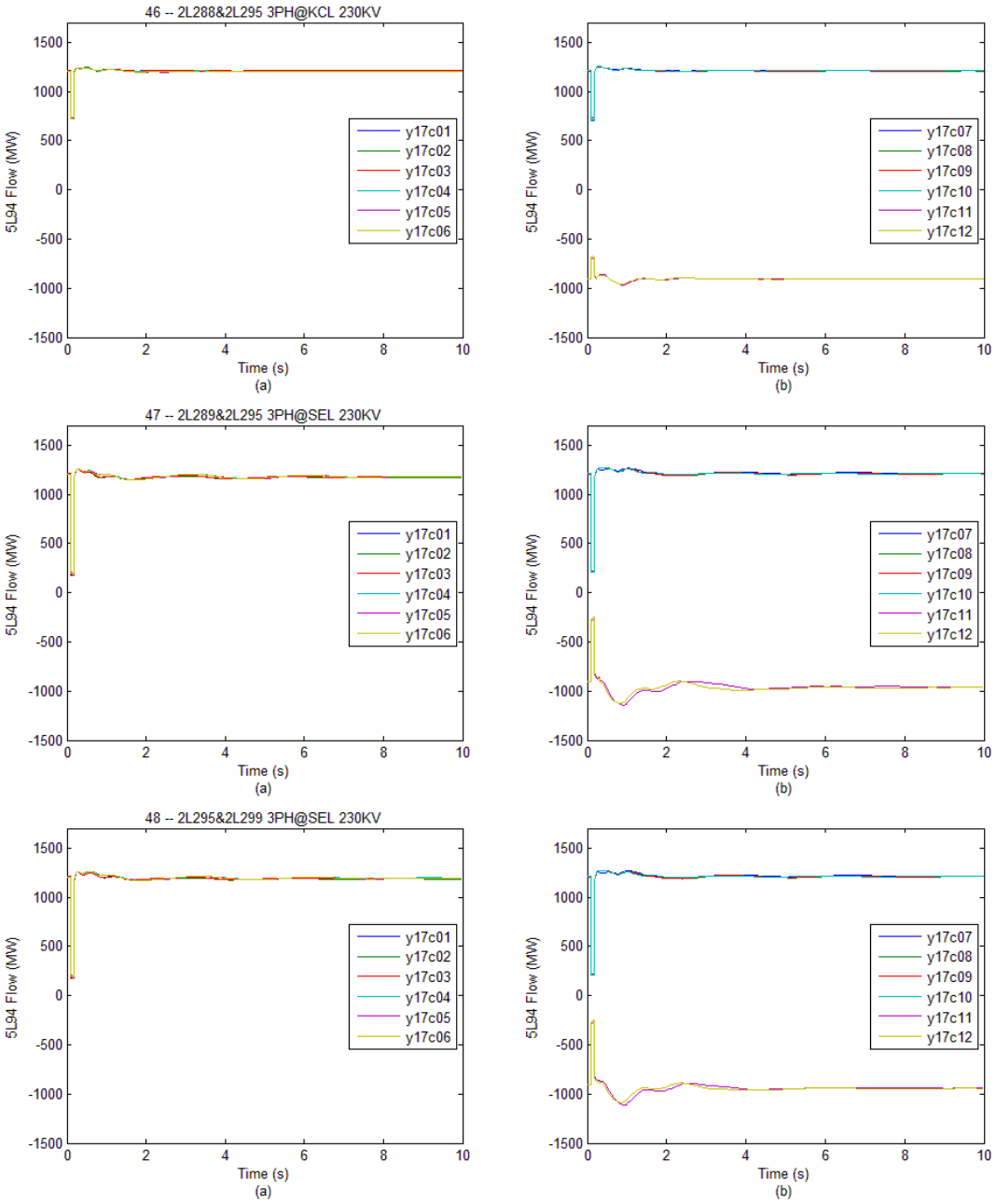




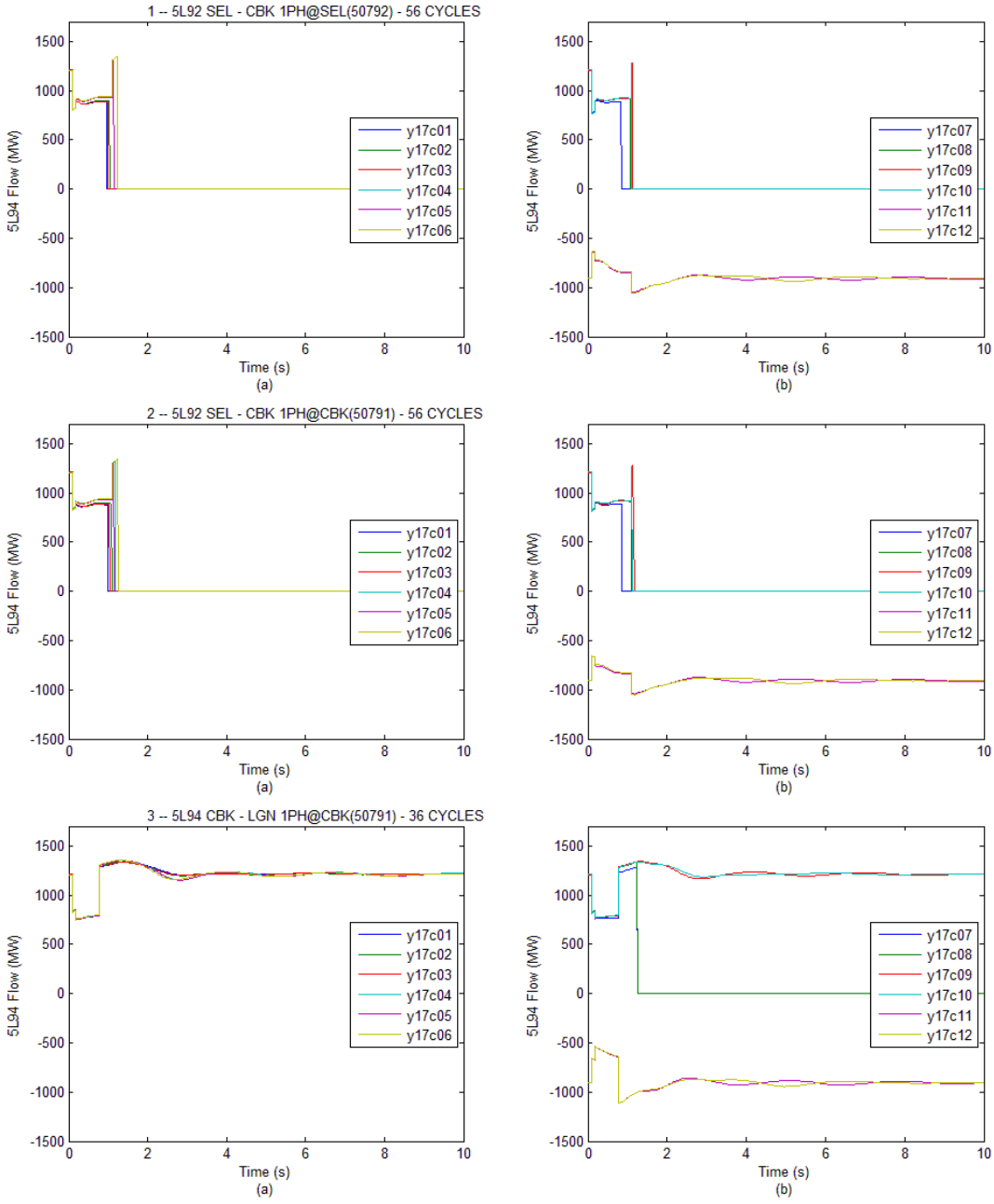




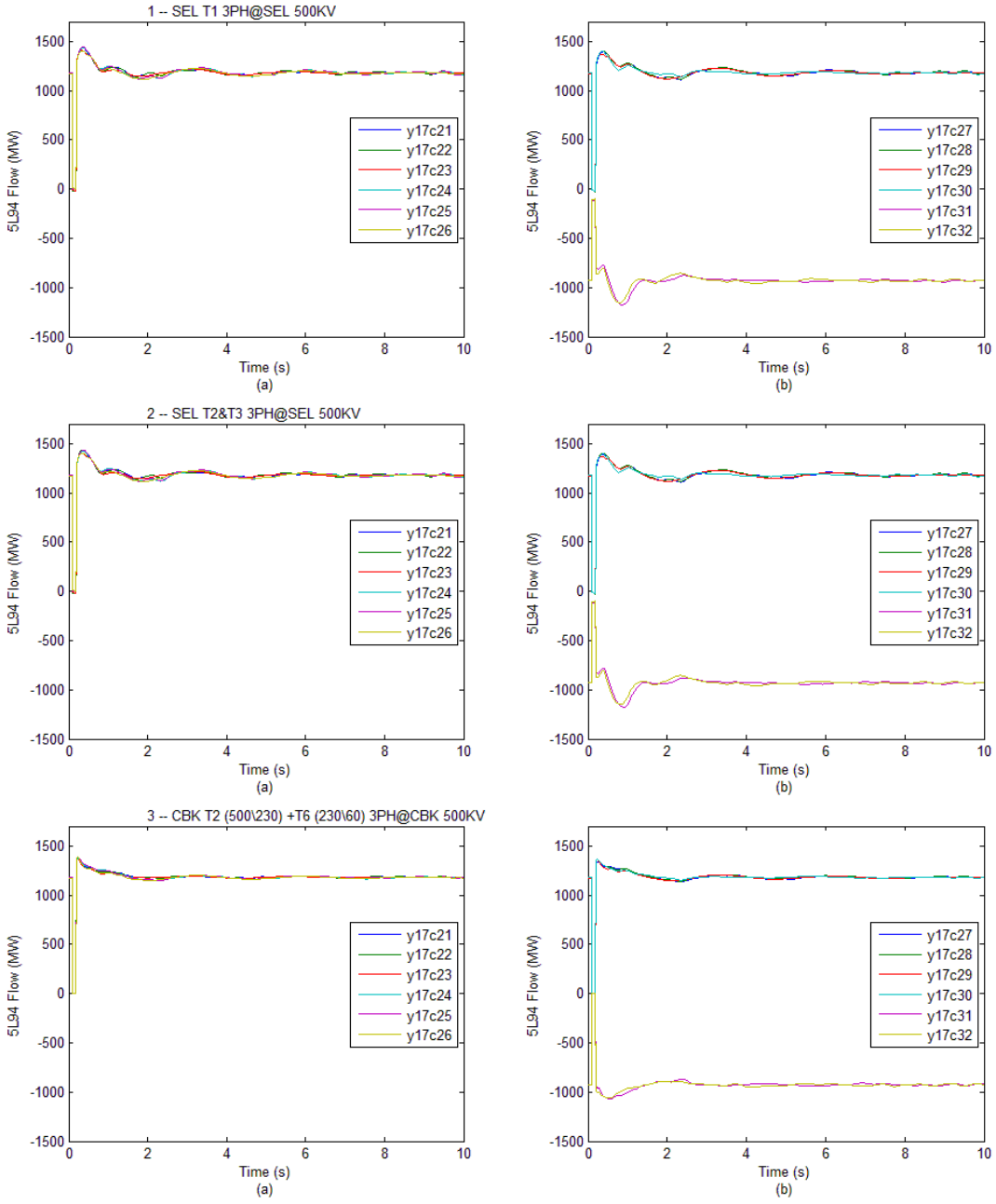


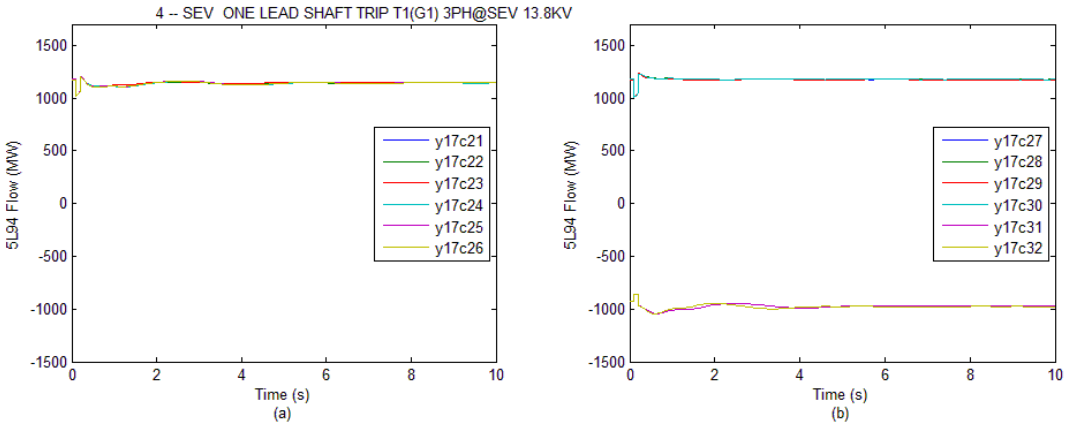


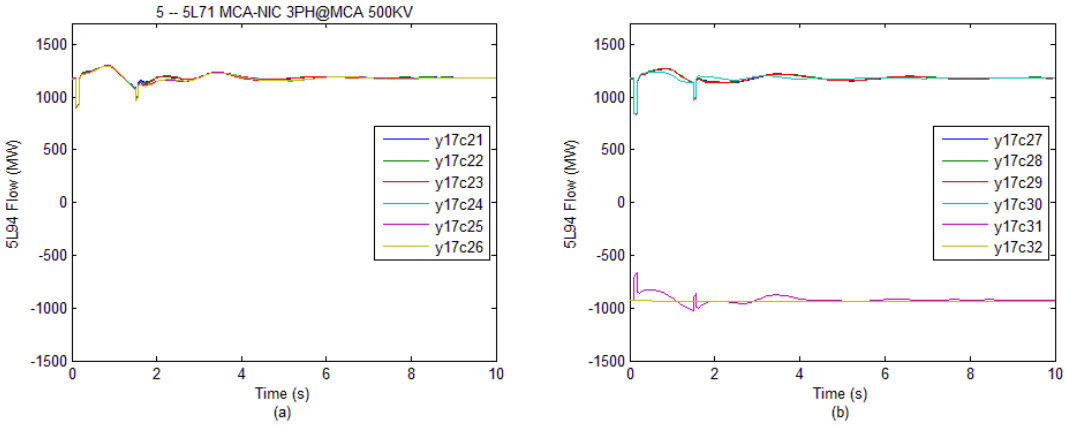
F.4 Y17 cases without Chapel Rock (SPR Contingency)

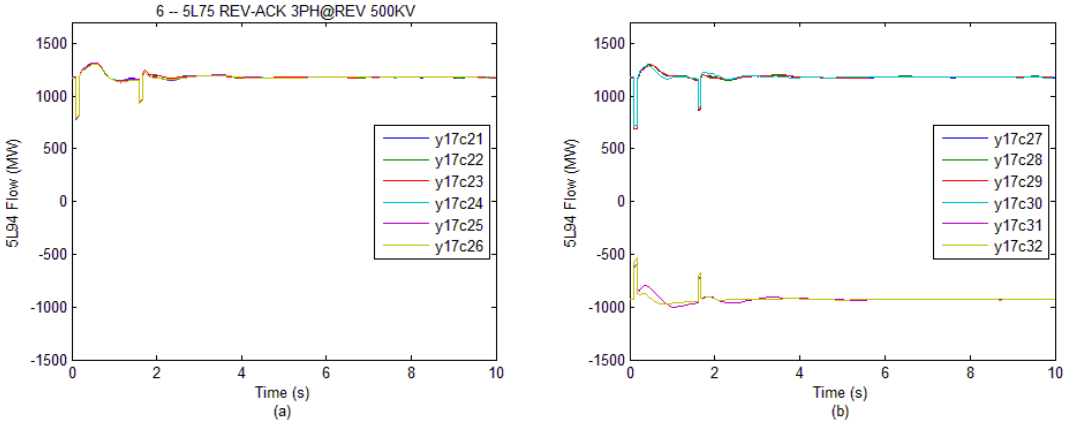


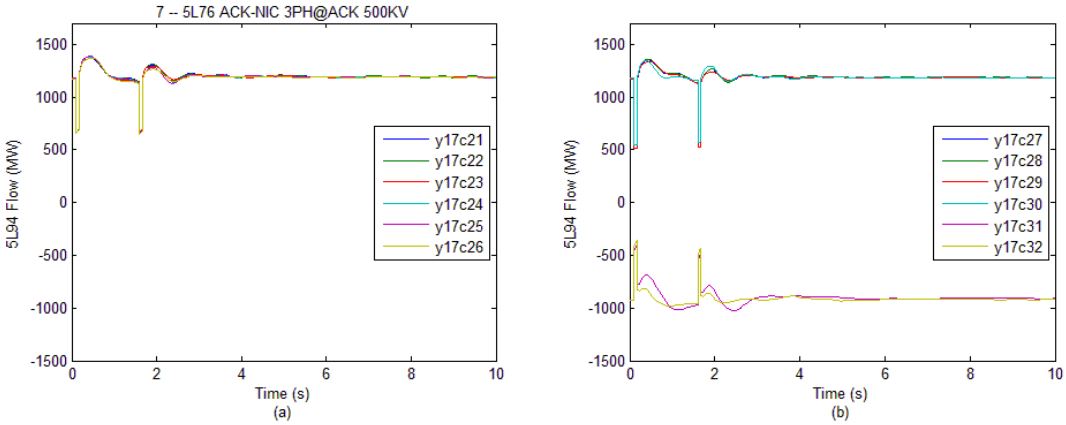
F.5 Y17 cases with Chapel Rock (N-1 and N-2 Contingency)

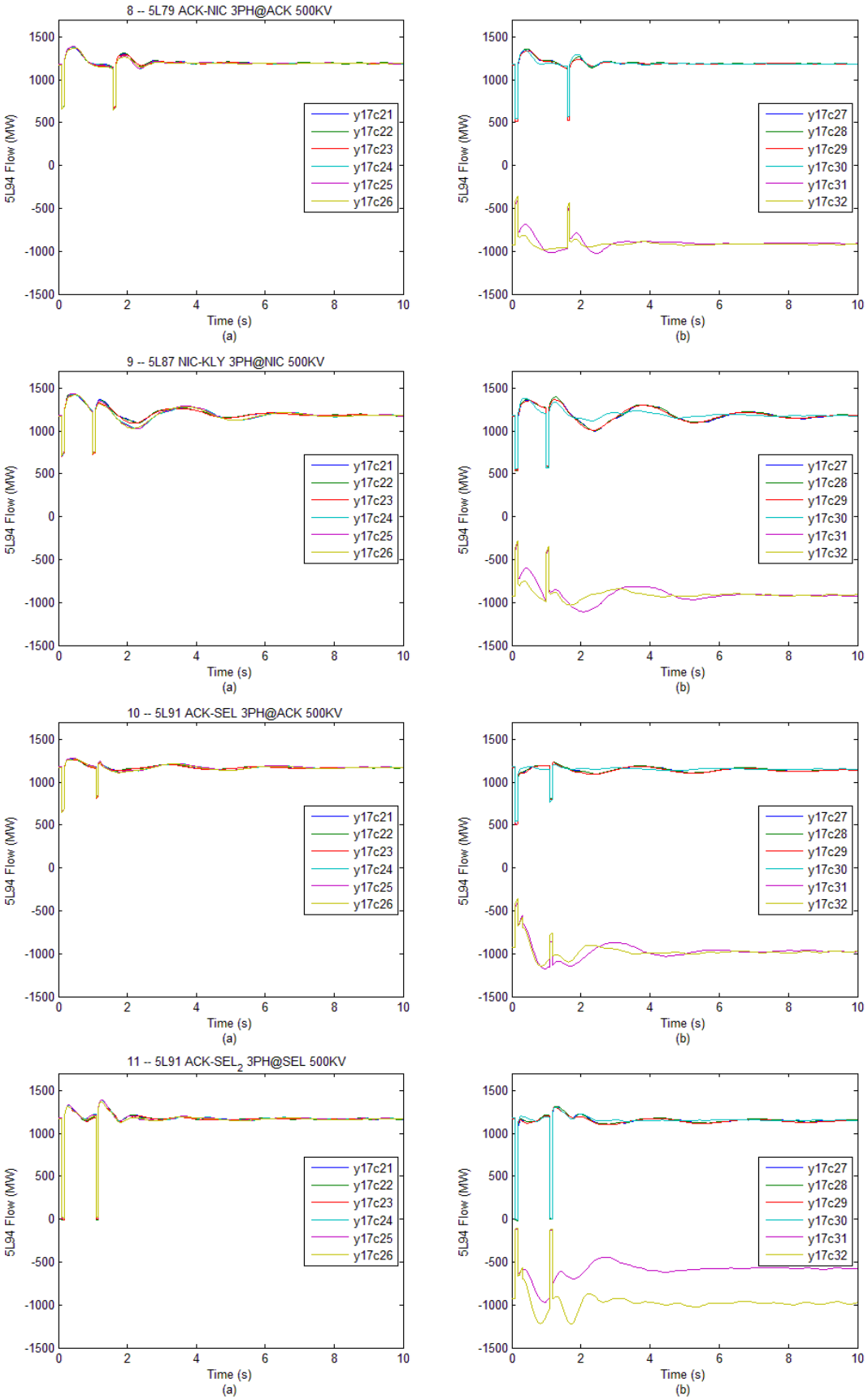


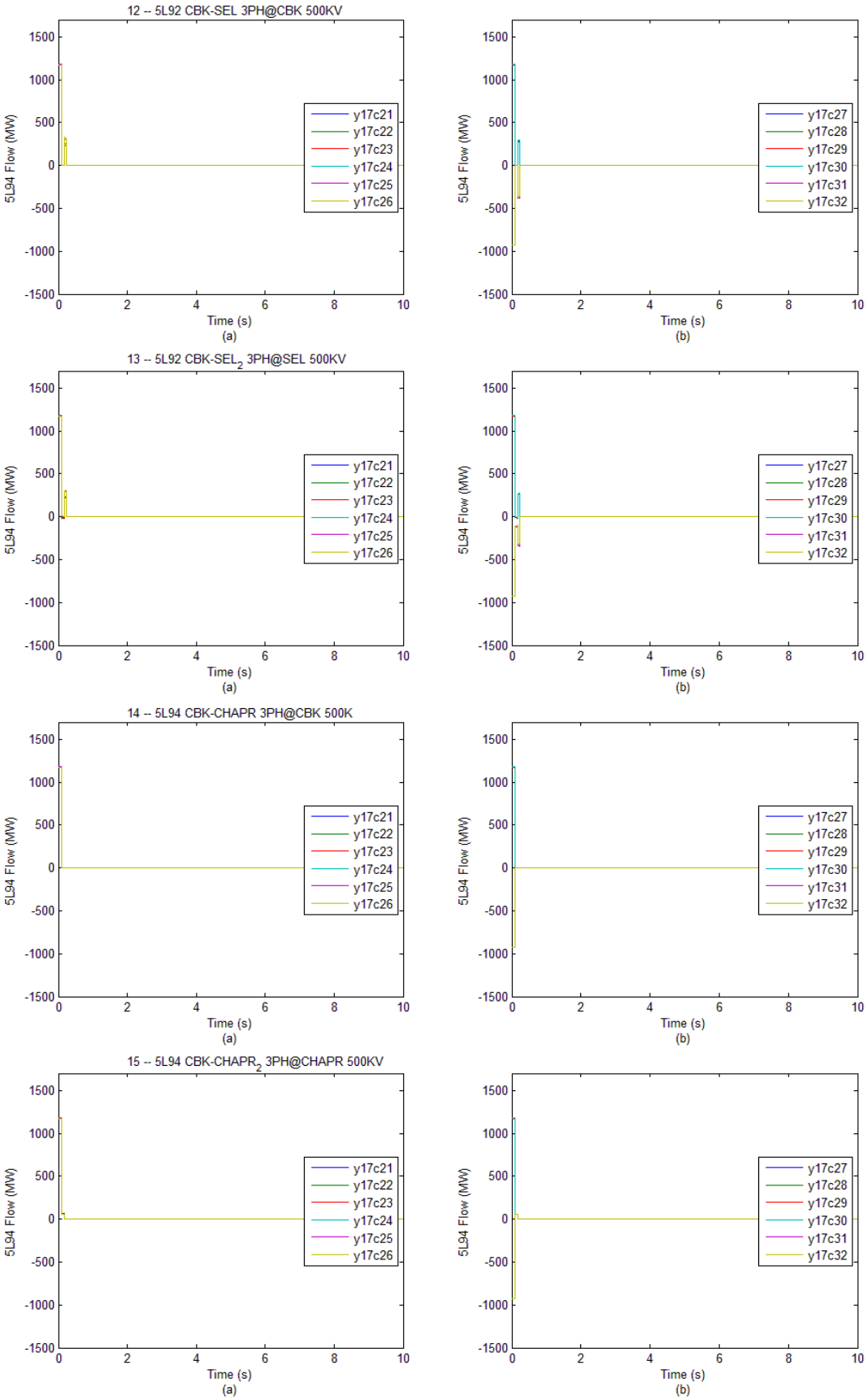


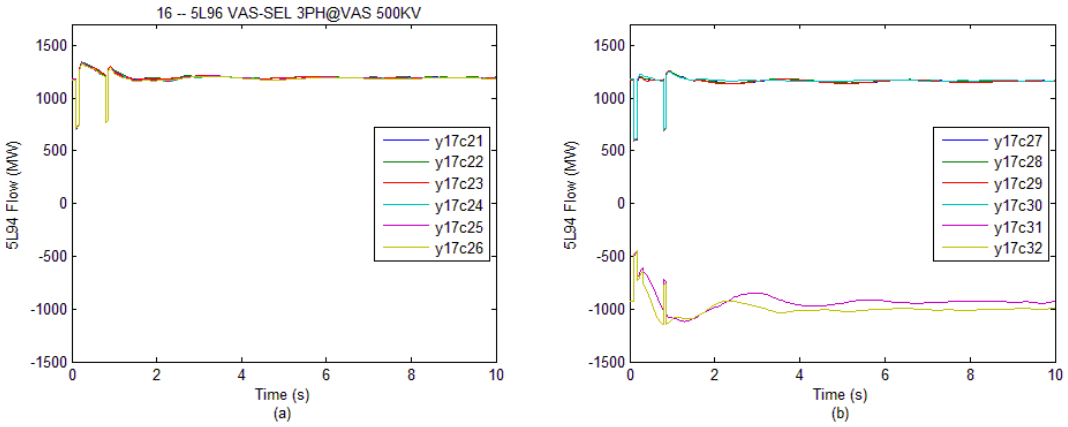


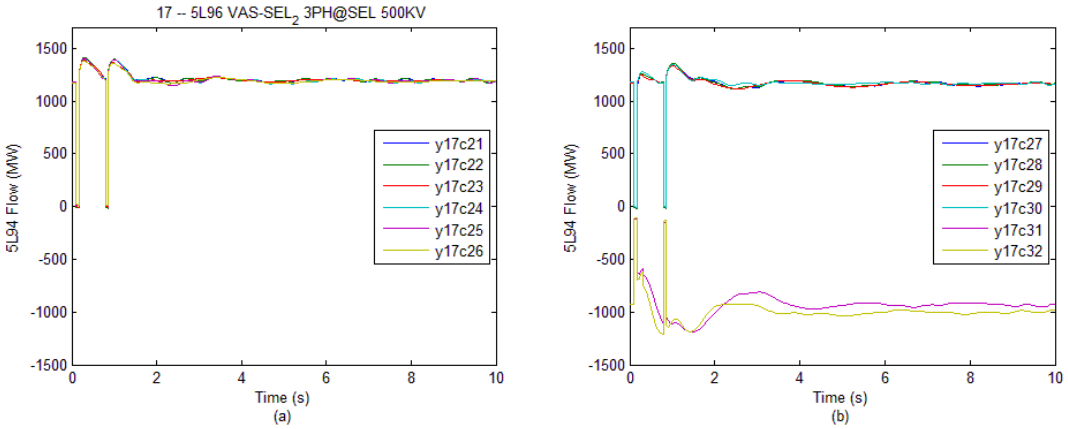


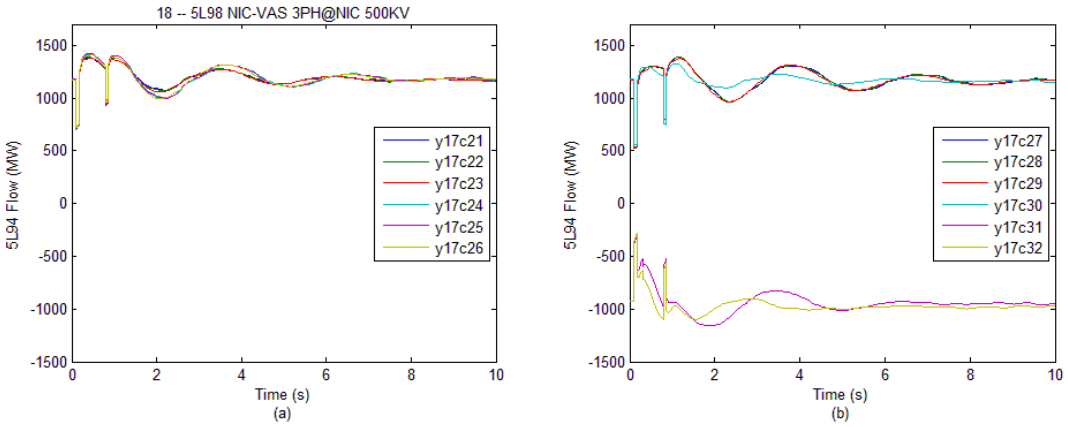


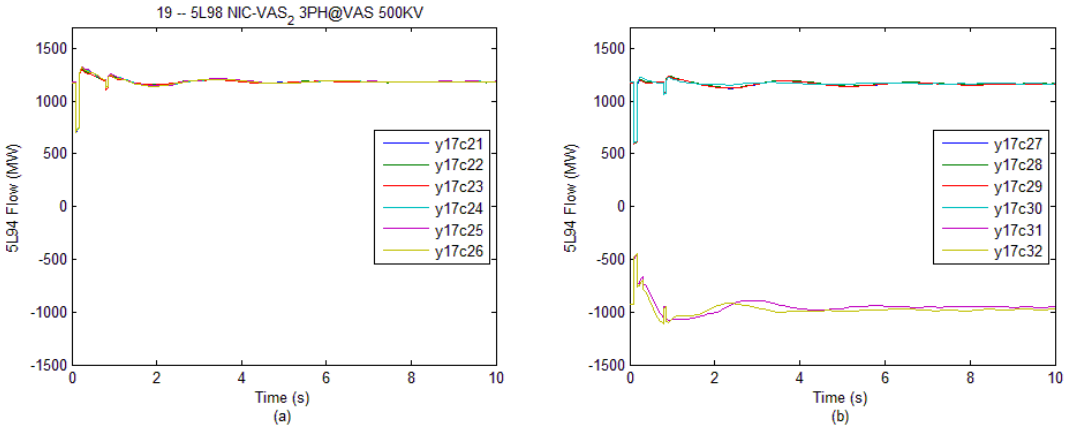


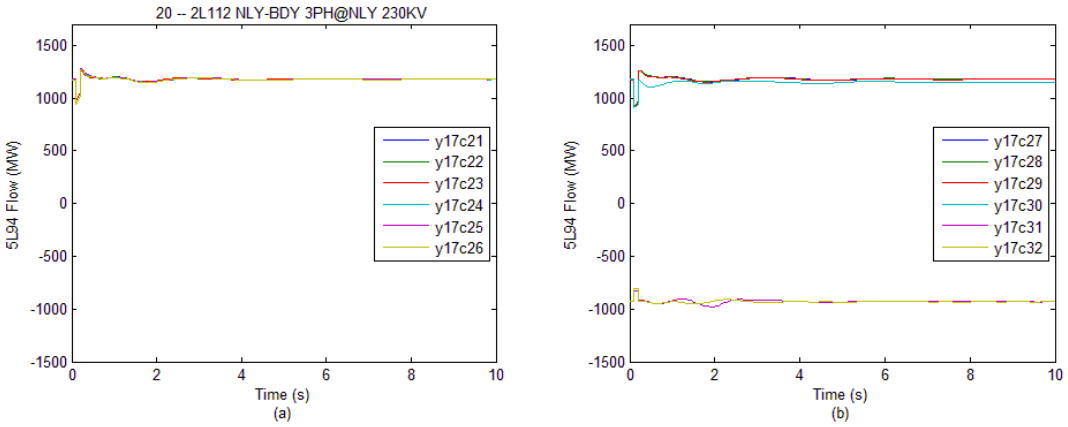


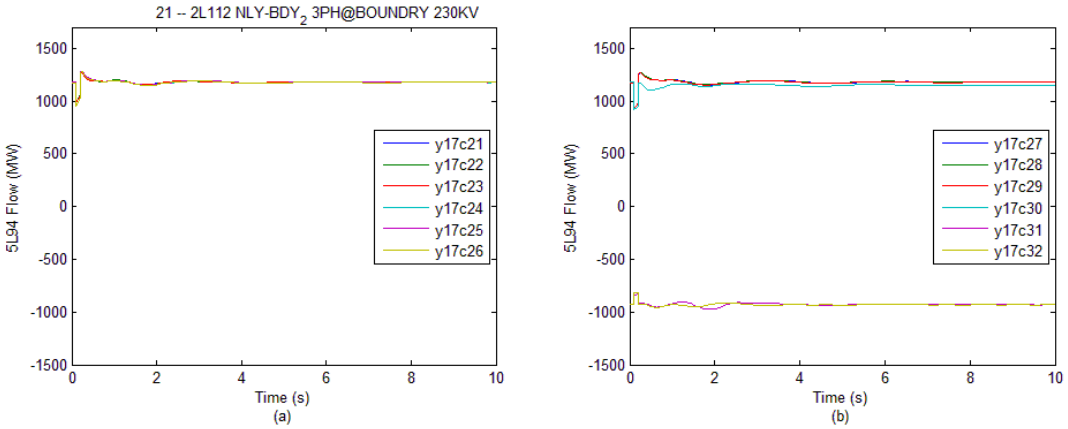


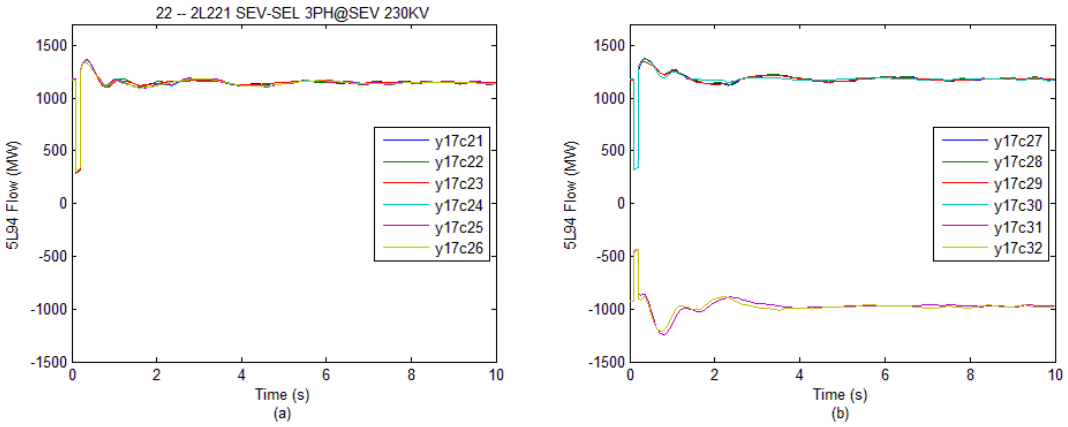


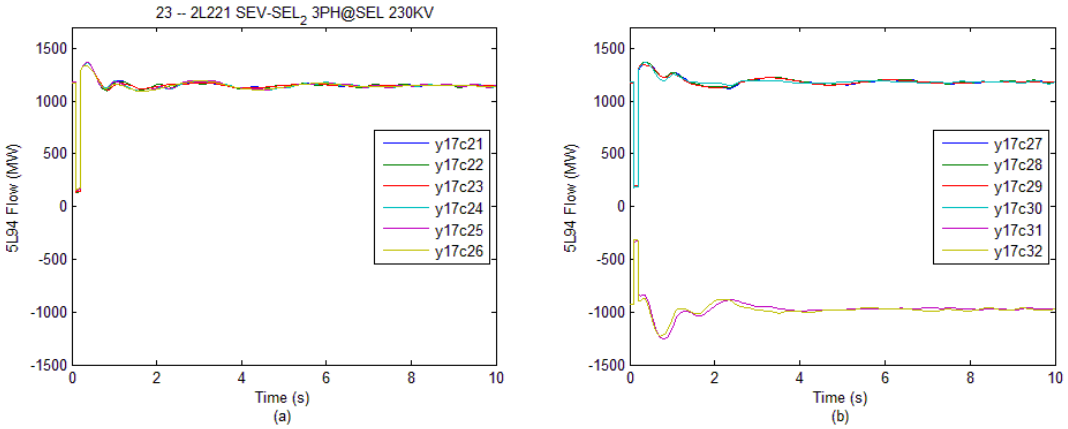


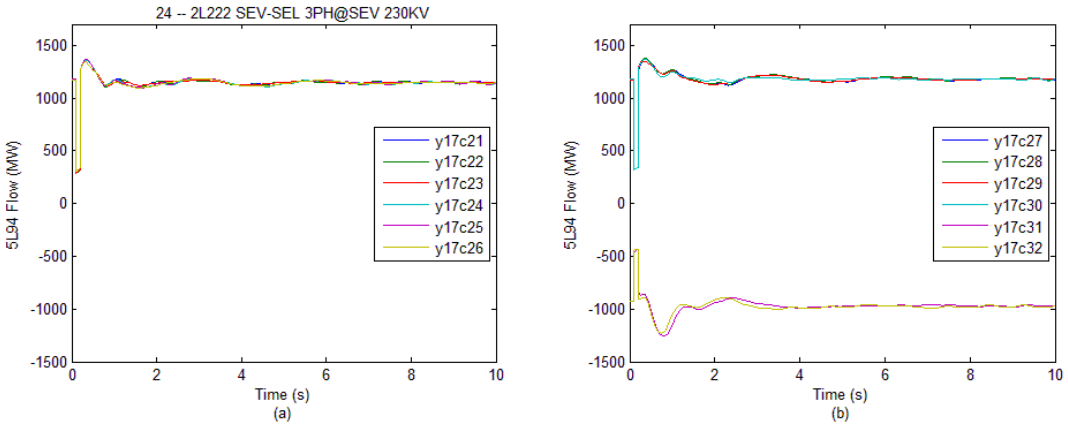


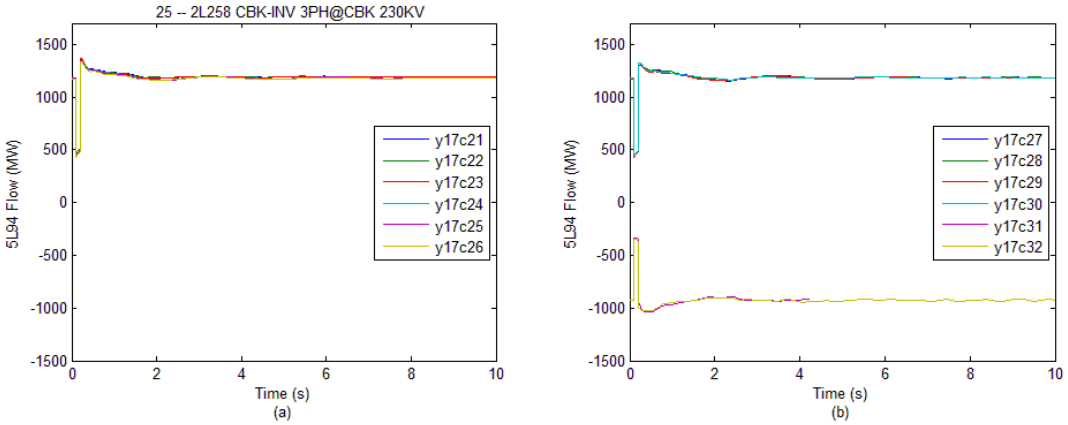


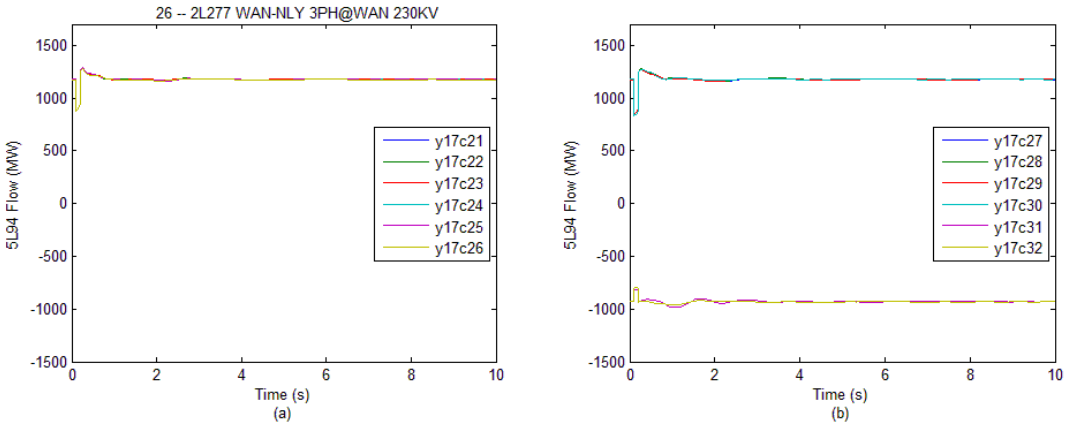


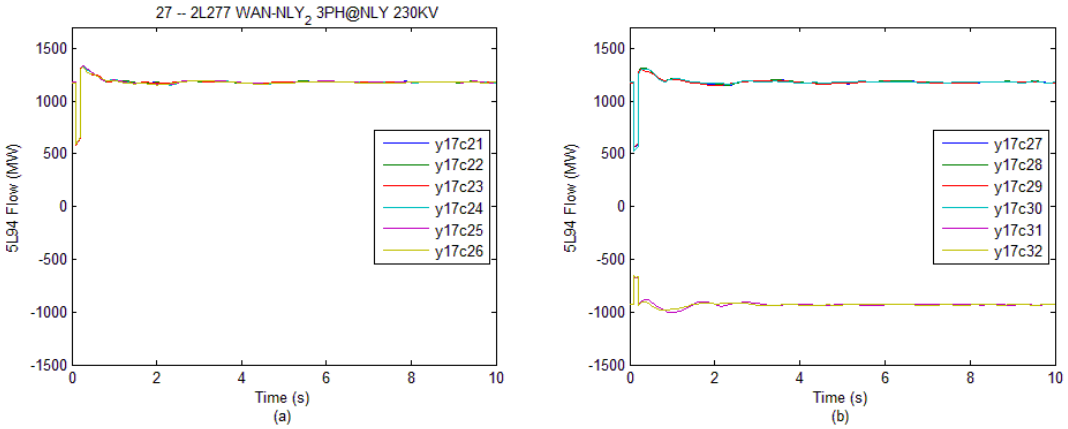


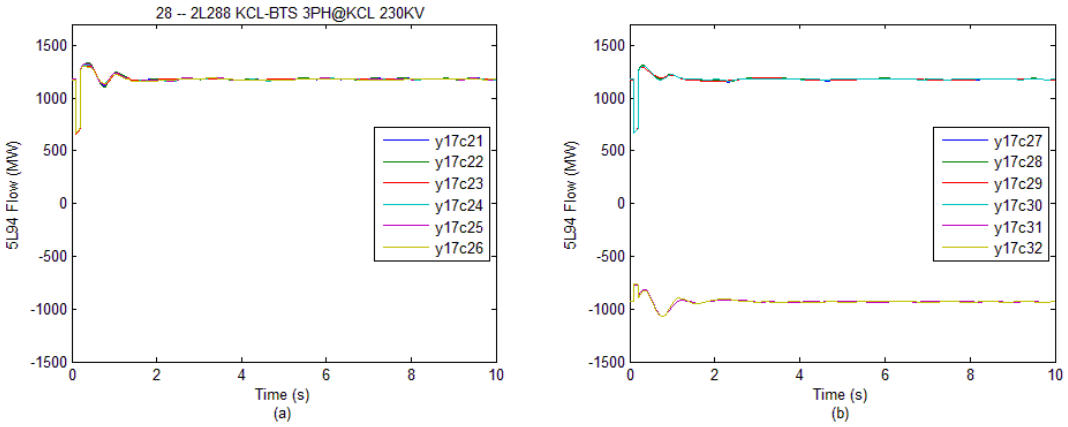


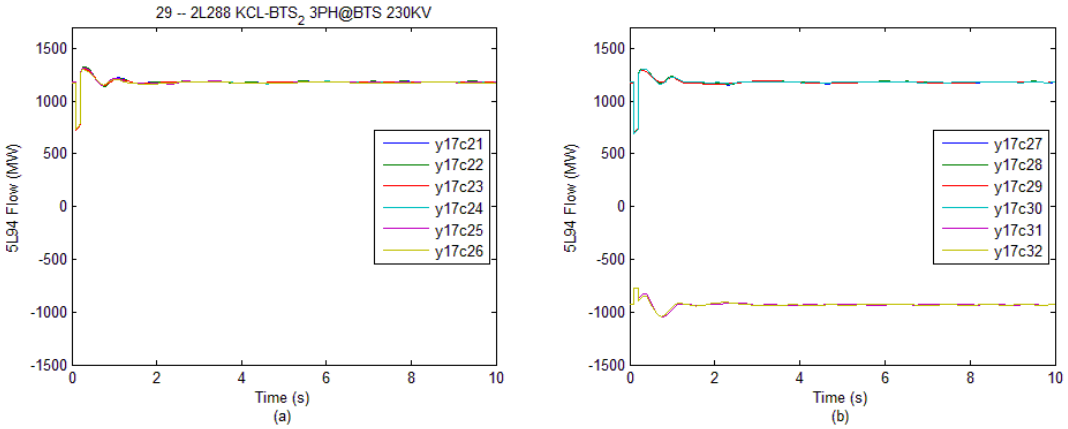


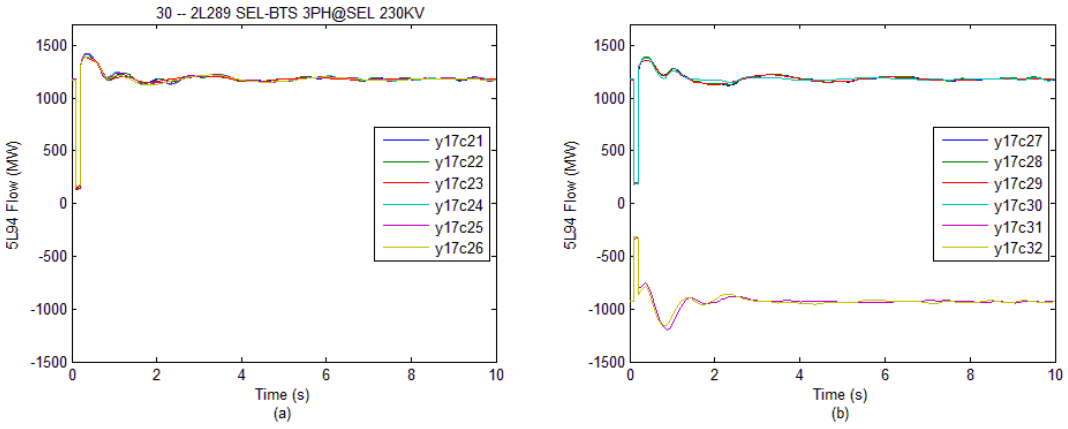


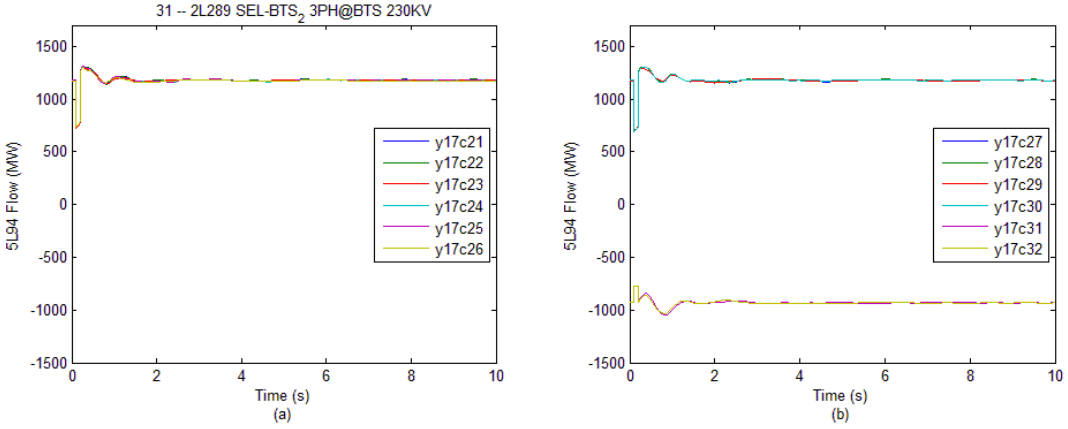


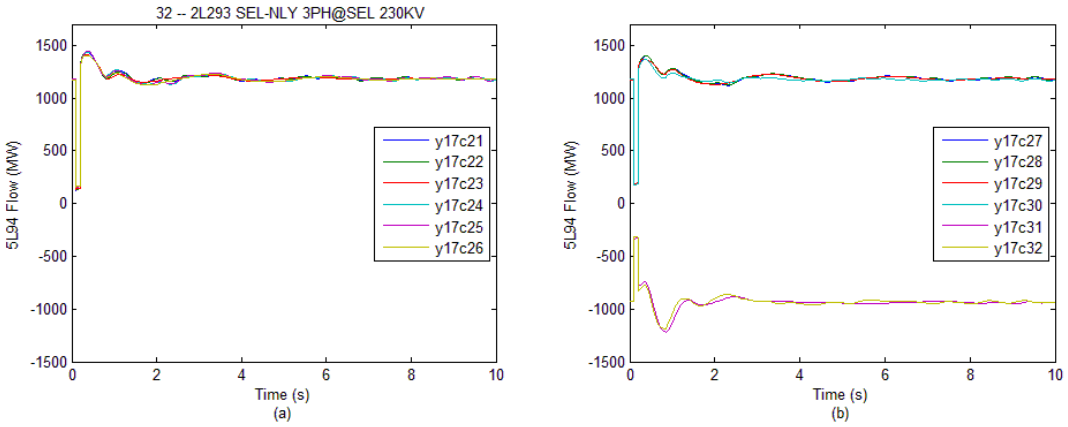


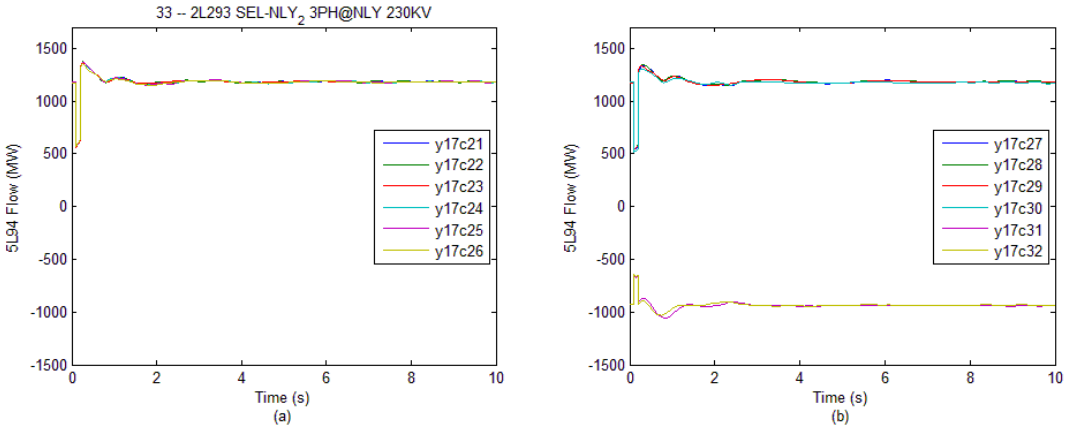


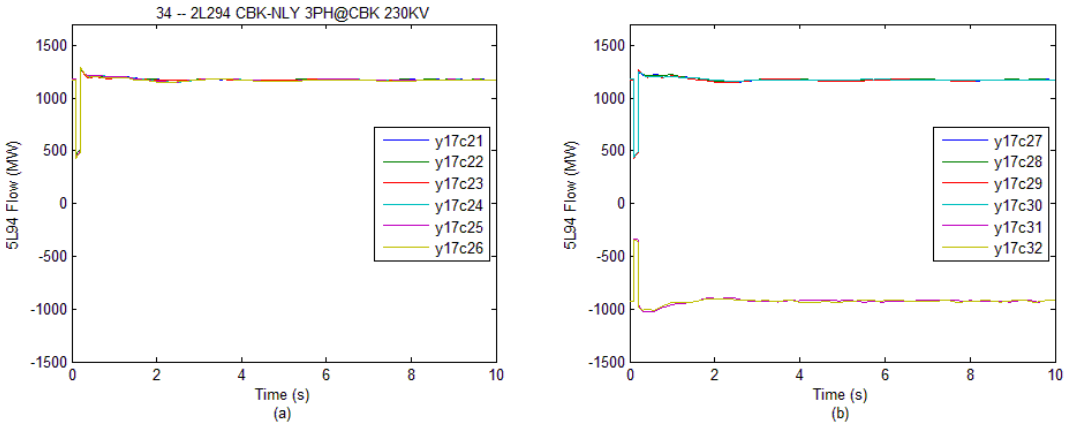


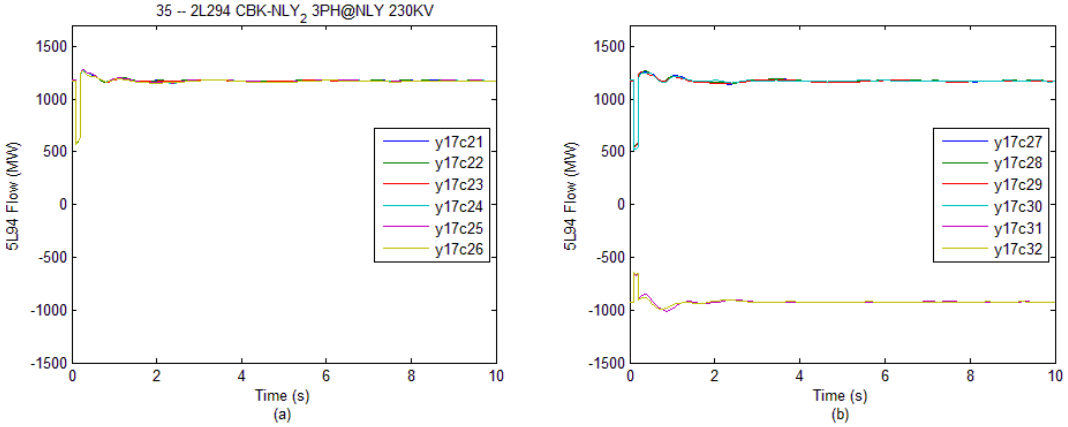


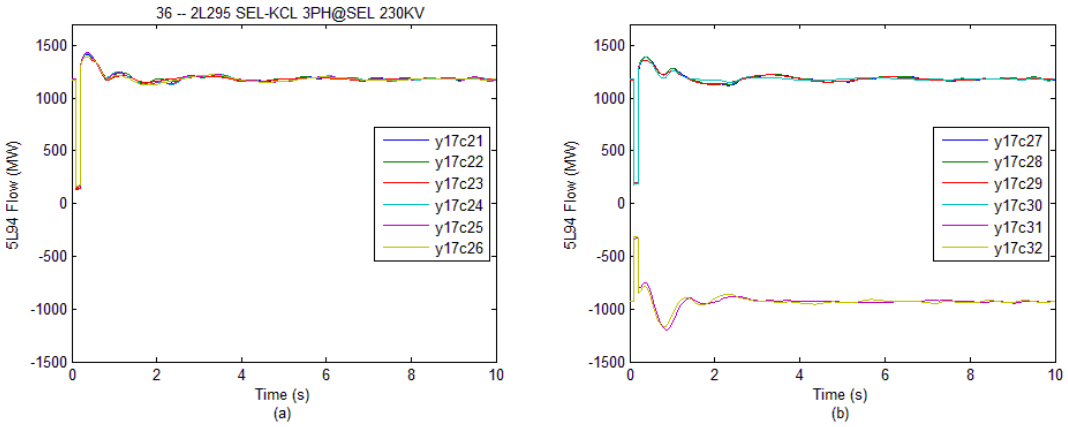


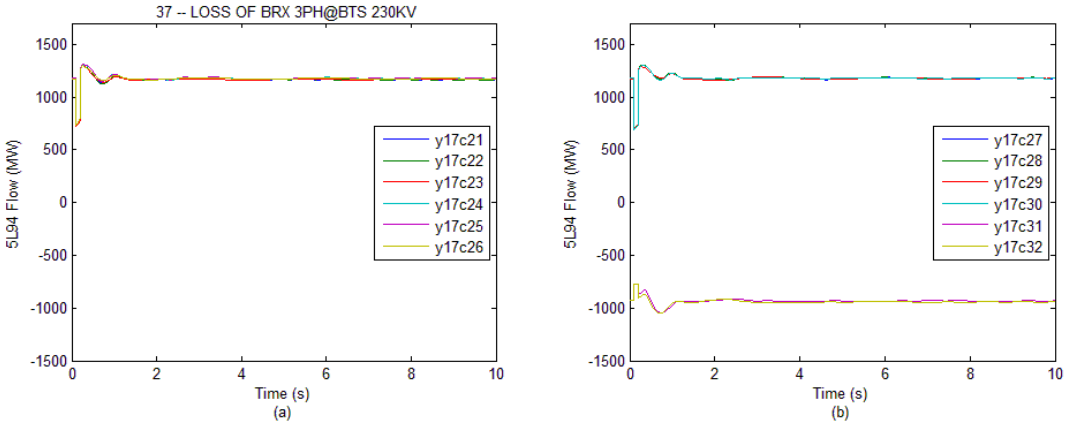


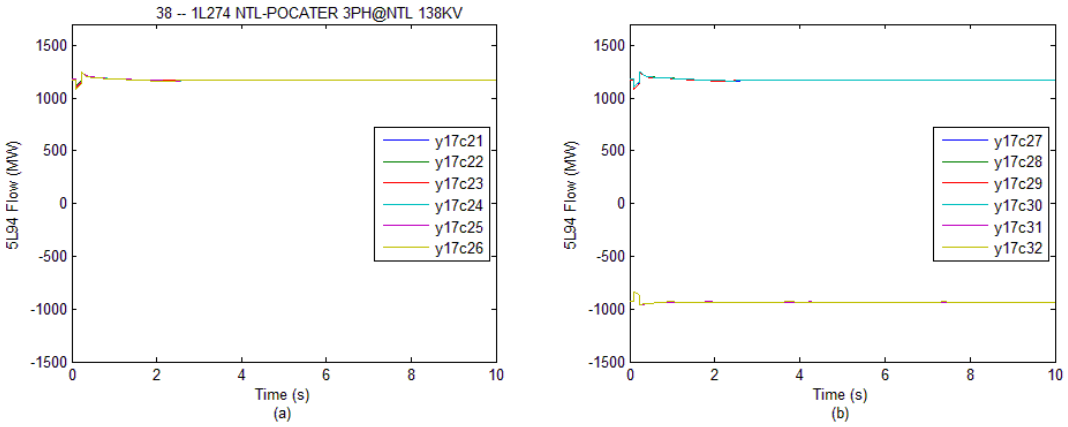


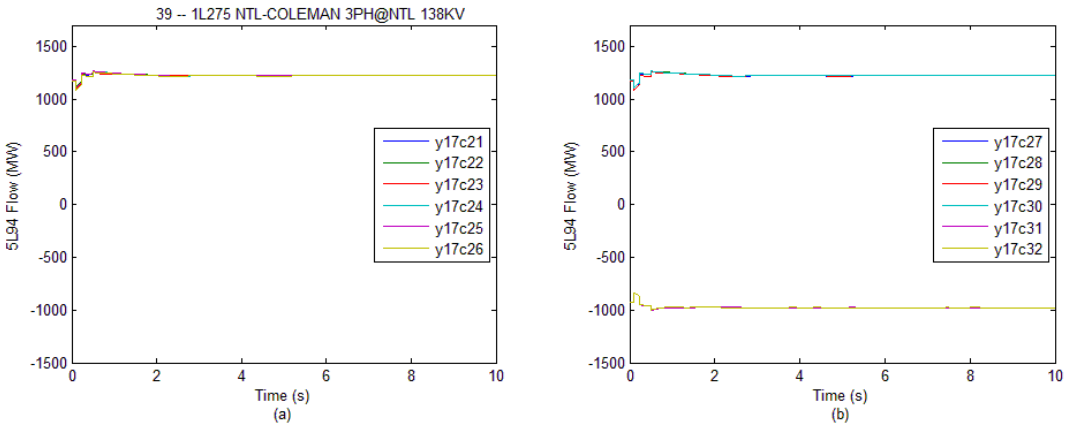


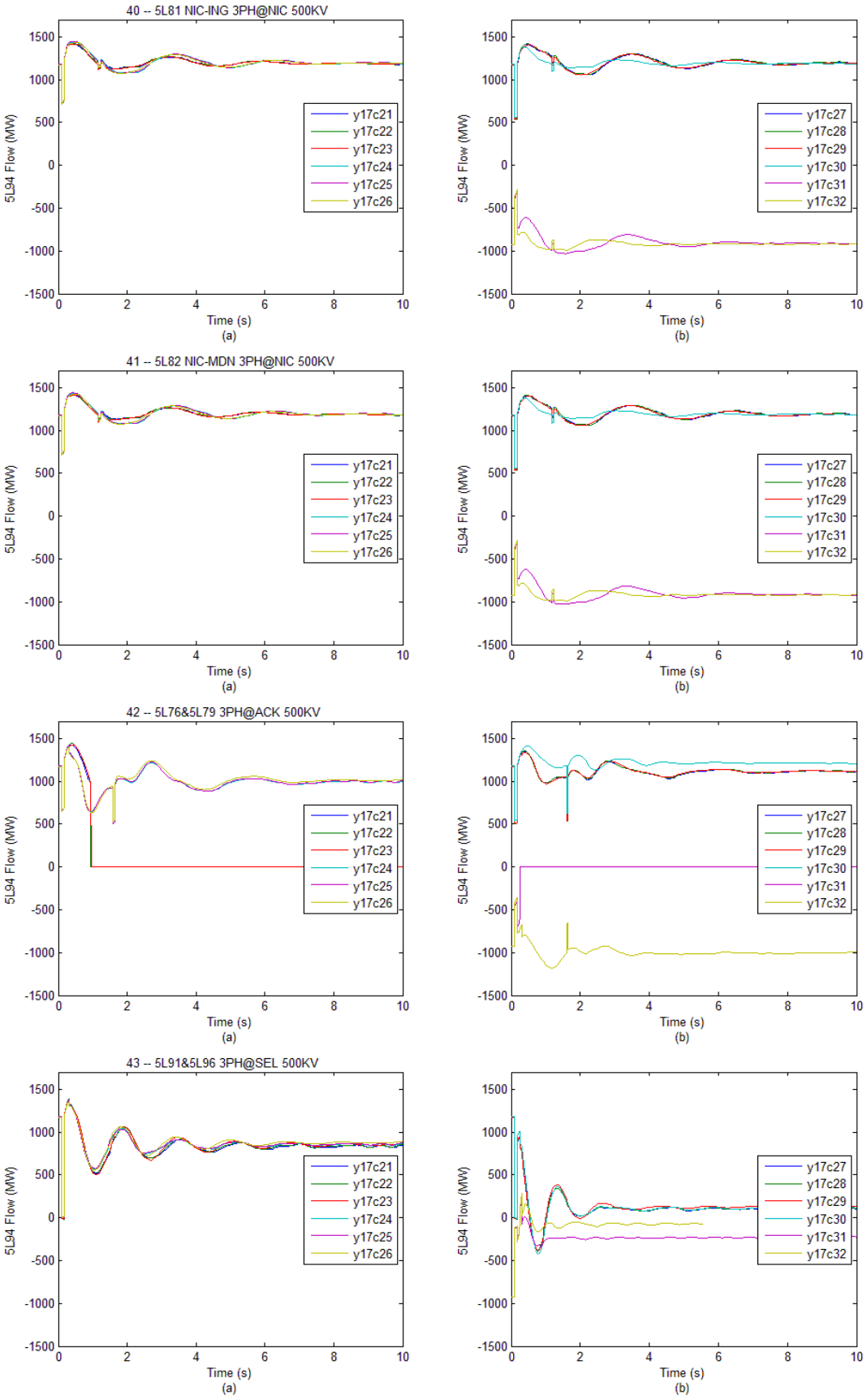


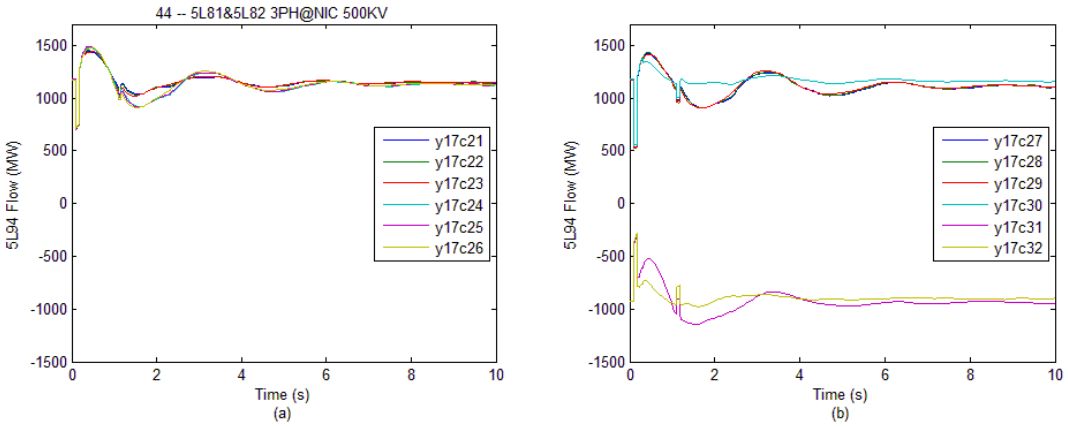


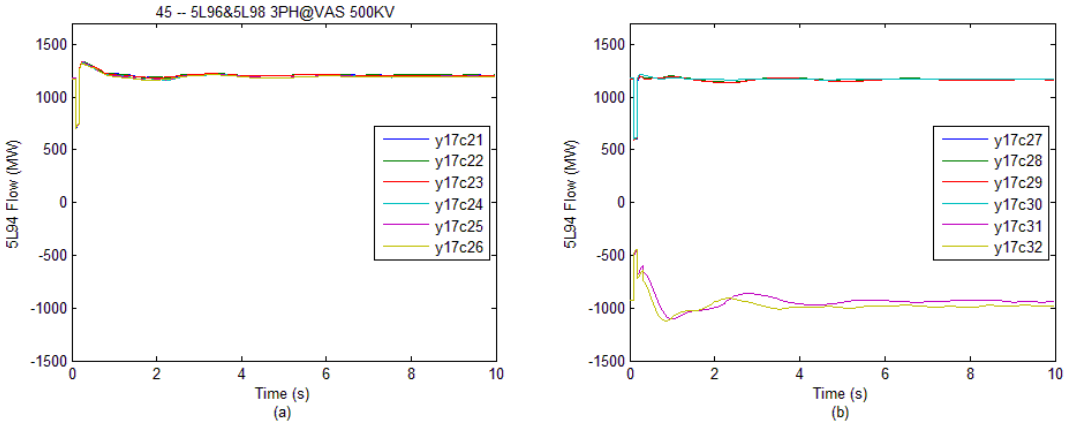


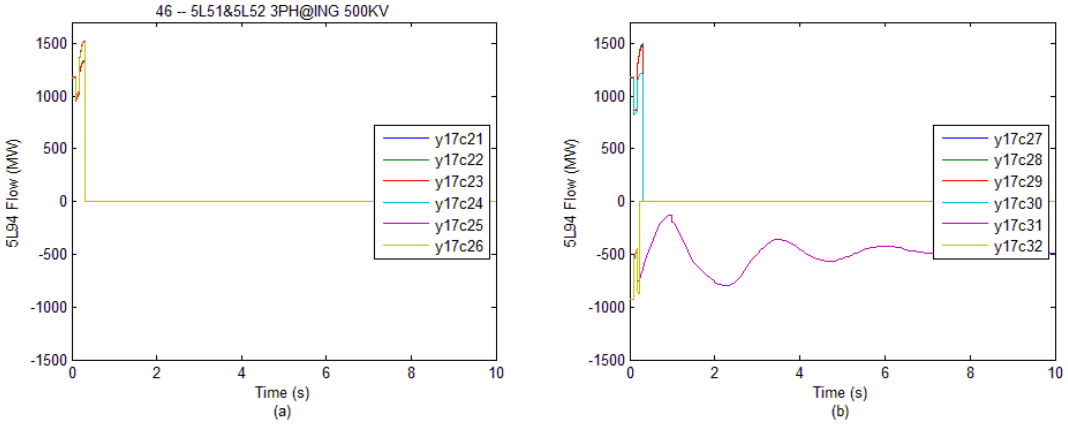


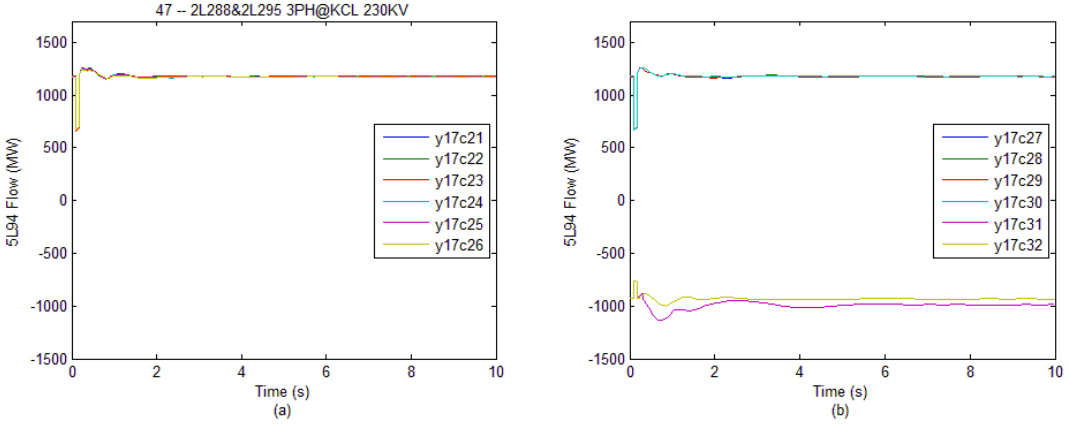


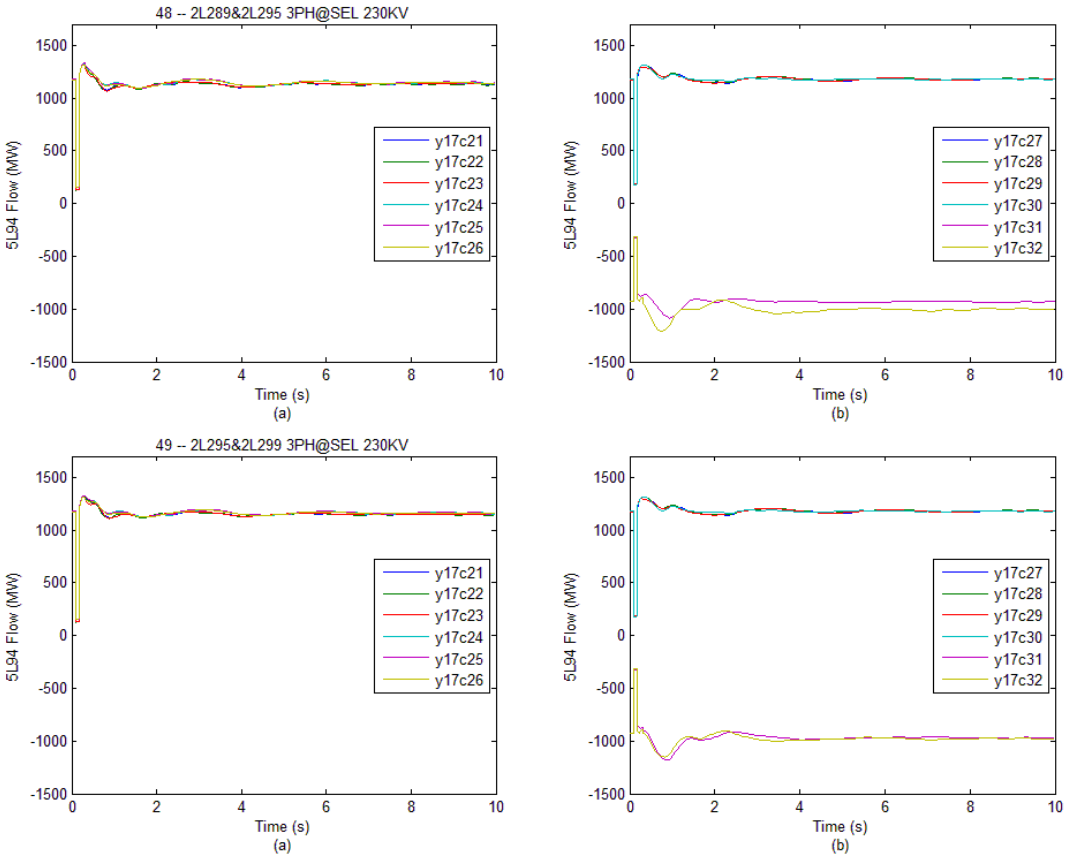




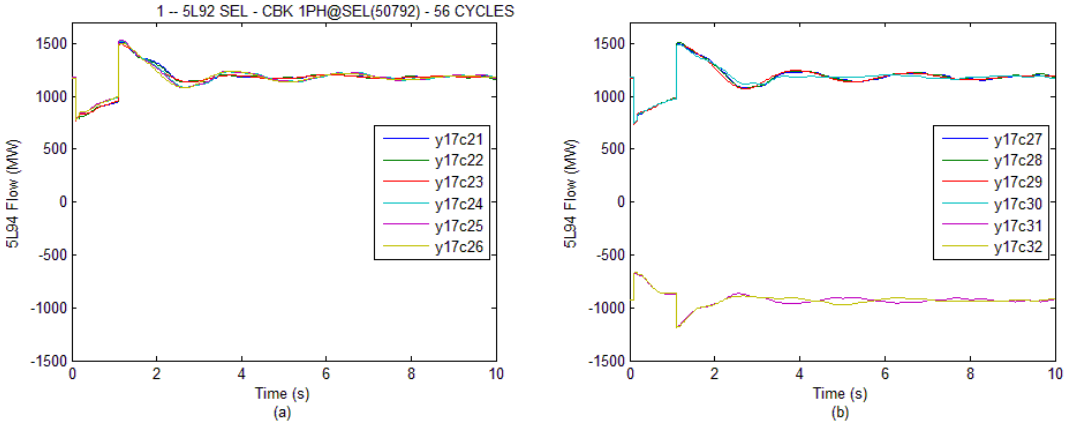


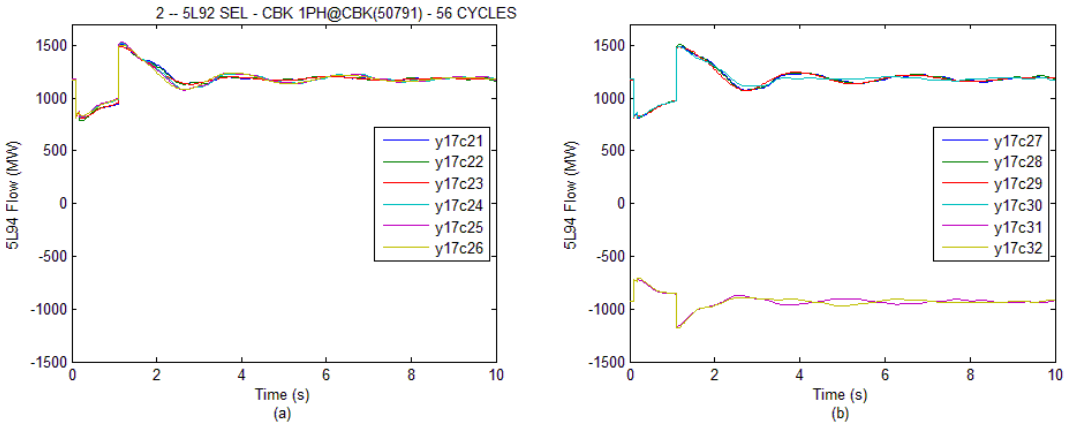


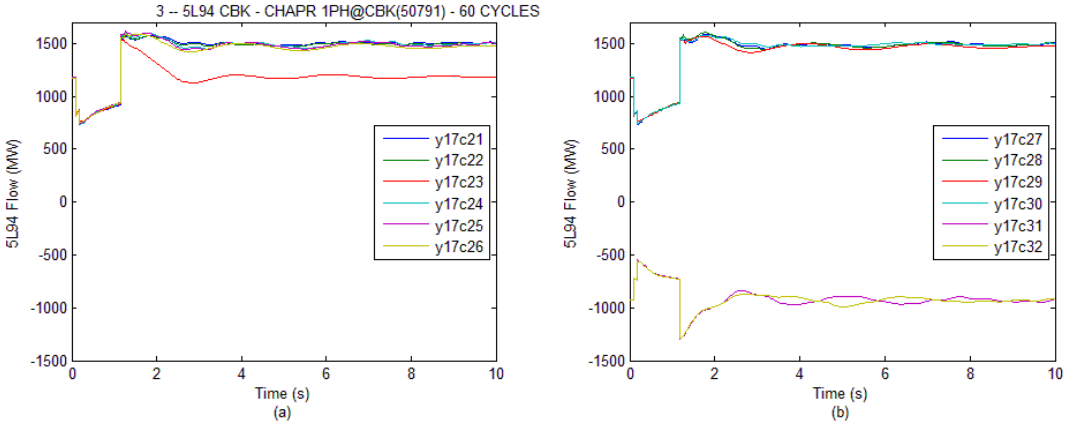




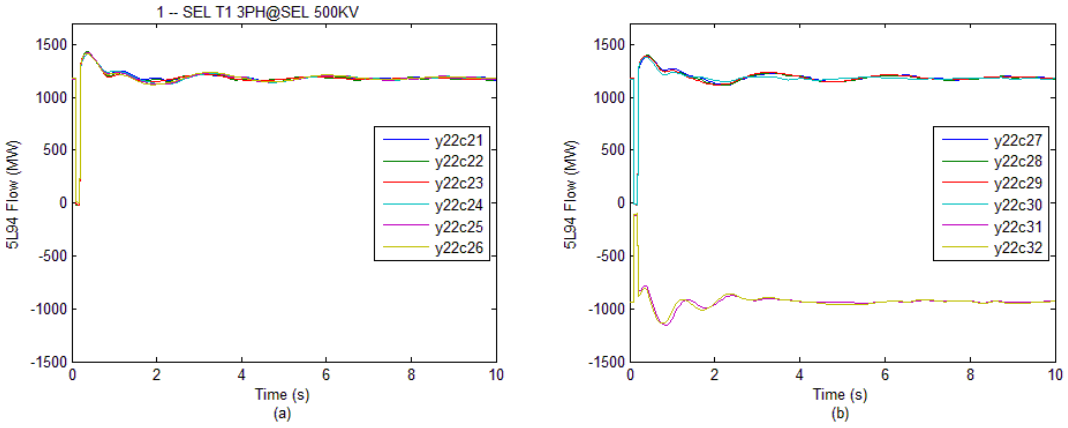
F.6 Y17 cases with Chapel Rock (SPR Contingency)

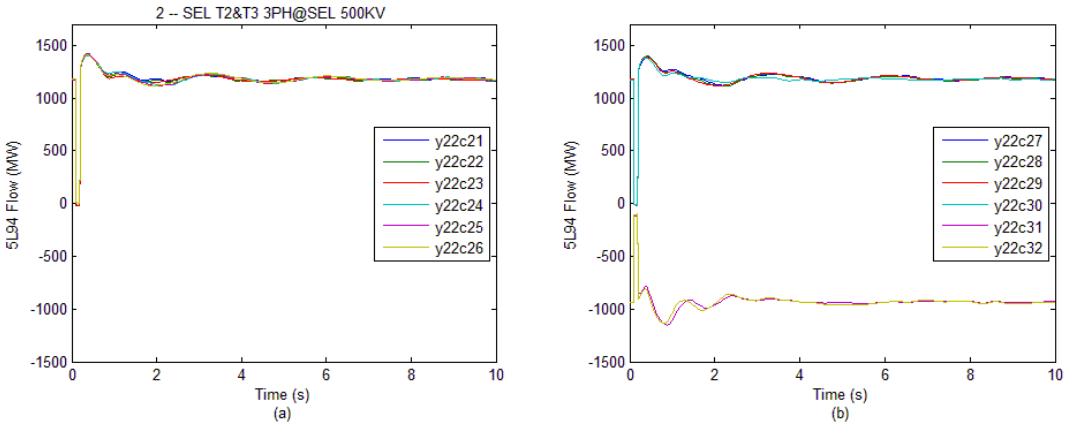


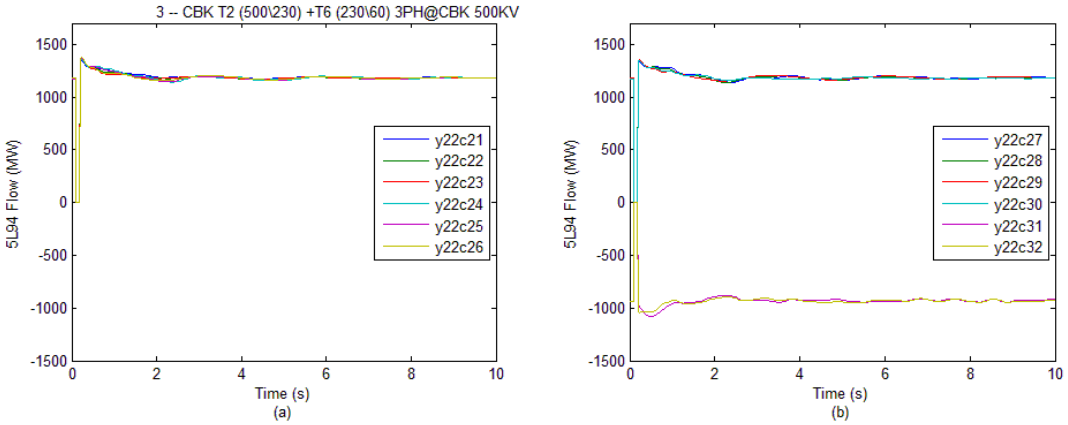


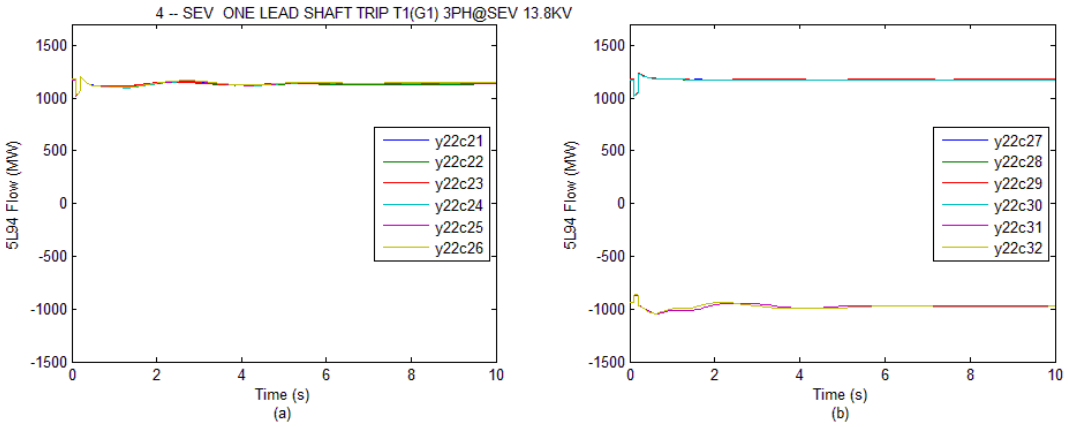


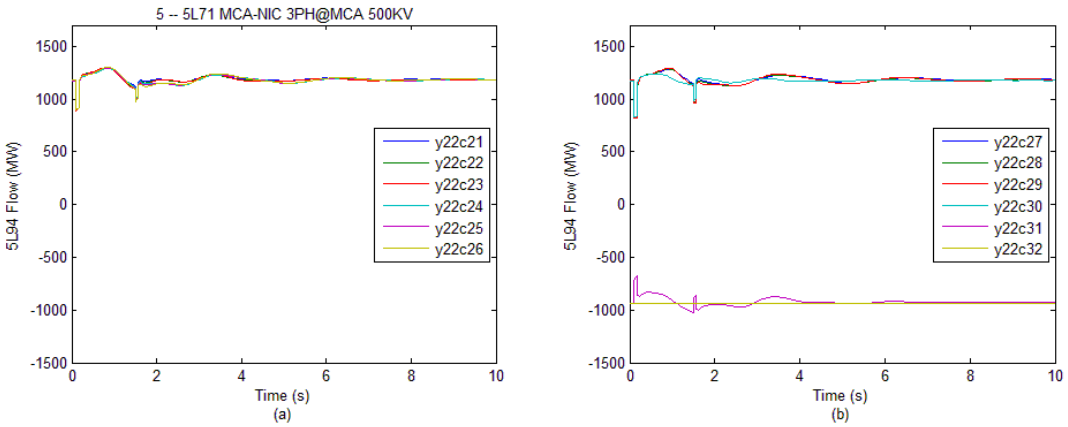
F.7 Y22 cases (N-1 and N-2 Contingency)

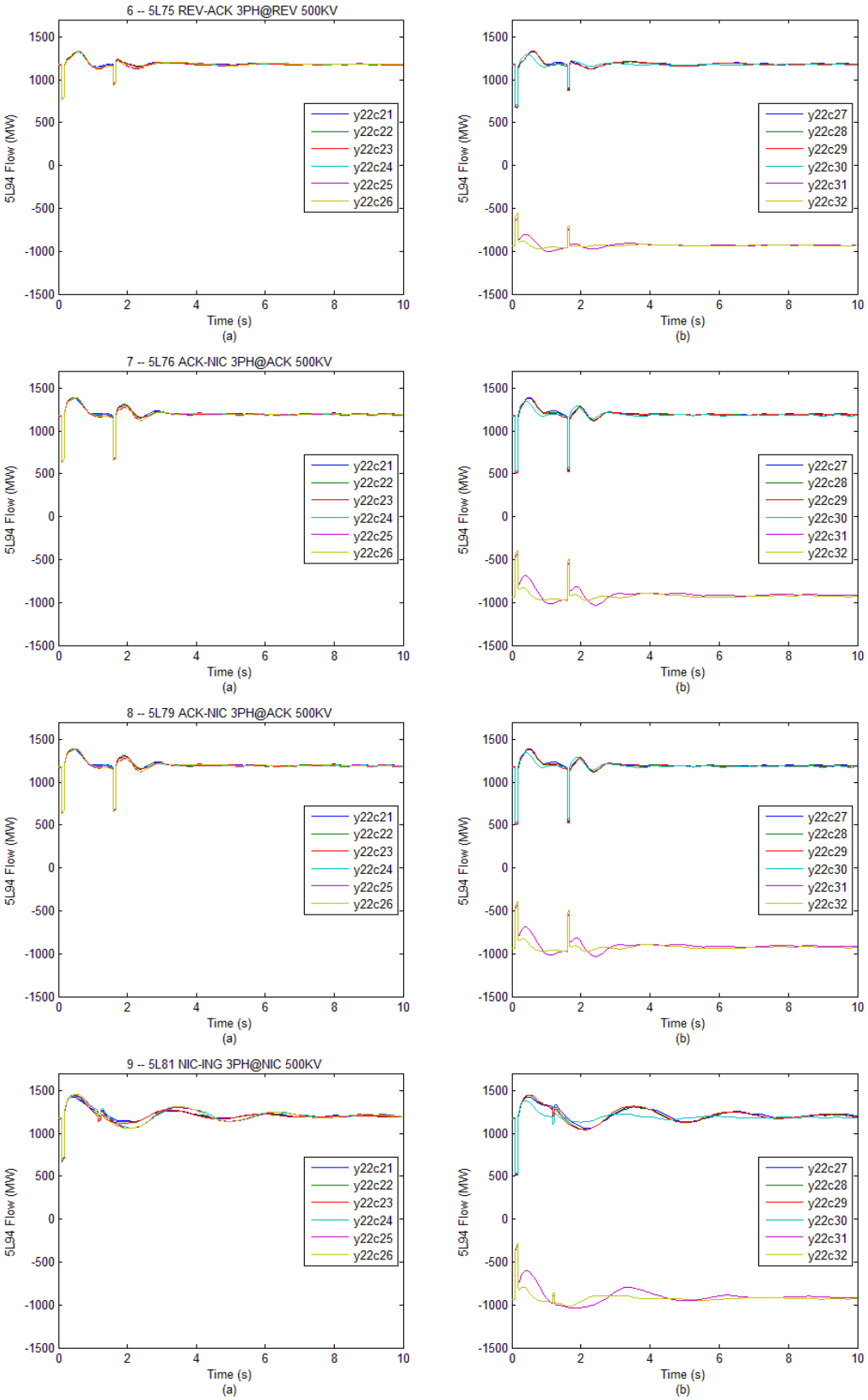


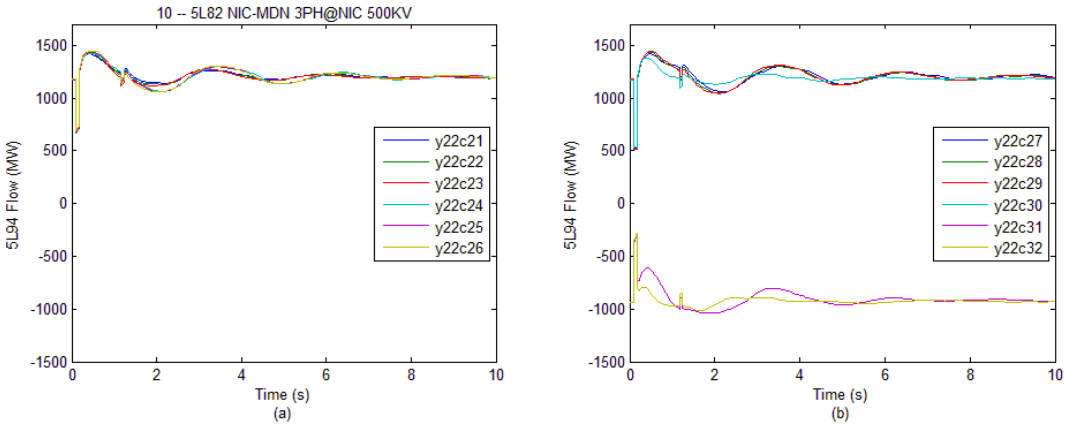


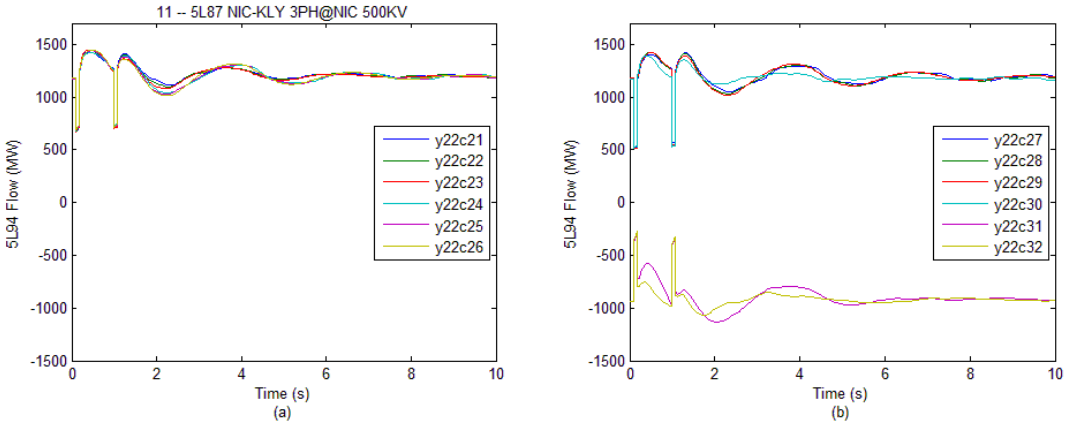


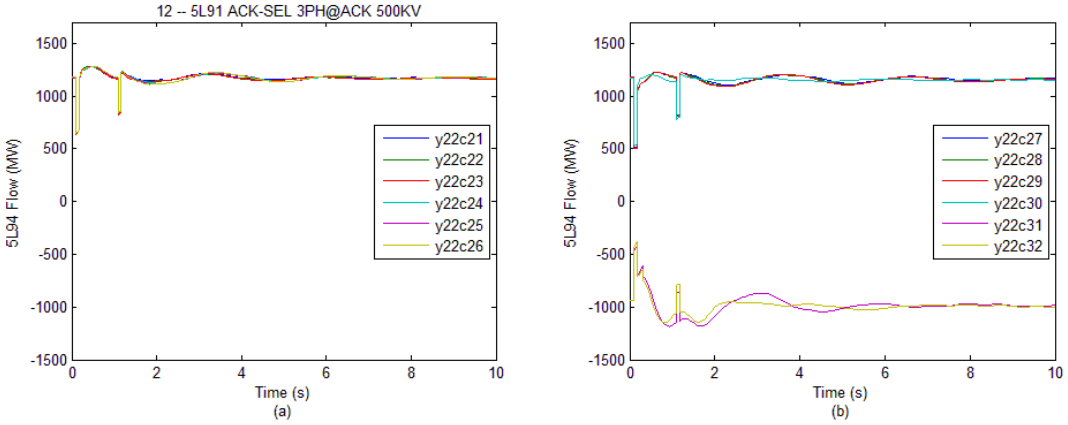


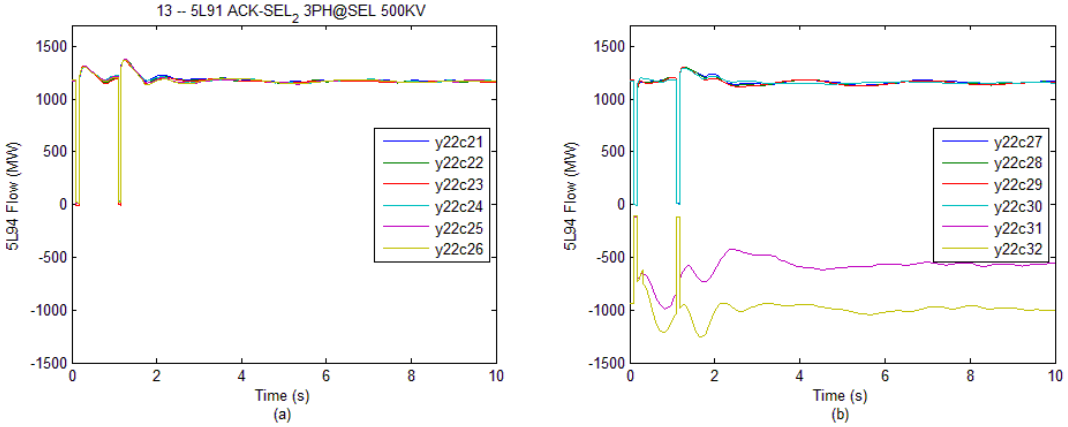


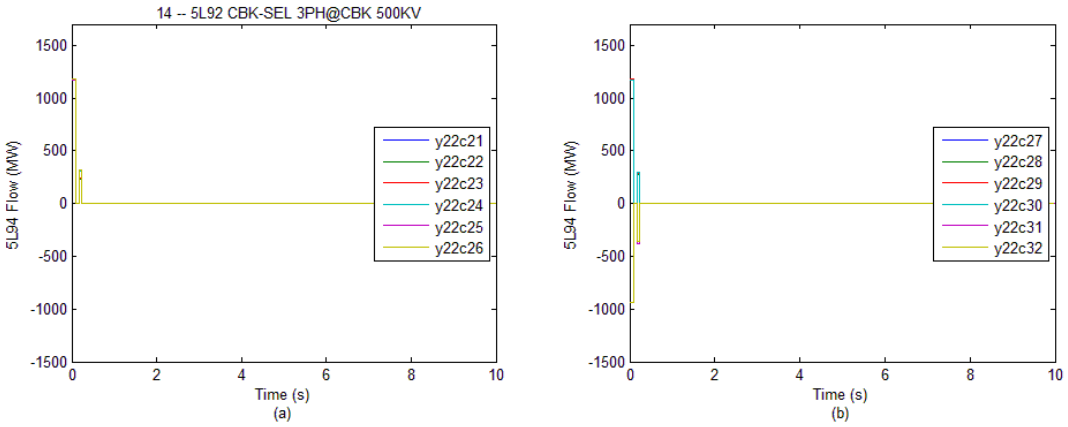


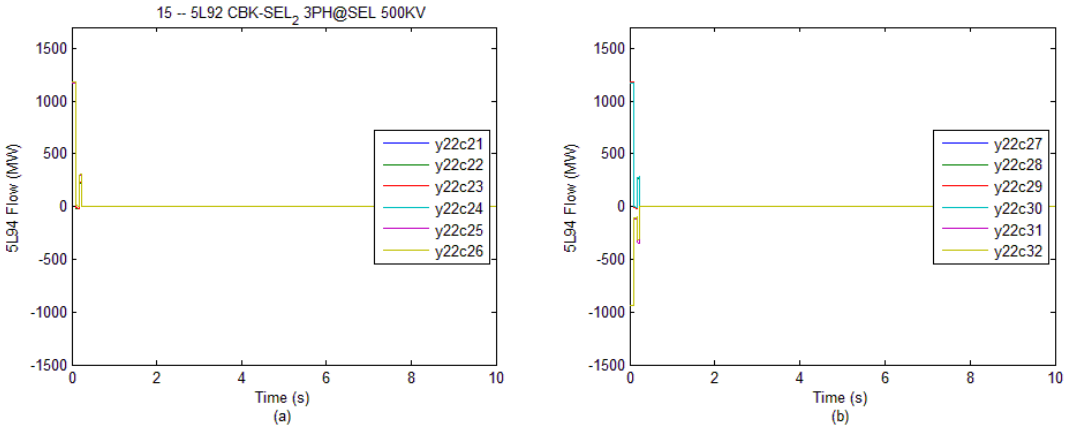


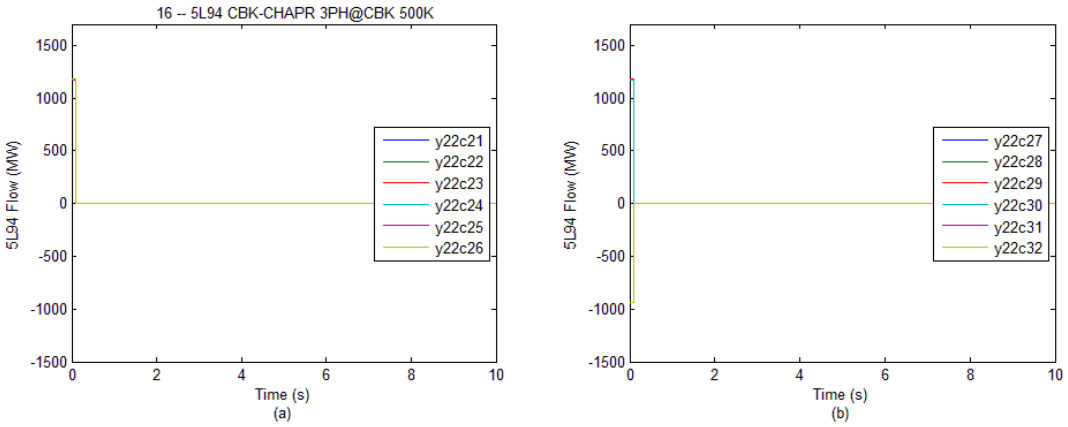


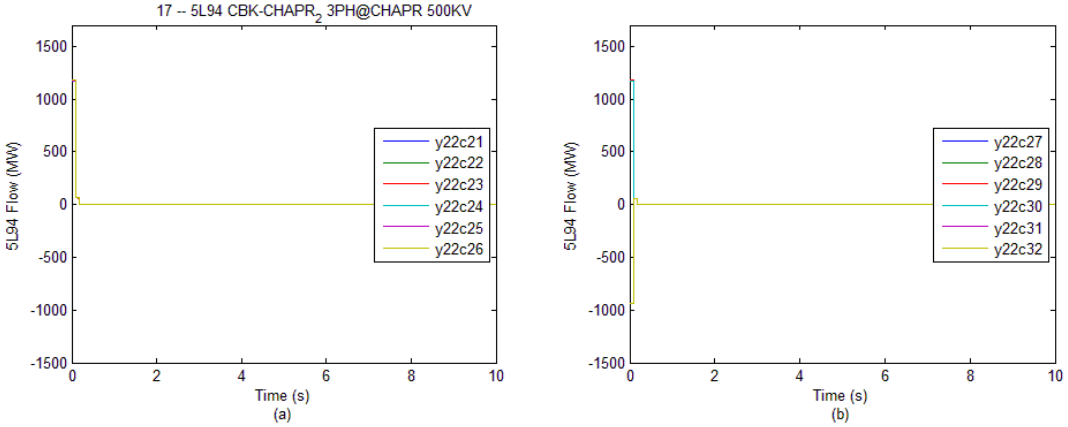


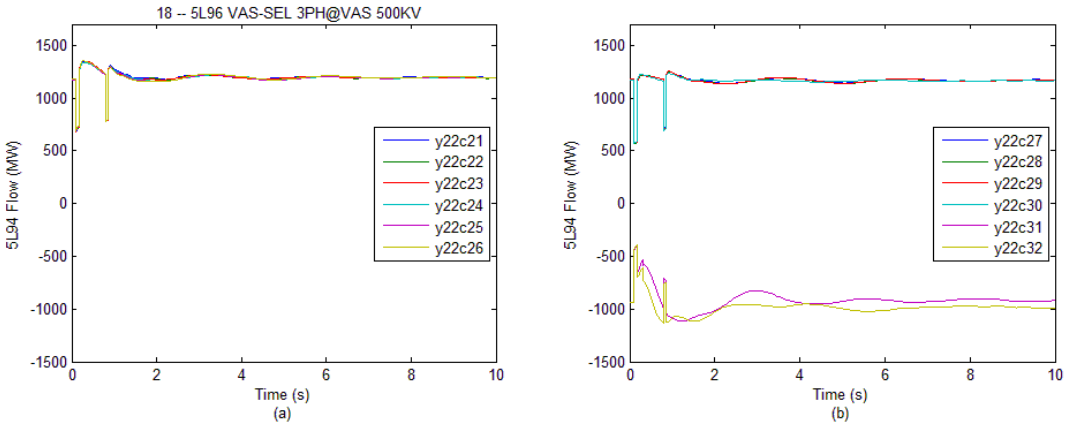


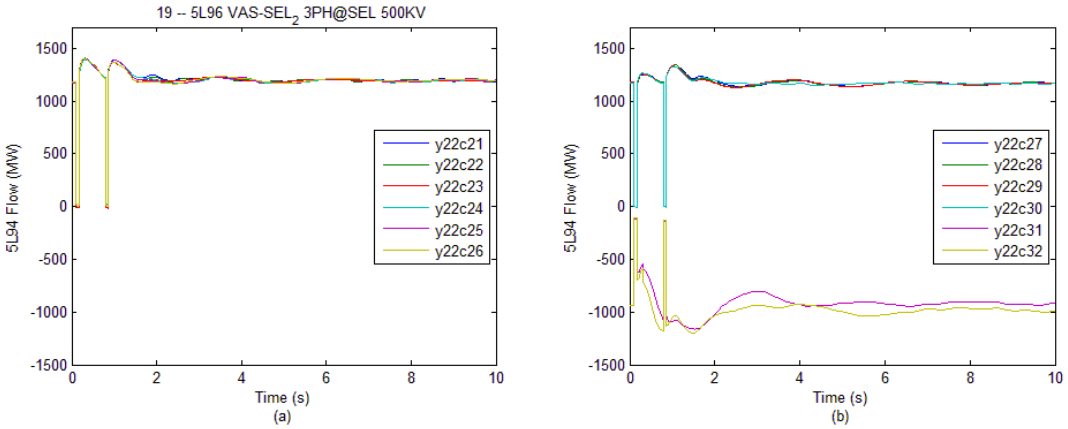


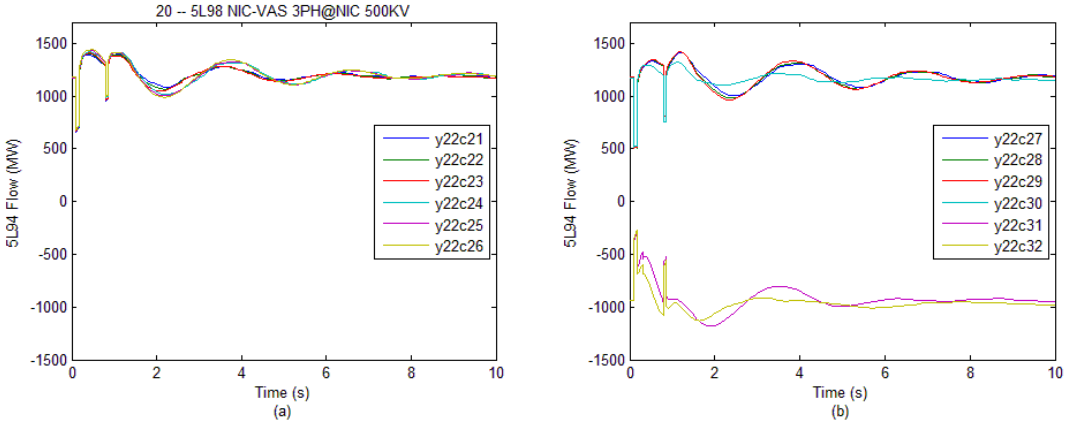


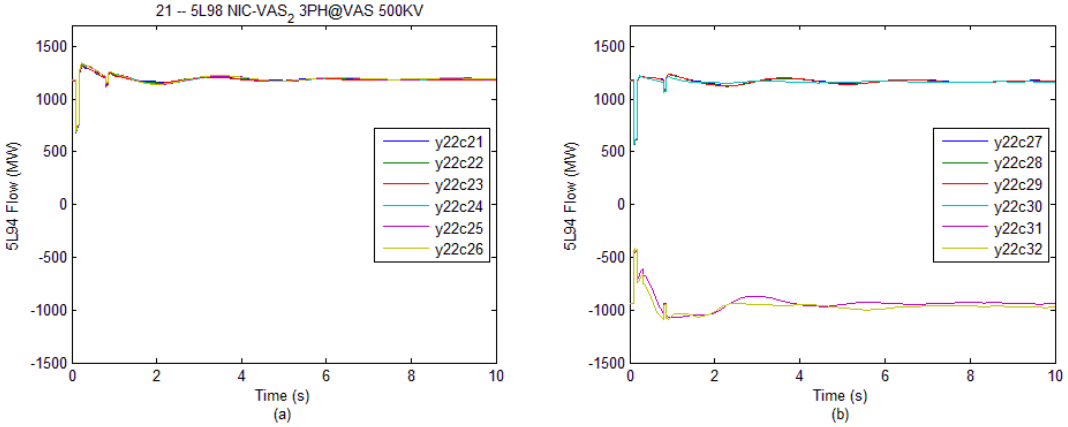


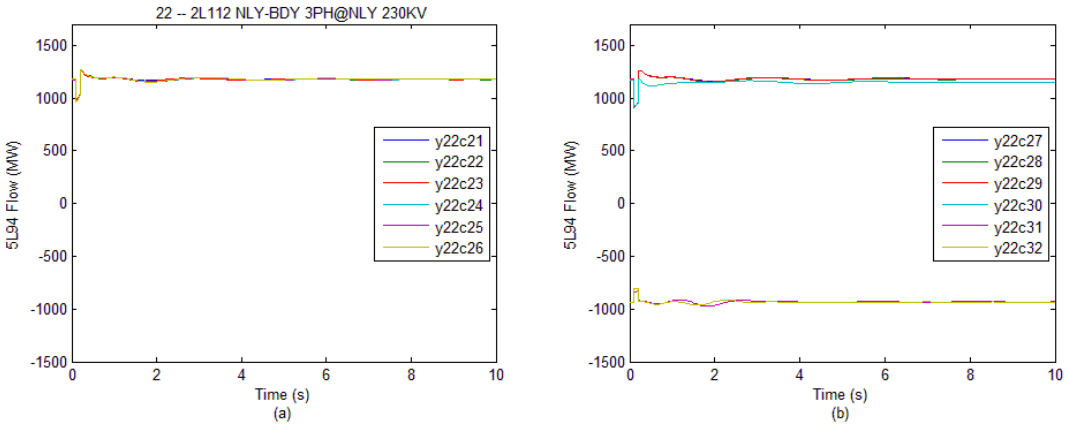


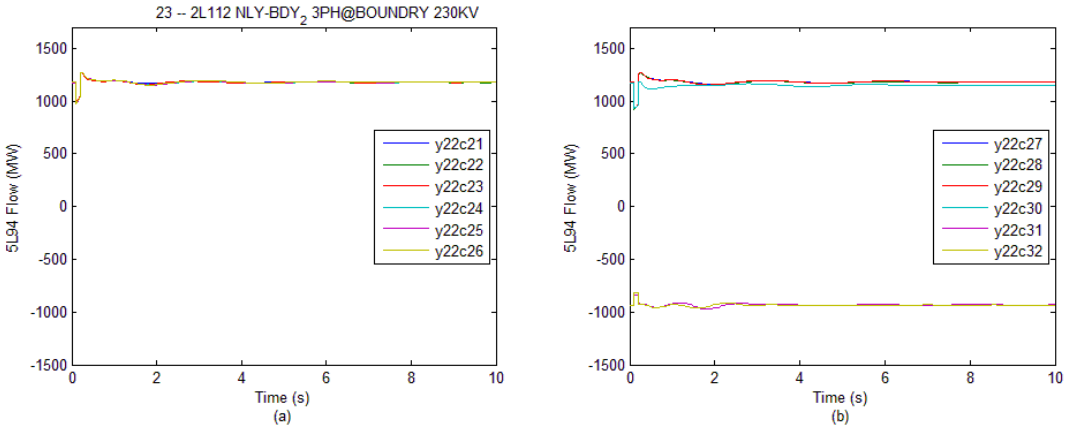


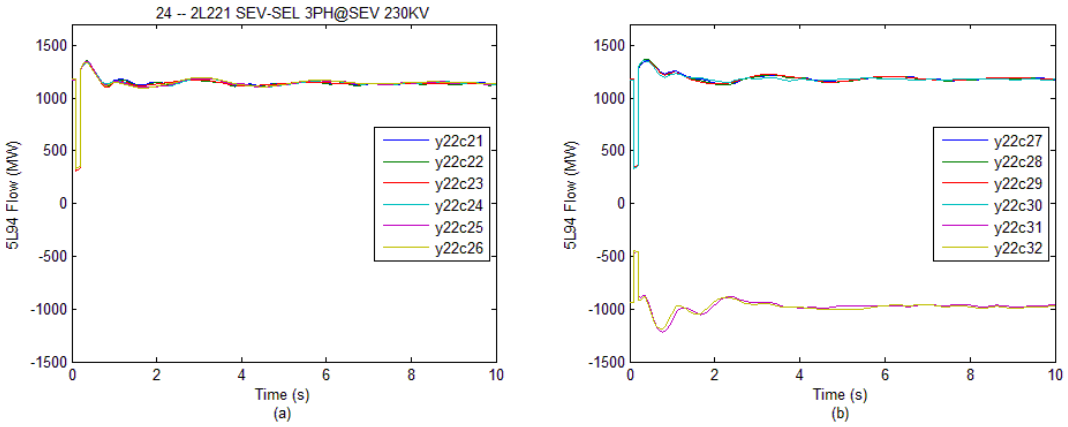


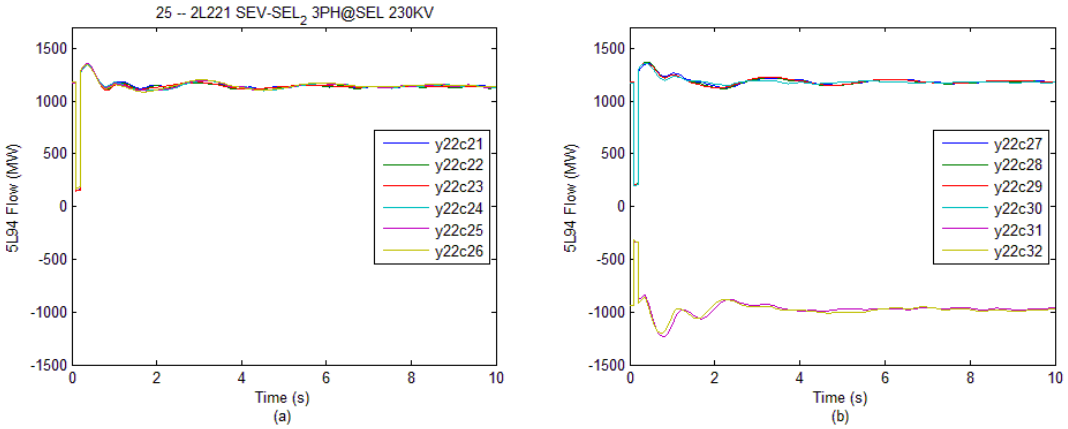


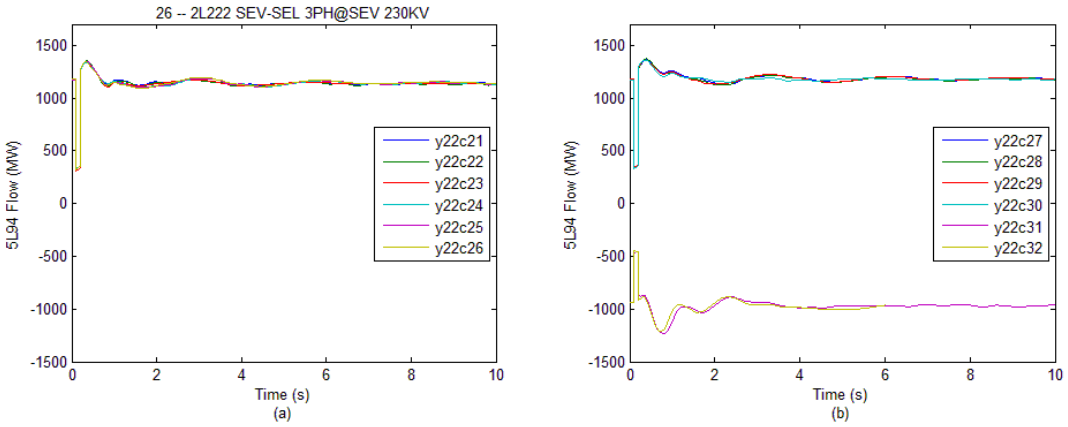


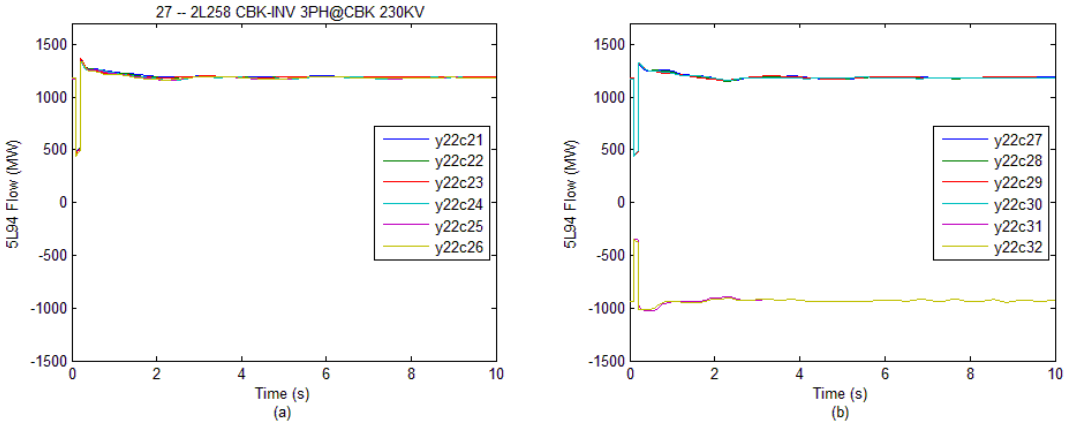


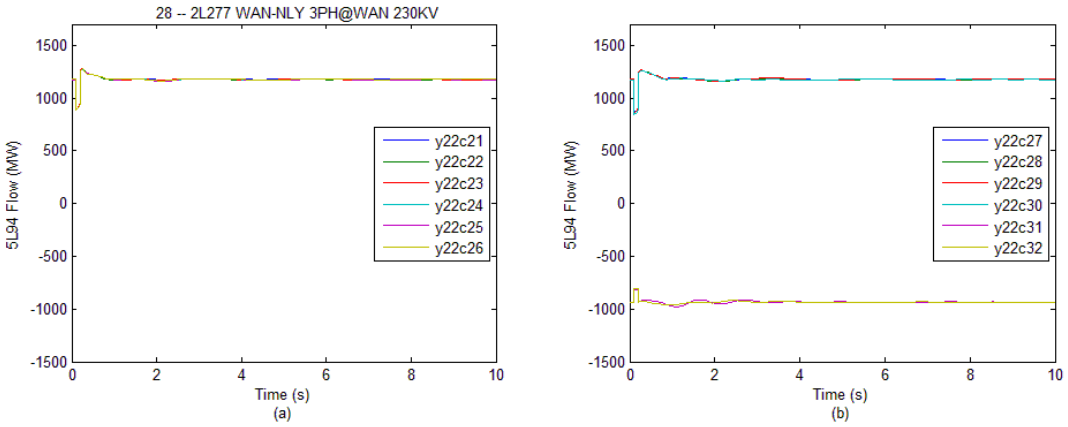


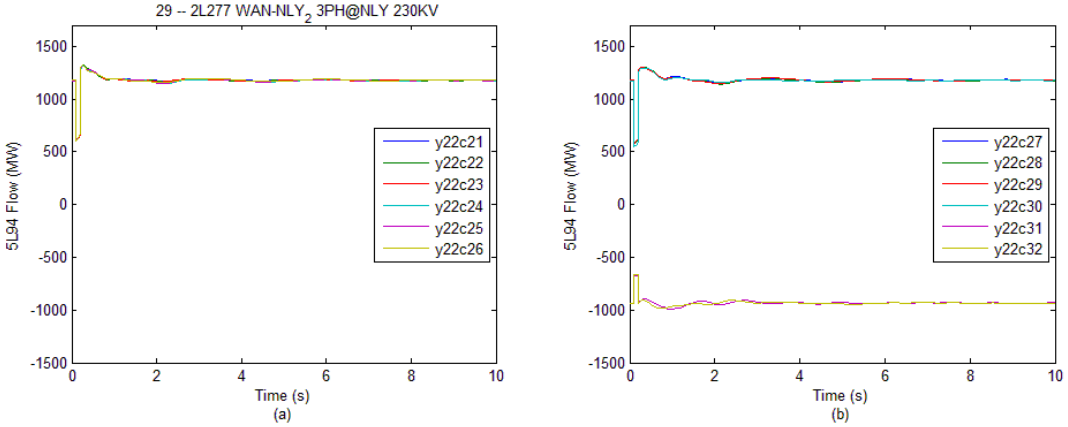


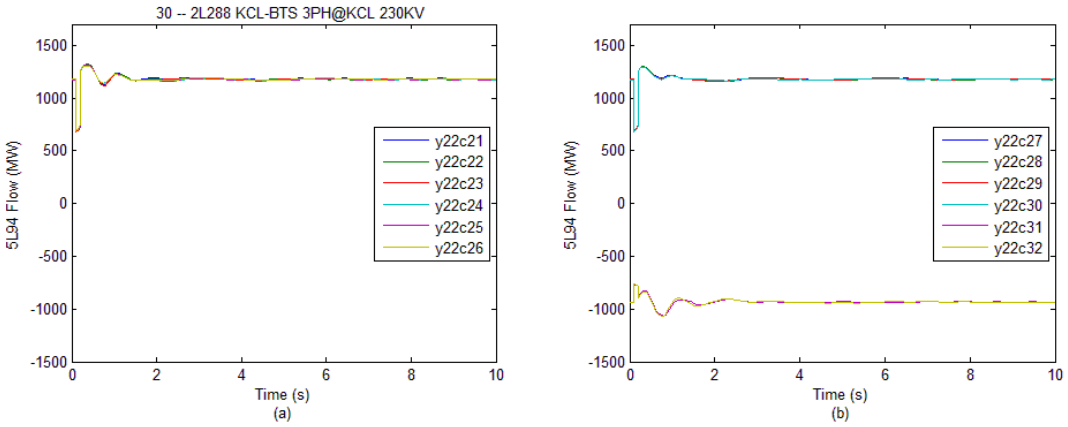


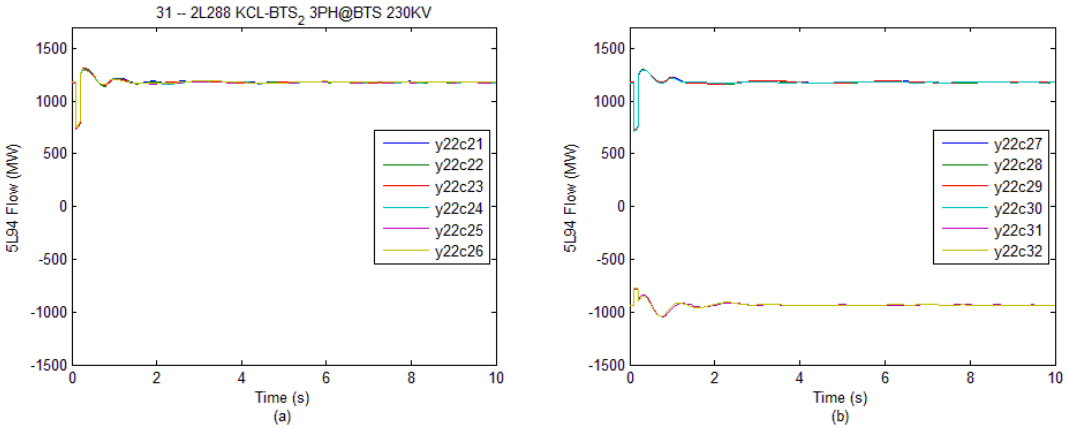


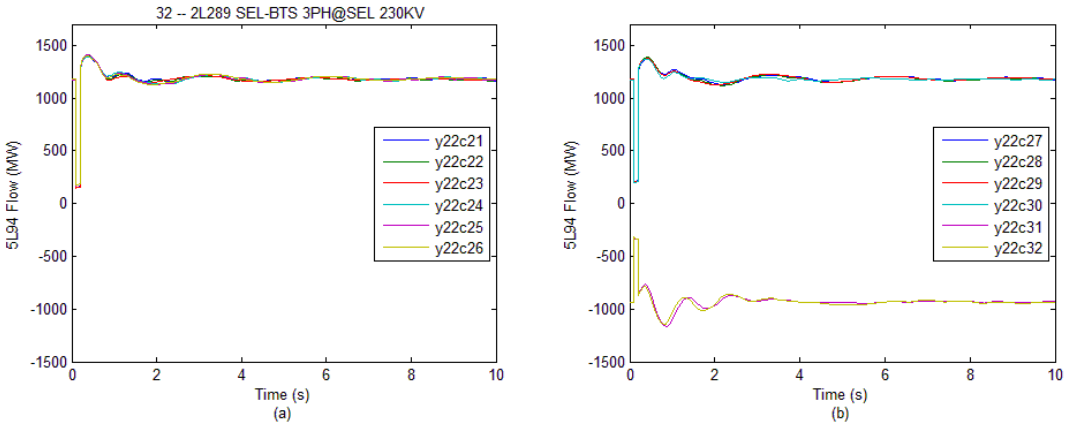


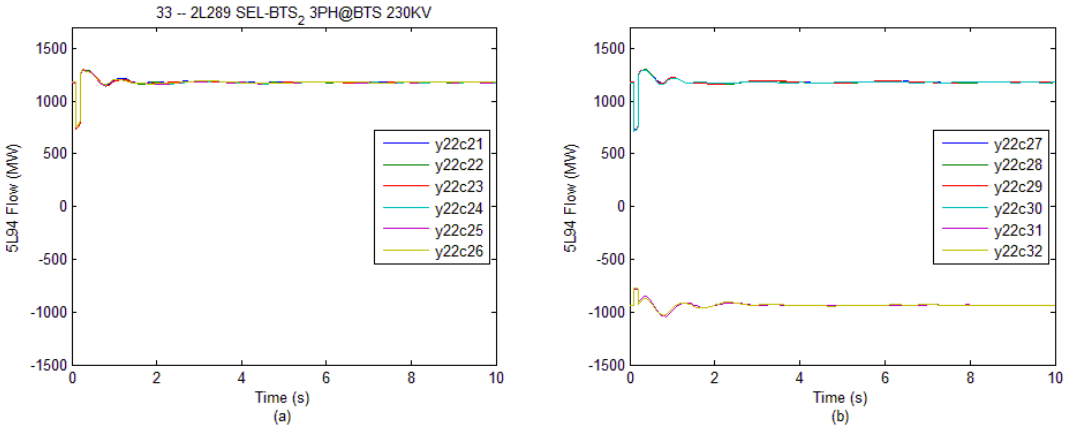


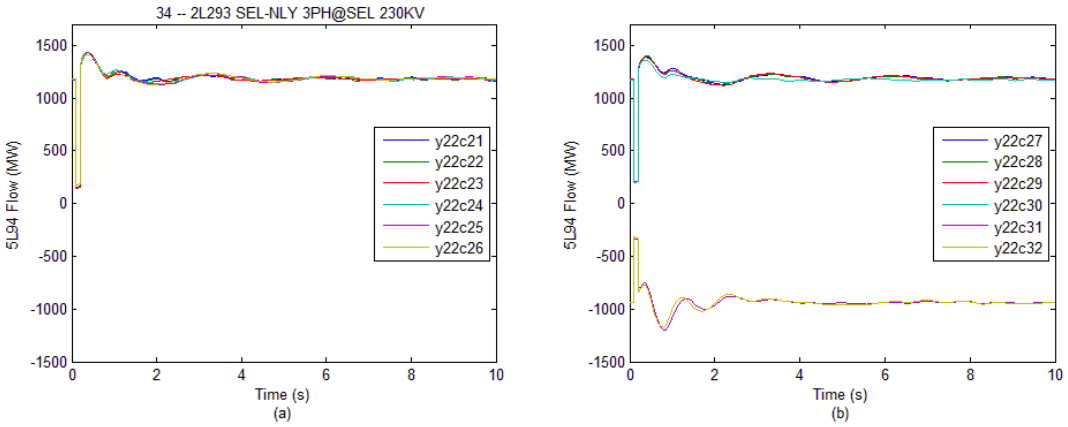


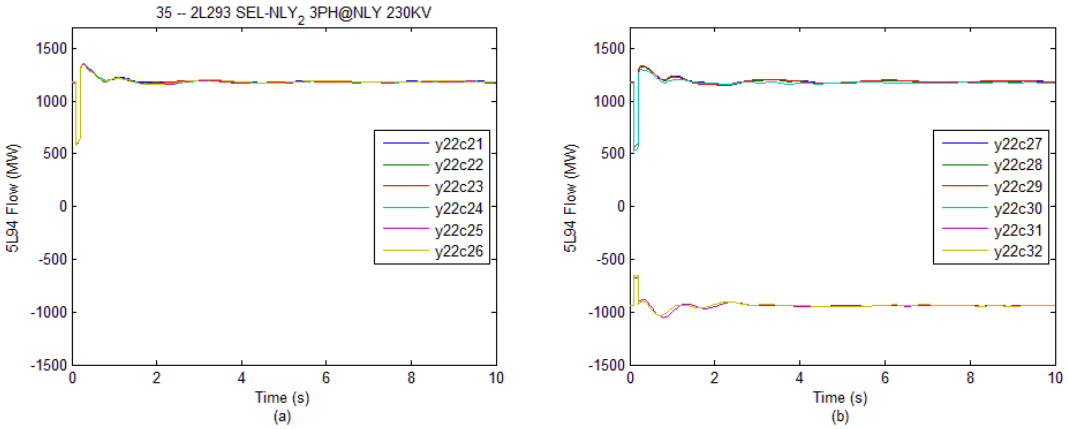


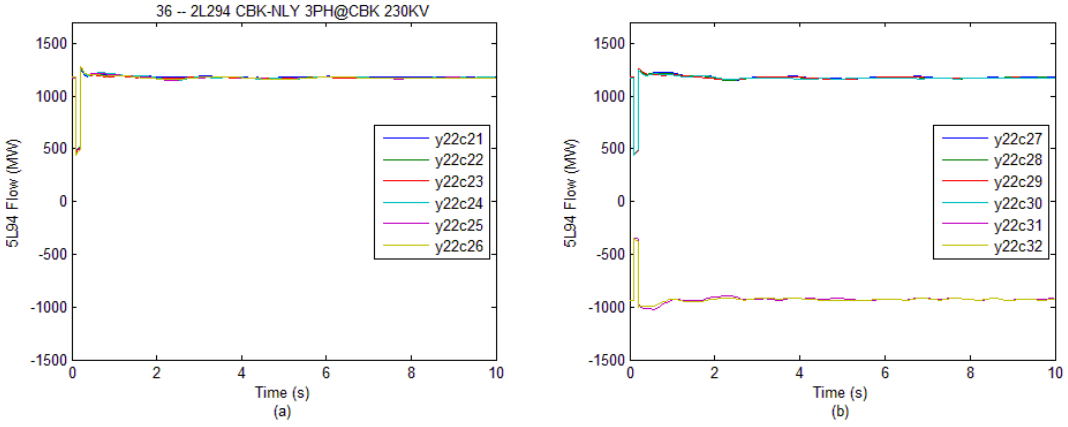


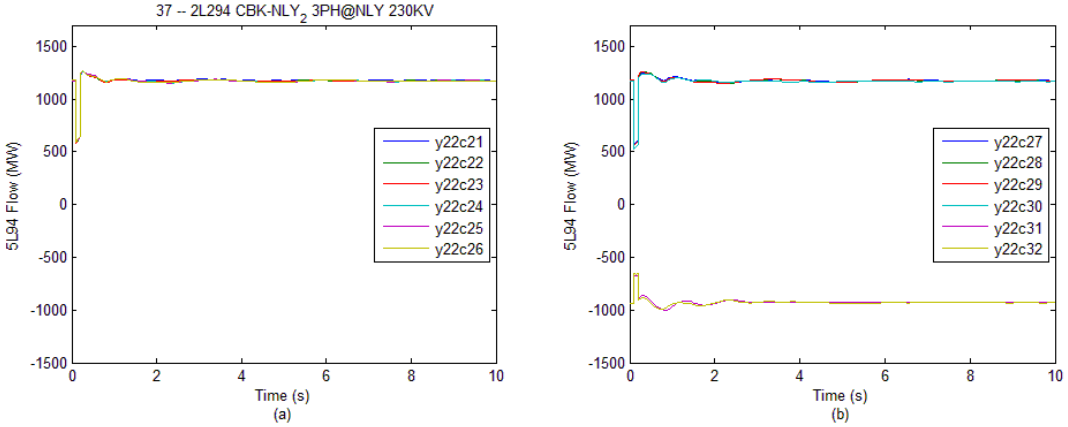


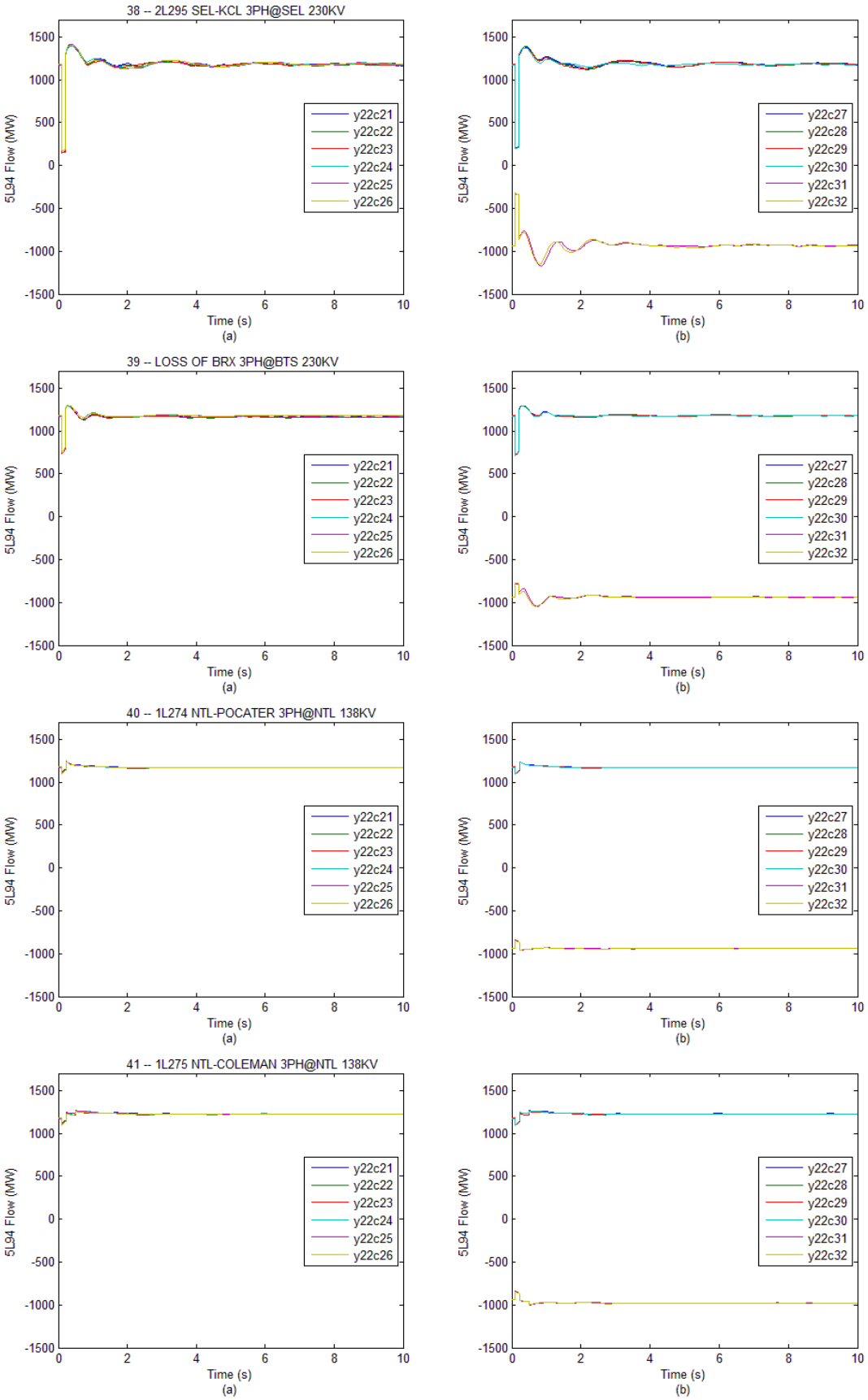


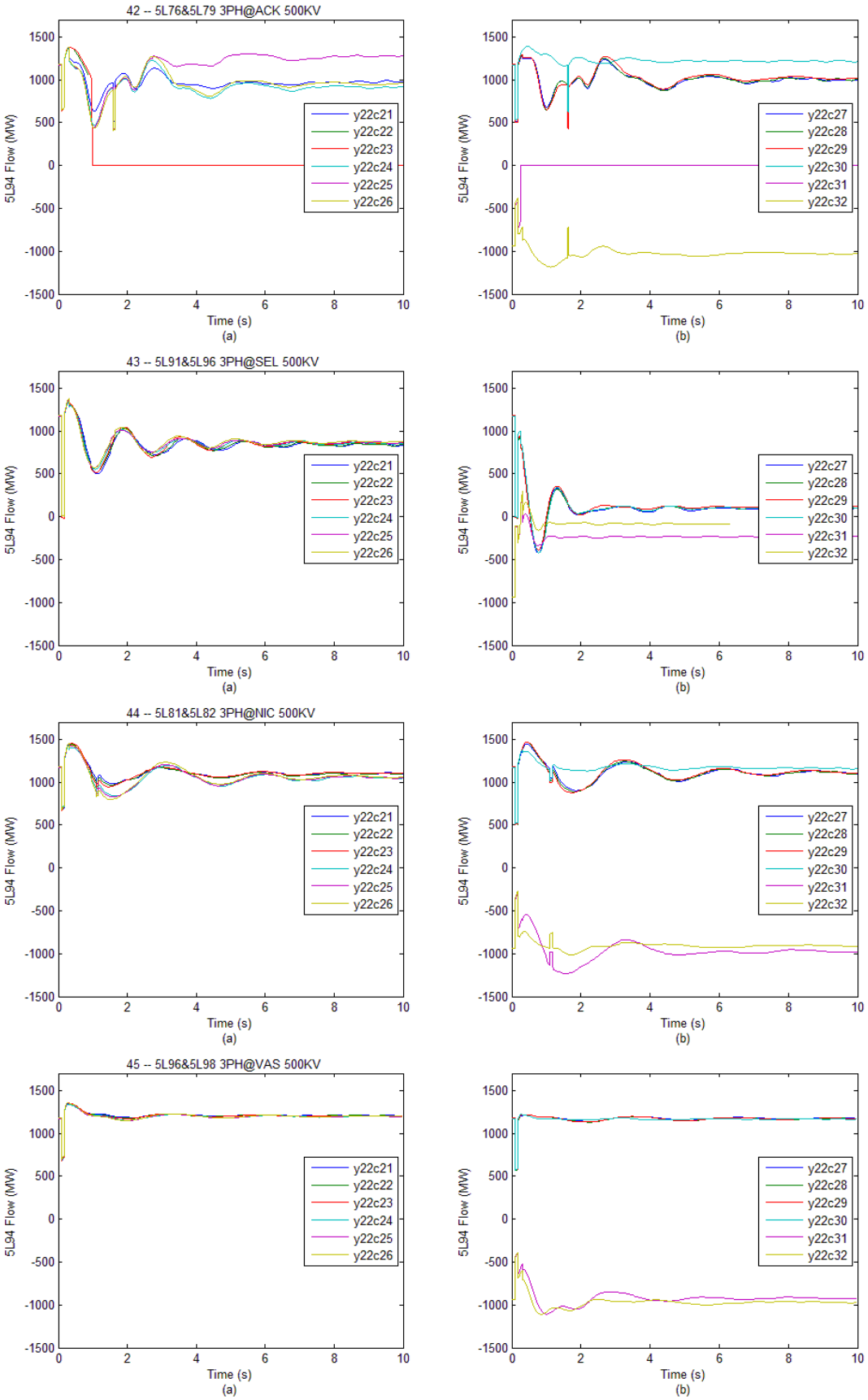


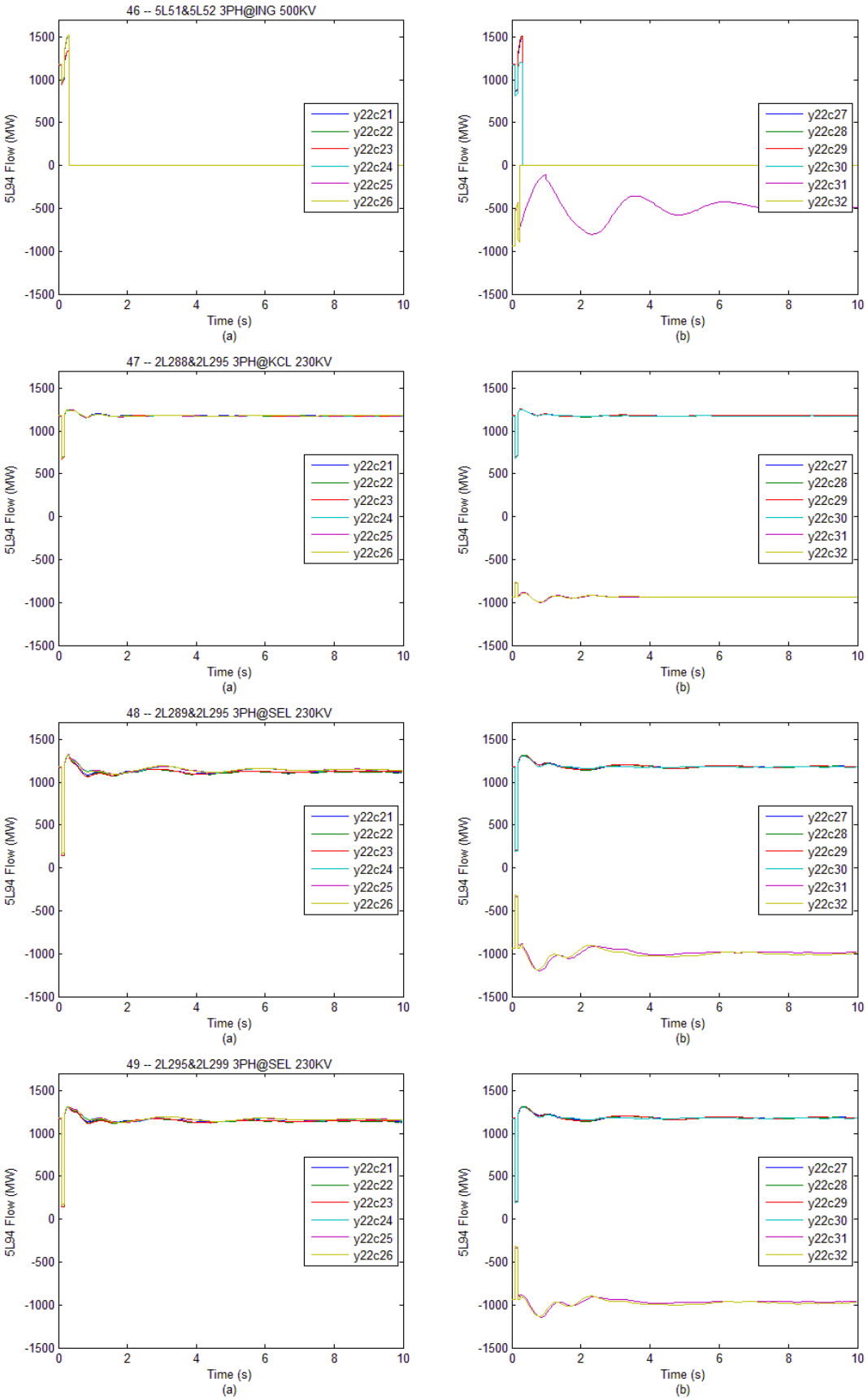




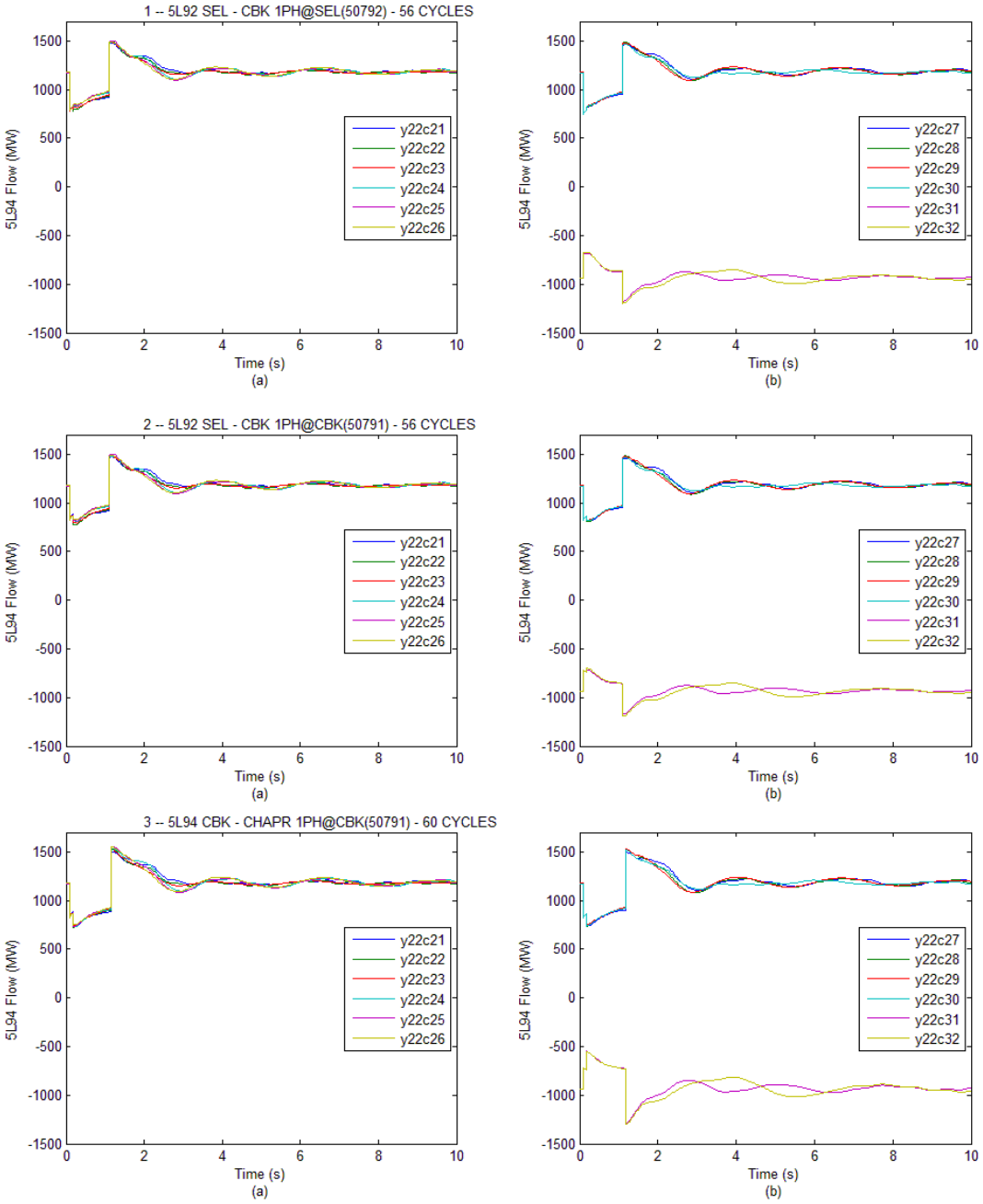








F.8 Y22 cases (SPR Contingency)

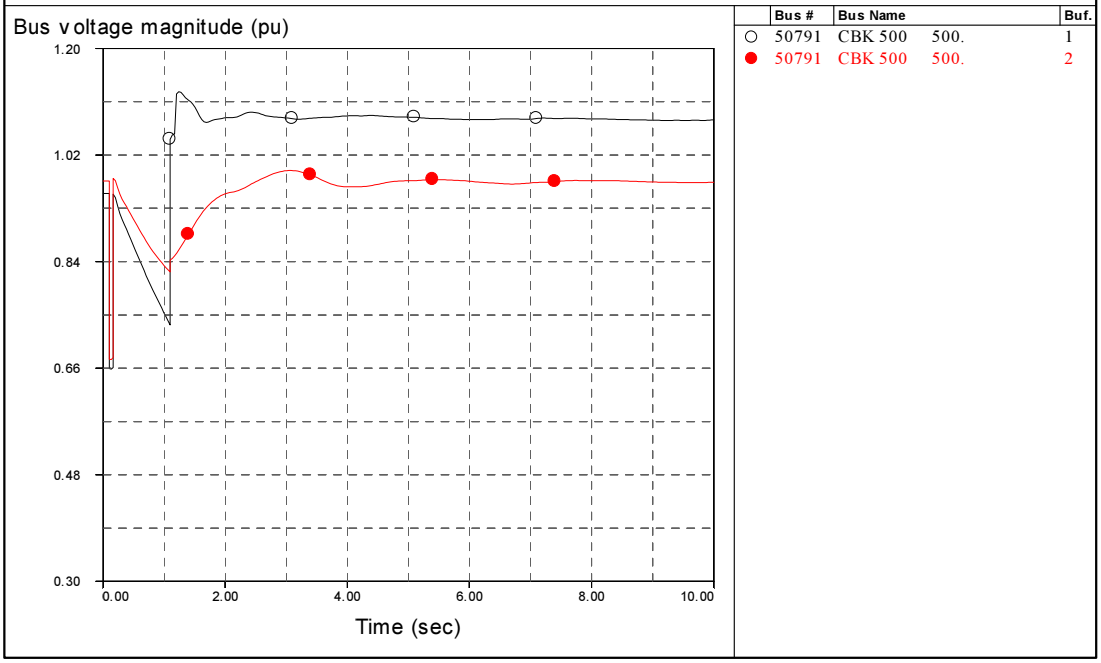


G. TABLES AND PLOTS OF MITIGATING MEASURES AND SENSITIVITY STUDY

G.1 y14c01, Single Pole Reclose with Reduced Transfer (1100 MW)

TSAT Aug 06, 2014 17:02:31

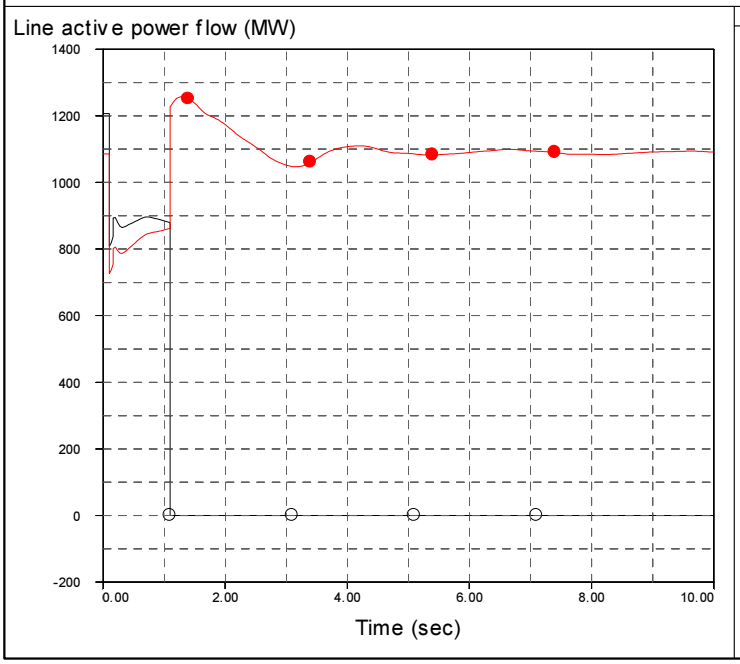
Buf.	Binary Result File	Scenario	Contingency
1	y14c01_spr_P1snvy.bin	Base Scenario	2 -- 5L92 SEL - CBK 1PH@CBK(50791) - 56 CYCLES
2	y14c01_spr_P1snvy.bin	PATH 1 FLOW 1100 MW	2 -- 5L92 SEL - CBK 1PH@CBK(50791) - 56 CYCLES



DSATools Output Analysis 11.0
Powertech Labs Inc.

TSAT Aug 06, 2014 17:02:31

Buf.	Binary Result File	Scenario	Contingency
1	y14c01_spr_P1snvy.bin	Base Scenario	2 -- 5L92 SEL - CBK 1PH@CBK(50791) - 56 CYCLES
2	y14c01_spr_P1snvy.bin	PATH 1 FLOW 1100 MW	2 -- 5L92 SEL - CBK 1PH@CBK(50791) - 56 CYCLES



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

DSATools OutputAnalysis 11.0
Powertech Labs Inc.

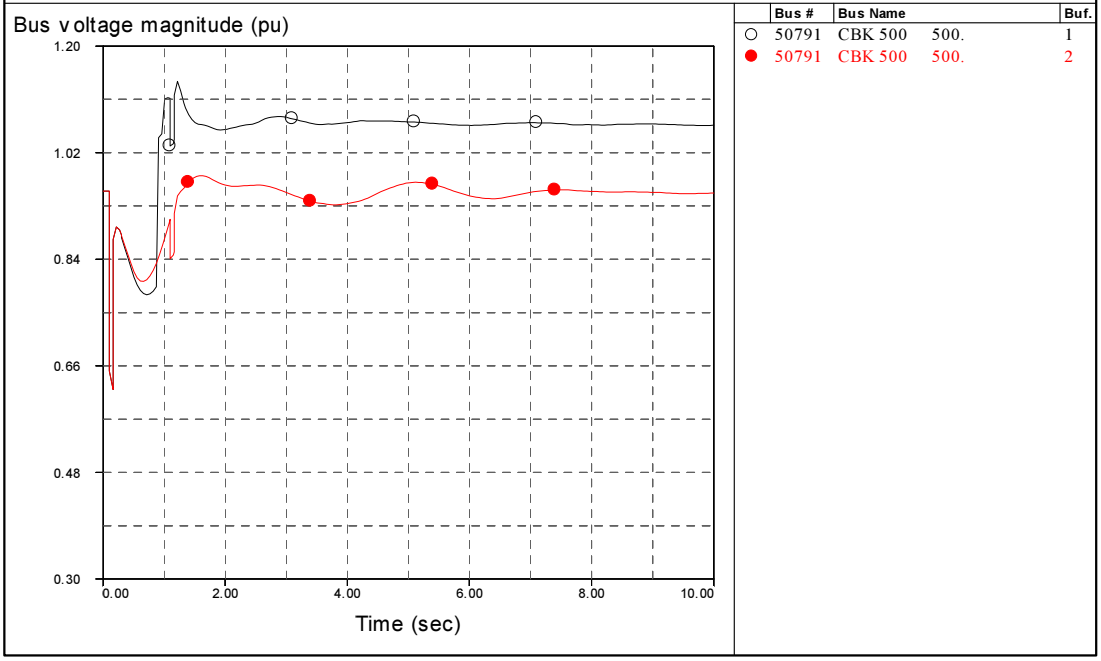
G.2 y14c01, Contingency 5L81&5L82 with Revised Gen Shedding

Original Gen Shedding: ALH G1 (52144, 1) and ALH G2 (52145, 2), total of 133 MW

Revised Gen Shedding: REV G1 (50644, 1), total of 490 MW

TSAT Aug 07, 2014 13:24:35

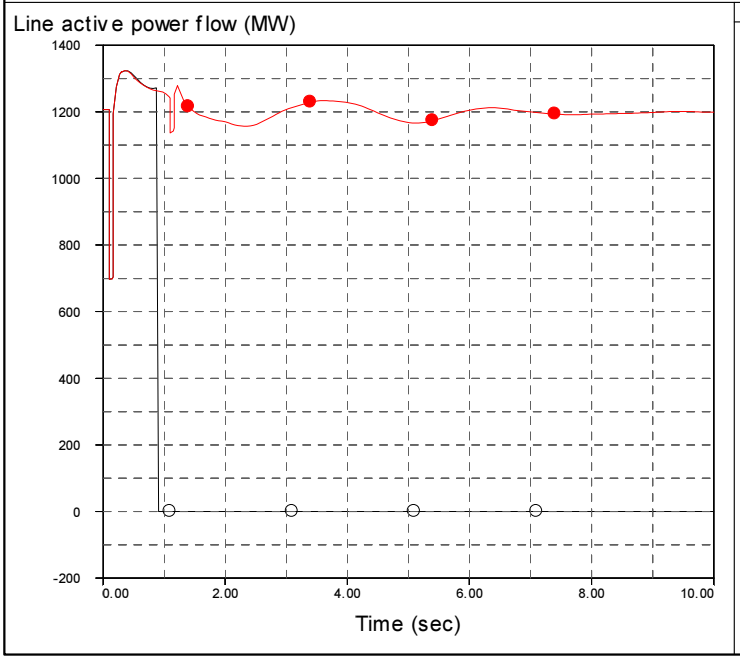
Buf.	Binary Result File	Scenario	Contingency
1	y14c01.bin	Base Scenario	1 -- 5L815L82 3PH@NIC 500KV
2	y14c01.bin	Base Scenario	2 -- 5L815L82 3PH@NIC 500KV - GS2



DSATools OutputAnalysis 11.0
Powertech Labs Inc.

TSAT Aug 07, 2014 13:24:35

Buf.	Binary Result File	Scenario	Contingency
1	y14c01.bin	Base Scenario	1 -- 5L815L82 3PH@NIC 500KV
2	y14c01.bin	Base Scenario	2 -- 5L815L82 3PH@NIC 500KV - GS2



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

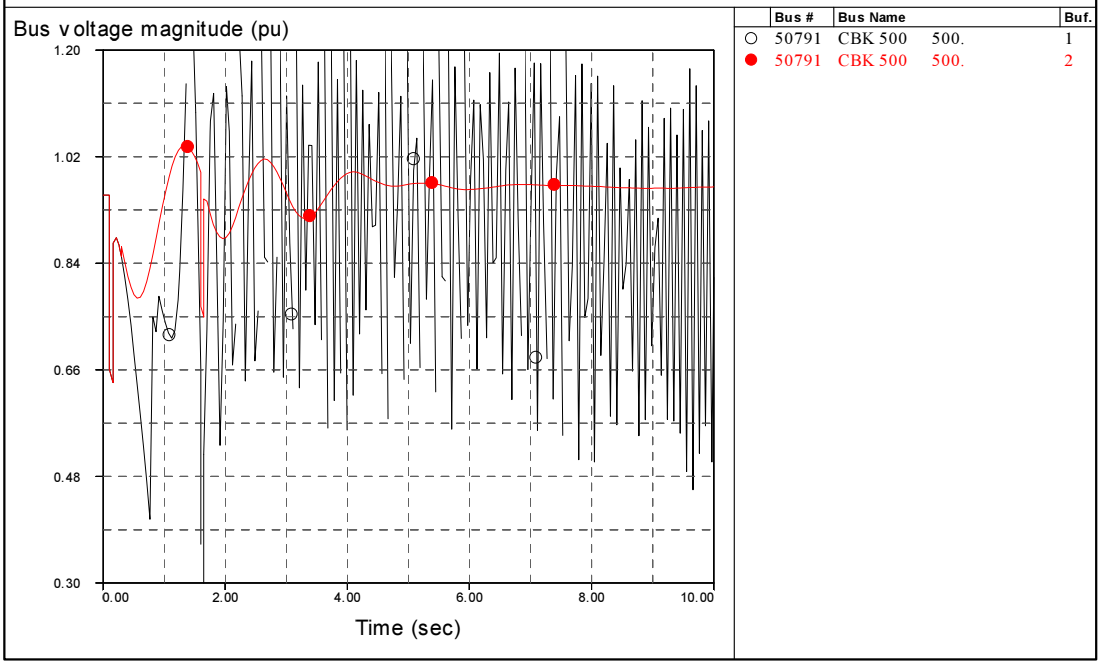
DSATools OutputAnalysis 11.0
Powertech Labs Inc.

G.3 y14c01, Contingency 5L76&5L79 with Gen Shedding

REV G1 (50644, 1), REV G2 (50645, 2), and KCL G1(50769, 1) total of 1100 MW is shed. The amount of original Gen. Shedding was 0 MW.

TSAT Aug 07, 2014 16:53:42

Buf.	Binary Result File	Scenario	Contingency
1	y14c01.bin	Base Scenario	1 -- 5L765L79 3PH@ACK 500KV
2	y14c01.bin	Base Scenario	3 -- 5L765L79 3PH@ACK 500KV - GS2

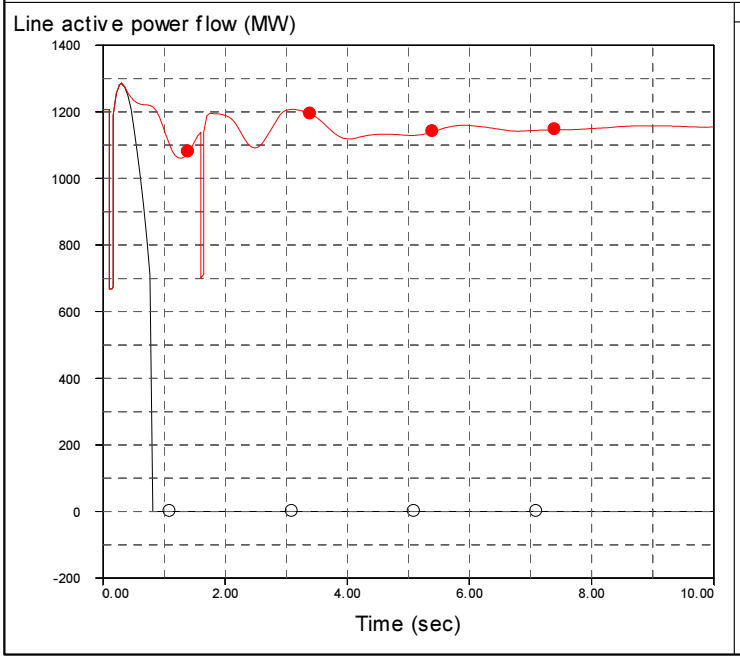


	Bus #	Bus Name		Buf.
○	50791	CBK 500	500.	1
●	50791	CBK 500	500.	2

DSATools OutputAnalysis 11.0
Powertech Labs Inc.

TSAT Aug 07, 2014 16:53:42

Buf.	Binary Result File	Scenario	Contingency
1	y14c01.bin	Base Scenario	1 -- 5L765L79 3PH@ACK 500KV
2	y14c01.bin	Base Scenario	3 -- 5L765L79 3PH@ACK 500KV - GS2



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

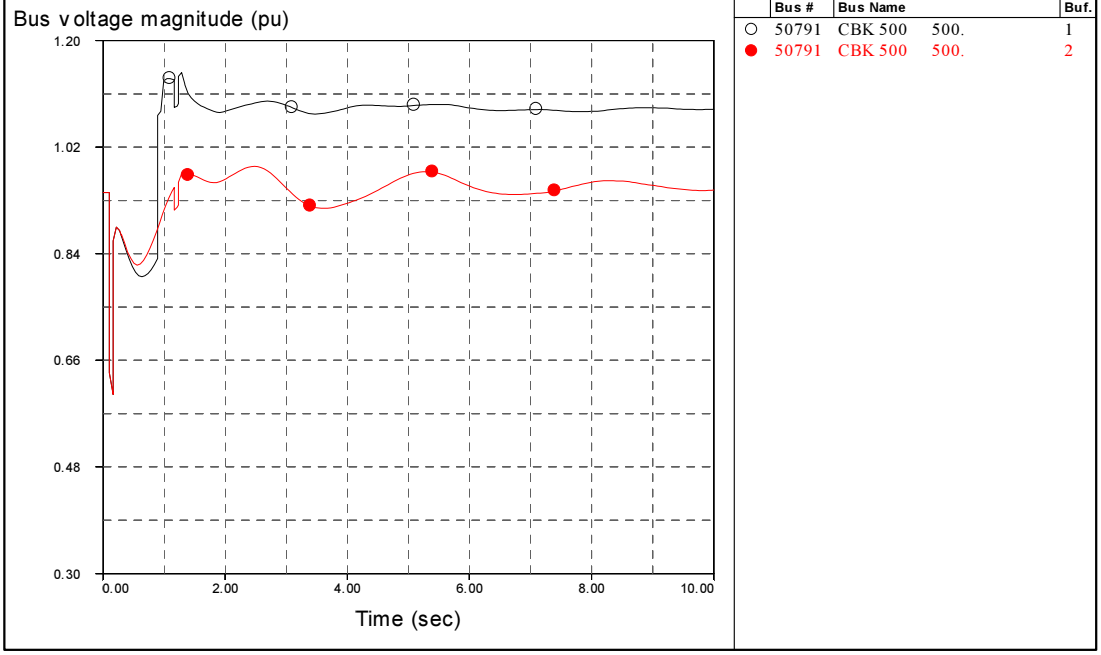
DSATools OutputAnalysis 11.0
Powertech Labs Inc.

G.4 y14c04, Contingency 5L81 with Gen Shedding

MCA G1 (50637,1) was shed. The amount of original Gen. Shedding was 0 MW.

TSAT Aug 06, 2014 15:34:45

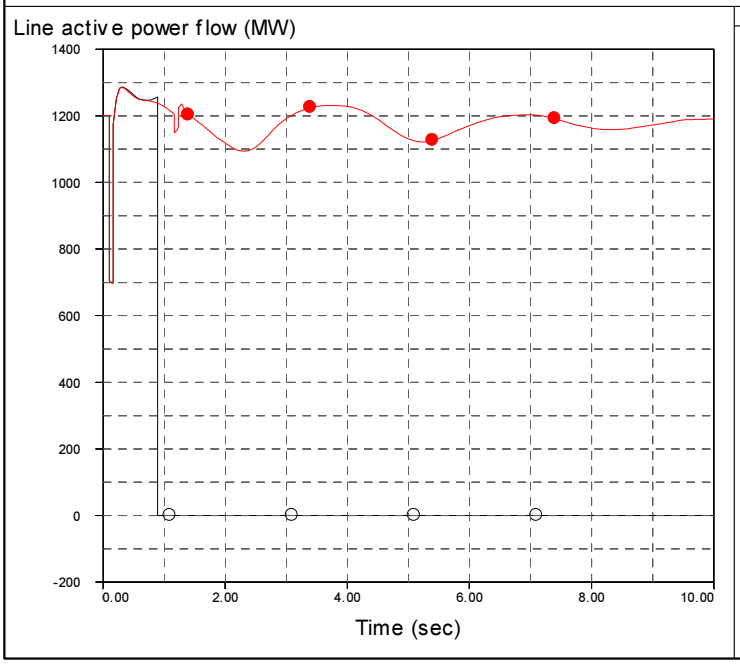
Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	Base Scenario	1 -- 5L81 NIC-ING 3PH@NIC 500KV
2	y14c04.bin	Base Scenario	2 -- 5L81 NIC-ING 3PH@NIC 500KV - GS



DSATools OutputAnalysis 11.0
Powertech Labs Inc.

TSAT Aug 06, 2014 15:34:45

Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	Base Scenario	1 -- 5L81 NIC-ING 3PH@NIC 500KV
2	y14c04.bin	Base Scenario	2 -- 5L81 NIC-ING 3PH@NIC 500KV - GS



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

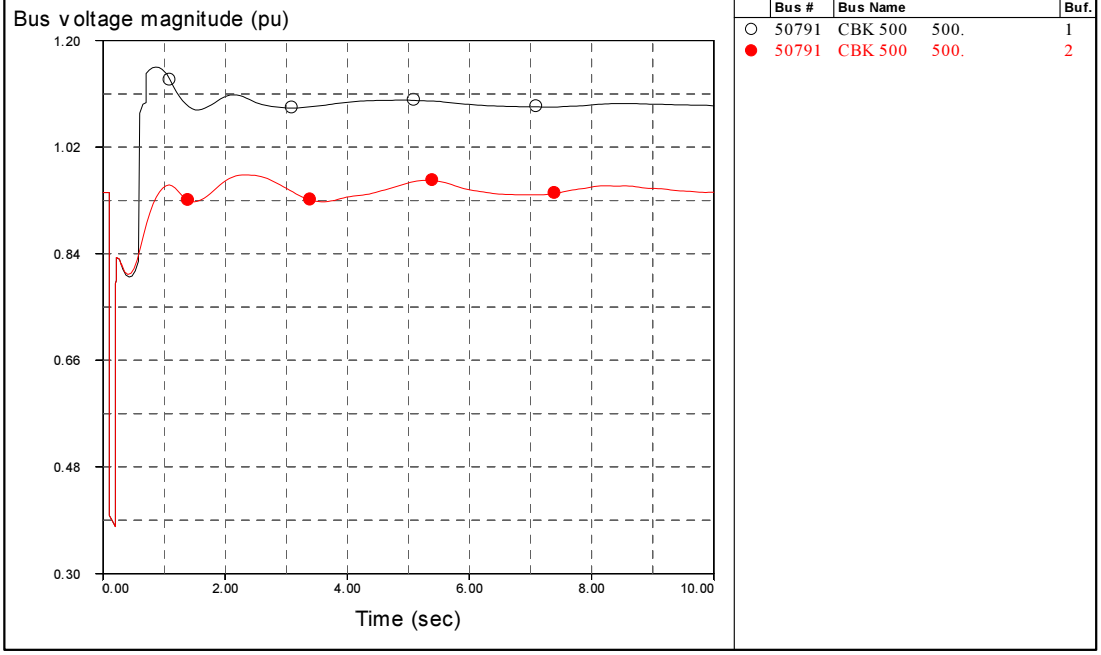
DSATools OutputAnalysis 11.0
Powertech Labs Inc.

G.5 y14c04, Contingency 2L289 with Gen Shedding

SEV G1 (50766, 1) was shed. The amount of original Gen. Shedding was 0 MW.

TSAT Aug 06, 2014 16:12:59

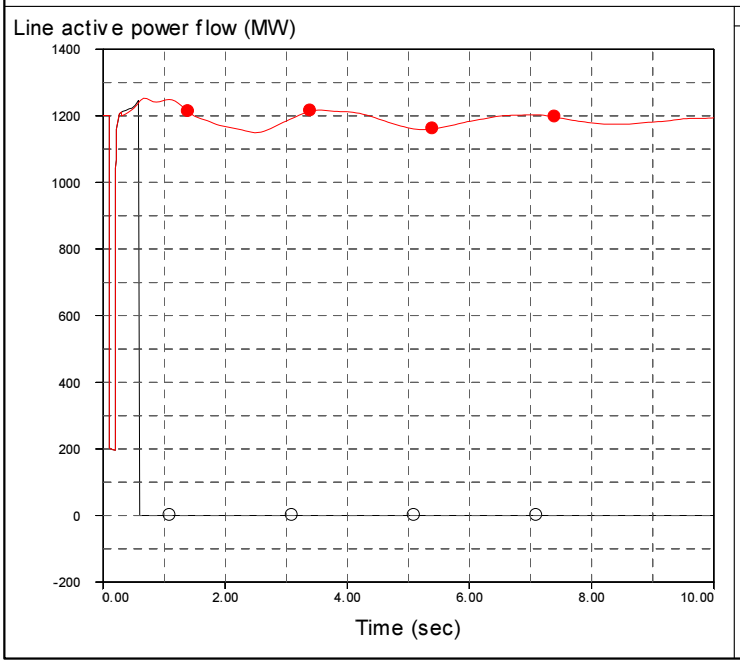
Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	Base Scenario	1 – 2L289 SEL-BTS 3PH@SEL 230KV
2	y14c04.bin	Base Scenario	2 – 2L289 SEL-BTS 3PH@SEL 230KV GS



DSATools OutputAnalysis 11.0
Powertech Labs Inc.

TSAT Aug 06, 2014 16:12:59

Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	Base Scenario	1 – 2L289 SEL-BTS 3PH@SEL 230KV
2	y14c04.bin	Base Scenario	2 – 2L289 SEL-BTS 3PH@SEL 230KV GS



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

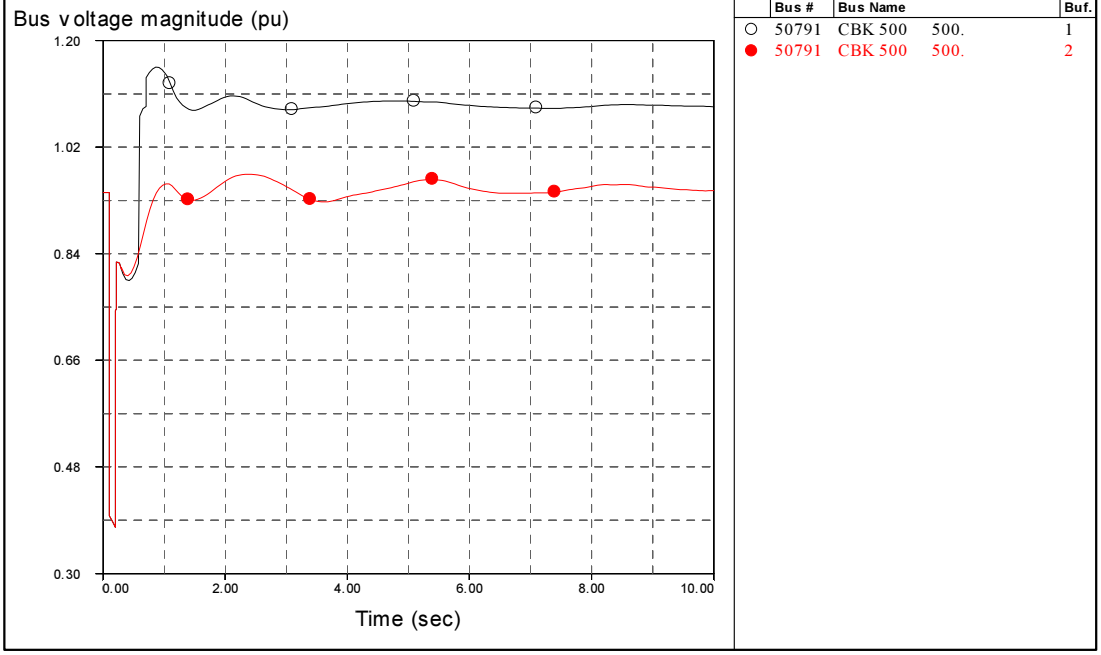
DSATools OutputAnalysis 11.0
Powertech Labs Inc.

G.6 y14c04, Contingency 2L293 with Gen Shedding

KCL G1 (50769, 1) was shed. The amount of original Gen. Shedding was 0 MW.

TSAT Aug 06, 2014 16:19:51

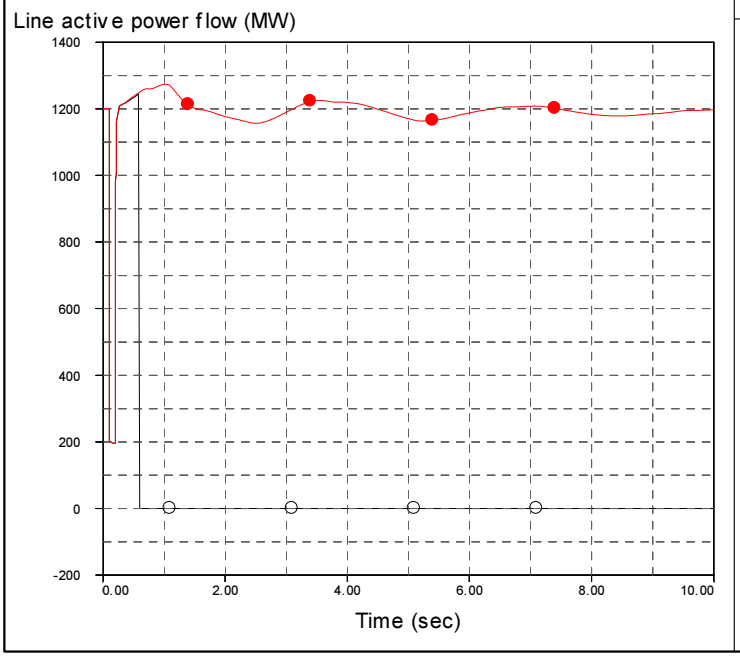
Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	Base Scenario	1 -- 2L293 SEL-NLY 3PH@SEL 230KV
2	y14c04.bin	Base Scenario	2 -- 2L293 SEL-NLY 3PH@SEL 230KV - GS



DSATools OutputAnalysis 11.0
Powertech Labs Inc.

TSAT Aug 06, 2014 16:19:51

Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	Base Scenario	1 -- 2L293 SEL-NLY 3PH@SEL 230KV
2	y14c04.bin	Base Scenario	2 -- 2L293 SEL-NLY 3PH@SEL 230KV - GS



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

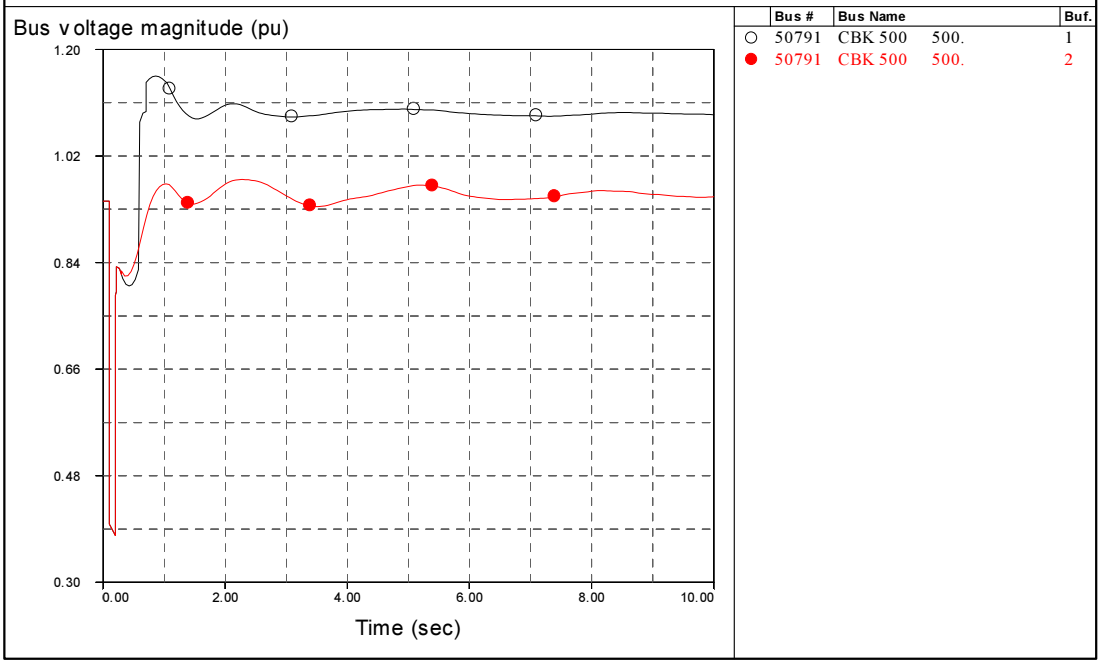
DSATools OutputAnalysis 11.0
Powertech Labs Inc.

G.7 y14c04, Contingency 2L295 with Gen Shedding

KCL G1 (50769, 1) and KCL G2 (50770, 2) were shed. The amount of original Gen. Shedding was 0 MW.

TSAT Aug 06, 2014 16:21:02

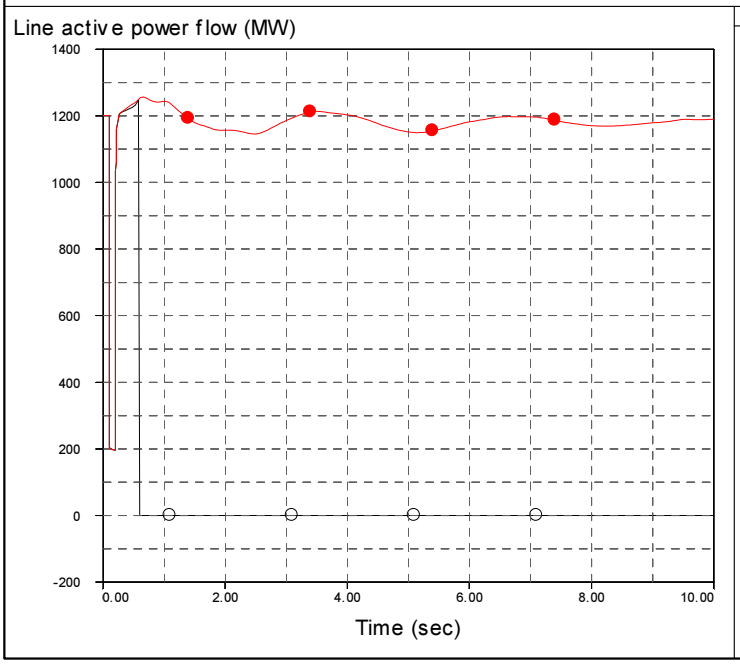
Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	Base Scenario	1 – 2L295 SEL-KCL 3PH@SEL 230KV
2	y14c04.bin	Base Scenario	2 – 2L295 SEL-KCL 3PH@SEL 230KV - GS



DSATools Output Analysis 11.0
Powertech Labs Inc.

TSAT Aug 06, 2014 16:21:02

Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	Base Scenario	1 – 2L295 SEL-KCL 3PH@SEL 230KV
2	y14c04.bin	Base Scenario	2 – 2L295 SEL-KCL 3PH@SEL 230KV - GS



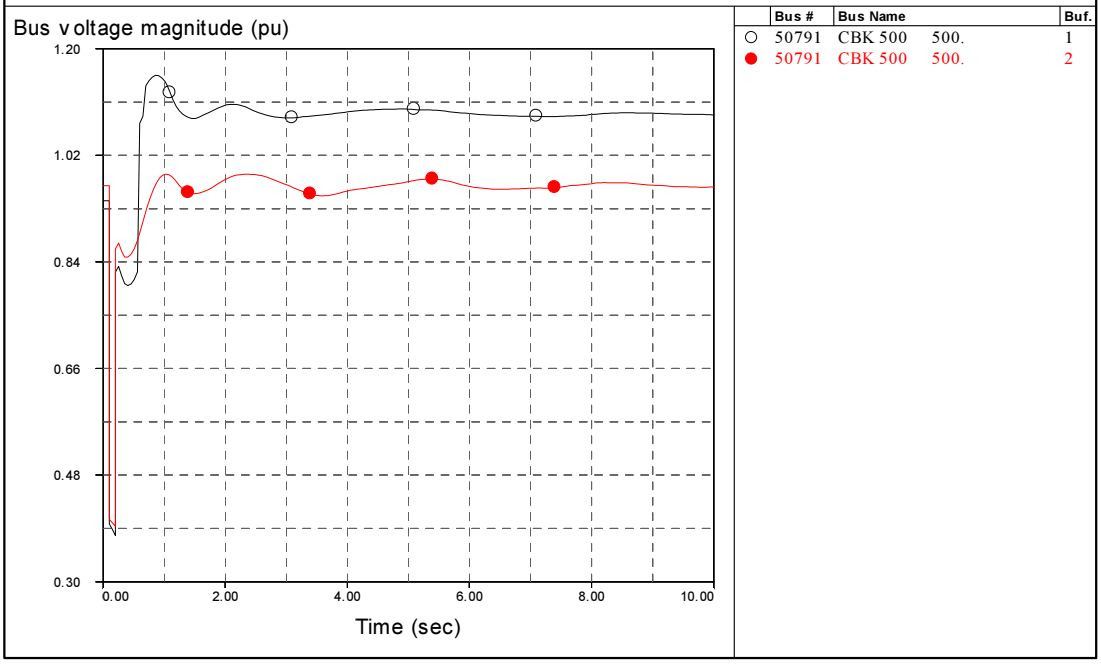
	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

DSATools OutputAnalysis 11.0
Powertech Labs Inc.

G.8 y14c04, Contingency 2L293 with Reduced Transfer (1100 MW)

TSAT Aug 07, 2014 12:01:35

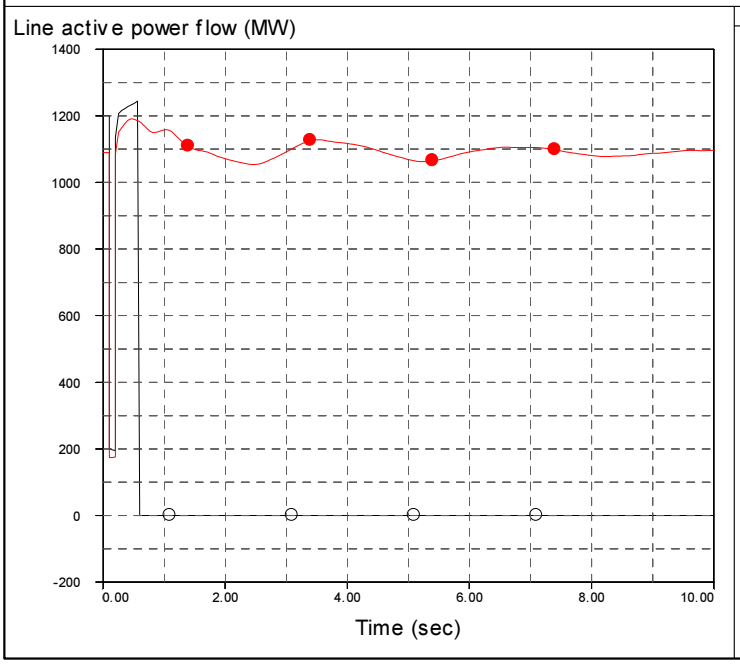
Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	1200 MW	1 -- 2L293 SEL-NLY 3PH@SEL 230KV
2	y14c04.bin	1100 MW	1 -- 2L293 SEL-NLY 3PH@SEL 230KV



DSATools Output Analysis 11.0
Powertech Labs Inc.

TSAT Aug 07, 2014 12:01:35

Buf.	Binary Result File	Scenario	Contingency
1	y14c04.bin	1200 MW	1 -- 2L293 SEL-NLY 3PH@SEL 230KV
2	y14c04.bin	1100 MW	1 -- 2L293 SEL-NLY 3PH@SEL 230KV



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

DSATools OutputAnalysis 11.0
Powertech Labs Inc.

G.9 y14c07, Raising Kootenay Area Generation during Export to AB

Kootenay Area generation in the original base case = 15 MW

Monitored Variables - y14c07_ST

Cont. Name	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
KOOTENAY AREA GEN = 555 MW							
PRE-CONTINGENCY	1.013	1.019	0.939	0.933	0.927	1.020	0.973
5L91 ACK-SEL	No post-contingency solution						
5L96 VAS-SEL	0.990	1.001	0.922	0.916	0.912	1.009	0.969
5L98 NIC-VAS	1.000	1.009	0.932	0.926	0.921	1.015	0.972
2L294 CBK-NLY	0.998	1.009	0.897	0.891	0.888	1.022	0.952
5L96&5L98	0.988	1.000	0.920	0.915	0.911	1.008	0.969
KOOTENAY AREA GEN = 1040 MW							
PRE-CONTINGENCY	1.019	1.022	0.944	0.937	0.931	1.022	0.974
5L91 ACK-SEL	0.996	1.008	0.929	0.922	0.918	1.014	0.971
5L96 VAS-SEL	1.007	1.014	0.935	0.929	0.924	1.017	0.972
2L294 CBK-NLY	1.009	1.016	0.916	0.909	0.906	1.026	0.966
5L96&5L98	1.006	1.013	0.935	0.928	0.923	1.017	0.972

Monitored Variables - y14c07_LT

	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
KOOTENAY AREA GEN = 555 MW							
PRE-CONTINGENCY	1.013	1.019	0.939	0.933	0.927	1.020	0.973
5L91 ACK-SEL	No post-contingency solution						
5L96 VAS-SEL	No post-contingency solution						
2L294 CBK-NLY	No post-contingency solution						
5L96&5L98	No post-contingency solution						
KOOTENAY AREA GEN = 1040 MW							
PRE-CONTINGENCY	1.019	1.022	0.944	0.937	0.931	1.022	0.974
5L91 ACK-SEL	0.996	1.008	0.929	0.922	0.918	1.014	0.971
5L96 VAS-SEL	1.007	1.014	0.935	0.929	0.924	1.017	0.972
5L98 NIC-VAS	1.013	1.018	0.941	0.934	0.929	1.020	0.974
2L294 CBK-NLY	1.009	1.016	0.916	0.909	0.906	1.026	0.966
5L96&5L98	1.006	1.013	0.935	0.928	0.923	1.017	0.972

G.10 y14c11, Curtailing Kootenay Area Generation during Import from AB

Kootenay Area generation in the original base case = 1149 MW

Monitored Variables - y14c11_ST

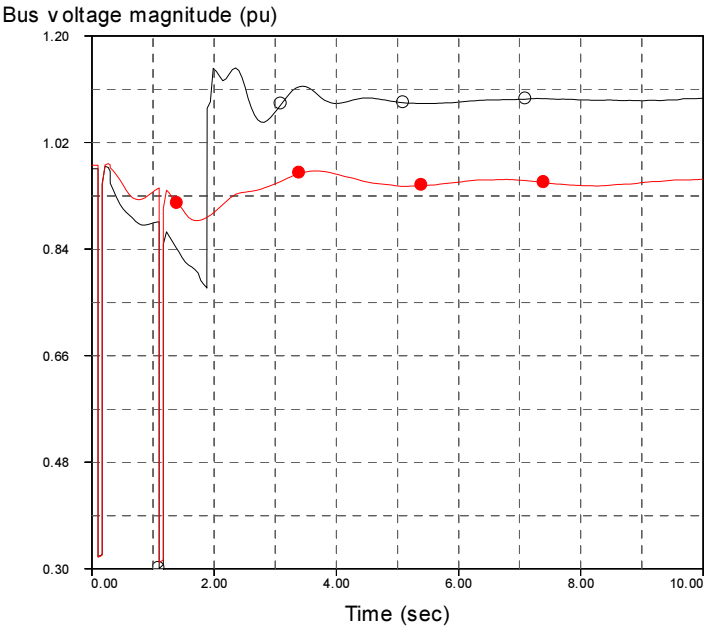
	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
Cont. Name							
KOOTENAY AREA GEN = 649 MW							
Pre Contingency	1.017	1.022	0.981	0.973	0.961	1.026	0.962
5L91 ACK-SEL	0.983	1.003	0.961	0.955	0.945	1.014	0.958
5L96 VAS-SEL	1.005	1.017	0.975	0.968	0.956	1.021	0.961

Monitored Variables - y14c11_LT

	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
Cont. Name							
KOOTENAY AREA GEN = 649 MW							
Pre Contingency	1.016	1.022	0.981	0.973	0.961	1.026	0.962
5L91 ACK-SEL	0.993	1.009	0.965	0.959	0.949	1.017	0.958
5L96 VAS-SEL	1.002	1.015	0.971	0.964	0.954	1.019	0.959

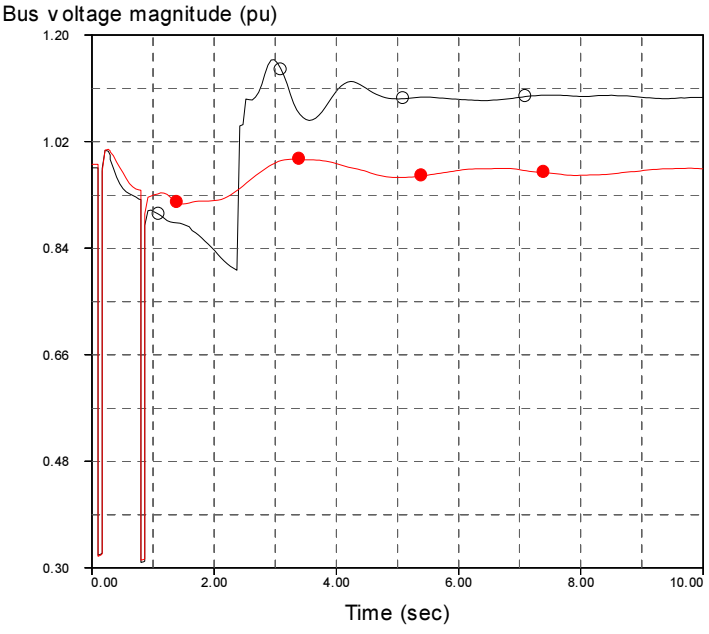
In the following plots 4 selected contingencies are run:
Y14c11n4 : The original y14c11 base case
Y14c11rg500 : The case where Kootenay Area generation is reduced by 500 MW

Buf.	Binary Result File	Scenario	Contingency
1	y14c11n4.bin	Base Scenario	1 -- 5L91 ACK-SEL_2 3PH@SEL 500KV
2	y14c11rg500.bin	Base Scenario	1 -- 5L91 ACK-SEL_2 3PH@SEL 500KV



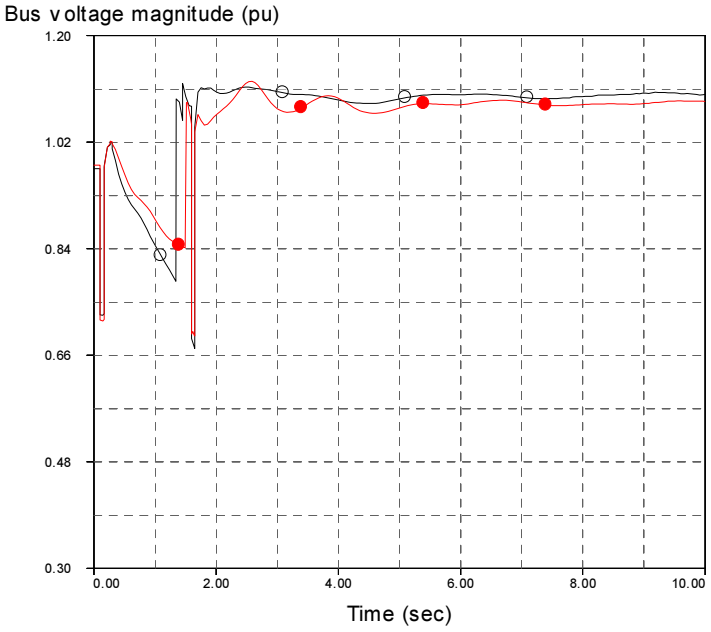
	Bus #	Bus Name		Buf.
○	50791	CBK 500	500.	1
●	50791	CBK 500	500.	2

Buf.	Binary Result File	Scenario	Contingency
1	y14c11n4.bin	Base Scenario	2 -- 5L96 VAS-SEL_2 3PH@SEL 500KV
2	y14c11rg500.bin	Base Scenario	2 -- 5L96 VAS-SEL_2 3PH@SEL 500KV



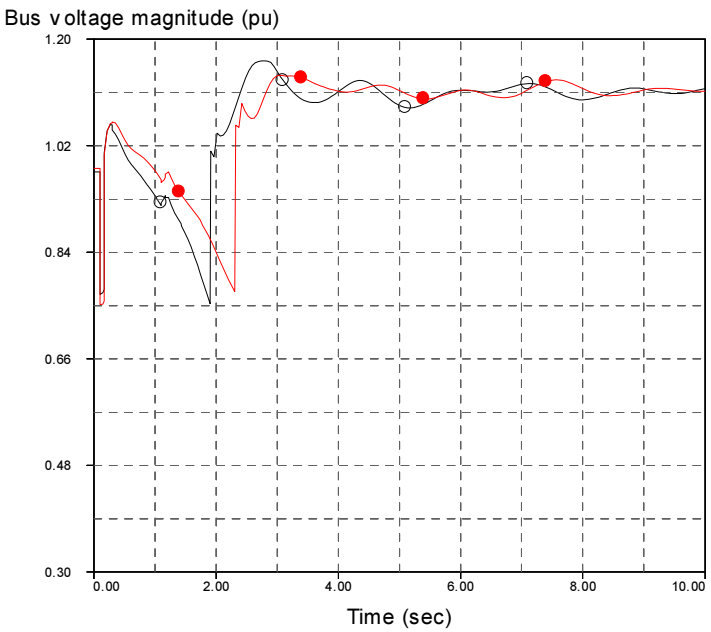
	Bus #	Bus Name		Buf.
○	50791	CBK 500	500.	1
●	50791	CBK 500	500.	2

Buf.	Binary Result File	Scenario	Contingency
1	y14c11n4.bin	Base Scenario	3 -- 5L765L79 3PH@ACK 500KV
2	y14c11rg500.bin	Base Scenario	3 -- 5L765L79 3PH@ACK 500KV



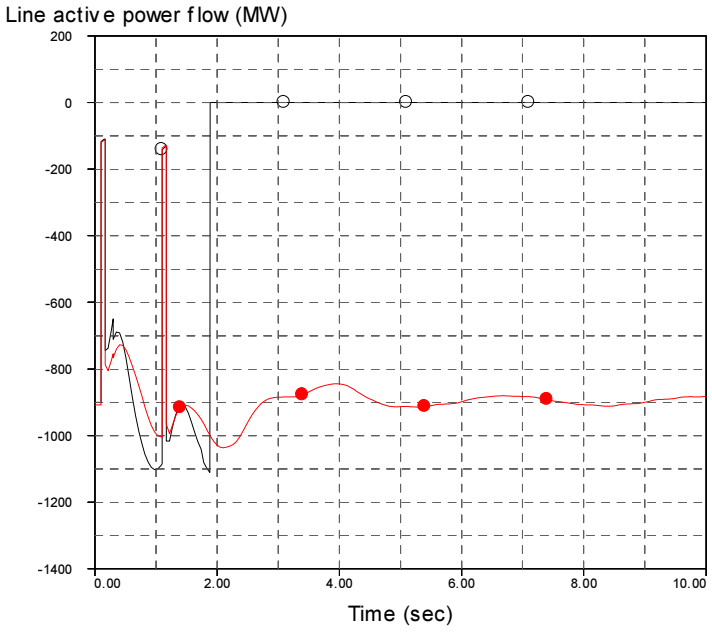
	Bus #	Bus Name		Buf.
○	50791	CBK 500	500.	1
●	50791	CBK 500	500.	2

Buf.	Binary Result File	Scenario	Contingency
1	y14c11n4.bin	Base Scenario	4 -- 5L815L82 3PH@NIC 500KV
2	y14c11rg500.bin	Base Scenario	4 -- 5L815L82 3PH@NIC 500KV



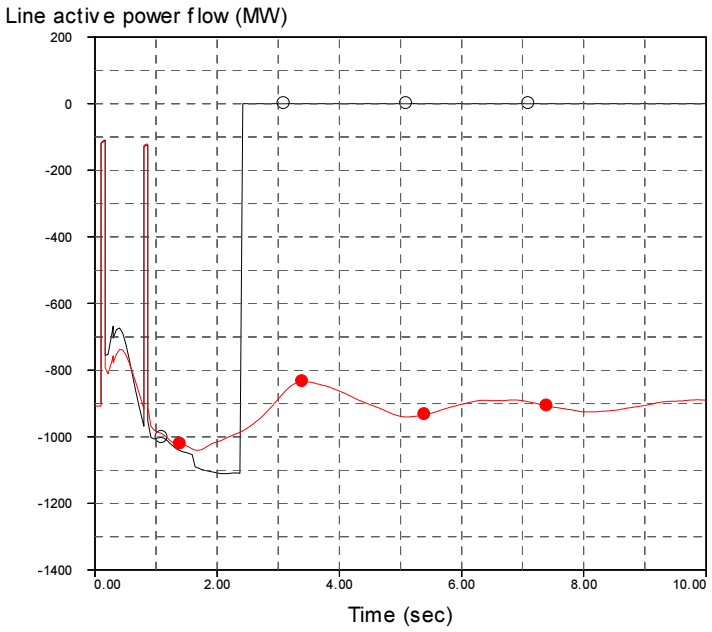
	Bus #	Bus Name		Buf.
○	50791	CBK 500	500.	1
●	50791	CBK 500	500.	2

Buf.	Binary Result File	Scenario	Contingency
1	y14c11n4.bin	Base Scenario	1 – 5L91 ACK-SEL_2 3PH@SEL 500KV
2	y14c11rg500.bin	Base Scenario	1 – 5L91 ACK-SEL_2 3PH@SEL 500KV



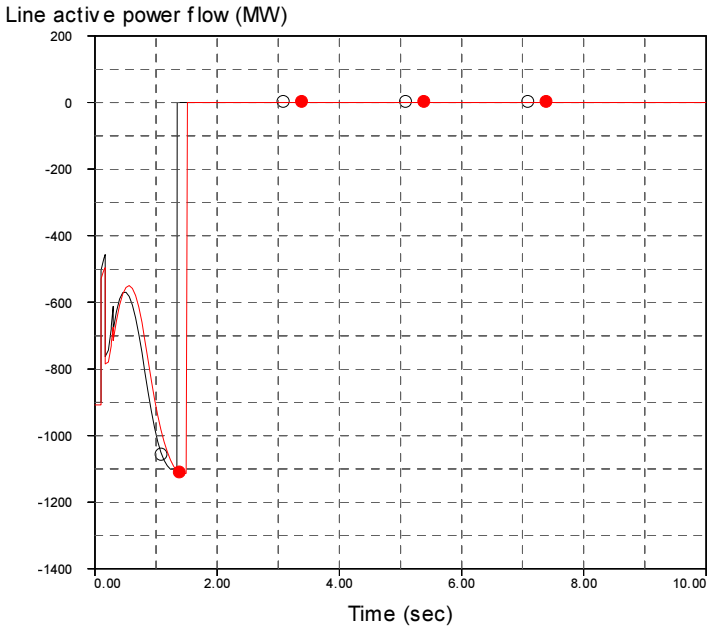
	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

Buf.	Binary Result File	Scenario	Contingency
1	y14c11n4.bin	Base Scenario	2 – 5L96 VAS-SEL_2 3PH@SEL 500KV
2	y14c11rg500.bin	Base Scenario	2 – 5L96 VAS-SEL_2 3PH@SEL 500KV



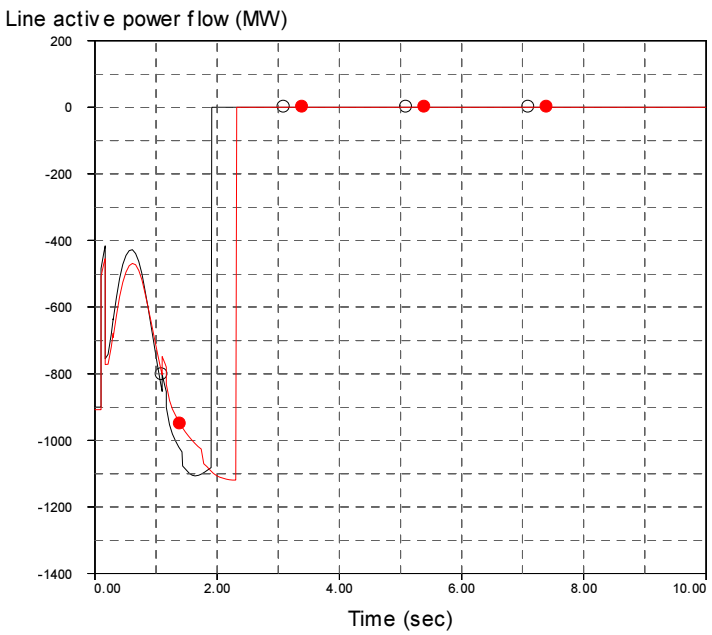
	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

Buf.	Binary Result File	Scenario	Contingency
1	y14c11n4.bin	Base Scenario	3 -- 5L765L79 3PH@ACK 500KV
2	y14c11rg500.bin	Base Scenario	3 -- 5L765L79 3PH@ACK 500KV



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

Buf.	Binary Result File	Scenario	Contingency
1	y14c11n4.bin	Base Scenario	4 -- 5L815L82 3PH@NIC 500KV
2	y14c11rg500.bin	Base Scenario	4 -- 5L815L82 3PH@NIC 500KV

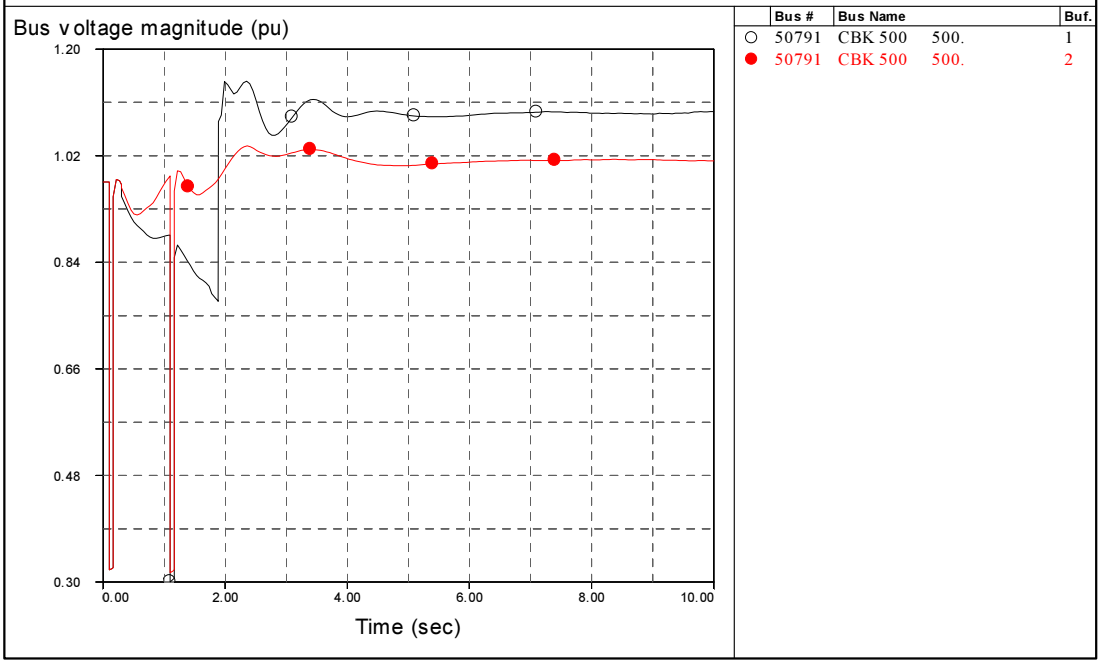


	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

G.11 y14c11, Contingency 5L91 with gen shedding in Alberta

TSAT Aug 08, 2014 10:48:05

Buf.	Binary Result File	Scenario	Contingency
1	y14c11.bin	Base Scenario	2 – 5L91 ACK-SEL_2 3PH@SEL 500KV
2	y14c11.bin	Base Scenario	3 – 5L91 ACK-SEL_2 3PH@SEL 500KV - GS IN AB

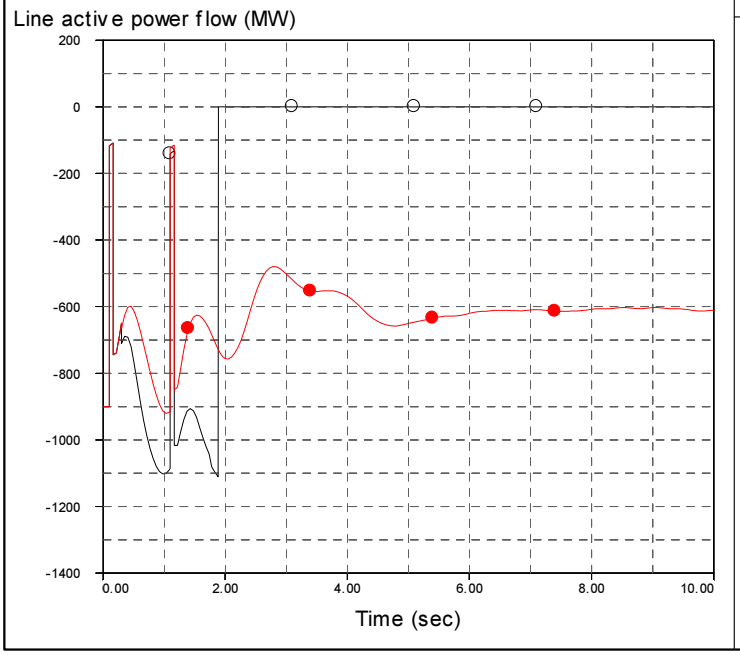


	Bus #	Bus Name		Buf.
○	50791	CBK 500	500.	1
●	50791	CBK 500	500.	2

DSATools OutputAnalysis 11.0
Powertech Labs Inc.

TSAT Aug 08, 2014 10:48:05

Buf.	Binary Result File	Scenario	Contingency
1	y14c11.bin	Base Scenario	2 – 5L91 ACK-SEL_2 3PH@SEL 500KV
2	y14c11.bin	Base Scenario	3 – 5L91 ACK-SEL_2 3PH@SEL 500KV - GS IN AB



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

DSATools OutputAnalysis 11.0
Powertech Labs Inc.

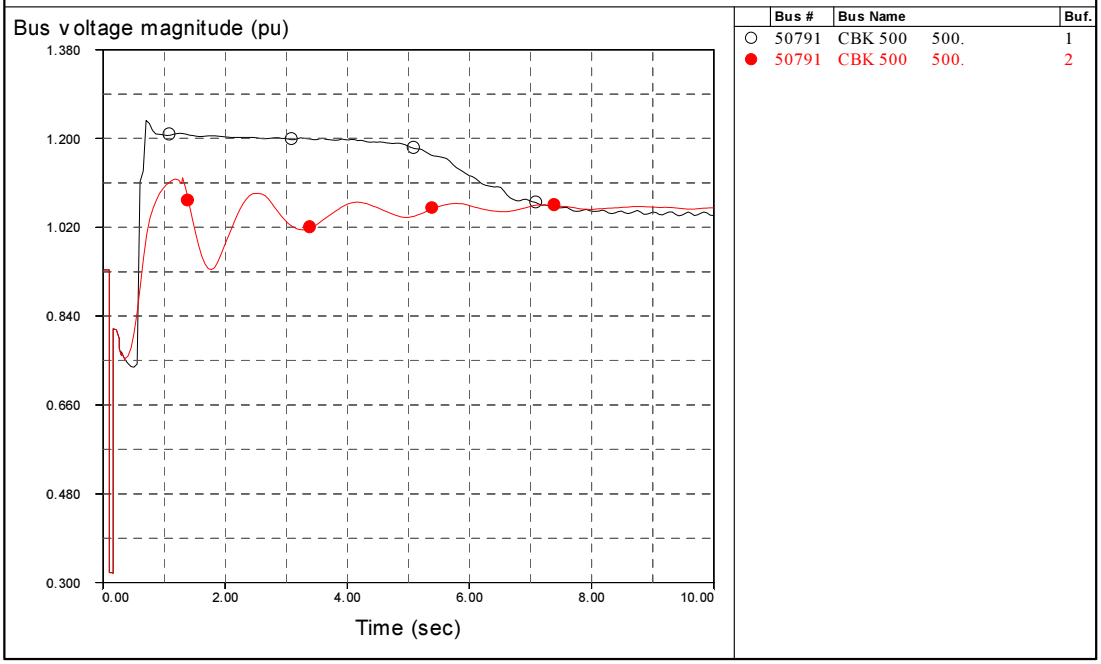
G.12 y17c01, Contingency 5L91&5L96 with increased gen shedding

Base case gen shedding: KCLG1 + KCLG2 + KCLG3 + ALHG1 (= 457 MW)

Adjusted gen shedding: KCLG1 + KCLG2 + KCLG3 + ALHG1 + ALHG2 + WANG1 + SEVG1 (= 775 MW)

TSAT Aug 08, 2014 08:54:01

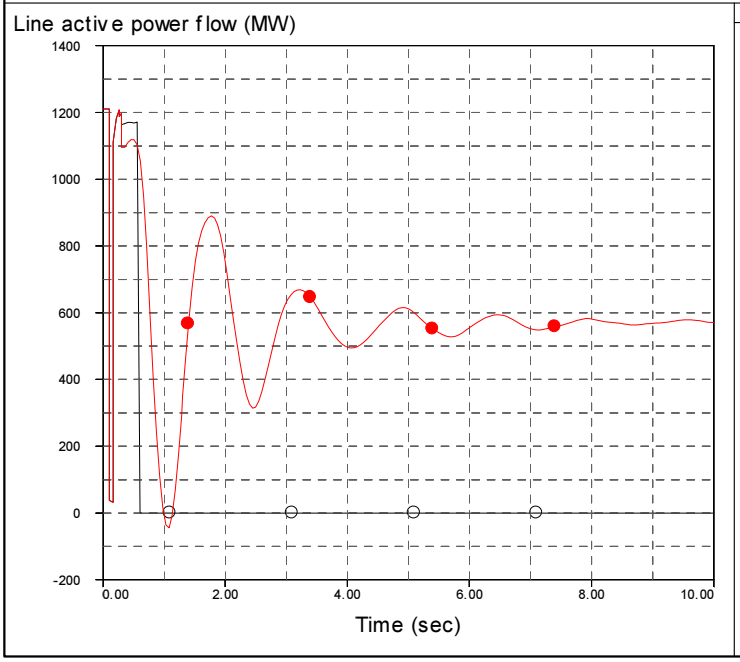
Buf.	Binary Result File	Scenario	Contingency
1	y17c01.bin	Base Scenario	1 -- 5L915L96 3PH@SEL 500KV
2	y17c01.bin	Base Scenario	2 -- 5L915L96 3PH@SEL 500KV - GS2



DSATools OutputAnalysis 11.0
Powertech Labs Inc.

TSAT Aug 08, 2014 08:54:01

Buf.	Binary Result File	Scenario	Contingency
1	y17c01.bin	Base Scenario	1 -- 5L915L96 3PH@SEL 500KV
2	y17c01.bin	Base Scenario	2 -- 5L915L96 3PH@SEL 500KV - GS2



	Bus #	Bus Name	ID	Buf.
○	50791	CBK 500 500.	01	1
	54158	LANGDON2 500.		
●	50791	CBK 500 500.	01	2
	54158	LANGDON2 500.		

DSATools OutputAnalysis 11.0
Powertech Labs Inc.

G.13 y17c07, Raising Kootenay Area Generation During Export to AB

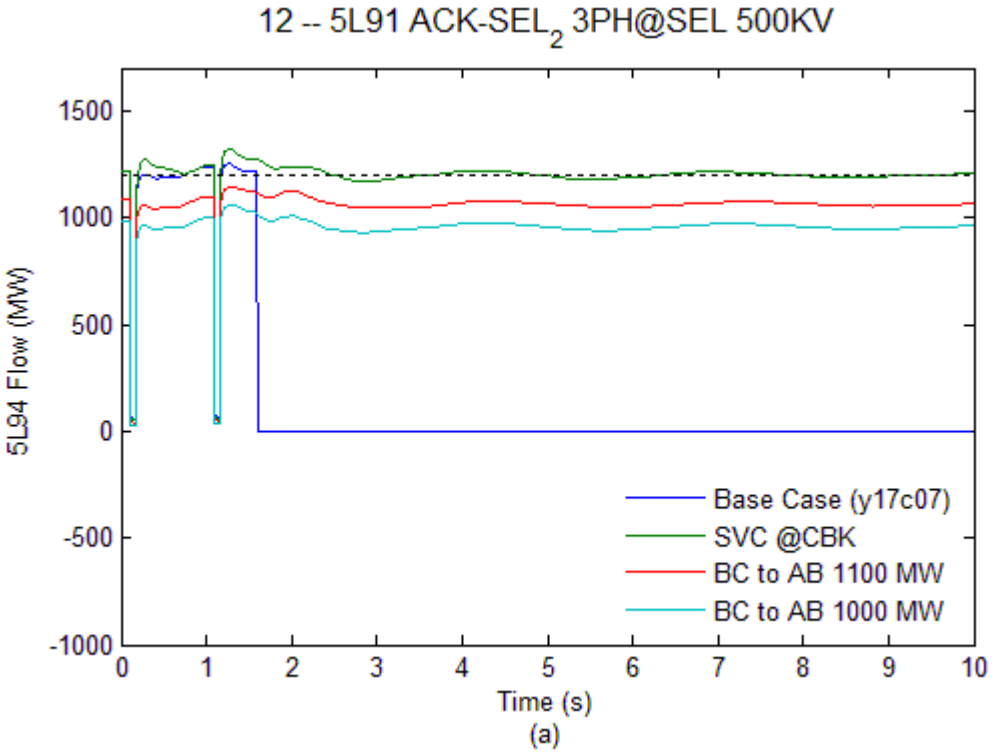
Monitored Variables - y17c07_ST

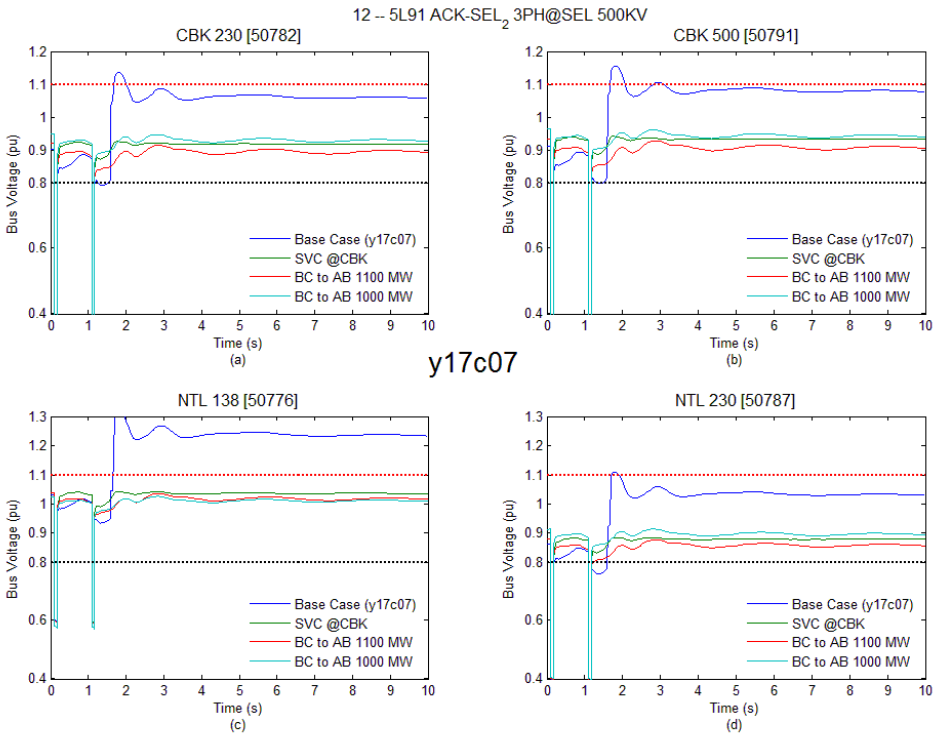
	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
KOOTENAY AREA GEN = 550 MW							
PRE-CONTINGENCY	1.001	1.010	0.906	0.897	0.864	1.014	0.943
5L91 ACK-SEL	0.933	0.952	0.846	0.839	0.813	0.970	0.926
5L96 VAS-SEL	0.974	0.989	0.884	0.877	0.847	0.999	0.939
2L294 CBK-NLY	0.986	1.000	0.864	0.854	0.827	1.017	0.931
5L96&5L98	0.971	0.986	0.881	0.873	0.844	0.997	0.938
KOOTENAY AREA GEN = 1016 MW							
PRE-CONTINGENCY	1.010	1.016	0.913	0.902	0.863	1.017	0.945
5L91 ACK-SEL	0.977	0.992	0.888	0.879	0.843	1.002	0.941
5L96 VAS-SEL	0.993	1.004	0.899	0.889	0.852	1.010	0.942
2L294 CBK-NLY	0.997	1.008	0.875	0.864	0.832	1.022	0.936
5L96&5L98	0.991	1.002	0.897	0.887	0.850	1.009	0.942

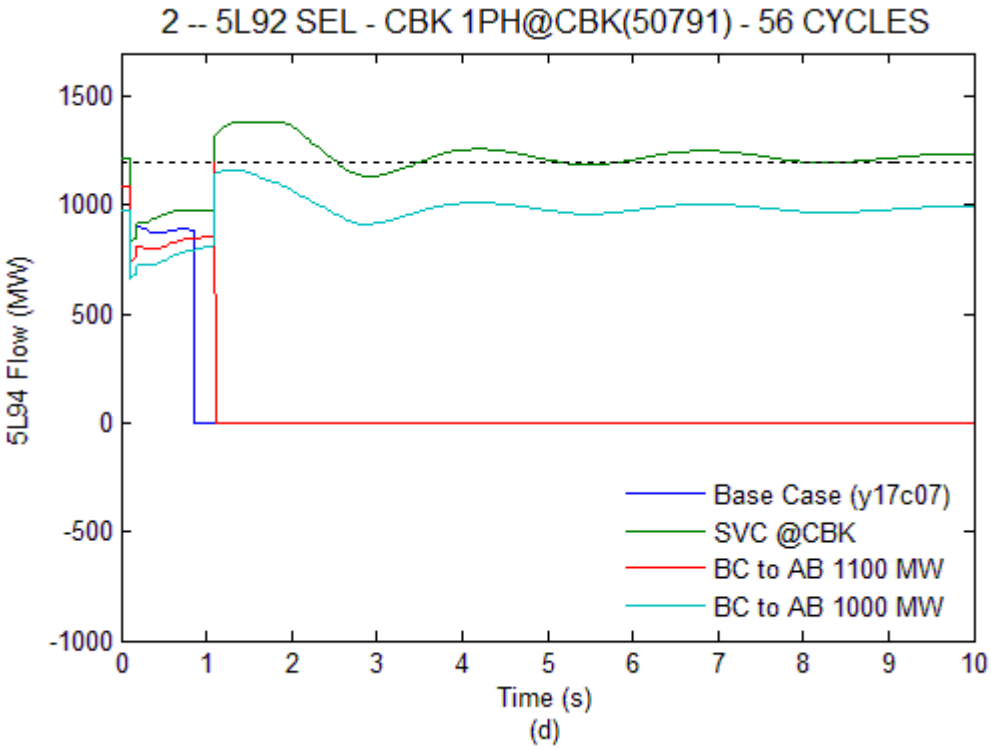
Monitored Variables - y17c07_LT

	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
KOOTENAY AREA GEN = 550 MW							
PRE-CONTINGENCY	1.002	1.011	0.908	0.900	0.875	1.015	0.944
5L91 ACK-SEL	No post-contingency solution						
5L96 VAS-SEL	No post-contingency solution						
2L294 CBK-NLY	No post-contingency solution						
5L96&5L98	No post-contingency solution						
KOOTENAY AREA GEN = 1016 MW							
PRE-CONTINGENCY	1.010	1.016	0.913	0.902	0.863	1.017	0.945
5L91 ACK-SEL	0.955	0.974	0.848	0.840	0.796	0.987	0.921
5L96 VAS-SEL	0.990	1.002	0.893	0.883	0.843	1.009	0.940
2L294 CBK-NLY	0.986	1.001	0.844	0.834	0.791	1.018	0.919
5L96&5L98	0.988	1.000	0.889	0.880	0.841	1.008	0.939

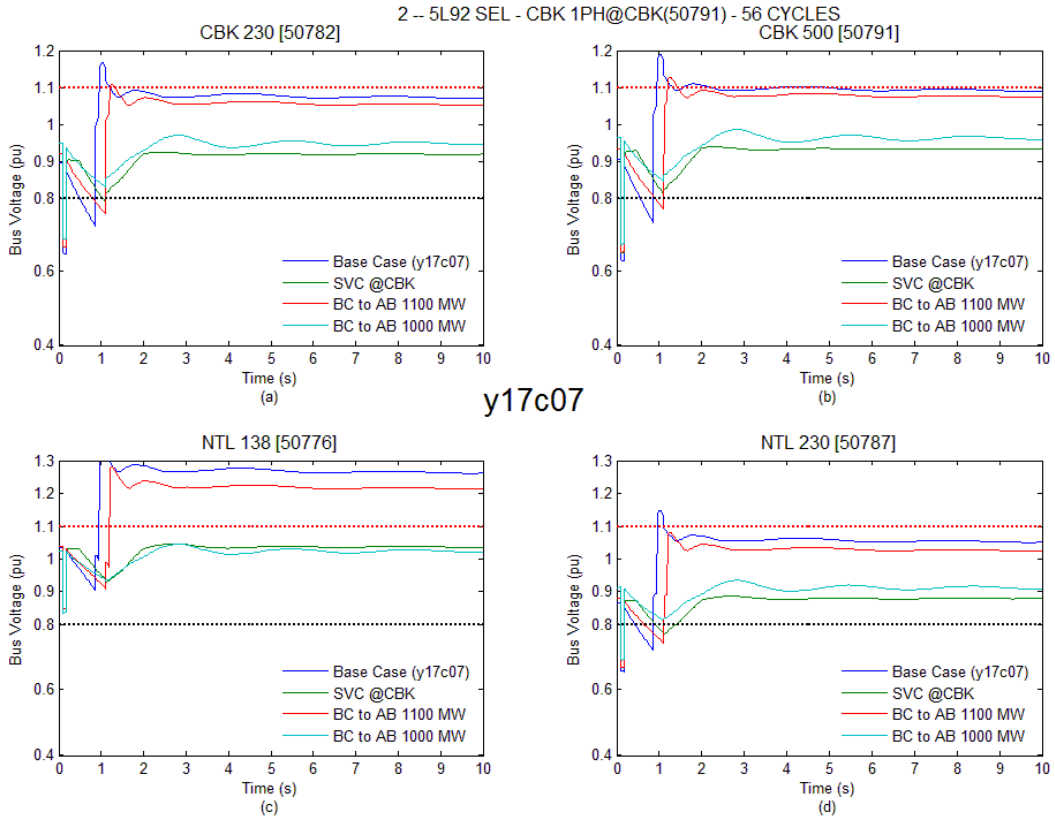
G.14 y17c07, Effect of Adding Dynamic VAr Support at CBK (+/- 250 Mvars SVC) or Reducing BC to AB Transfer



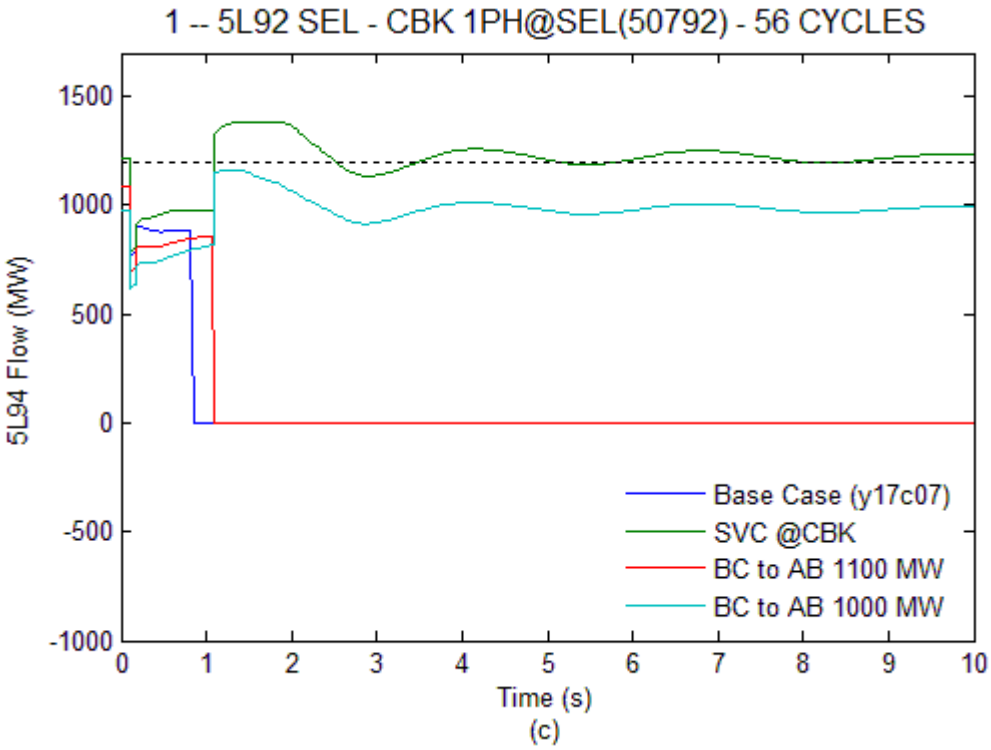


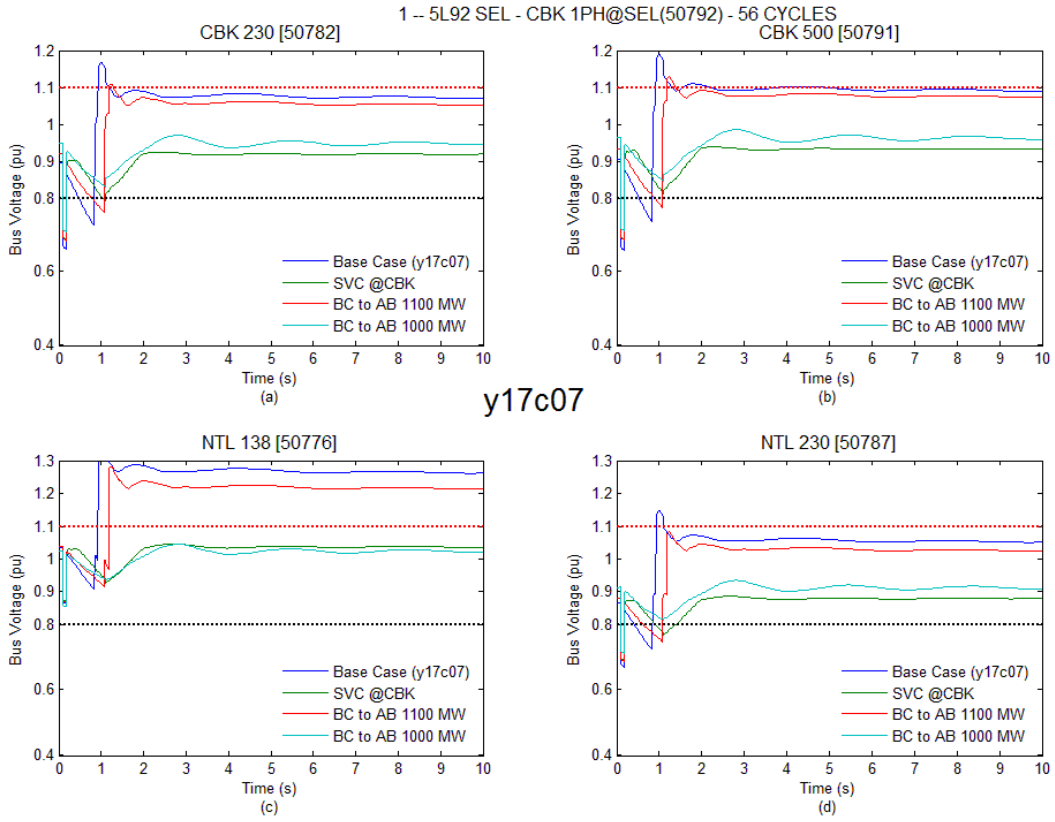


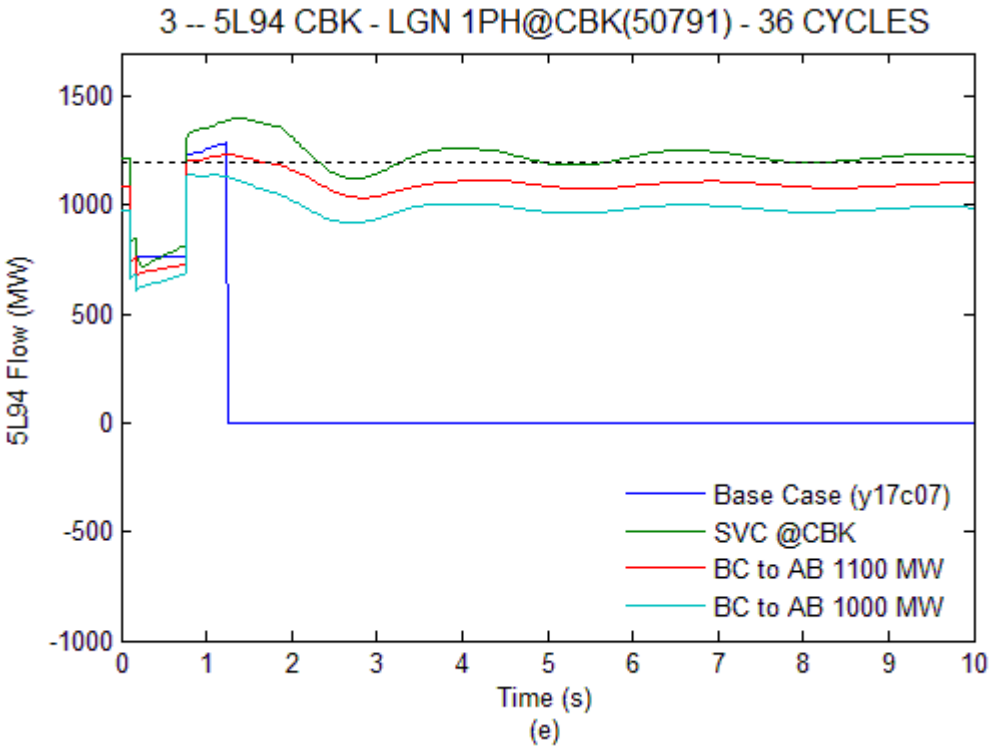
(d)



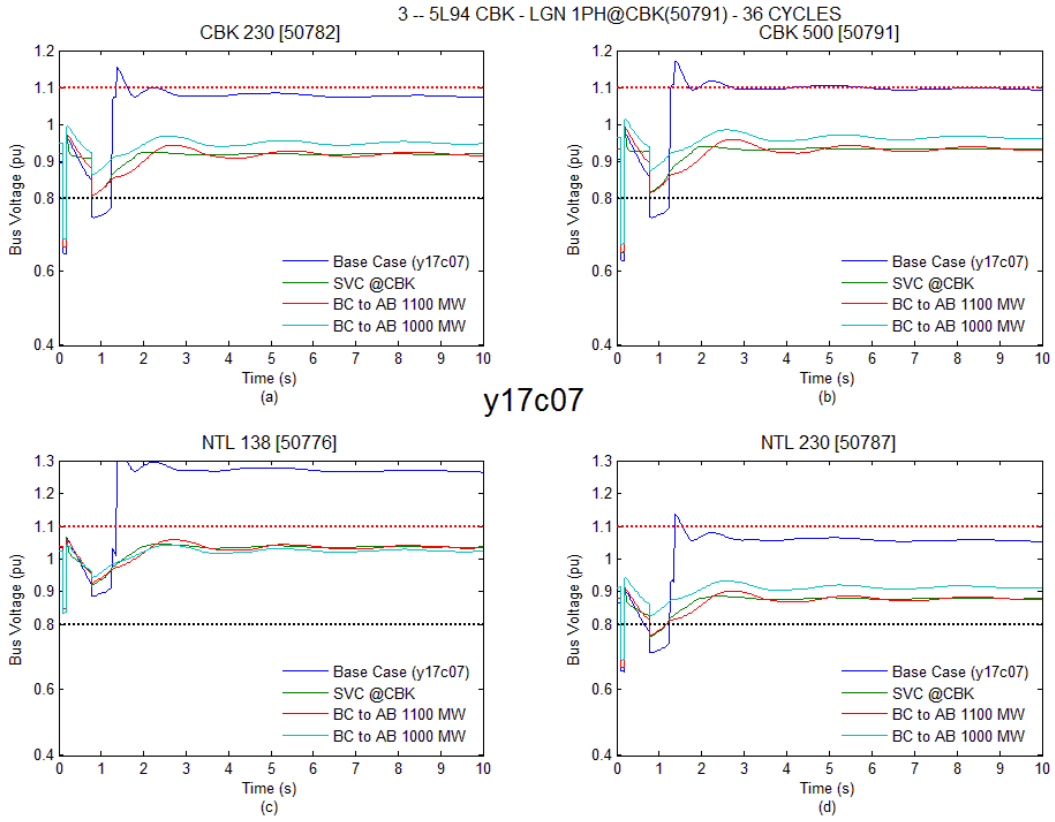
y17c07



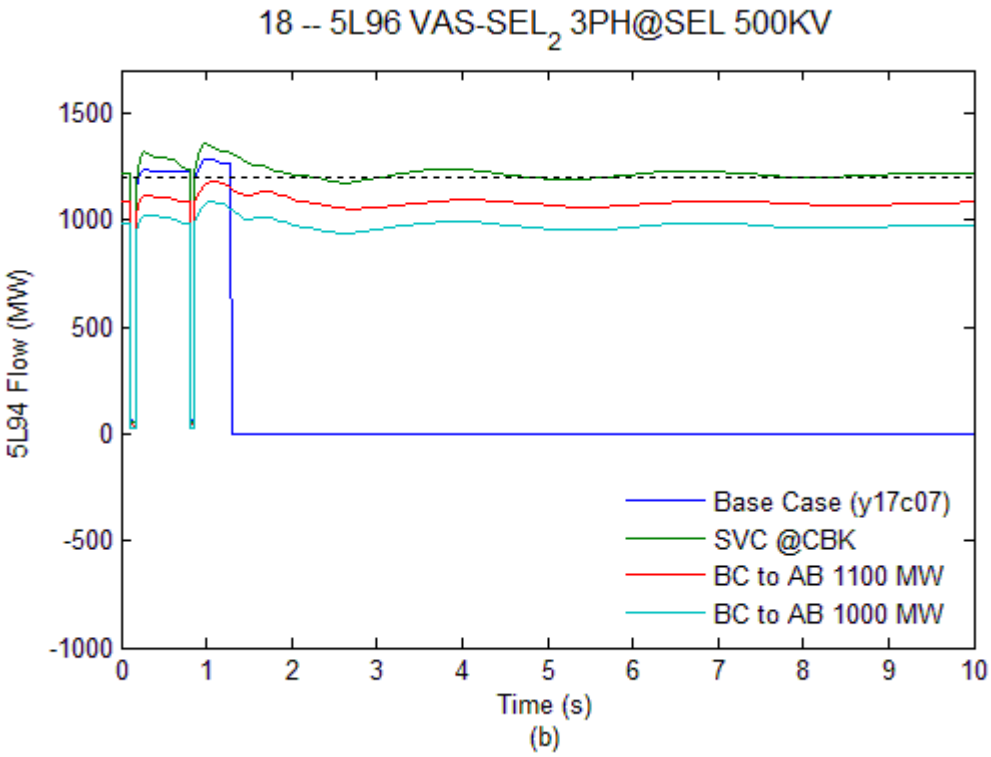




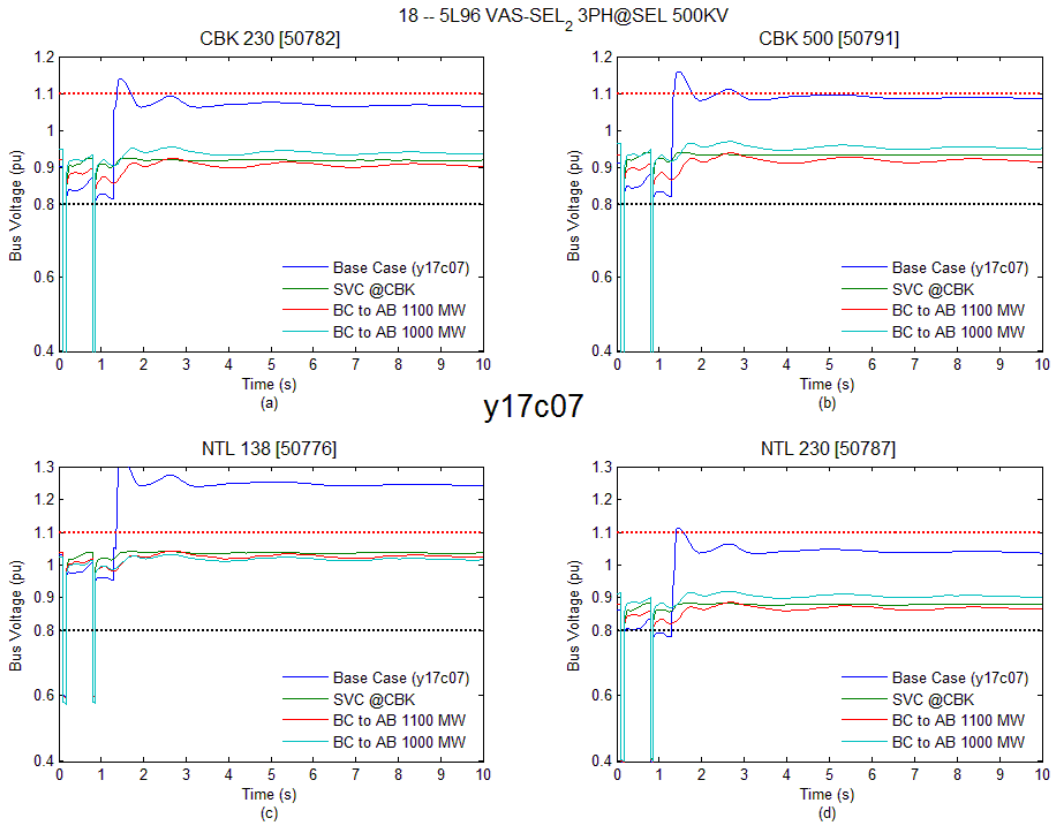
(e)



y17c07



(b)



y17c07

y17c07 (SVC @CBK)		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.985	0.985	0.000	0.950	0.950	0.000	1.038	1.038	0.000	1.044	1.043	0.002
N-1	SEL T1	0.984	0.984	0.000	0.951	0.951	0.000	1.037	1.037	0.000	1.044	1.042	0.002
	CBK T2+T6	0.985	0.985	0.000	0.950	0.950	0.000	1.039	1.039	-0.002	1.044	1.043	0.002
	SEL Shaft Trip T1	0.981	0.985	0.000	0.952	0.950	0.000	1.038	1.038	0.000	1.046	1.040	0.004
	5L75 REV-ACK	0.984	0.984	0.000	0.951	0.950	0.000	1.038	1.038	0.000	1.041	1.041	0.003
	5L91 ACK-SEL	0.000	0.983	0.001	1.000	0.950	0.000	1.190	1.037	0.000	1.052	1.037	0.007
	5L92 CBK-SEL	0.980	0.000	0.985	0.951	0.000	0.950	1.037	1.032	0.006	1.045	1.046	-0.002
	5L94 CBK-LGN	0.978	0.000	0.985	0.951	0.000	0.950	1.038	1.027	0.011	1.040	1.047	-0.002
	5L96 VAS-SEL	0.985	0.984	0.000	0.950	0.951	0.000	1.037	1.037	0.000	1.044	1.043	0.001
	5L98 NIC-VAS	0.981	0.984	0.001	0.952	0.951	0.000	1.038	1.037	0.000	1.046	1.040	0.004
	2L112 NLY-BDY	0.983	0.985	0.000	0.951	0.950	0.000	1.038	1.037	0.000	1.045	1.042	0.002
	2L222 SEV-SEL	0.985	0.985	0.000	0.950	0.950	0.000	1.038	1.038	0.000	1.044	1.042	0.002
	2L258 CBK-INV	0.985	0.984	0.000	0.950	0.950	0.000	1.038	1.035	0.003	1.044	1.043	0.002
	2L277 WAN-NLY	0.984	0.985	0.000	0.951	0.950	0.000	1.037	1.038	0.000	1.044	1.042	0.002
	2L288 KCL-BTS	0.986	0.985	0.000	0.950	0.950	0.000	1.039	1.038	0.000	1.043	1.043	0.002
	2L289 SEL-BTS	0.977	0.984	0.000	0.951	0.950	0.000	1.038	1.037	0.000	1.044	1.042	0.002
	2L293 SEL-NLY	0.984	0.985	0.000	0.950	0.950	0.000	1.037	1.039	-0.001	1.044	1.043	0.001
	2L294 CBK-NLY	0.985	0.983	0.001	0.950	0.950	0.000	1.038	1.037	0.001	1.044	1.043	0.001
	2L295 SEL-KCL	0.987	0.985	0.000	0.951	0.950	0.000	1.056	1.037	0.000	1.044	1.042	0.002
	1L274 NTL-POCATER	0.991	0.984	0.000	0.950	0.950	0.000	1.037	1.029	0.008	1.026	1.043	0.001
	1L275 NTL-COLEMAN	0.989	0.985	0.000	0.950	0.946	0.004	1.037	1.031	0.006	1.029	1.042	0.002
	5L82 NIC-MDN	0.969	0.985	0.000	0.952	0.950	0.000	1.037	1.038	0.000	1.038	1.038	0.006
N-2	5L76&5L79	1.075	0.984	0.000	1.011	0.951	0.000	1.085	1.037	0.000	1.026	1.049	-0.005
	5L91&5L96	0.987	1.075	-0.090	0.954	1.012	-0.061	1.040	1.022	0.015	1.056	1.035	0.010
	5L81&5L82	0.979	0.984	0.001	0.951	0.951	0.000	1.037	1.037	0.000	1.039	1.036	0.008
	5L96&5L98	1.075	0.984	0.001	1.000	0.951	0.000	1.212	1.037	0.000	1.106	1.040	0.004
	5L51&5L52	0.988	1.075	-0.091	0.955	0.000	0.950	1.040	1.026	0.011	1.028	1.072	-0.027
	2L288&2L295	0.984	0.984	0.000	0.950	0.950	0.000	1.037	1.037	0.000	1.044	1.042	0.002
	2L289&2L295	0.984	0.984	0.000	0.951	0.951	0.000	1.037	1.037	0.000	1.044	1.042	0.002
	2L295&2L299	0.984	0.984	0.000	0.951	0.951	0.000	1.037	1.037	0.000	1.044	1.042	0.002

y17c07 (BC to AB 1100 MW)		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.919	0.919	0.000	0.934	0.934	0.000	1.037	1.037	0.000	0.879	0.879	0.000
N-1	SEL T1	0.919	0.919	0.000	0.933	0.933	0.000	1.036	1.036	0.000	0.879	0.879	0.000
	CBK T2+T6	0.917	0.924	-0.004	0.929	0.937	-0.004	1.036	1.041	-0.004	0.877	0.883	-0.004
	SEL Shaft Trip T1	0.919	0.920	0.000	0.933	0.934	0.000	1.037	1.037	0.000	0.879	0.879	0.000
	5L75 REV-ACK	0.916	0.924	-0.004	0.930	0.938	-0.005	1.035	1.040	-0.003	0.877	0.883	-0.004
	5L91 ACK-SEL	0.891	0.891	0.029	0.903	0.904	0.030	1.015	1.023	0.014	0.855	0.853	0.026
	5L92 CBK-SEL	1.045	0.972	-0.053	1.069	0.994	-0.061	1.227	1.020	0.017	1.028	0.954	-0.075
	5L94 CBK-LGN	1.047	1.002	-0.083	1.064	1.032	-0.098	1.229	1.026	0.011	1.029	0.985	-0.105
	5L96 VAS-SEL	0.906	0.912	0.007	0.919	0.926	0.008	1.027	1.031	0.006	0.868	0.873	0.006
	5L98 NIC-VAS	0.913	0.918	0.001	0.927	0.933	0.001	1.033	1.036	0.000	0.874	0.878	0.001
	2L112 NLY-BDY	0.915	0.924	-0.005	0.930	0.940	-0.006	1.034	1.041	-0.004	0.876	0.883	-0.004
	2L222 SEV-SEL	0.919	0.920	0.000	0.933	0.934	0.000	1.037	1.037	0.000	0.879	0.879	0.000
	2L258 CBK-INV	0.911	0.914	0.005	0.928	0.931	0.003	1.031	1.033	0.004	0.872	0.875	0.005
	2L277 WAN-NLY	0.917	0.925	-0.006	0.931	0.940	-0.007	1.035	1.042	-0.005	0.877	0.884	-0.005
	2L288 KCL-BTS	0.920	0.920	0.000	0.934	0.934	0.000	1.037	1.038	0.000	0.879	0.880	0.000
	2L289 SEL-BTS	0.918	0.926	-0.007	0.932	0.941	-0.008	1.036	1.042	-0.005	0.878	0.885	-0.006
	2L293 SEL-NLY	0.919	0.928	-0.008	0.932	0.942	-0.008	1.037	1.043	-0.006	0.879	0.886	-0.007
	2L294 CBK-NLY	0.893	0.897	0.022	0.908	0.913	0.021	1.018	1.028	0.009	0.858	0.859	0.020
	2L295 SEL-KCL	0.919	0.927	-0.007	0.933	0.942	-0.008	1.036	1.042	-0.006	0.878	0.885	-0.006
	1L274 NTL-POCATER	0.926	0.932	-0.013	0.940	0.944	-0.011	1.059	1.036	0.001	0.894	0.912	-0.033
	1L275 NTL-COLEMAN	0.921	0.924	-0.005	0.932	0.936	-0.003	1.069	1.034	0.003	0.899	0.903	-0.024
	5L82 NIC-MDN	0.915	0.926	-0.006	0.929	0.940	-0.007	1.034	1.042	-0.005	0.875	0.884	-0.005
N-2	5L76&5L79	0.936	0.919	0.000	0.952	0.934	0.000	1.052	1.037	0.000	0.896	0.879	0.000
	5L91&5L96	1.021	0.993	-0.074	1.044	1.025	-0.091	1.113	1.026	0.011	0.977	0.961	-0.082
	5L81&5L82	0.939	0.922	-0.003	0.956	0.937	-0.004	1.054	1.039	-0.002	0.898	0.882	-0.003
	5L96&5L98	0.904	0.911	0.008	0.917	0.925	0.009	1.026	1.031	0.006	0.867	0.872	0.007
	5L51&5L52	1.076	1.018	-0.099	1.095	1.049	-0.116	1.267	1.030	0.007	1.060	1.001	-0.122
	2L288&2L295	0.918	0.926	-0.007	0.932	0.941	-0.007	1.036	1.042	-0.005	0.878	0.885	-0.006
	2L289&2L295	0.916	0.925	-0.005	0.930	0.940	-0.006	1.034	1.041	-0.004	0.876	0.884	-0.005
	2L295&2L299	0.916	0.924	-0.005	0.930	0.939	-0.005	1.035	1.041	-0.004	0.876	0.883	-0.004

y17c07 (BC to AB 1000 MW)		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.949	0.949	0.000	0.964	0.964	0.000	1.025	1.025	0.000	0.913	0.913	0.000
N-1	SEL T1	0.949	0.949	0.000	0.964	0.963	0.000	1.025	1.025	0.000	0.913	0.913	0.000
	CBK T2+T6	0.947	0.946	0.003	0.959	0.959	0.005	1.025	1.024	0.001	0.912	0.911	0.002
	SEL Shaft Trip T1	0.949	0.949	0.000	0.964	0.964	0.000	1.026	1.026	0.000	0.914	0.914	0.000
	5L75 REV-ACK	0.947	0.946	0.003	0.961	0.960	0.004	1.024	1.023	0.003	0.911	0.910	0.003
	5L91 ACK-SEL	0.931	0.932	0.017	0.945	0.947	0.017	1.013	1.029	-0.004	0.899	0.895	0.018
	5L92 CBK-SEL	1.053	0.980	-0.031	1.077	1.002	-0.038	1.172	1.028	-0.003	1.036	0.961	-0.048
	5L94 CBK-LGN	1.049	1.006	-0.057	1.067	1.035	-0.071	1.167	1.030	-0.004	1.032	0.988	-0.075
	5L96 VAS-SEL	0.940	0.945	0.004	0.954	0.960	0.004	1.019	1.030	-0.005	0.906	0.909	0.005
	5L98 NIC-VAS	0.945	0.940	0.009	0.960	0.955	0.009	1.023	1.027	-0.001	0.910	0.905	0.009
	2L112 NLY-BDY	0.947	0.946	0.003	0.962	0.961	0.003	1.024	1.023	0.002	0.911	0.911	0.003
	2L222 SEV-SEL	0.949	0.949	0.000	0.964	0.964	0.000	1.026	1.025	0.000	0.914	0.913	0.000
	2L258 CBK-INV	0.941	0.942	0.007	0.959	0.960	0.004	1.019	1.021	0.005	0.906	0.908	0.006
	2L277 WAN-NLY	0.948	0.947	0.002	0.962	0.962	0.002	1.024	1.024	0.001	0.912	0.912	0.002
	2L288 KCL-BTS	0.949	0.949	0.000	0.964	0.964	0.000	1.025	1.025	0.000	0.913	0.913	0.000
	2L289 SEL-BTS	0.948	0.948	0.001	0.963	0.962	0.001	1.025	1.024	0.001	0.913	0.912	0.001
	2L293 SEL-NLY	0.949	0.949	0.000	0.963	0.963	0.001	1.026	1.025	0.000	0.914	0.914	0.000
	2L294 CBK-NLY	0.931	0.924	0.025	0.946	0.941	0.023	1.013	1.032	-0.006	0.899	0.886	0.028
	2L295 SEL-KCL	0.948	0.948	0.001	0.963	0.963	0.001	1.025	1.024	0.001	0.913	0.912	0.001
	1L274 NTL-POCATER	0.955	0.958	-0.009	0.969	0.971	-0.007	1.046	1.037	-0.011	0.928	0.938	-0.025
	1L275 NTL-COLEMAN	0.950	0.947	0.002	0.963	0.960	0.004	1.048	1.031	-0.006	0.930	0.928	-0.015
	5L82 NIC-MDN	0.946	0.947	0.002	0.960	0.961	0.003	1.023	1.024	0.002	0.910	0.911	0.002
N-2	5L76&5L79	0.962	0.948	0.001	0.978	0.963	0.001	1.037	1.024	0.001	0.926	0.912	0.001
	5L91&5L96	1.027	0.994	-0.045	1.047	1.026	-0.062	1.088	1.027	-0.001	0.992	0.962	-0.049
	5L81&5L82	0.963	0.951	-0.002	0.980	0.967	-0.003	1.038	1.027	-0.001	0.928	0.915	-0.002
	5L96&5L98	0.939	0.944	0.005	0.953	0.959	0.005	1.018	1.029	-0.004	0.905	0.908	0.006
	5L51&5L52	1.070	1.016	-0.067	1.089	1.047	-0.083	1.193	1.028	-0.003	1.054	0.999	-0.086
	2L288&2L295	0.948	0.947	0.002	0.962	0.962	0.002	1.024	1.024	0.001	0.912	0.912	0.002
	2L289&2L295	0.946	0.946	0.003	0.961	0.961	0.003	1.023	1.023	0.002	0.911	0.911	0.003
	2L295&2L299	0.946	0.946	0.003	0.961	0.961	0.003	1.023	1.023	0.002	0.911	0.911	0.003

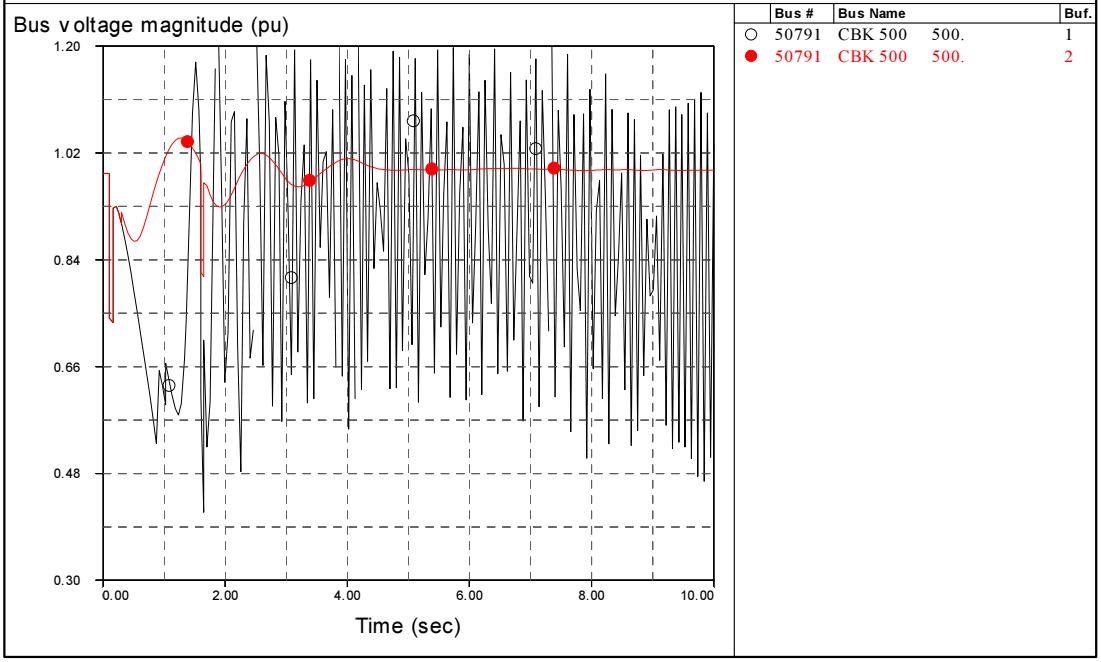
G.15 y17c21, Contingency 5L76& 5L79 with Increased Gen Shedding

Original gen shedding: ALHG1 (52144, 1) = 70 MW

Revised gen shedding = ALHG1 (52144, 1) + REV G1 (50644, 1) + REV G2 (50645, 2) + KCL G1(50769, 1) total of 1195 MW is shed.

TSAT Aug 08, 2014 14:40:16

Buf.	Binary Result File	Scenario	Contingency
1	y17c21.bin	Base Scenario	1 -- 5L765L79 3PH@ACK 500KV
2	y17c21.bin	Base Scenario	2 -- 5L765L79 3PH@ACK 500KV - GS

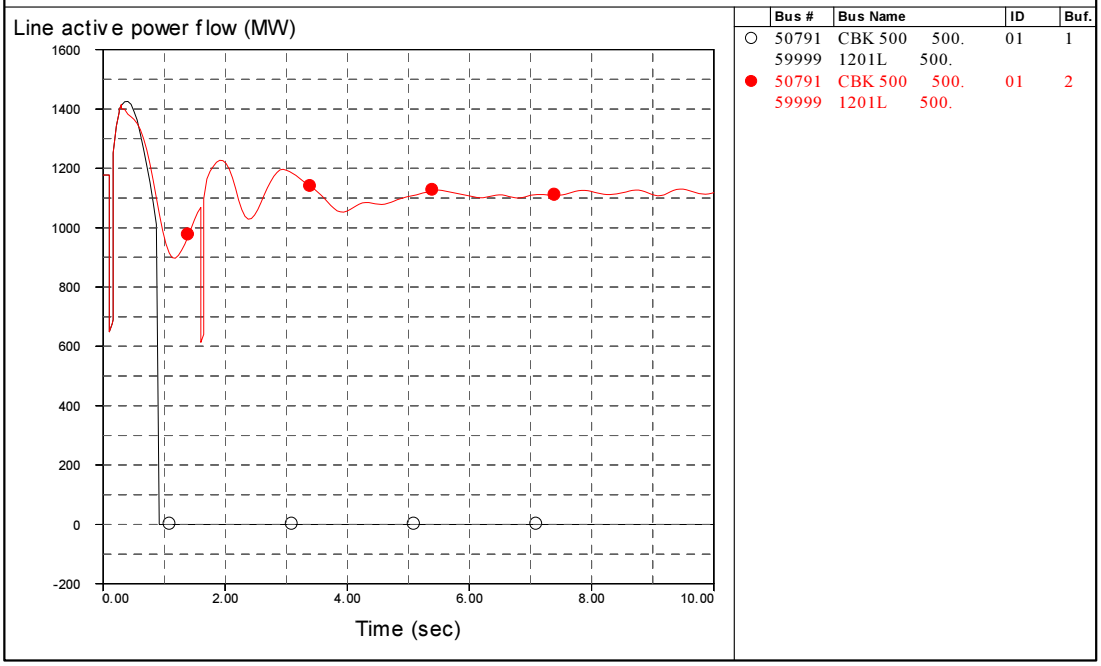


	Bus #	Bus Name		Buf.
○	50791	CBK 500	500.	1
●	50791	CBK 500	500.	2

DSATools Output Analysis 11.0
Powertech Labs Inc.

TSAT Aug 08, 2014 14:40:16

Buf.	Binary Result File	Scenario	Contingency
1	y17c21.bin	Base Scenario	1 -- 5L765L79 3PH@ACK 500KV
2	y17c21.bin	Base Scenario	2 -- 5L765L79 3PH@ACK 500KV - GS



	Bus #	Bus Name		ID	Buf.
○	50791	CBK 500	500.	01	1
	59999	1201L	500.		
●	50791	CBK 500	500.	01	2
	59999	1201L	500.		

DSATools OutputAnalysis 11.0
Powertech Labs Inc.

G.16 y17c31, y22c31, Contingency 5L76&5L79 without Direct Transfer Tripping of 5L94

Monitored Variables - y17c31_ST

	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
Cont. Name							
Pre Contingency	1.018	1.021	1.018	1.000	0.972	1.027	1.022
5L76&5L79	1.001	1.012	1.007	0.990	0.963	1.022	1.021

Monitored Variables - y17c31_LT

	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
Cont. Name							
Pre Contingency	1.018	1.021	1.018	1.000	0.972	1.027	1.022
5L76&5L79	1.008	1.016	1.014	0.998	0.970	1.025	1.022

Monitored Variables - y22c31_ST

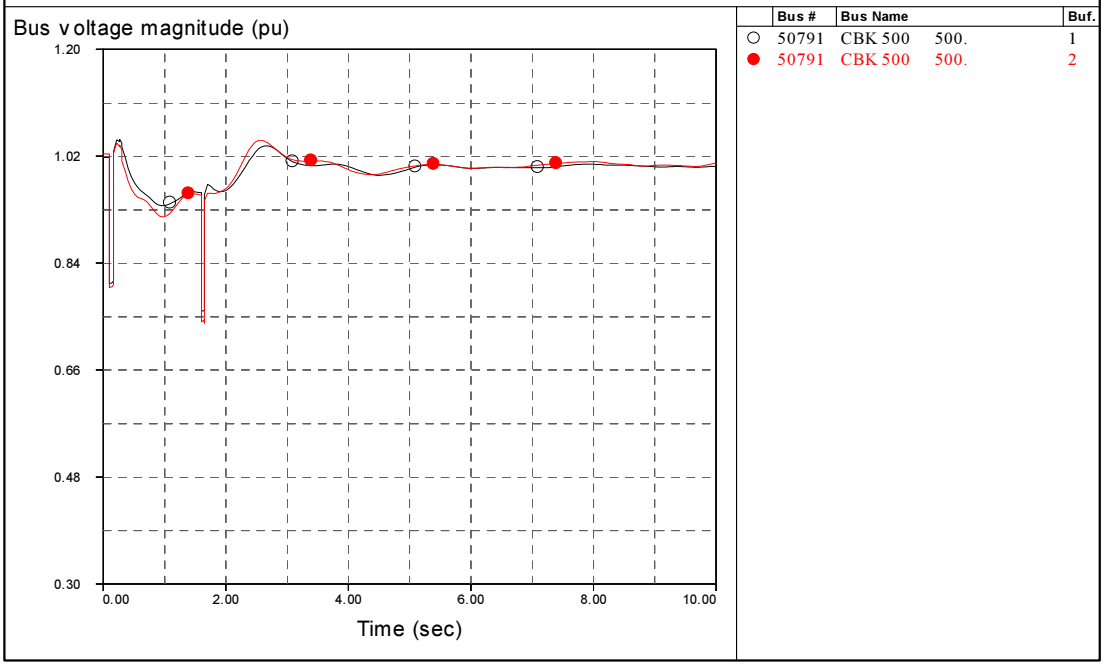
	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
Cont. Name							
Pre Contingency	1.025	1.026	1.024	0.998	0.970	1.030	1.034
5L76&5L79	1.011	1.017	1.012	0.987	0.959	1.025	1.033

Monitored Variables - y22c31_LT

	[50792] SEL 500	[50783] SEL 230	[50791] CBK 500	[50782] CBK 230	[50787] NTL 230	[50784] NLY 230	[54158] LANG 500
Cont. Name							
Pre Contingency	1.025	1.026	1.024	0.998	0.970	1.030	1.034
5L76&5L79	1.021	1.024	1.023	0.997	0.969	1.030	1.034

TSAT Dec 16, 2014 17:17:23

Buf.	Binary Result File	Scenario	Contingency
1	y17c31_7679.bin	Base Scenario	1 -- 5L765L79 3PH@ACK 500KV
2	y22c31_7679.bin	Base Scenario	1 -- 5L765L79 3PH@ACK 500KV

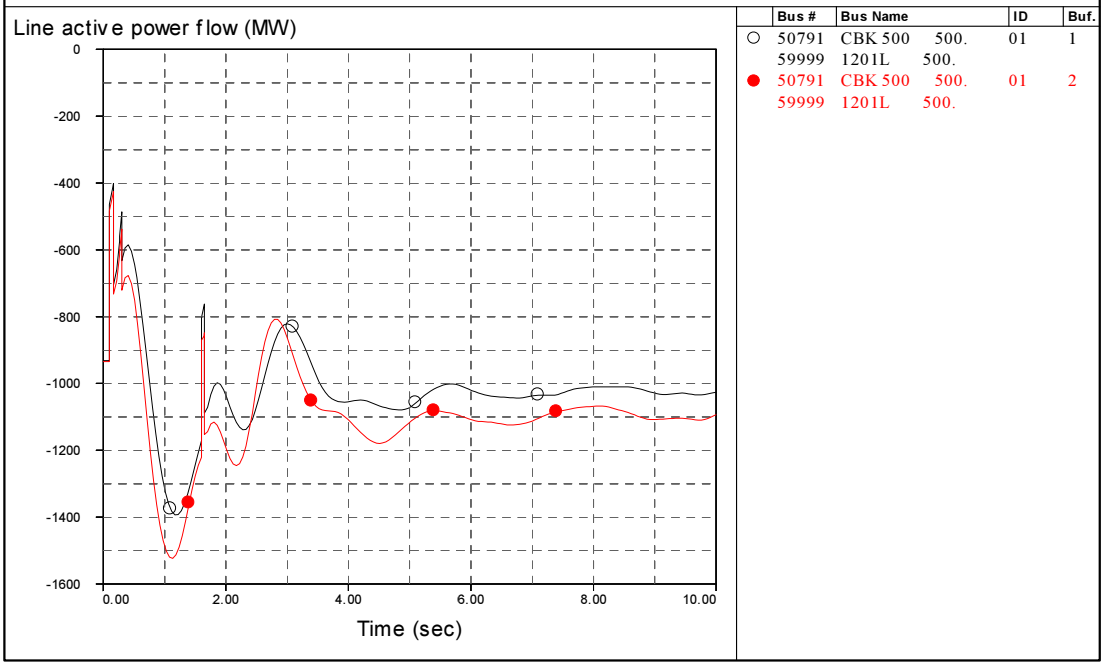


	Bus #	Bus Name		Buf.
○	50791	CBK 500	500.	1
●	50791	CBK 500	500.	2

DSATools Output Analysis 11.0
Powertech Labs Inc.

TSAT Dec 16, 2014 17:17:23

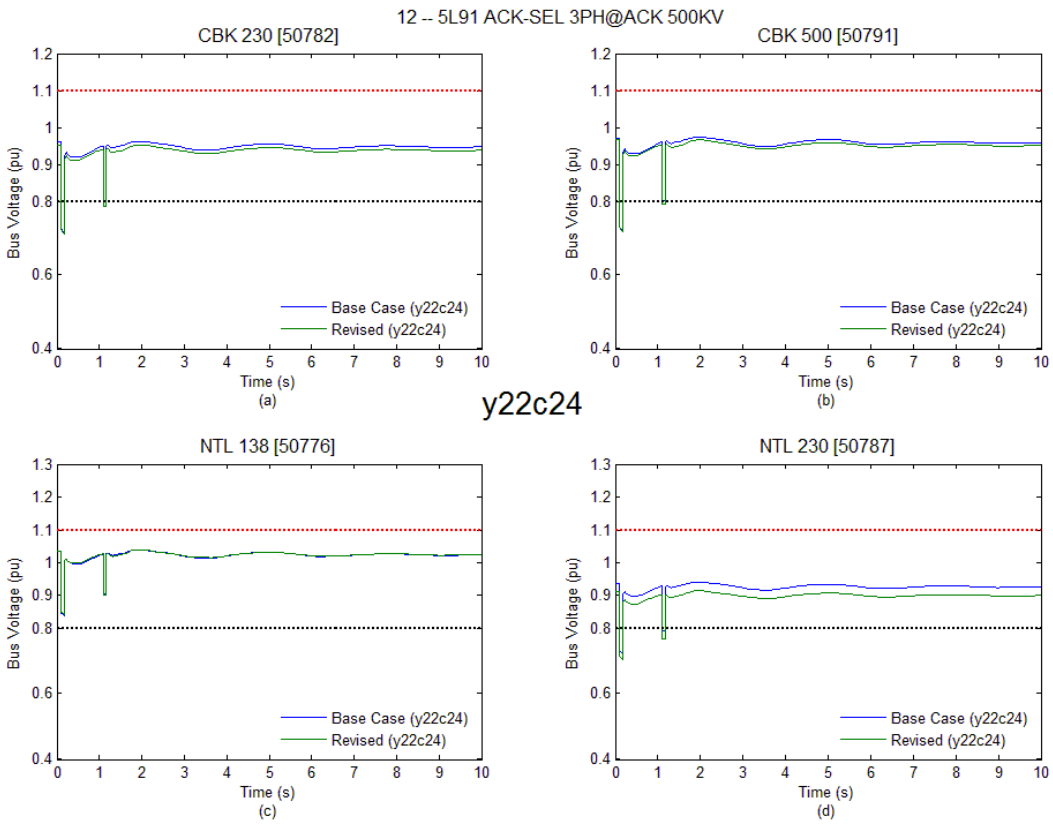
Buf.	Binary Result File	Scenario	Contingency
1	y17c31_7679.bin	Base Scenario	1 -- 5L765L79 3PH@ACK 500KV
2	y22c31_7679.bin	Base Scenario	1 -- 5L765L79 3PH@ACK 500KV

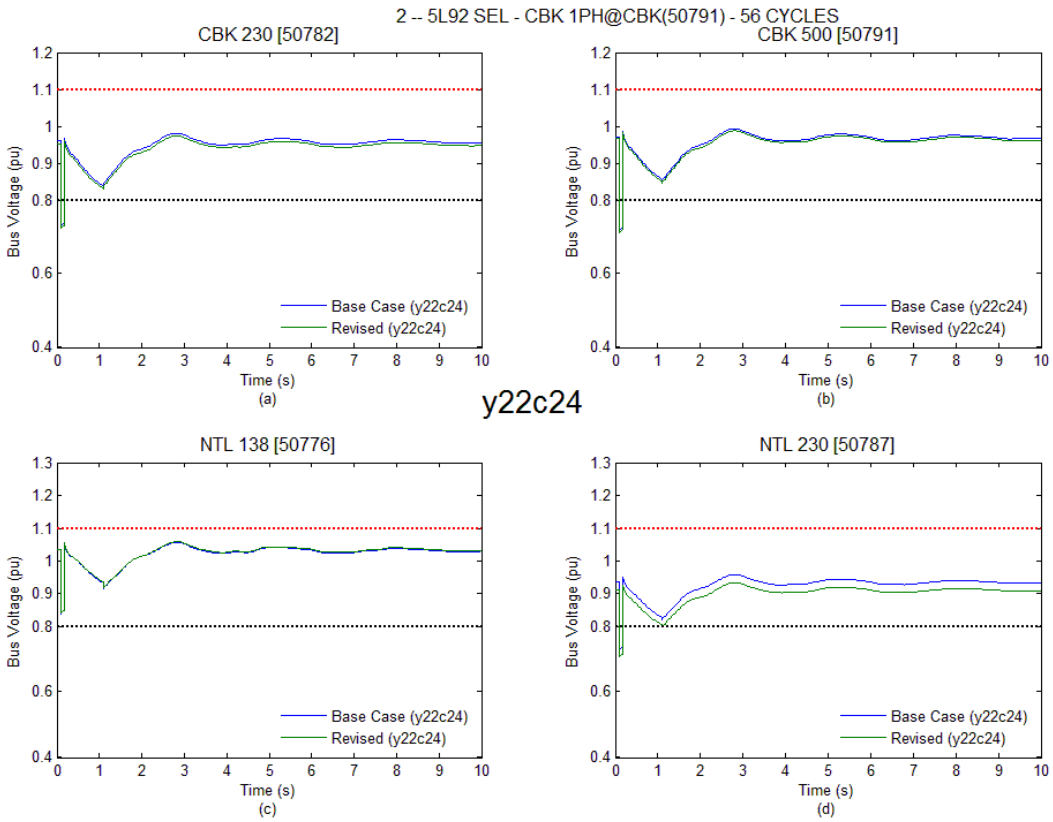


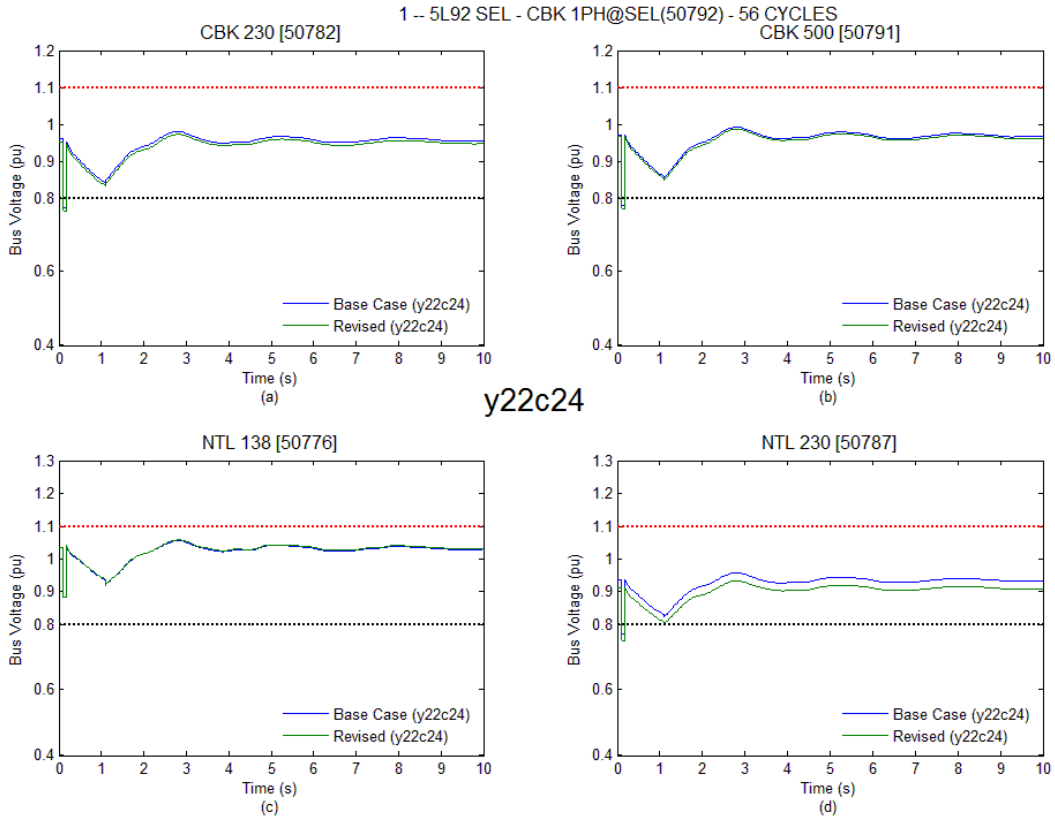
	Bus #	Bus Name		ID	Buf.
○	50791	CBK 500	500.	01	1
	59999	1201L	500.		
●	50791	CBK 500	500.	01	2
	59999	1201L	500.		

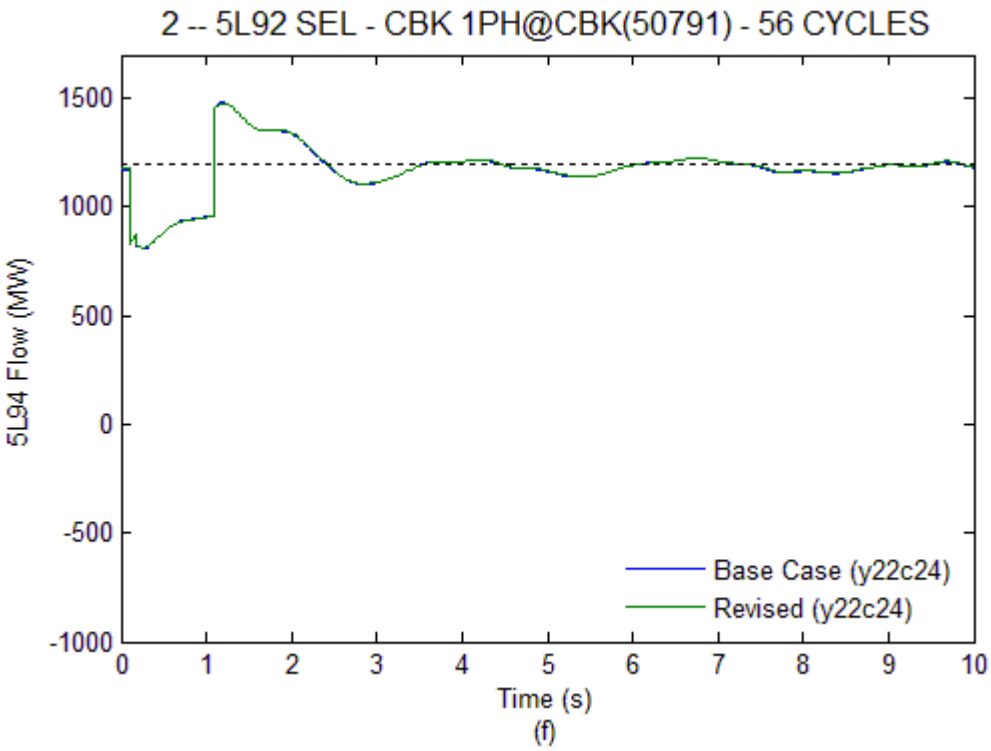
DSATools Output Analysis 11.0
Powertech Labs Inc.

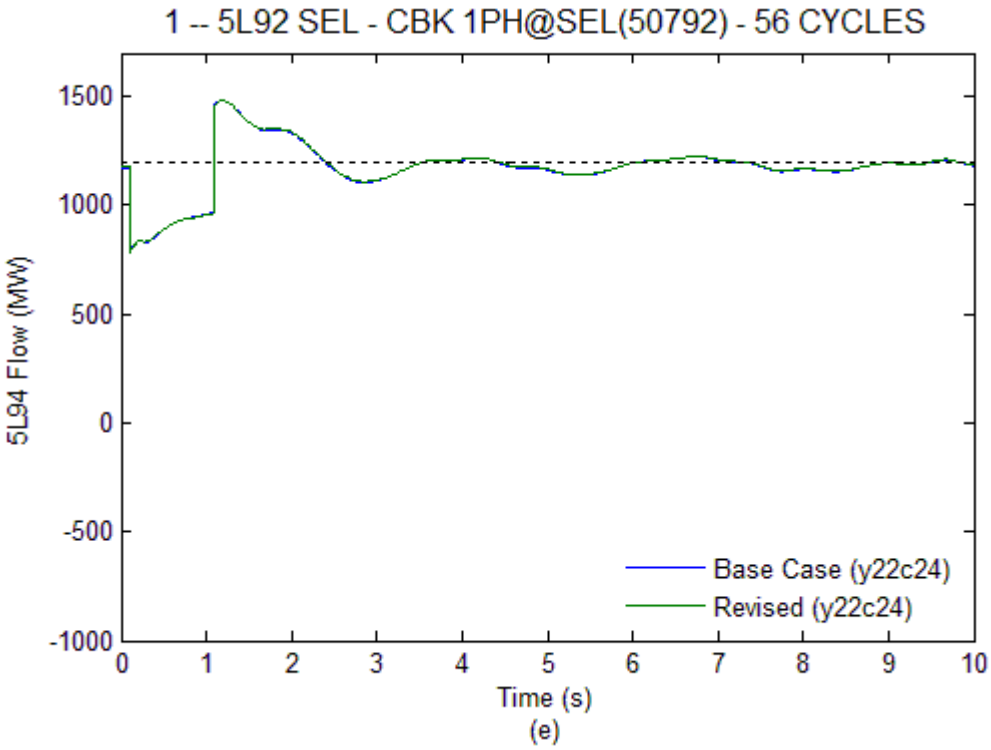
G.17 y22c24, Effect of BCH Project Deferrals



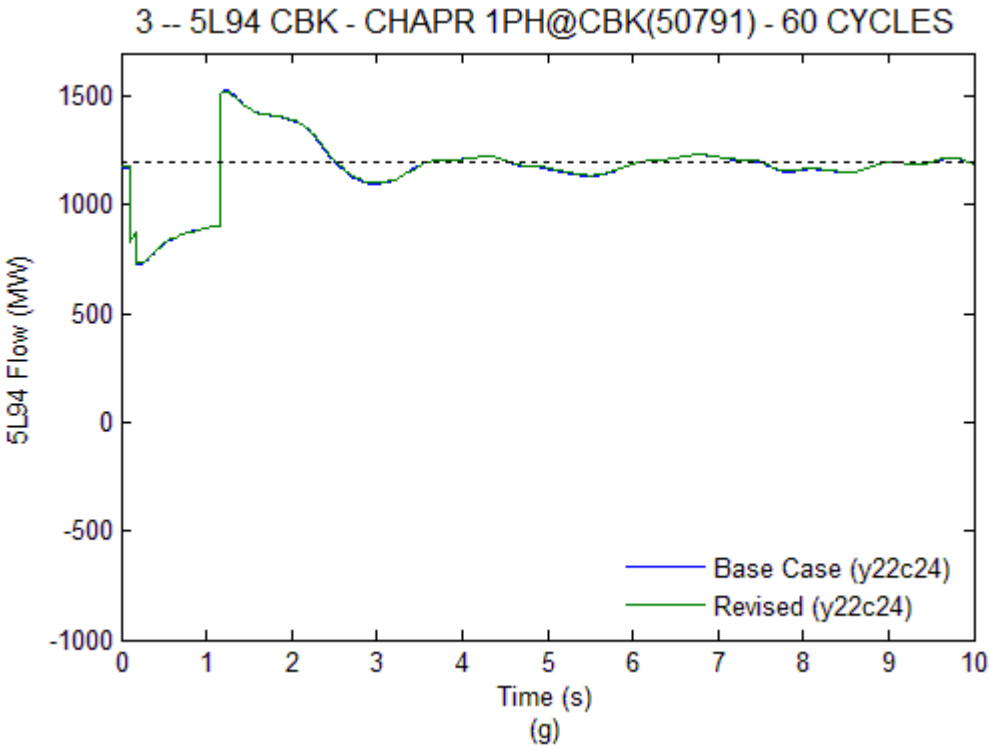




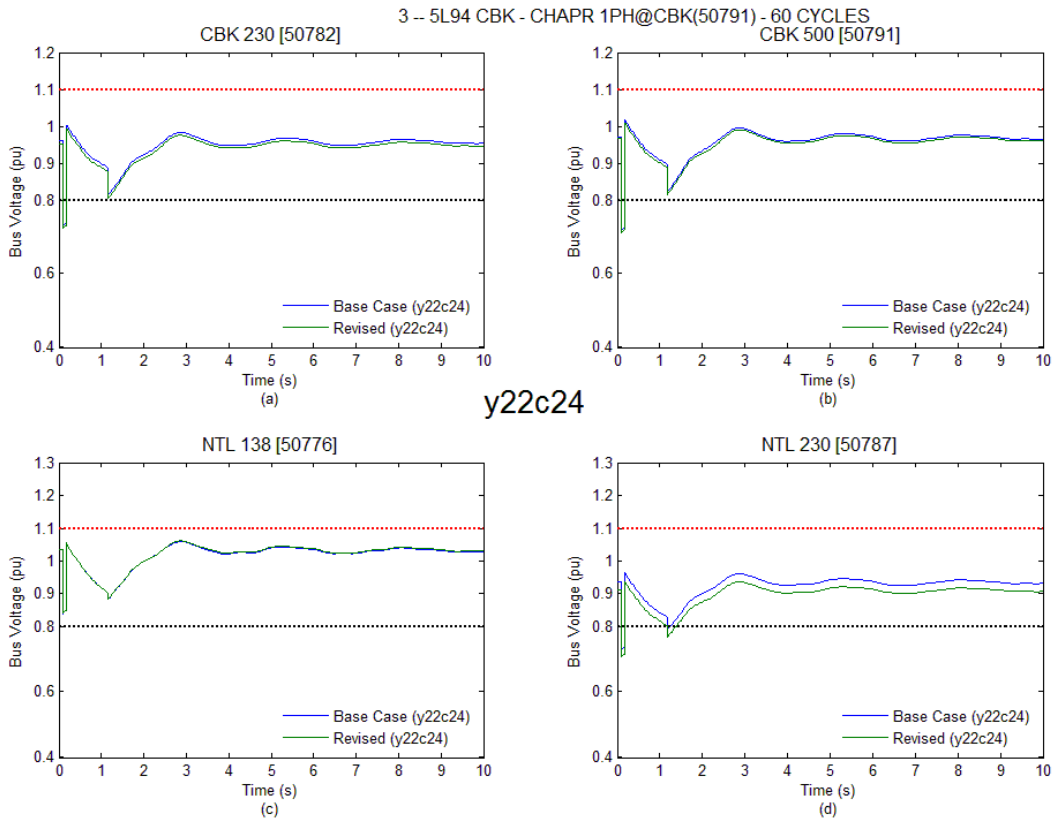


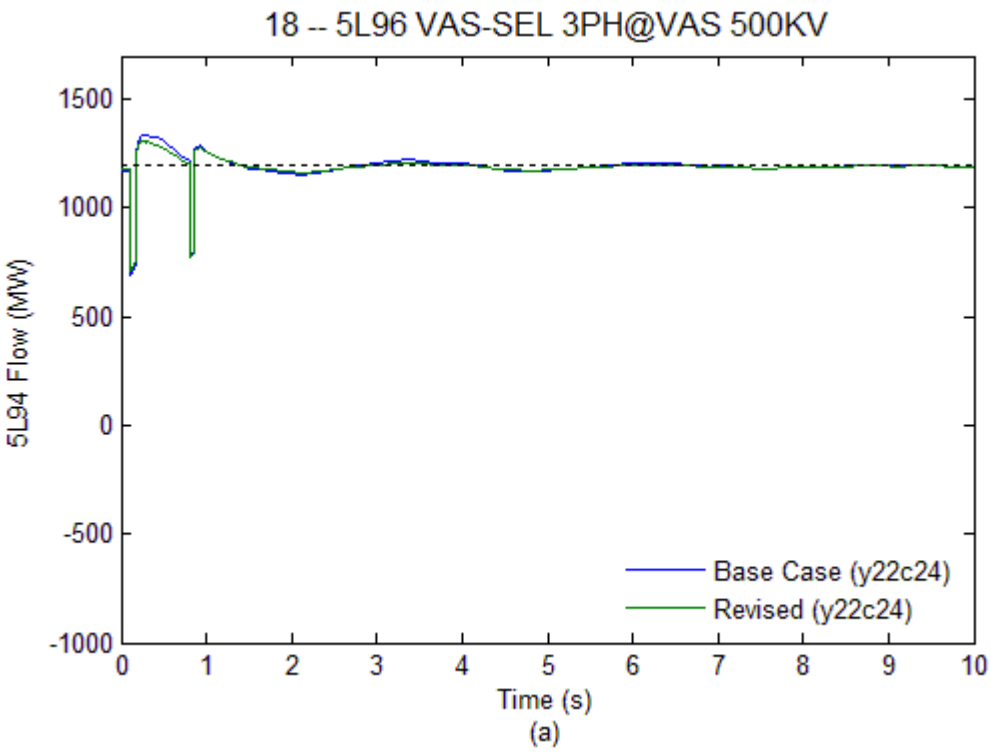


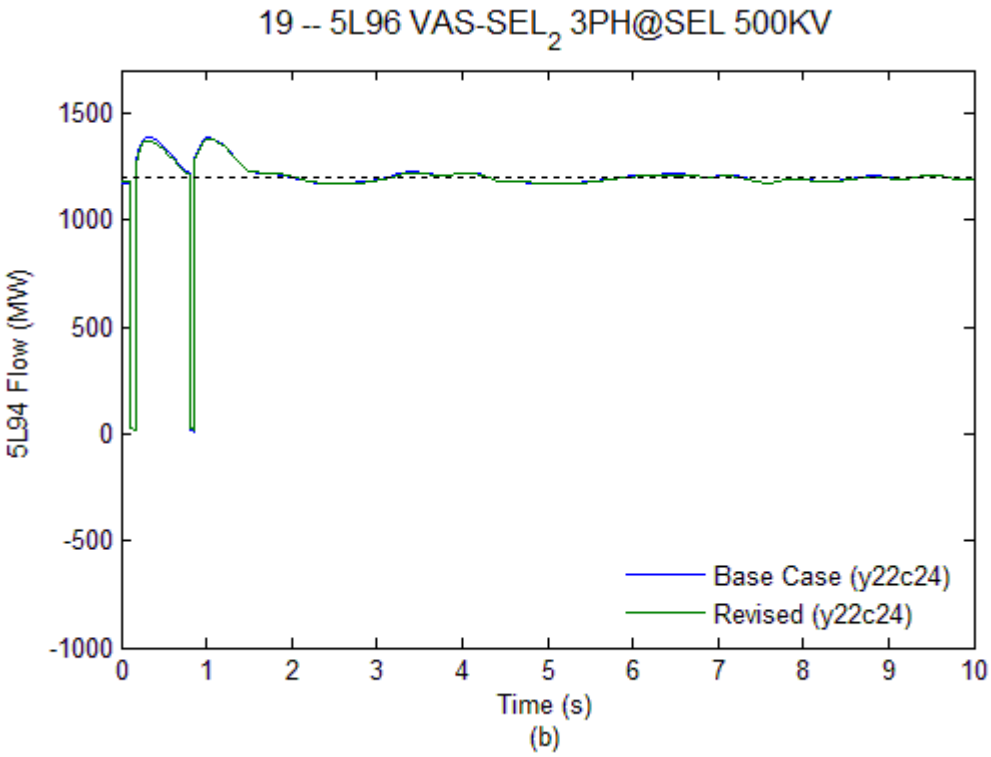
(e)

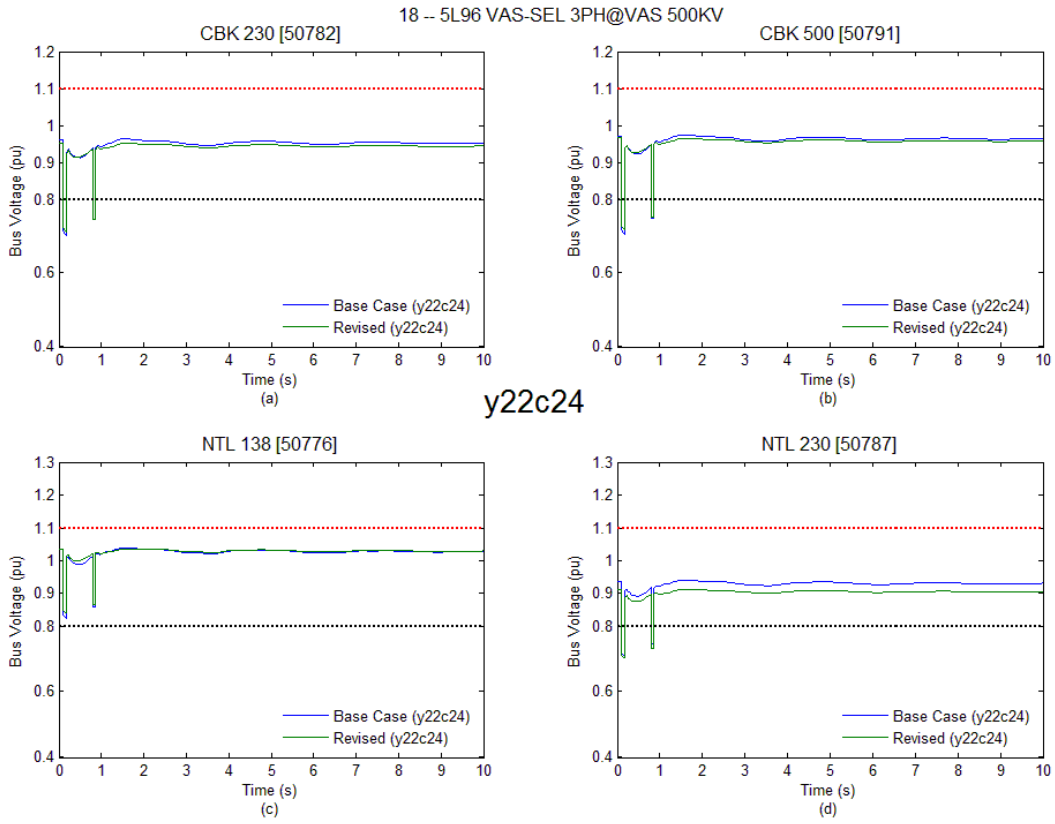


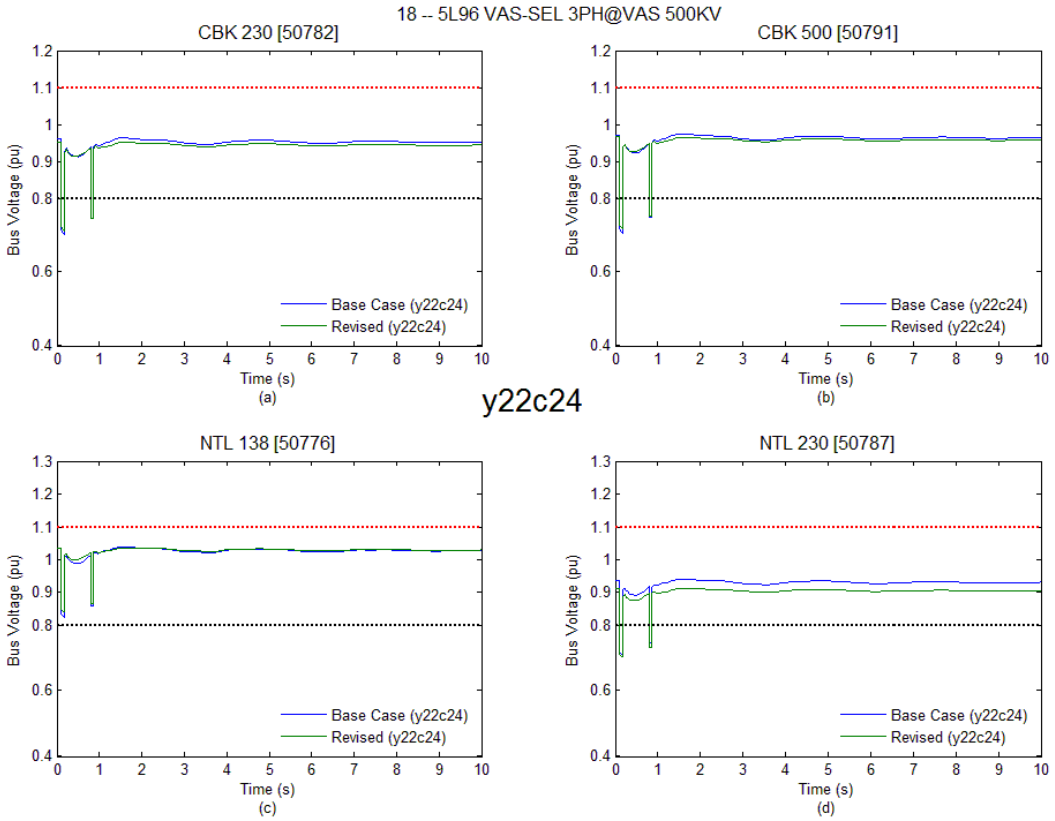
(g)

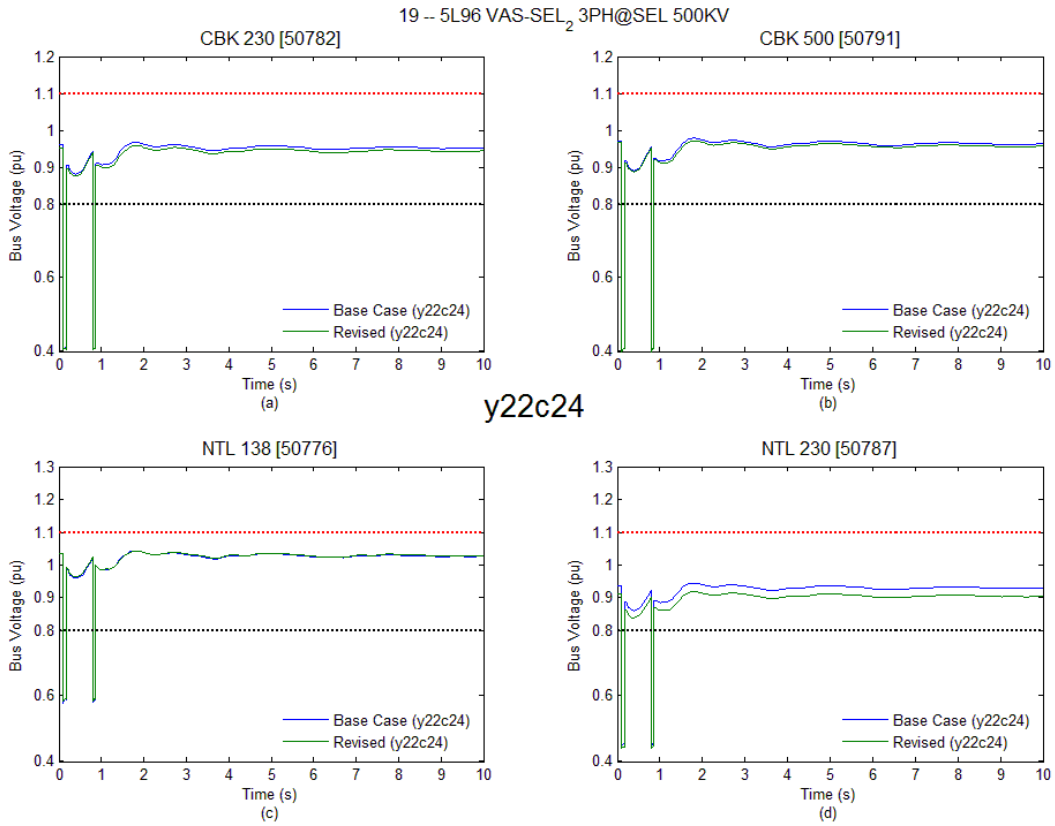


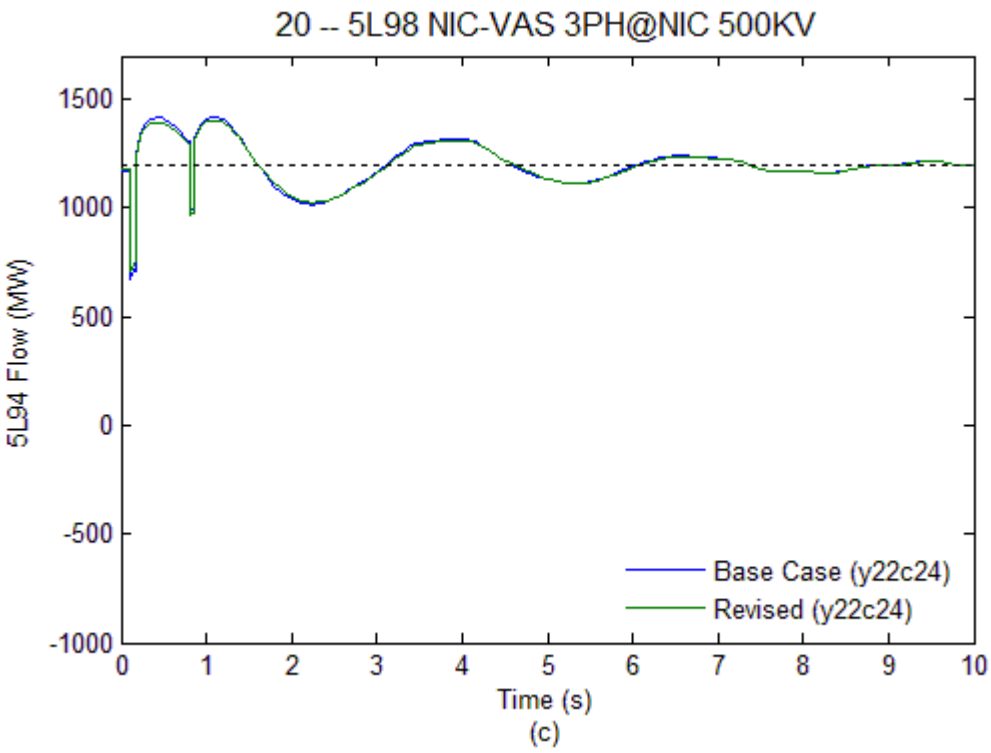


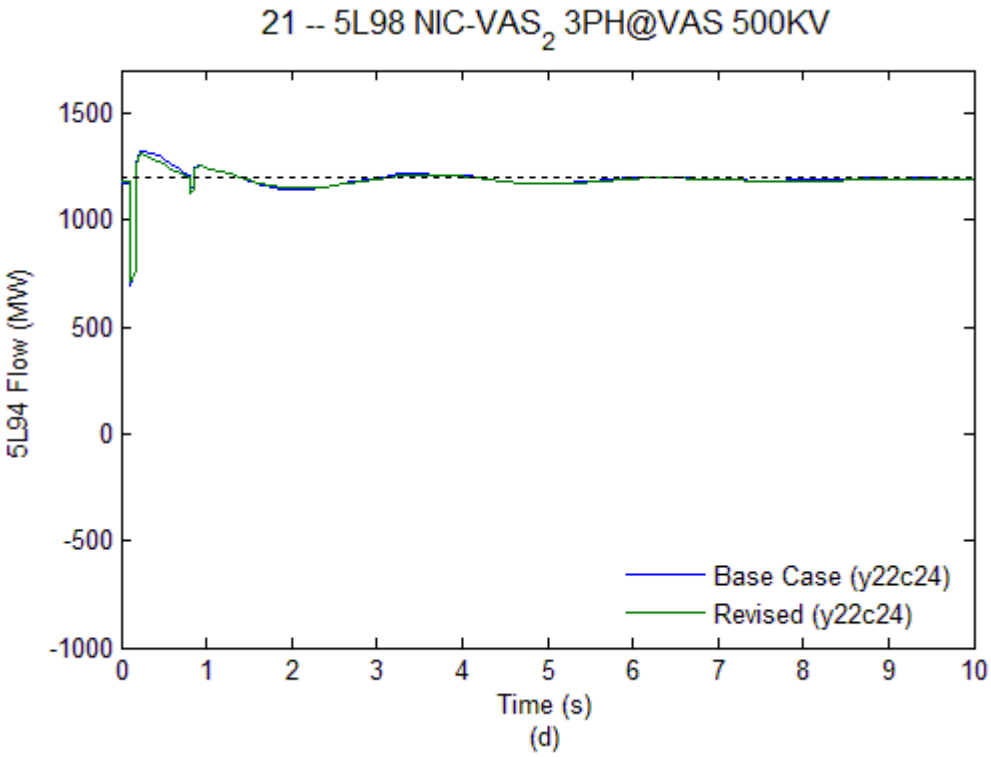


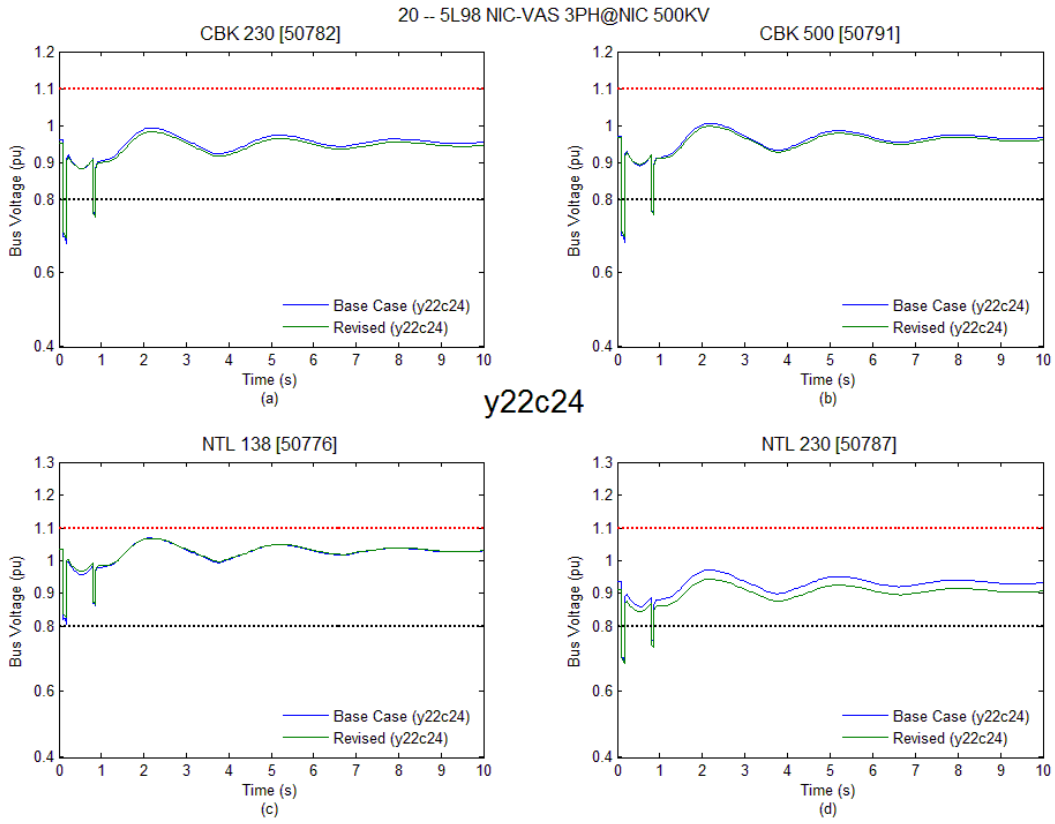


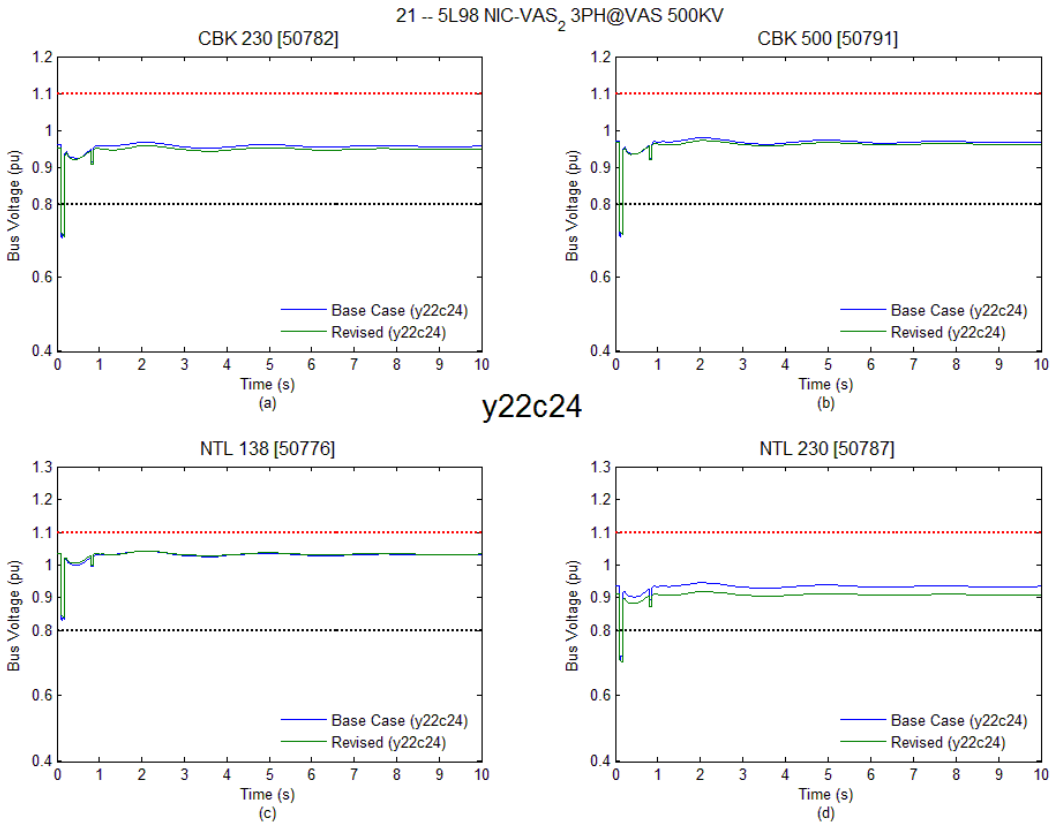












y22c24_Rev		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.952	0.952	0.000	0.966	0.966	0.000	1.036	1.036	0.000	0.912	0.912	0.000
N-1	SEL T1	0.951	0.955	-0.003	0.966	0.970	-0.004	1.035	1.038	-0.002	0.911	0.915	-0.003
	CBK T2+T6	0.952	0.956	-0.003	0.964	0.968	-0.001	1.037	1.040	-0.003	0.913	0.916	-0.003
	SEL Shaft Trip T1	0.956	0.952	0.000	0.970	0.966	0.000	1.039	1.036	0.000	0.916	0.912	0.000
	5L75 REV-ACK	0.952	0.955	-0.003	0.966	0.970	-0.003	1.036	1.038	-0.002	0.912	0.915	-0.003
	5L91 ACK-SEL	1.058	0.948	0.005	1.073	0.962	0.005	1.204	1.033	0.004	1.041	0.908	0.004
	5L92 CBK-SEL	0.948	0.985	-0.033	0.961	1.009	-0.043	1.033	1.037	0.000	0.908	0.969	-0.056
	5L94 CBK-LGN	0.951	1.015	-0.063	0.965	1.043	-0.076	1.035	1.029	0.007	0.911	1.000	-0.087
	5L96 VAS-SEL	0.951	0.953	0.000	0.965	0.967	0.000	1.035	1.037	0.000	0.911	0.913	0.000
	5L98 NIC-VAS	0.956	0.956	-0.003	0.970	0.970	-0.003	1.039	1.039	-0.002	0.916	0.915	-0.003
	2L112 NLY-BDY	0.956	0.955	-0.003	0.970	0.970	-0.003	1.039	1.038	-0.002	0.916	0.915	-0.002
	2L222 SEV-SEL	0.952	0.956	-0.003	0.965	0.970	-0.003	1.036	1.039	-0.002	0.912	0.915	-0.003
	2L258 CBK-INV	0.952	0.947	0.005	0.966	0.966	0.000	1.036	1.033	0.003	0.912	0.908	0.004
	2L277 WAN-NLY	0.951	0.955	-0.003	0.966	0.969	-0.003	1.036	1.039	-0.002	0.912	0.915	-0.003
	2L288 KCL-BTS	0.953	0.956	-0.004	0.966	0.970	-0.004	1.037	1.039	-0.003	0.913	0.916	-0.003
	2L289 SEL-BTS	0.943	0.955	-0.003	0.955	0.970	-0.003	1.030	1.039	-0.002	0.905	0.915	-0.003
	2L293 SEL-NLY	0.951	0.957	-0.005	0.966	0.970	-0.004	1.036	1.040	-0.004	0.912	0.917	-0.004
	2L294 CBK-NLY	0.952	0.945	0.007	0.966	0.958	0.008	1.036	1.032	0.005	0.912	0.907	0.006
	2L295 SEL-KCL	0.956	0.955	-0.003	0.969	0.970	-0.003	1.055	1.039	-0.002	0.924	0.915	-0.003
	1L274 NTL-POCATER	0.951	0.959	-0.007	0.964	0.971	-0.004	1.035	1.031	0.005	0.911	0.938	-0.026
	1L275 NTL-COLEMAN	0.951	0.957	-0.004	0.965	0.968	-0.001	1.035	1.031	0.005	0.911	0.940	-0.028
	5L82 NIC-MDN	0.944	0.955	-0.003	0.958	0.969	-0.003	1.030	1.038	-0.002	0.906	0.915	-0.002
N-2	5L76&5L79	0.935	0.947	0.006	0.949	0.961	0.006	1.025	1.034	0.003	0.898	0.908	0.004
	5L91&5L96	0.976	0.954	-0.002	0.992	0.969	-0.003	1.057	1.038	-0.002	0.935	0.915	-0.002
	5L81&5L82	0.948	0.953	-0.001	0.962	0.967	0.000	1.033	1.037	0.000	0.908	0.913	0.000
	5L96&5L98	1.066	1.015	-0.062	1.082	1.044	-0.077	1.215	1.148	-0.112	1.049	0.995	-0.082
	5L51&5L52	0.964	0.954	-0.001	0.979	0.968	-0.002	1.047	1.037	-0.001	0.924	0.914	-0.001
	2L288&2L295	0.951	0.955	-0.002	0.965	0.969	-0.003	1.035	1.038	-0.002	0.911	0.915	-0.002
	2L289&2L295	0.956	0.956	-0.003	0.970	0.970	-0.004	1.039	1.039	-0.002	0.916	0.915	-0.003
	2L295&2L299	0.952	0.955	-0.002	0.966	0.969	-0.003	1.036	1.038	-0.002	0.912	0.914	-0.002

G.18 Chapel Rock 500/240 kV Fixed-Tap Transformer Model Sensitivity

Case Name	Comments/ Notes
Y22C27_Trsncx1	Base Case: Y22C27 Transformer Sensitivity Case-1 Chapel Rock 500/240 kV taps fixed at 1
Y22C27_Trsncx2	Base Case: Y22C27 Transformer Sensitivity Case-2 Chapel Rock 500/240 kV taps fixed at 0.975
Y22C31_Trsncx3	Base Case: Y22C31 Transformer Sensitivity Case-3 Chapel Rock 500/240 kV taps fixed at 1
Y22C31_Trsncx4	Base Case: Y22C31 Transformer Sensitivity Case-4 Chapel Rock 500/240 kV taps fixed at 0.975

G.18.1 Power Flow Contingency Results

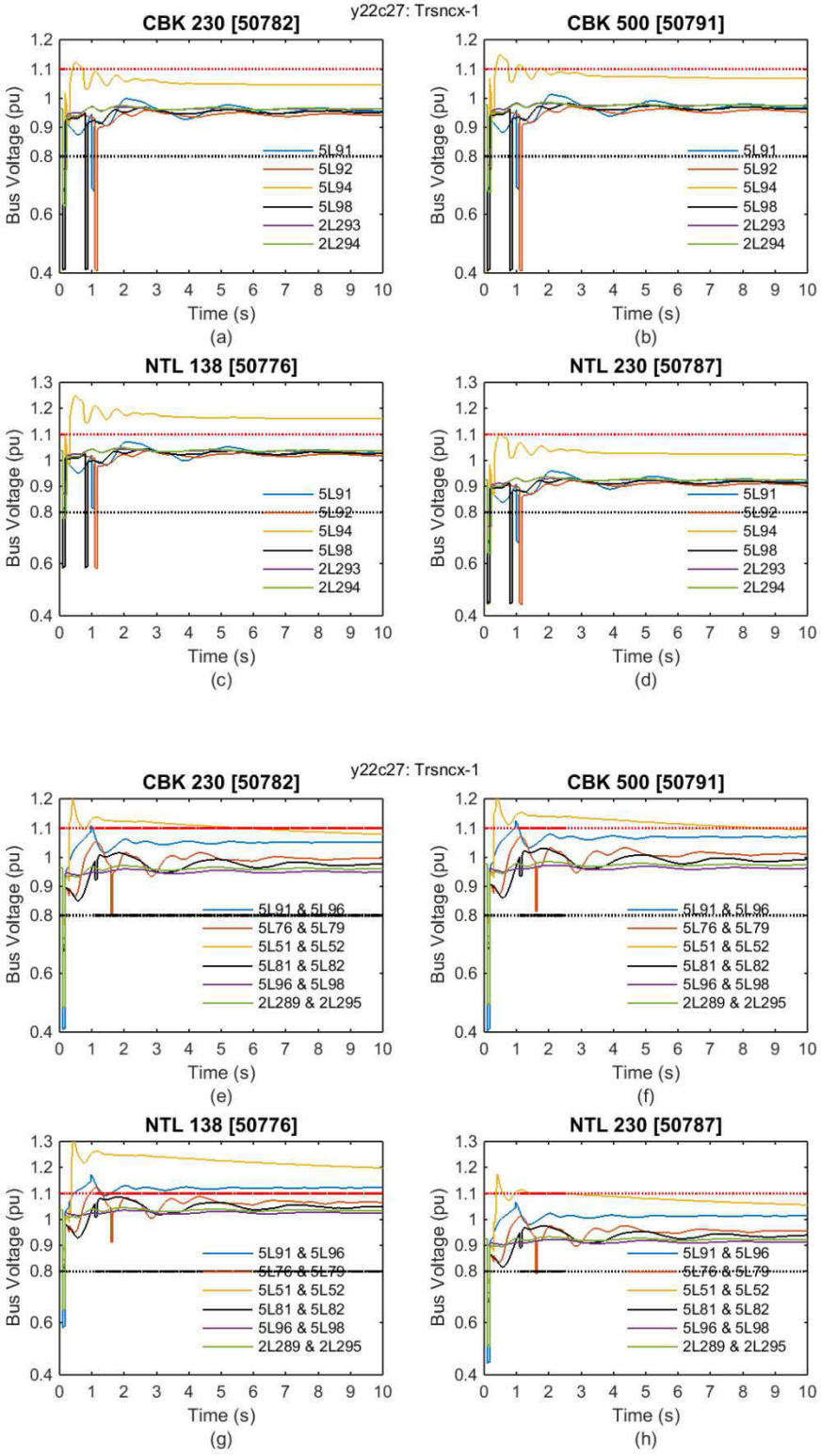
y22c27 Trscnx 1		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.964	0.964	0.000	0.977	0.977	0.000	1.037	1.037	0.000	0.925	0.925	0.000
N-1	SEL T1	0.963	0.963	0.001	0.977	0.977	0.000	1.037	1.037	0.000	0.925	0.925	0.000
	CBK T2+T6	0.963	0.963	0.001	0.974	0.974	0.003	1.038	1.038	-0.001	0.926	0.925	0.000
	SEL Shaft Trip T1	0.964	0.964	0.000	0.977	0.977	0.000	1.037	1.038	-0.001	0.925	0.925	0.000
	5L75 REV-ACK	0.962	0.966	-0.002	0.976	0.980	-0.003	1.037	1.039	-0.002	0.924	0.927	-0.002
	5L91 ACK-SEL	0.952	0.953	0.011	0.965	0.967	0.010	1.029	1.038	-0.001	0.915	0.913	0.012
	5L92 CBK-SEL	0.975	0.979	-0.015	0.999	1.003	-0.026	1.090	1.030	0.007	0.957	0.962	-0.037
	5L94 CBK-LGN	1.065	1.019	-0.055	1.079	1.045	-0.068	1.199	1.033	0.004	1.049	1.004	-0.079
	5L96 VAS-SEL	0.957	0.961	0.003	0.970	0.974	0.003	1.033	1.036	0.001	0.920	0.923	0.002
	5L98 NIC-VAS	0.961	0.964	0.000	0.974	0.977	0.000	1.036	1.037	0.000	0.923	0.925	0.000
	2L112 NLY-BDY	0.962	0.966	-0.002	0.976	0.980	-0.003	1.036	1.039	-0.002	0.924	0.927	-0.002
	2L222 SEV-SEL	0.964	0.964	0.000	0.977	0.977	0.000	1.038	1.038	-0.001	0.925	0.925	0.000
	2L258 CBK-INV	0.954	0.955	0.009	0.973	0.973	0.004	1.031	1.032	0.005	0.917	0.918	0.007
	2L277 WAN-NLY	0.963	0.963	0.001	0.976	0.976	0.001	1.037	1.037	0.000	0.924	0.924	0.001
	2L288 KCL-BTS	0.964	0.964	0.000	0.977	0.977	0.000	1.037	1.037	0.000	0.925	0.925	0.000
	2L289 SEL-BTS	0.963	0.963	0.001	0.976	0.976	0.001	1.037	1.037	0.000	0.924	0.924	0.001
	2L293 SEL-NLY	0.964	0.965	-0.001	0.976	0.977	0.000	1.038	1.038	-0.001	0.926	0.926	-0.001
	2L294 CBK-NLY	0.954	0.957	0.007	0.966	0.970	0.007	1.032	1.034	0.003	0.918	0.920	0.005
	2L295 SEL-KCL	0.963	0.967	-0.003	0.976	0.981	-0.004	1.037	1.040	-0.003	0.924	0.928	-0.003
	1L274 NTL-POCATER	0.967	0.970	-0.006	0.980	0.981	-0.004	1.056	1.039	-0.002	0.937	0.948	-0.023
	1L275 NTL-COLEMAN	0.968	0.968	-0.004	0.979	0.979	-0.002	1.082	1.031	0.006	0.950	0.950	-0.025
	5L82 NIC-MDN	0.961	0.966	-0.002	0.975	0.979	-0.002	1.036	1.039	-0.002	0.923	0.927	-0.002
N-2	5L76&5L79	0.978	0.964	0.000	0.992	0.978	-0.001	1.049	1.038	-0.001	0.939	0.925	0.000
	5L91&5L96	1.033	1.000	-0.036	1.049	1.029	-0.052	1.102	1.072	-0.035	0.995	0.959	-0.034
	5L81&5L82	0.972	0.965	-0.001	0.986	0.979	-0.002	1.045	1.039	-0.002	0.934	0.926	-0.001
	5L96&5L98	0.957	0.960	0.004	0.970	0.974	0.003	1.033	1.035	0.002	0.919	0.922	0.003
	5L51&5L52	1.088	1.031	-0.067	1.103	1.060	-0.083	1.228	1.153	-0.116	1.074	1.012	-0.087
	2L288&2L295	0.963	0.967	-0.003	0.976	0.981	-0.004	1.037	1.040	-0.003	0.924	0.928	-0.003
	2L289&2L295	0.962	0.966	-0.002	0.975	0.980	-0.003	1.036	1.039	-0.002	0.924	0.927	-0.002
	2L295&2L299	0.962	0.966	-0.002	0.975	0.980	-0.003	1.036	1.039	-0.002	0.924	0.927	-0.002

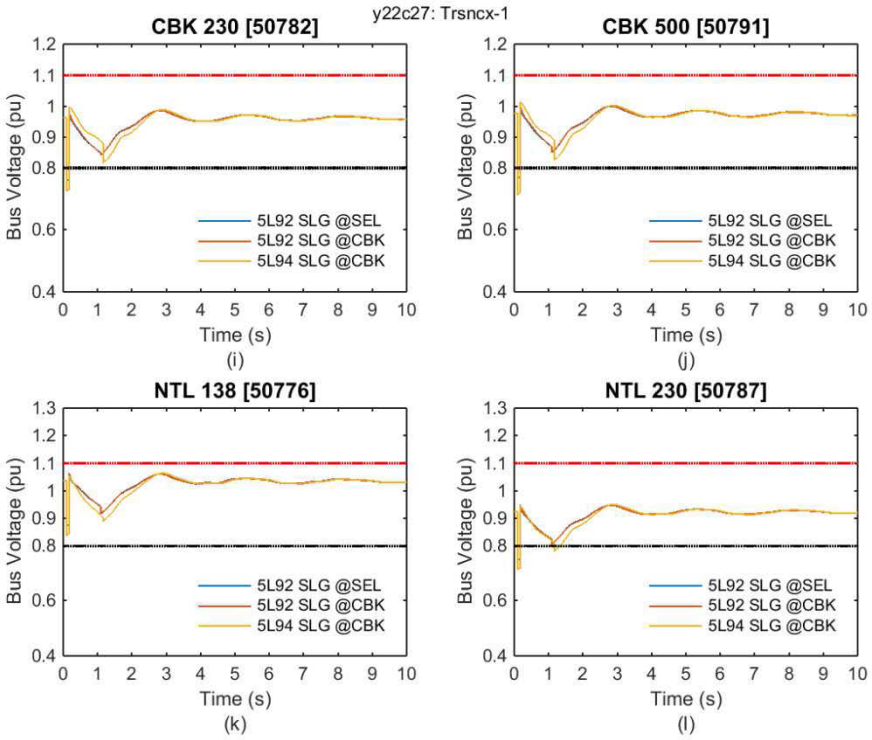
y22c27 Trscnx 2		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.958	0.958	0.000	0.970	0.970	0.000	1.035	1.035	0.000	0.921	0.921	0.000
N-1	SEL T1	0.957	0.957	0.001	0.970	0.970	0.000	1.035	1.035	0.000	0.921	0.921	0.000
	CBK T2+T6	0.958	0.962	-0.004	0.967	0.971	-0.001	1.037	1.039	-0.004	0.922	0.925	-0.004
	SEL Shaft Trip T1	0.957	0.958	0.000	0.970	0.970	0.000	1.035	1.035	0.000	0.921	0.921	0.000
	5L75 REV-ACK	0.956	0.960	-0.002	0.968	0.973	-0.003	1.034	1.037	-0.002	0.920	0.923	-0.002
	5L91 ACK-SEL	0.945	0.946	0.012	0.958	0.959	0.011	1.027	1.035	0.000	0.911	0.908	0.013
	5L92 CBK-SEL	0.975	0.979	-0.021	0.999	1.003	-0.033	1.090	1.030	0.005	0.957	0.962	-0.041
	5L94 CBK-LGN	1.065	1.019	-0.061	1.079	1.045	-0.075	1.199	1.033	0.002	1.049	1.004	-0.083
	5L96 VAS-SEL	0.951	0.954	0.004	0.963	0.967	0.003	1.030	1.033	0.002	0.915	0.918	0.003
	5L98 NIC-VAS	0.954	0.958	0.000	0.967	0.970	0.000	1.033	1.035	0.000	0.918	0.921	0.000
	2L112 NLY-BDY	0.956	0.960	-0.002	0.968	0.973	-0.003	1.034	1.037	-0.002	0.919	0.923	-0.002
	2L222 SEV-SEL	0.957	0.958	0.000	0.970	0.970	0.000	1.035	1.035	0.000	0.921	0.921	0.000
	2L258 CBK-INV	0.948	0.948	0.010	0.965	0.966	0.004	1.028	1.036	-0.001	0.913	0.910	0.011
	2L277 WAN-NLY	0.957	0.961	-0.003	0.969	0.974	-0.004	1.035	1.038	-0.003	0.920	0.924	-0.003
	2L288 KCL-BTS	0.958	0.961	-0.003	0.970	0.974	-0.004	1.035	1.038	-0.003	0.921	0.924	-0.003
	2L289 SEL-BTS	0.957	0.961	-0.003	0.969	0.974	-0.004	1.035	1.038	-0.003	0.920	0.924	-0.003
	2L293 SEL-NLY	0.958	0.963	-0.005	0.969	0.974	-0.004	1.036	1.039	-0.004	0.922	0.925	-0.004
	2L294 CBK-NLY	0.947	0.949	0.009	0.959	0.962	0.008	1.029	1.037	-0.002	0.913	0.911	0.010
	2L295 SEL-KCL	0.957	0.961	-0.003	0.969	0.974	-0.004	1.035	1.038	-0.003	0.920	0.924	-0.003
	1L274 NTL-POCATER	0.961	0.964	-0.006	0.973	0.974	-0.004	1.054	1.036	-0.001	0.933	0.944	-0.023
	1L275 NTL-COLEMAN	0.961	0.961	-0.003	0.971	0.971	-0.001	1.075	1.036	-0.001	0.944	0.944	-0.023
	5L82 NIC-MDN	0.955	0.960	-0.002	0.967	0.972	-0.002	1.034	1.037	-0.002	0.919	0.923	-0.002
N-2	5L76&5L79	0.972	0.961	-0.003	0.985	0.974	-0.004	1.047	1.038	-0.003	0.935	0.924	-0.003
	5L91&5L96	1.025	0.993	-0.035	1.041	1.022	-0.052	1.098	1.069	-0.034	0.990	0.954	-0.033
	5L81&5L82	0.966	0.959	-0.001	0.979	0.972	-0.002	1.043	1.036	-0.001	0.930	0.922	-0.001
	5L96&5L98	0.950	0.954	0.004	0.962	0.966	0.004	1.030	1.033	0.002	0.915	0.918	0.003
	5L51&5L52	1.088	1.031	-0.073	1.103	1.060	-0.090	1.228	1.153	-0.118	1.074	1.012	-0.091
	2L288&2L295	0.957	0.961	-0.003	0.969	0.973	-0.003	1.035	1.037	-0.002	0.920	0.923	-0.002
	2L289&2L295	0.956	0.960	-0.002	0.968	0.973	-0.003	1.034	1.037	-0.002	0.919	0.923	-0.002
	2L295&2L299	0.956	0.960	-0.002	0.968	0.973	-0.003	1.034	1.037	-0.002	0.919	0.923	-0.002

y22c31 Trscnx 3		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	1.010	1.010	0.000	1.027	1.027	0.000	1.028	1.028	0.000	0.987	0.987	0.000
N-1	SEL T1	1.009	1.009	0.001	1.026	1.026	0.001	1.028	1.028	0.000	0.987	0.987	0.000
	CBK T2+T6	1.014	1.014	-0.004	1.026	1.026	0.001	1.029	1.031	-0.003	0.990	0.991	-0.004
	SEL Shaft Trip T1	1.011	1.009	0.001	1.027	1.026	0.001	1.028	1.028	0.000	0.988	0.986	0.001
	5L75 REV-ACK	1.009	1.009	0.001	1.025	1.025	0.002	1.027	1.027	0.001	0.986	0.986	0.001
	5L91 ACK-SEL	1.004	1.015	-0.005	1.020	1.034	-0.007	1.022	1.024	0.004	0.982	0.992	-0.005
	5L92 CBK-SEL	1.042	1.027	-0.017	1.066	1.051	-0.024	1.096	1.080	-0.052	1.026	1.011	-0.024
	5L94 CBK-LGN	1.034	1.025	-0.015	1.054	1.044	-0.017	1.088	1.078	-0.049	1.018	1.009	-0.022
	5L96 VAS-SEL	1.007	1.001	0.009	1.023	1.017	0.010	1.026	1.022	0.006	0.984	0.979	0.008
	5L98 NIC-VAS	1.011	1.005	0.005	1.028	1.022	0.005	1.028	1.025	0.003	0.988	0.983	0.004
	2L112 NLY-BDY	1.010	1.010	0.000	1.026	1.026	0.001	1.028	1.028	0.000	0.987	0.987	0.000
	2L222 SEV-SEL	1.010	1.009	0.001	1.027	1.025	0.002	1.027	1.027	0.001	0.987	0.986	0.001
	2L258 CBK-INV	1.001	1.001	0.009	1.022	1.022	0.005	1.023	1.023	0.005	0.980	0.980	0.007
	2L277 WAN-NLY	1.010	1.010	0.000	1.026	1.026	0.001	1.028	1.028	0.000	0.987	0.987	0.000
	2L288 KCL-BTS	1.010	1.010	0.000	1.027	1.027	0.000	1.028	1.028	0.000	0.987	0.987	0.000
	2L289 SEL-BTS	1.009	1.009	0.001	1.026	1.026	0.001	1.028	1.028	0.000	0.987	0.987	0.000
	2L293 SEL-NLY	1.010	1.010	0.000	1.027	1.027	0.000	1.029	1.029	-0.001	0.987	0.987	0.000
	2L294 CBK-NLY	1.004	1.004	0.006	1.023	1.023	0.004	1.025	1.024	0.004	0.982	0.982	0.005
	2L295 SEL-KCL	1.009	1.009	0.001	1.026	1.026	0.001	1.028	1.028	0.000	0.987	0.987	0.000
	1L274 NTL-POCATER	1.011	1.010	0.000	1.027	1.026	0.001	1.044	1.037	-0.009	0.994	0.992	-0.005
	1L275 NTL-COLEMAN	1.012	1.012	-0.002	1.027	1.027	0.000	1.064	1.039	-0.011	0.996	0.997	-0.010
	5L82 NIC-MDN	1.010	1.009	0.001	1.026	1.026	0.001	1.028	1.028	0.000	0.987	0.987	0.000
N-2	5L76&5L79	1.039	1.025	-0.015	1.060	1.045	-0.018	1.093	1.078	-0.050	1.023	1.009	-0.022
	5L91&5L96	1.046	1.027	-0.017	1.066	1.047	-0.020	1.068	1.040	-0.012	1.021	1.002	-0.015
	5L81&5L82	1.008	1.008	0.002	1.025	1.025	0.002	1.025	1.027	0.001	0.985	0.986	0.001
	5L96&5L98	1.009	1.004	0.006	1.025	1.021	0.006	1.027	1.024	0.004	0.986	0.982	0.005
	5L51&5L52	1.036	1.029	-0.019	1.056	1.052	-0.025	1.057	1.042	-0.014	1.011	1.004	-0.017
	2L288&2L295	1.009	1.009	0.001	1.025	1.026	0.001	1.027	1.027	0.001	0.986	0.986	0.001
	2L289&2L295	1.012	1.010	0.000	1.029	1.027	0.000	1.028	1.028	0.000	0.989	0.987	0.000
	2L295&2L299	1.011	1.008	0.002	1.027	1.025	0.002	1.028	1.027	0.001	0.987	0.986	0.001

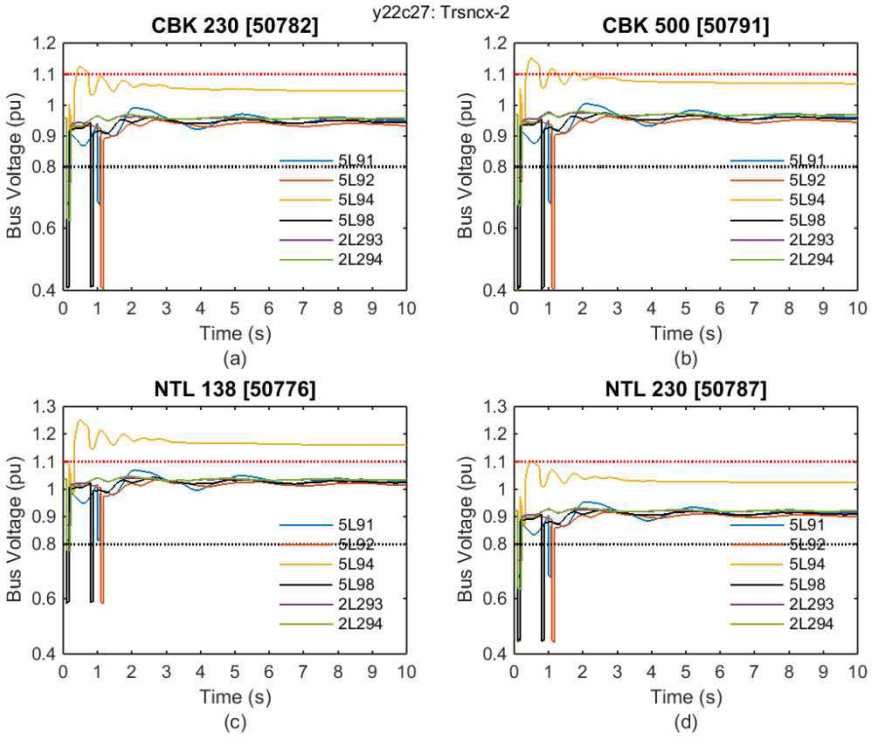
y22c31 Trscnx 4		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	1.002	1.002	0.000	1.017	1.017	0.000	1.032	1.032	0.000	0.978	0.978	0.000
N-1	SEL T1	1.001	1.001	0.001	1.016	1.016	0.001	1.031	1.031	0.001	0.978	0.978	0.000
	CBK T2+T6	1.006	1.007	-0.004	1.015	1.015	0.002	1.034	1.035	-0.003	0.982	0.982	-0.004
	SEL Shaft Trip T1	1.002	1.001	0.001	1.017	1.016	0.001	1.031	1.031	0.001	0.978	0.978	0.000
	5L75 REV-ACK	1.001	1.001	0.001	1.015	1.015	0.002	1.031	1.031	0.001	0.977	0.977	0.001
	5L91 ACK-SEL	0.996	0.995	0.007	1.009	1.009	0.008	1.025	1.027	0.005	0.973	0.972	0.006
	5L92 CBK-SEL	1.057	1.039	-0.037	1.081	1.063	-0.046	1.127	1.107	-0.075	1.040	1.023	-0.045
	5L94 CBK-LGN	1.038	1.025	-0.023	1.057	1.044	-0.027	1.105	1.091	-0.059	1.021	1.008	-0.030
	5L96 VAS-SEL	0.998	0.992	0.010	1.013	1.006	0.011	1.029	1.025	0.008	0.975	0.970	0.008
	5L98 NIC-VAS	1.003	1.001	0.001	1.018	1.016	0.001	1.032	1.031	0.001	0.979	0.977	0.001
	2L112 NLY-BDY	1.001	1.001	0.001	1.016	1.016	0.001	1.031	1.031	0.001	0.978	0.978	0.000
	2L222 SEV-SEL	1.002	1.004	-0.002	1.017	1.019	-0.002	1.031	1.033	-0.001	0.978	0.980	-0.002
	2L258 CBK-INV	0.993	0.993	0.009	1.012	1.012	0.005	1.026	1.026	0.006	0.971	0.971	0.007
	2L277 WAN-NLY	1.002	1.001	0.001	1.016	1.016	0.001	1.031	1.031	0.001	0.978	0.978	0.000
	2L288 KCL-BTS	1.002	1.002	0.000	1.016	1.016	0.001	1.031	1.031	0.001	0.978	0.978	0.000
	2L289 SEL-BTS	1.001	1.001	0.001	1.016	1.016	0.001	1.031	1.031	0.001	0.978	0.978	0.000
	2L293 SEL-NLY	1.002	1.002	0.000	1.016	1.017	0.000	1.032	1.032	0.000	0.978	0.978	0.000
	2L294 CBK-NLY	0.995	0.995	0.007	1.013	1.012	0.005	1.027	1.027	0.005	0.972	0.972	0.006
	2L295 SEL-KCL	1.001	1.001	0.001	1.016	1.016	0.001	1.031	1.031	0.001	0.978	0.978	0.000
	1L274 NTL-POCATER	1.002	1.003	-0.001	1.016	1.017	0.000	1.047	1.026	0.006	0.985	0.988	-0.010
	1L275 NTL-COLEMAN	1.004	1.004	-0.002	1.017	1.017	0.000	1.068	1.043	-0.011	0.988	0.988	-0.010
	5L82 NIC-MDN	1.002	1.001	0.001	1.016	1.016	0.001	1.031	1.031	0.001	0.978	0.978	0.000
N-2	5L76&5L79	1.043	1.027	-0.025	1.063	1.047	-0.030	1.111	1.094	-0.062	1.026	1.011	-0.033
	5L91&5L96	1.038	1.020	-0.018	1.057	1.038	-0.021	1.072	1.045	-0.013	1.012	0.994	-0.016
	5L81&5L82	1.000	1.000	0.002	1.014	1.015	0.002	1.029	1.031	0.002	0.976	0.977	0.001
	5L96&5L98	1.000	0.996	0.006	1.015	1.010	0.007	1.030	1.027	0.005	0.977	0.973	0.005
	5L51&5L52	1.031	1.024	-0.022	1.049	1.045	-0.028	1.063	1.048	-0.016	1.005	0.997	-0.019
	2L288&2L295	1.001	1.001	0.001	1.015	1.015	0.002	1.031	1.031	0.001	0.977	0.977	0.001
	2L289&2L295	1.004	1.002	0.000	1.019	1.017	0.000	1.032	1.031	0.001	0.980	0.978	0.000
	2L295&2L299	1.002	1.004	-0.002	1.017	1.019	-0.002	1.031	1.033	-0.001	0.978	0.980	-0.002

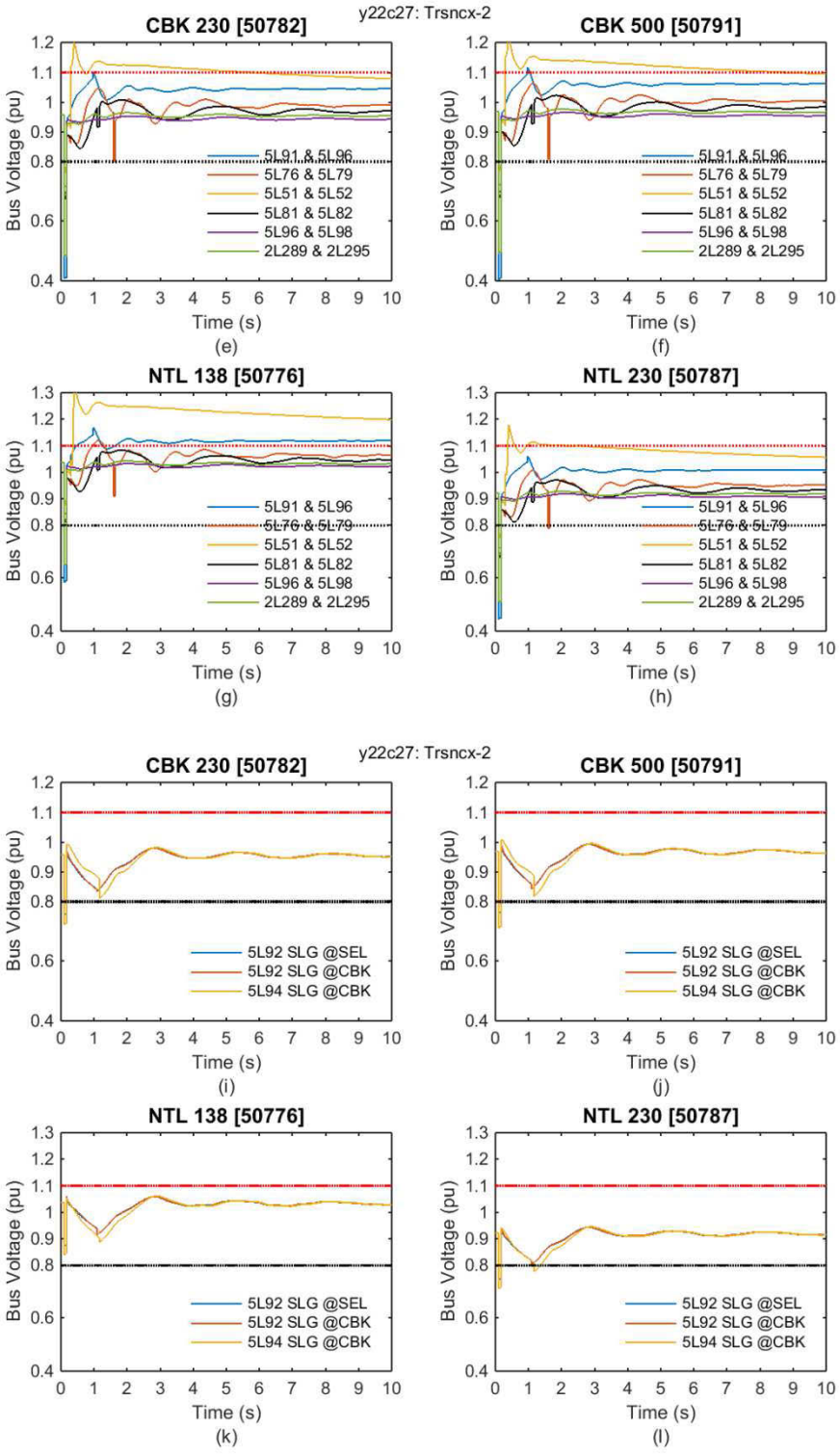
G.18.2 **Y22C27_Trsncx1-Voltages**



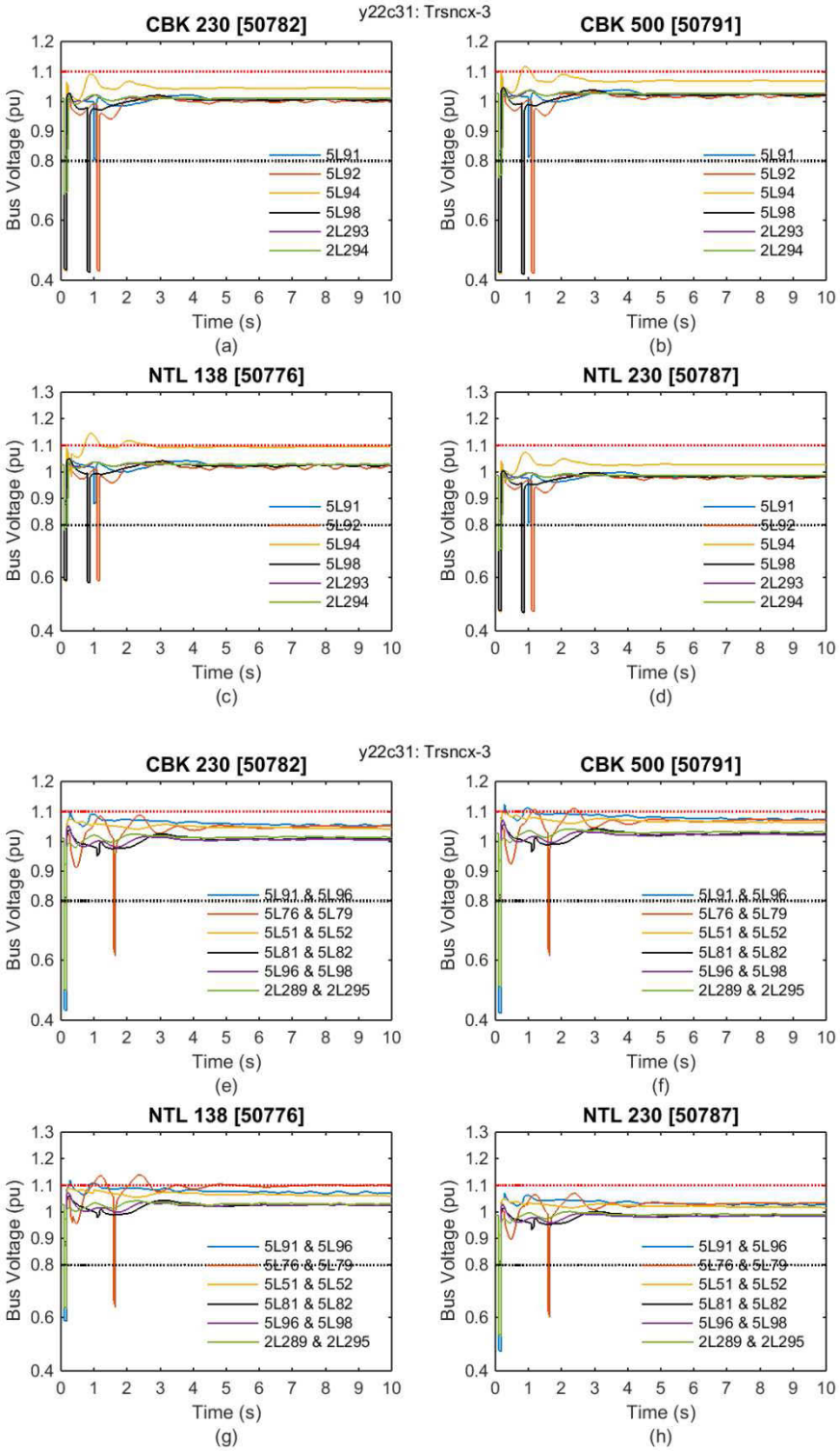


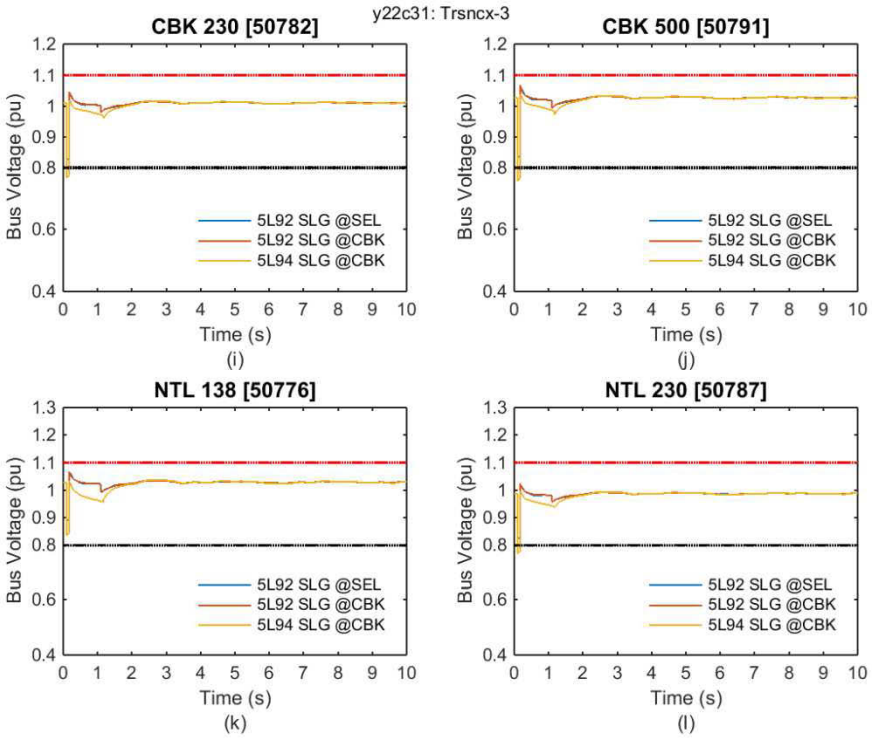
G.18.3 **Y22C27_Trsncx2-Voltages**



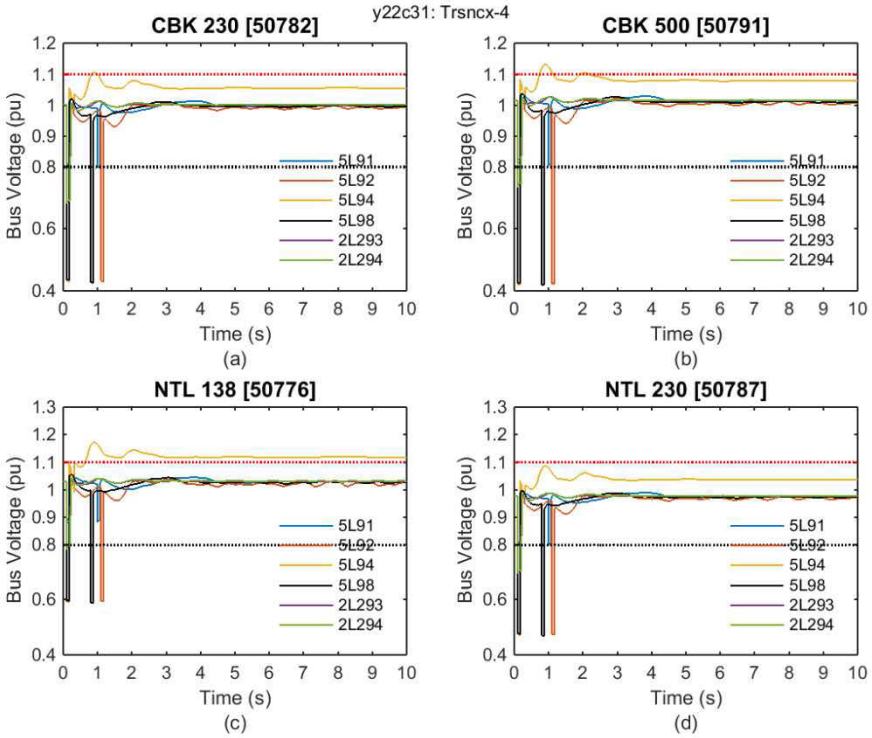


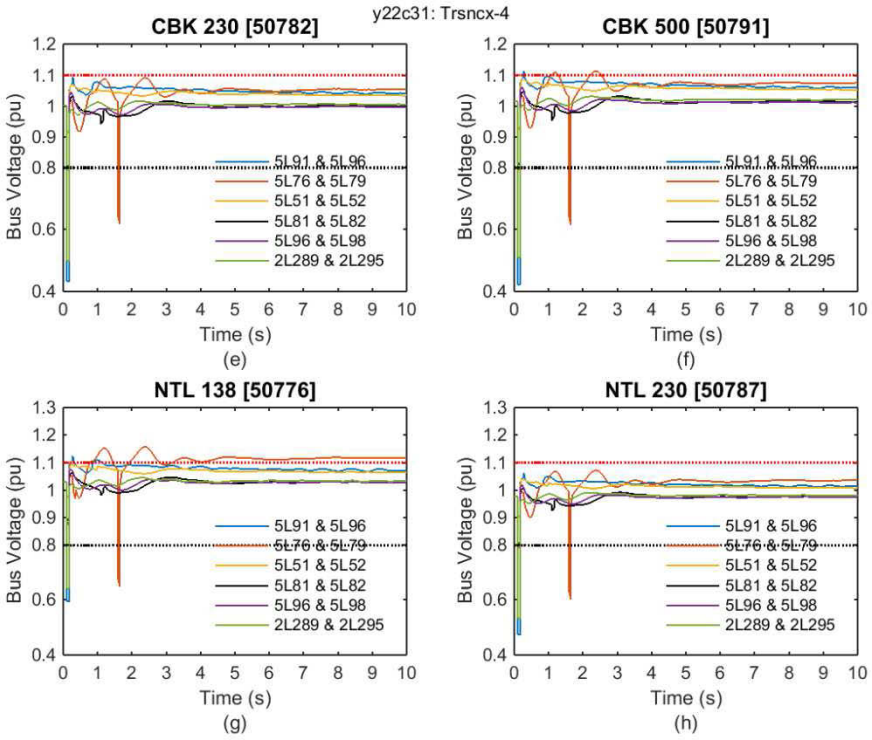
G.18.4 **Y22C31_Trsncx3-Voltages**

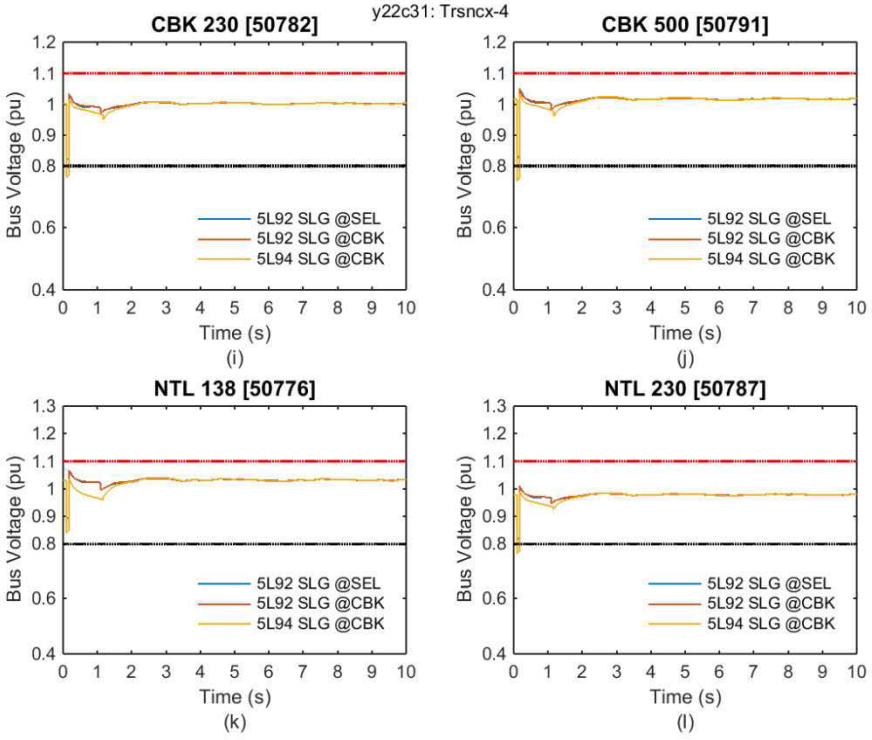




G.18.5 **Y22C31_Trsncx4-Voltages**

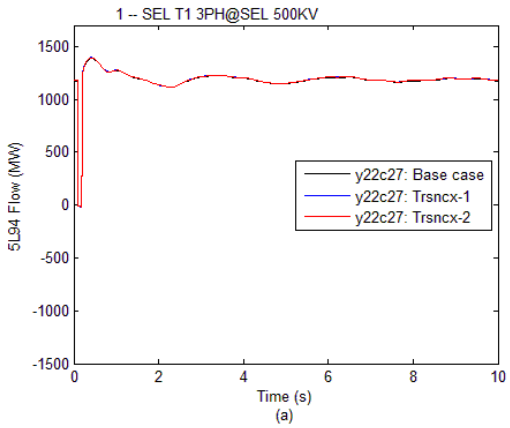


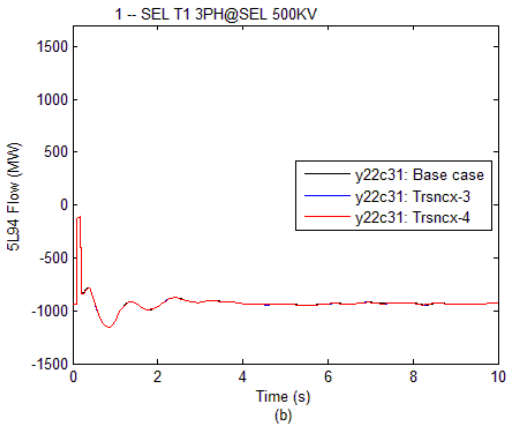


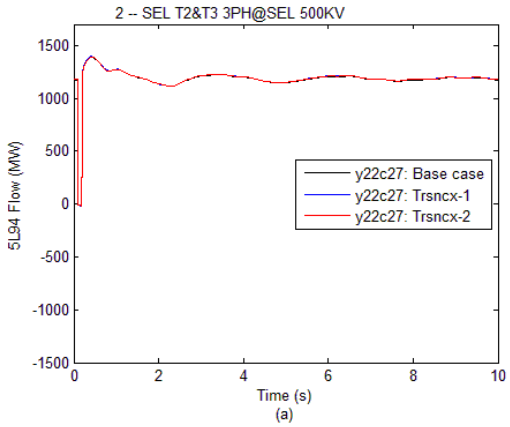


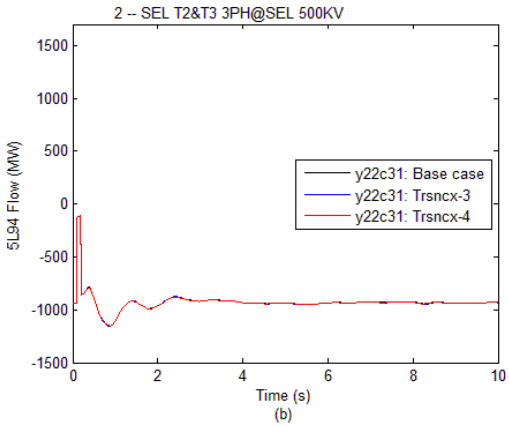
G.18.6 **5L94 MW Flows (N1 and N2 Contingencies)**

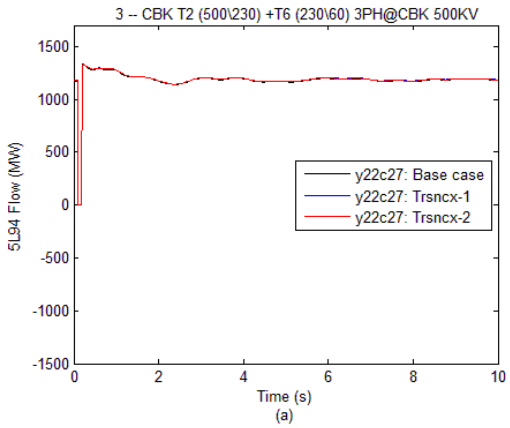
Y22C27_Trsncx1, Y22C27_Trsncx2, Y22C31_Trsncx3, Y22C31_Trsncx4

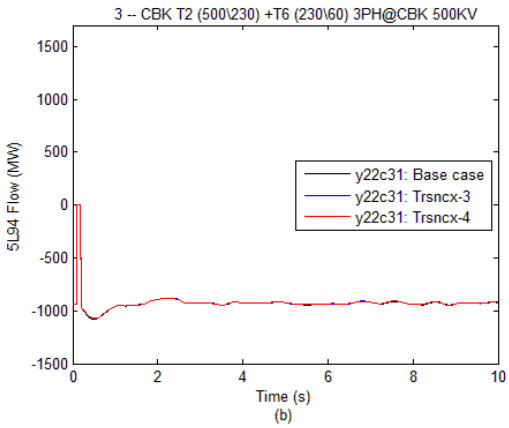


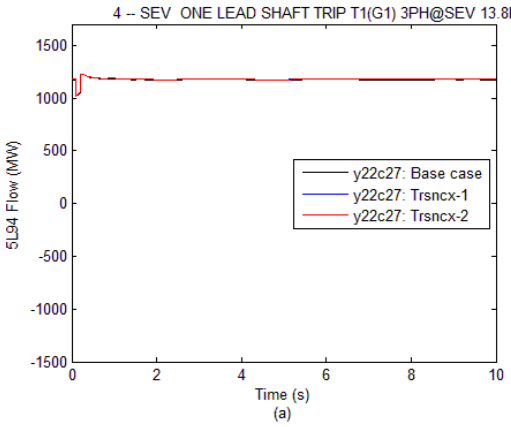




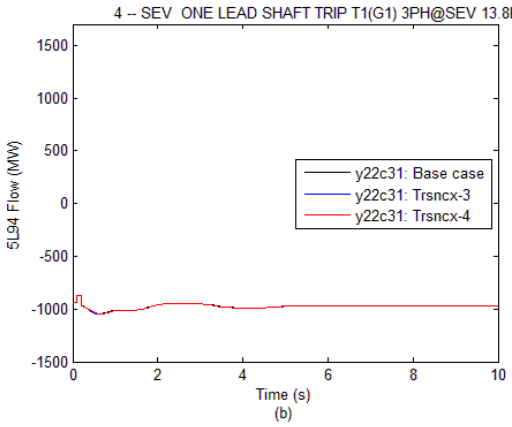




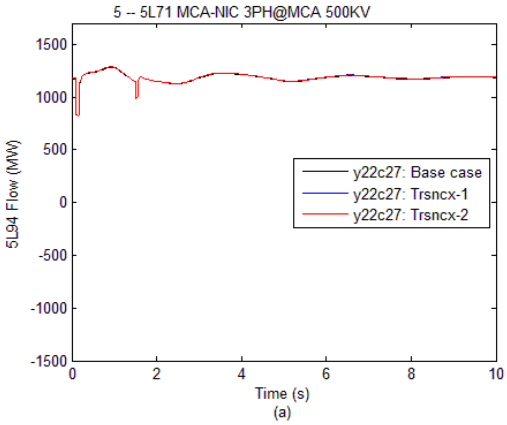




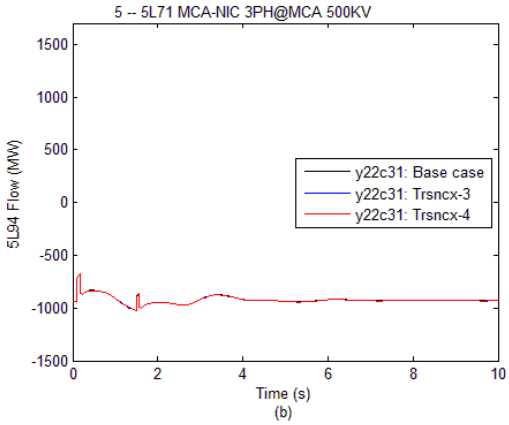
(a)



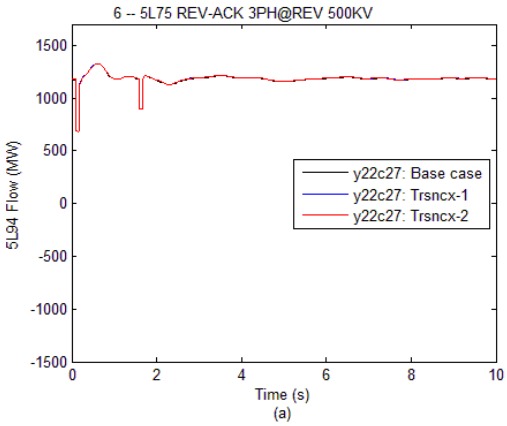
(b)



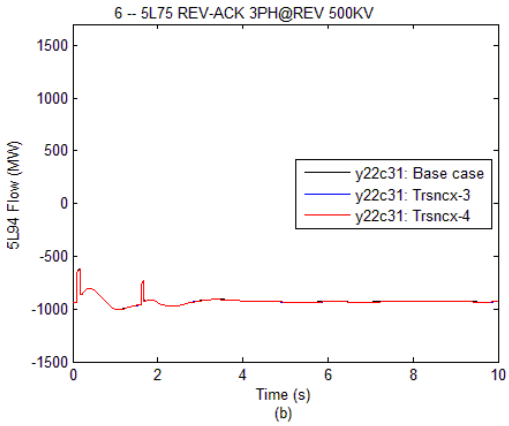
(a)



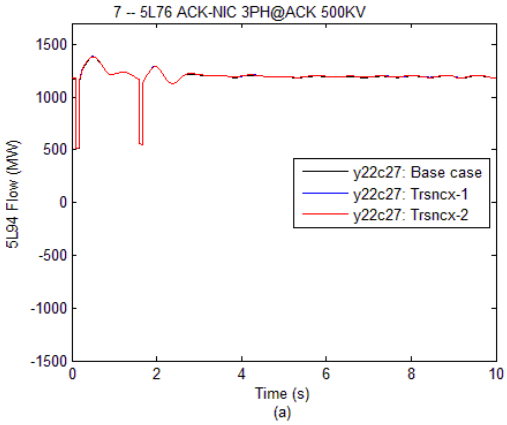
(b)



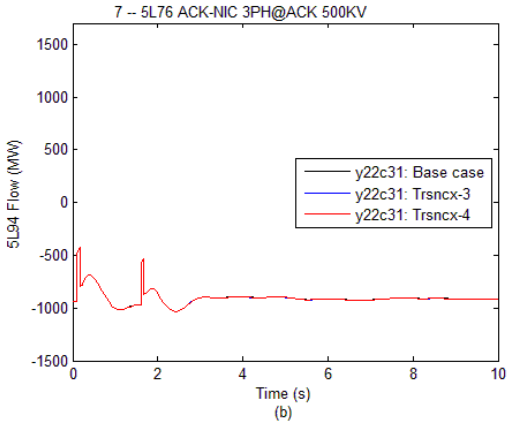
(a)



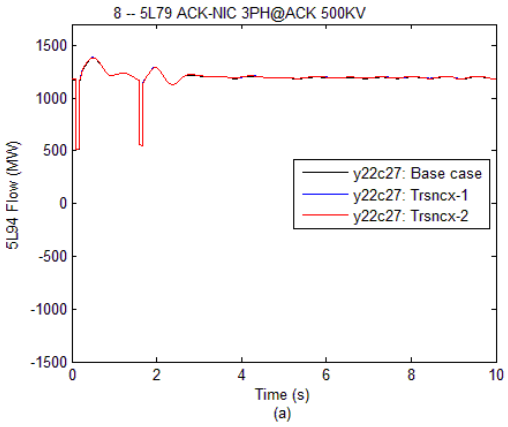
(b)

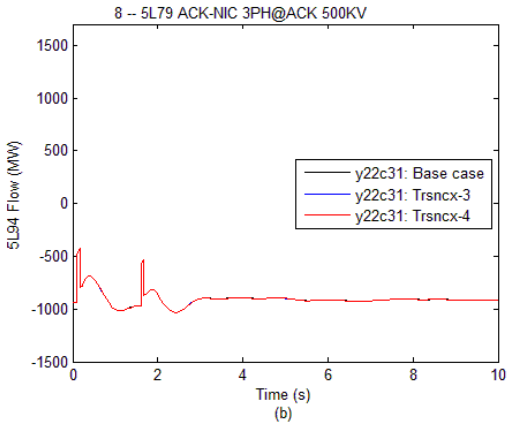


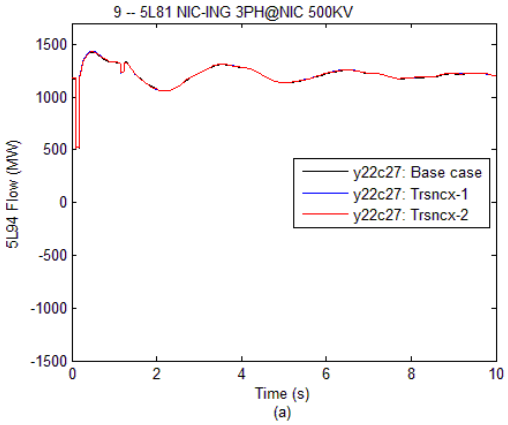
(a)

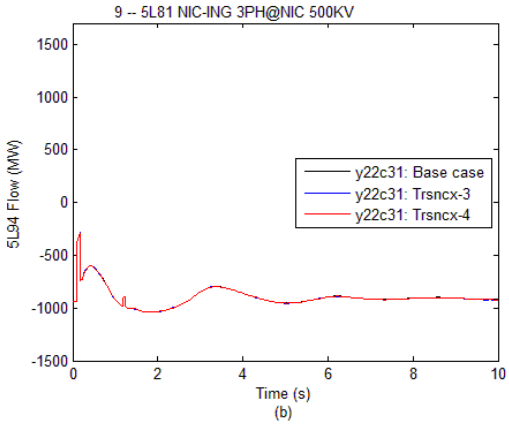


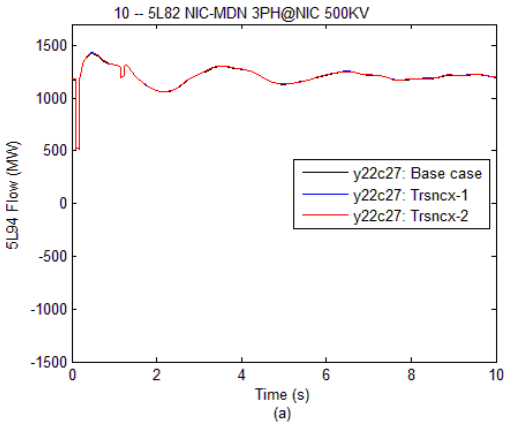
(b)

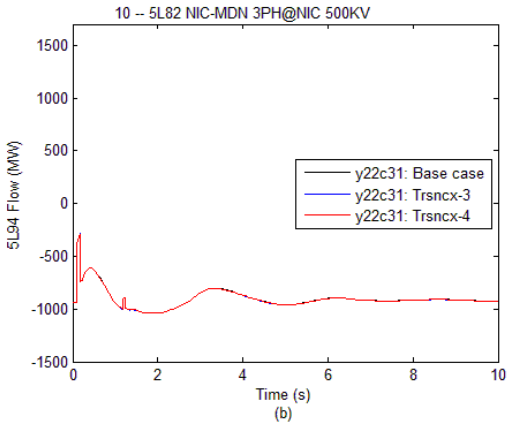


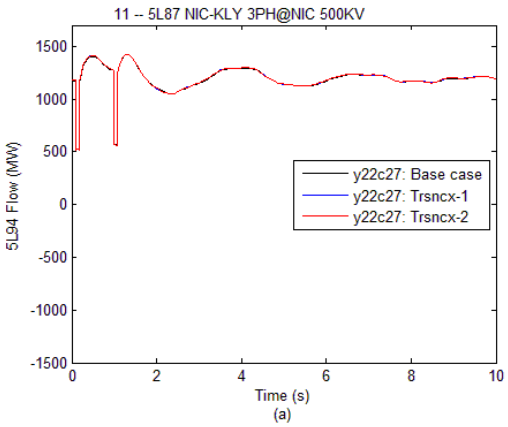


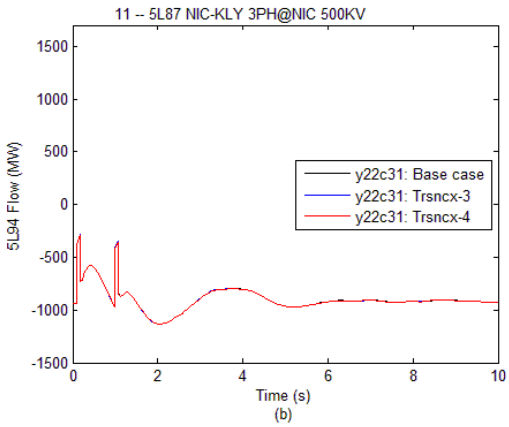


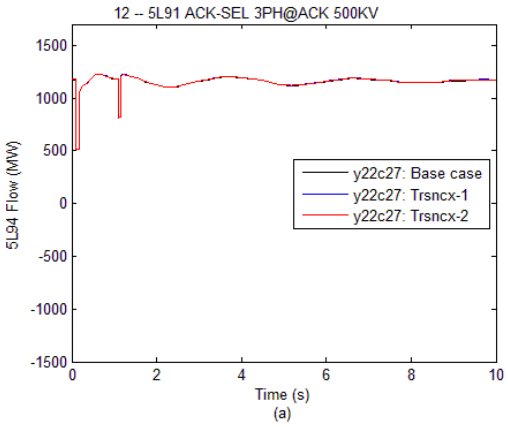




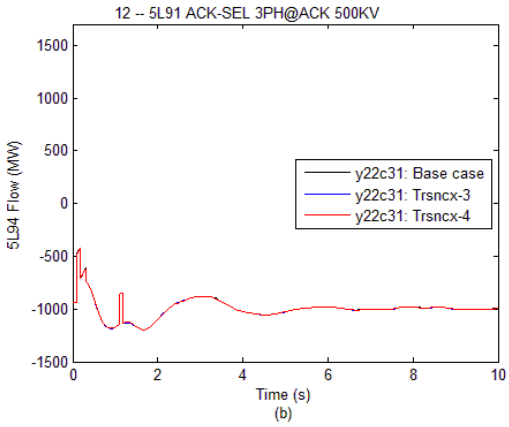




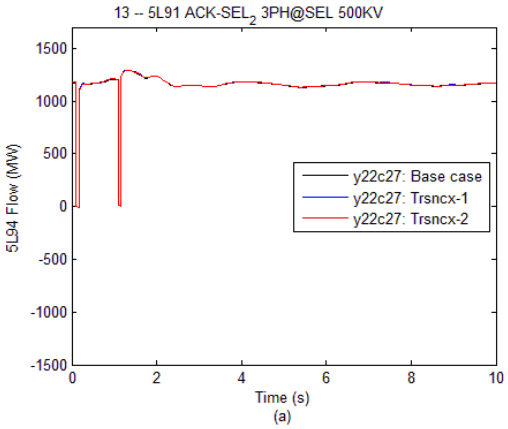




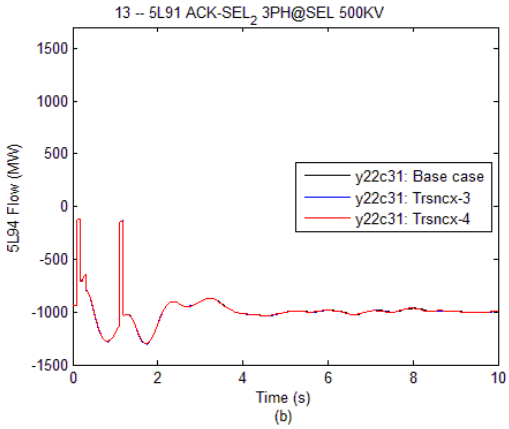
(a)



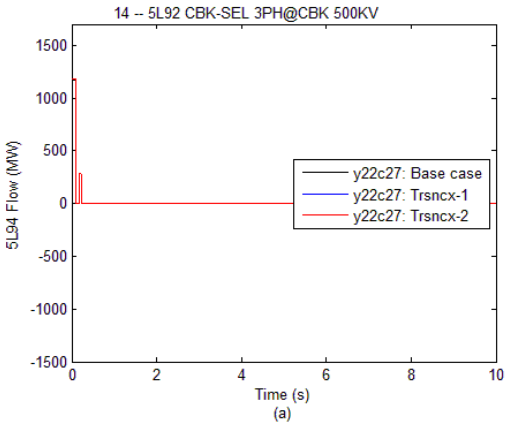
(b)



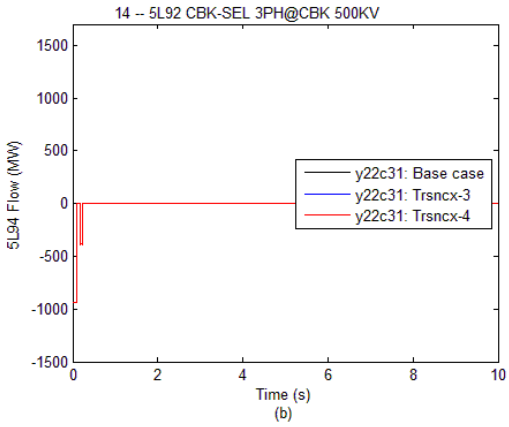
(a)



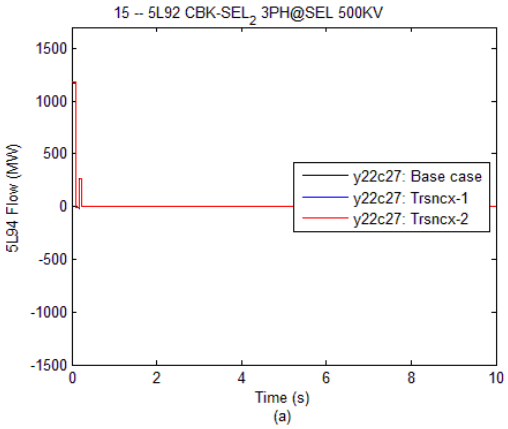
(b)



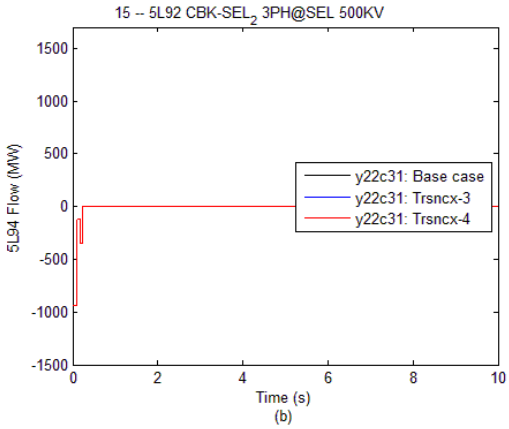
(a)



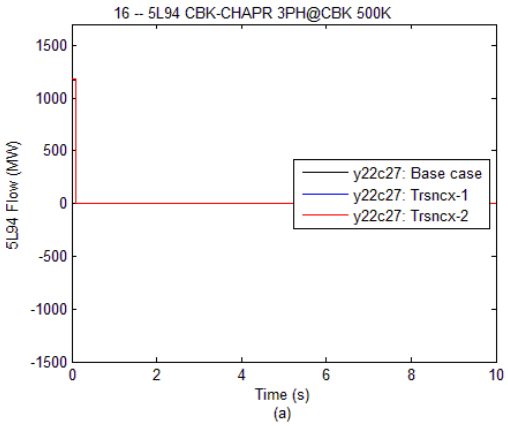
(b)



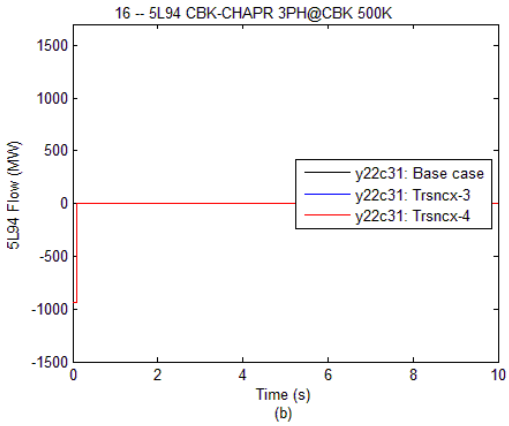
(a)



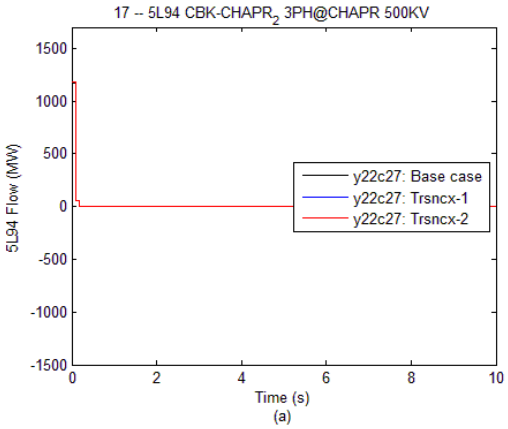
(b)



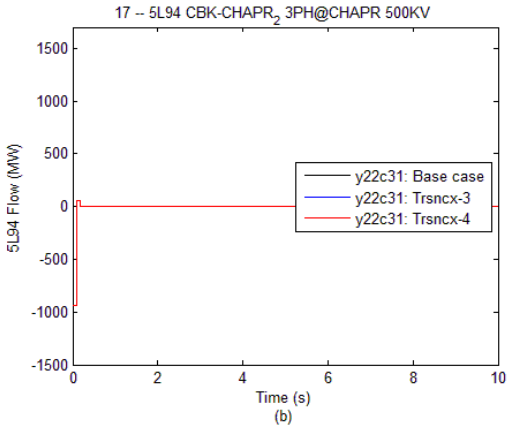
(a)



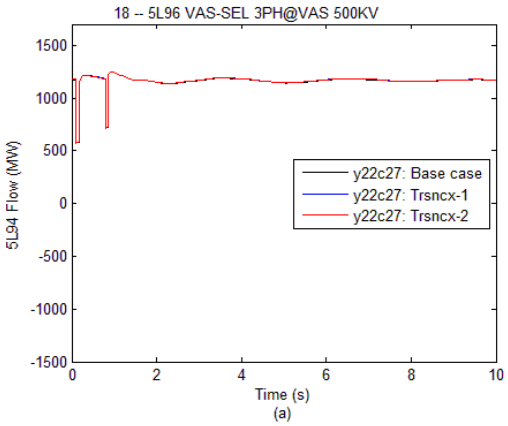
(b)



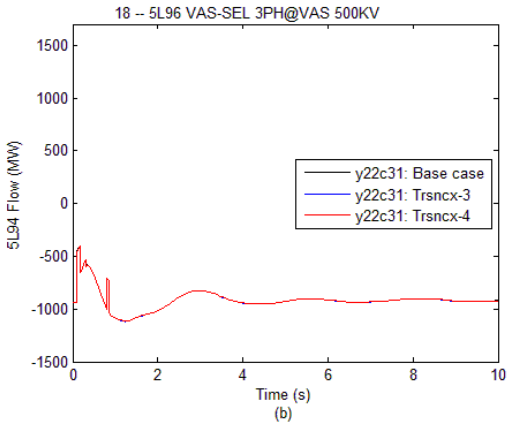
(a)



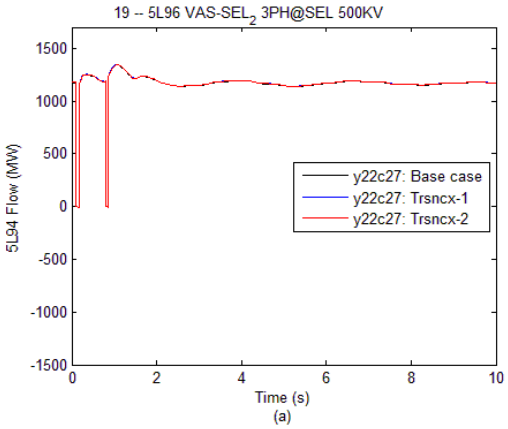
(b)



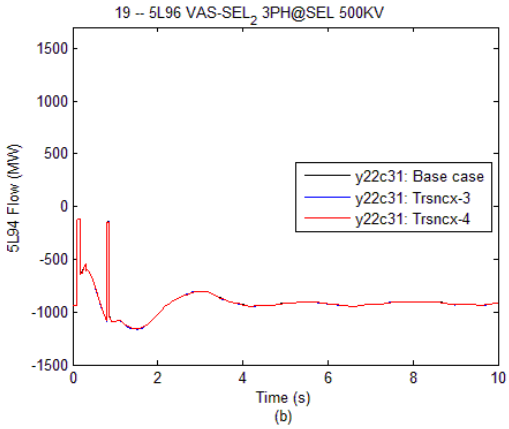
(a)



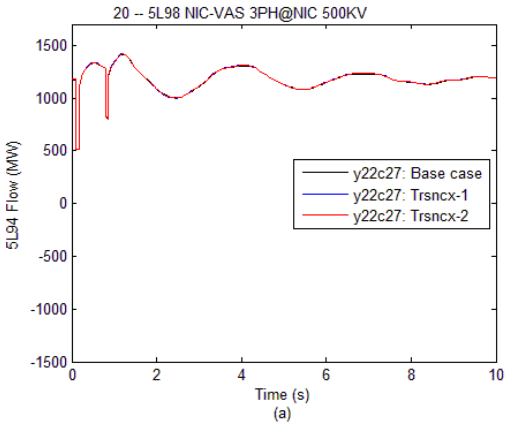
(b)



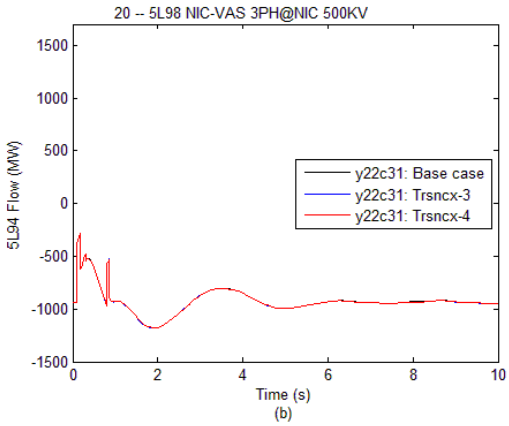
(a)



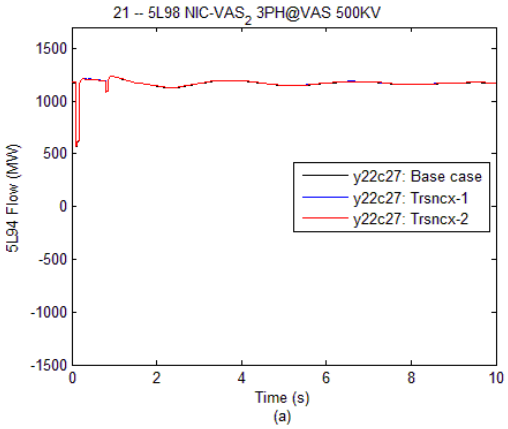
(b)



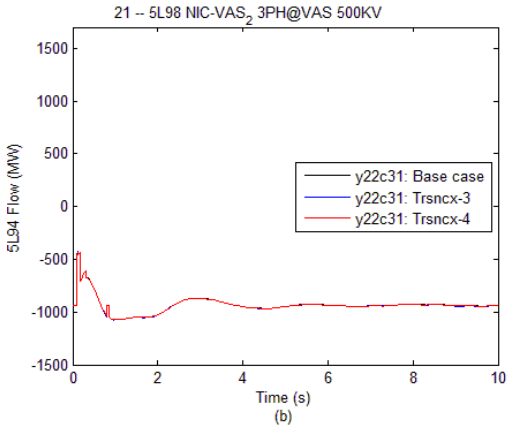
(a)



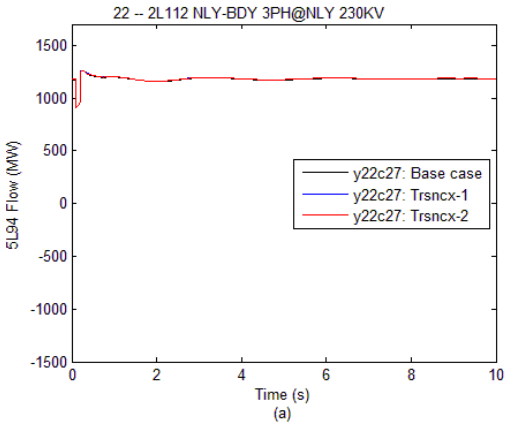
(b)



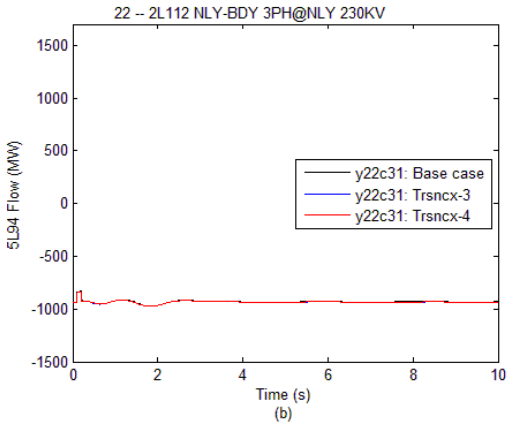
(a)



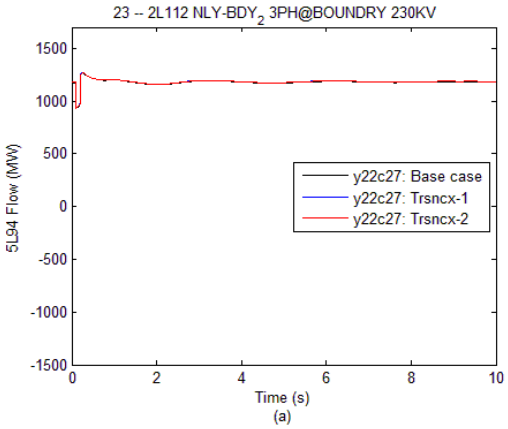
(b)



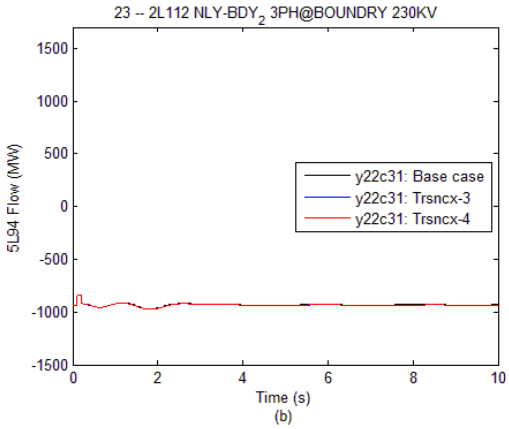
(a)



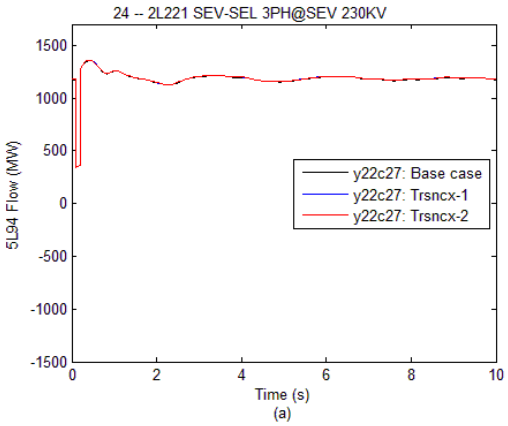
(b)



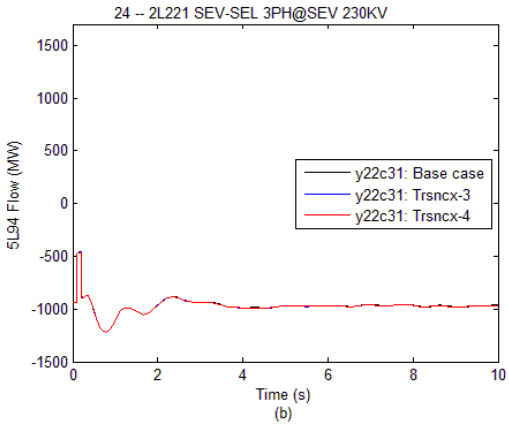
(a)



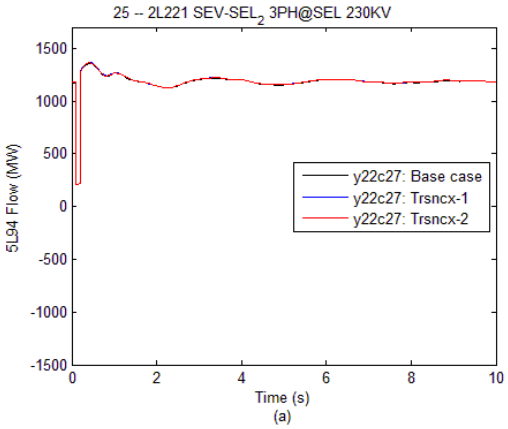
(b)



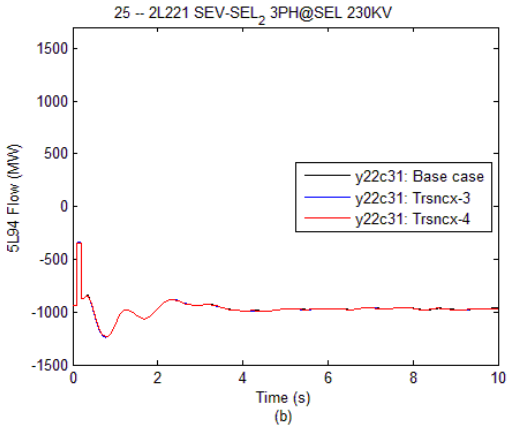
(a)



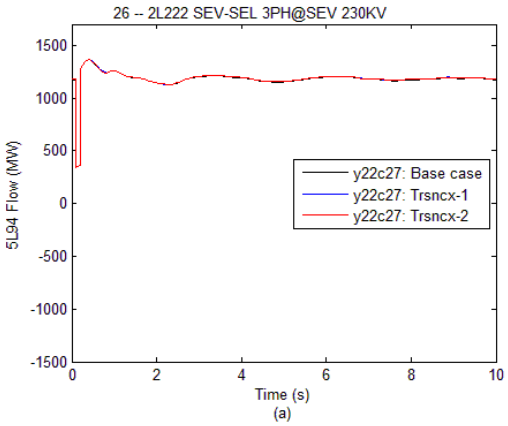
(b)



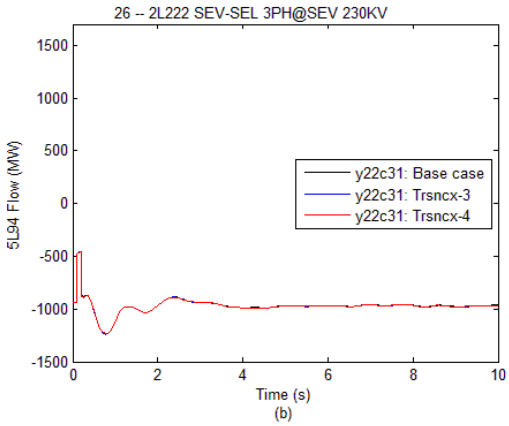
(a)



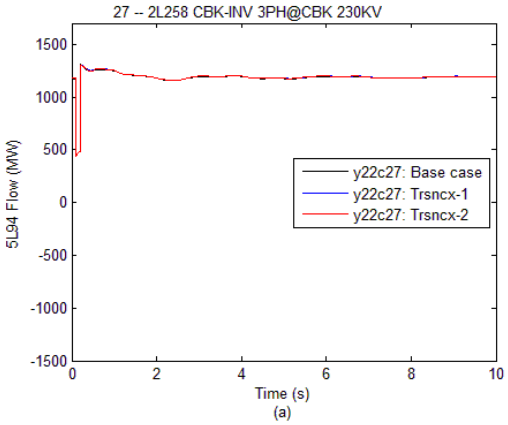
(b)



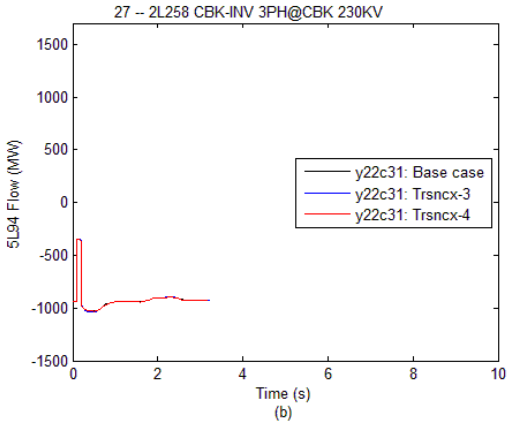
(a)



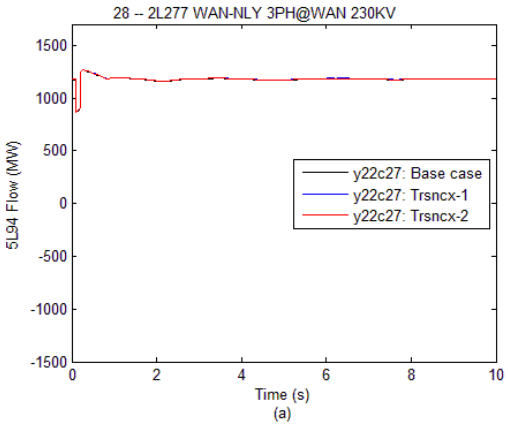
(b)



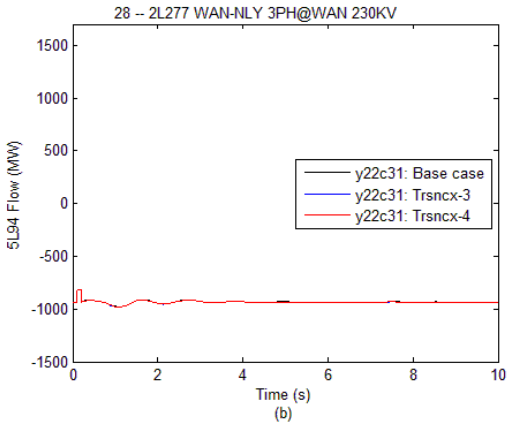
(a)



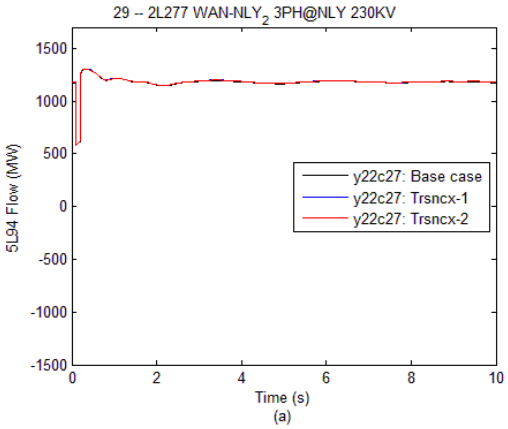
(b)



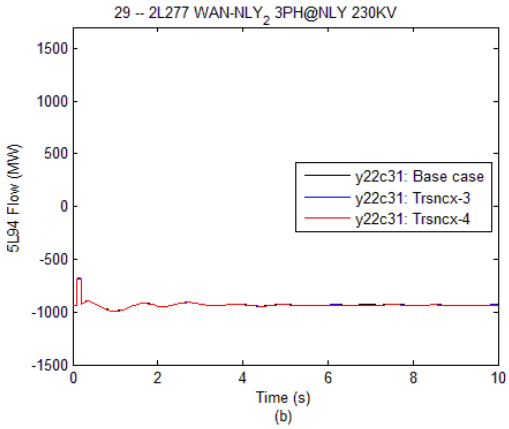
(a)



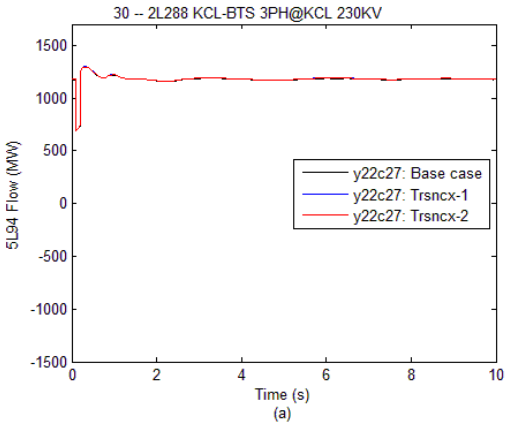
(b)



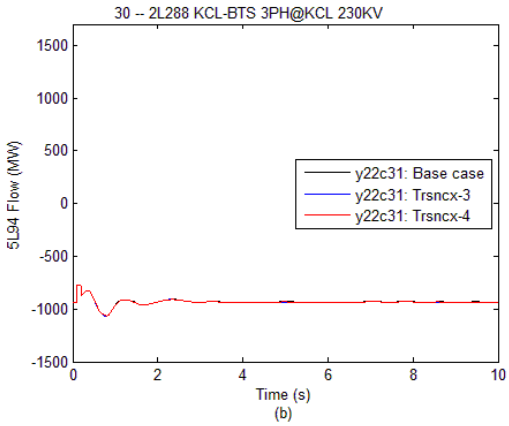
(a)



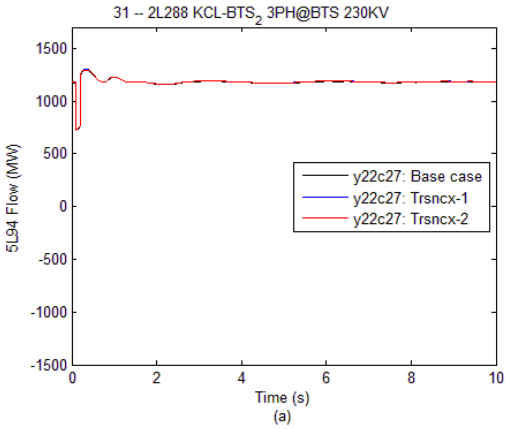
(b)



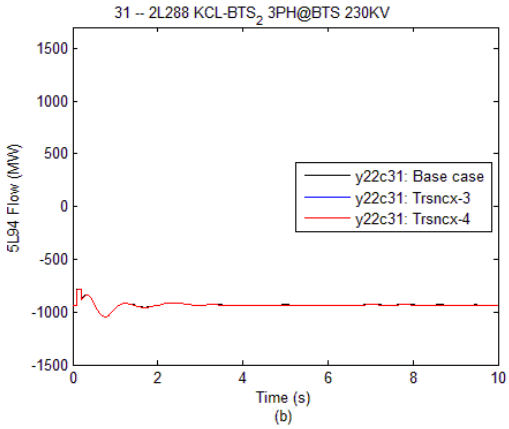
(a)



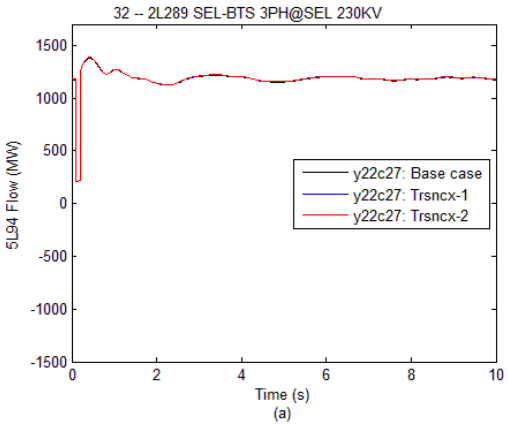
(b)



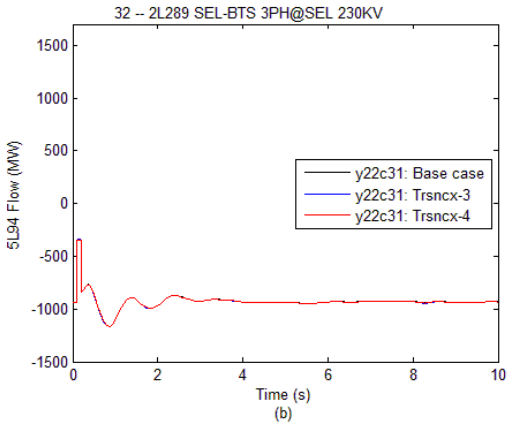
(a)



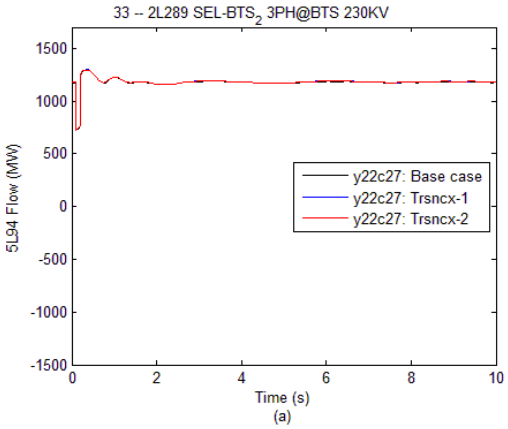
(b)



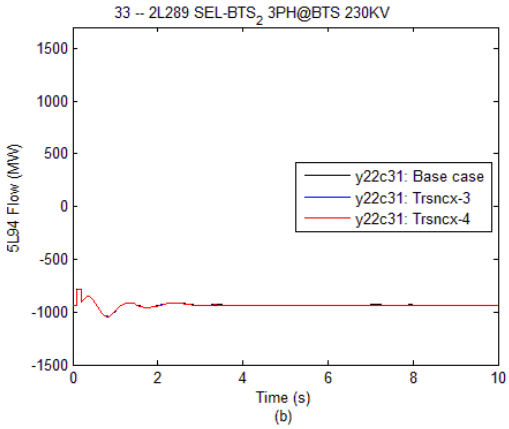
(a)



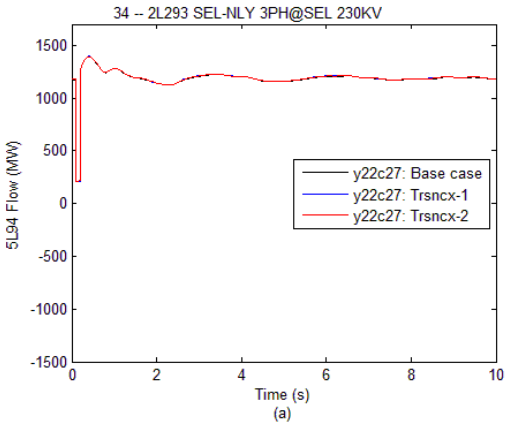
(b)



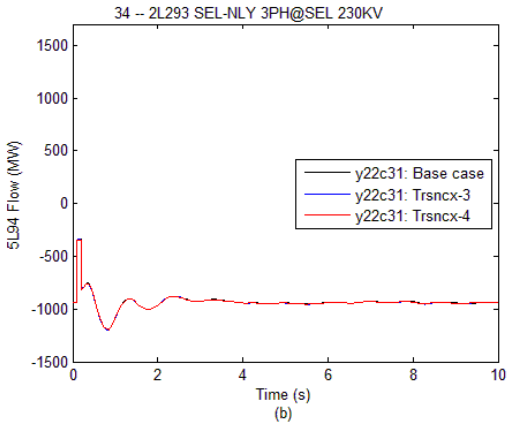
(a)



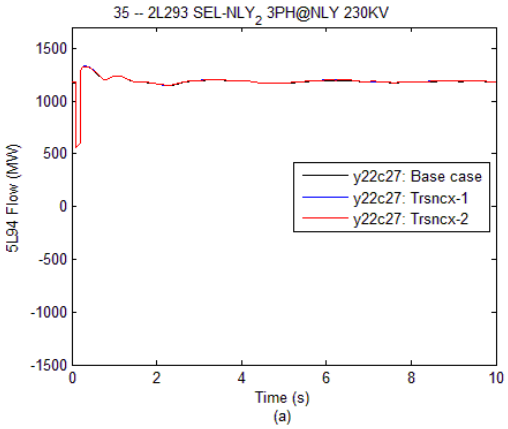
(b)



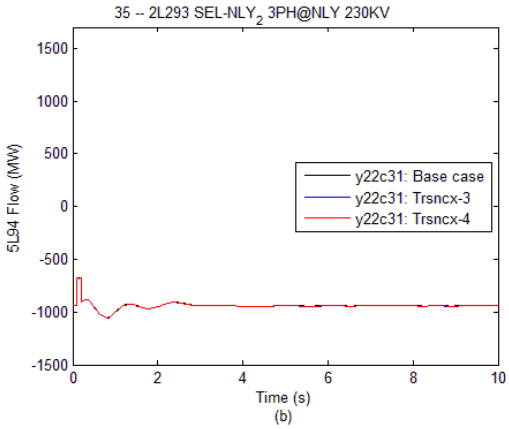
(a)



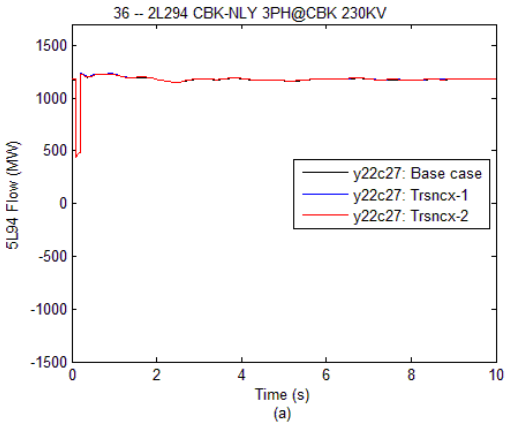
(b)



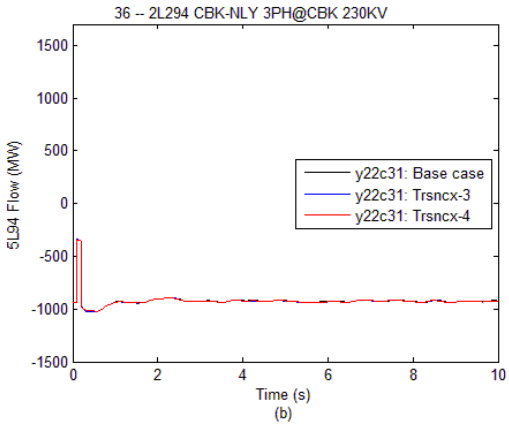
(a)



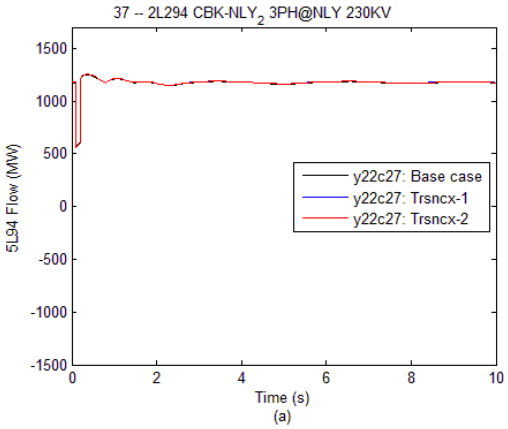
(b)



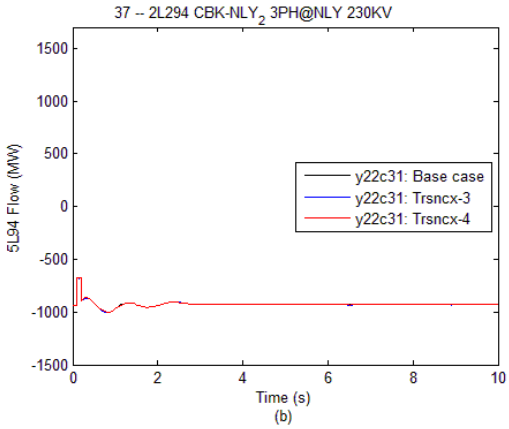
(a)



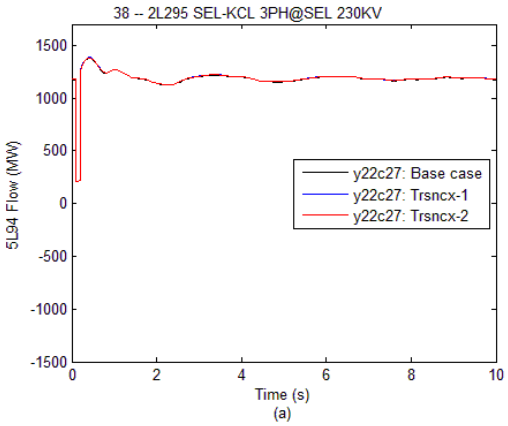
(b)



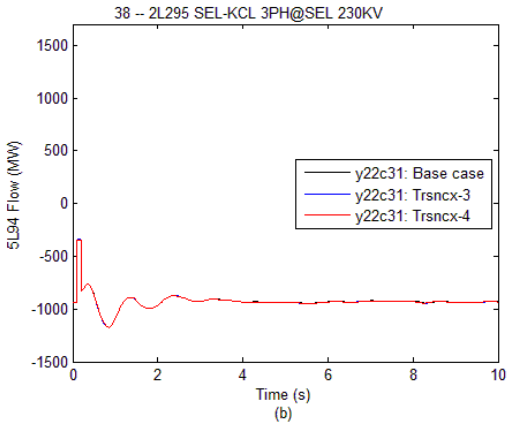
(a)



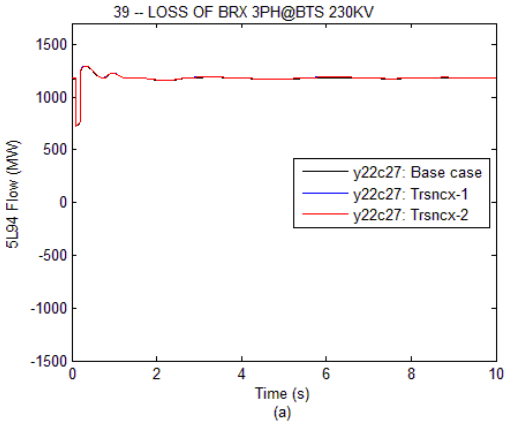
(b)



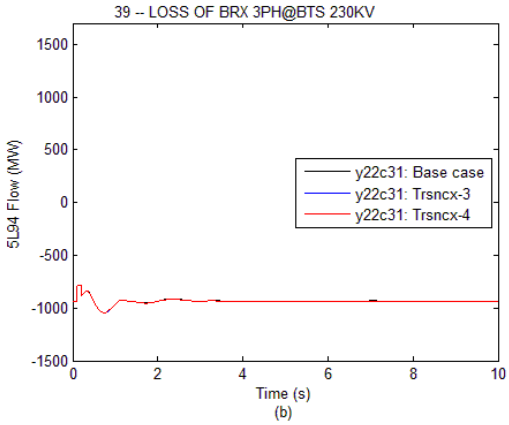
(a)



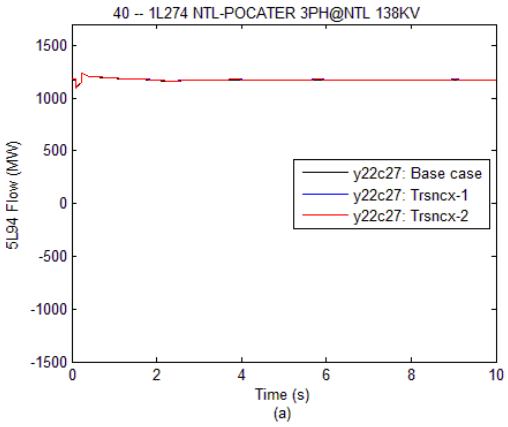
(b)

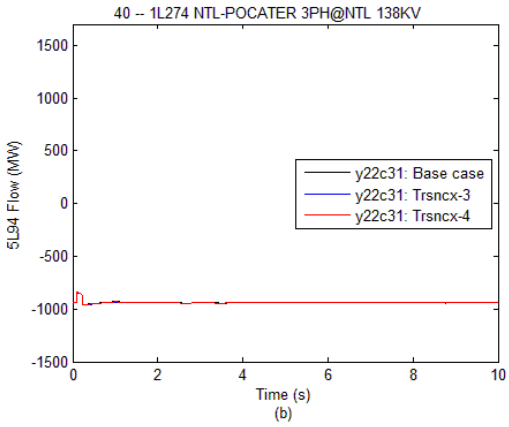


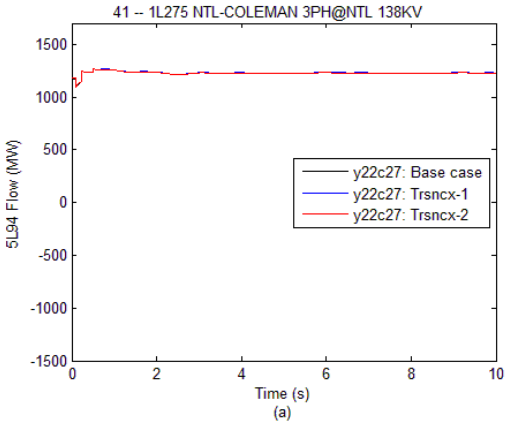
(a)

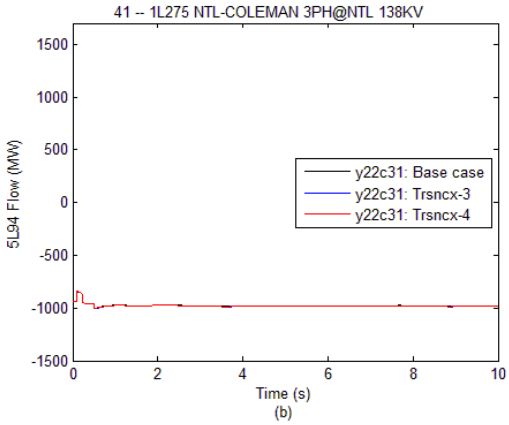


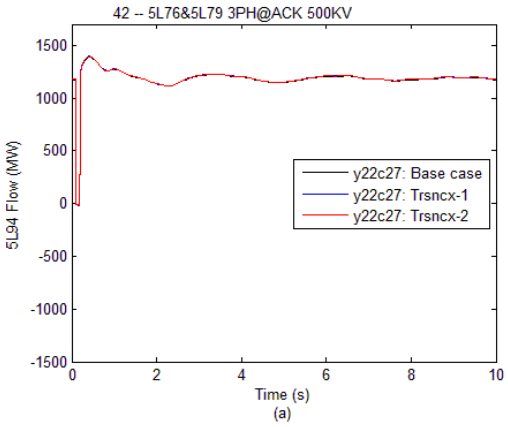
(b)

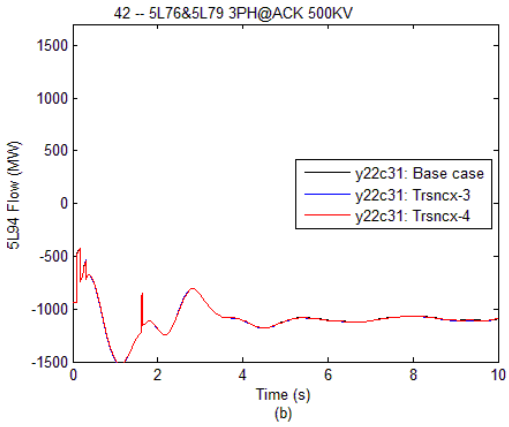


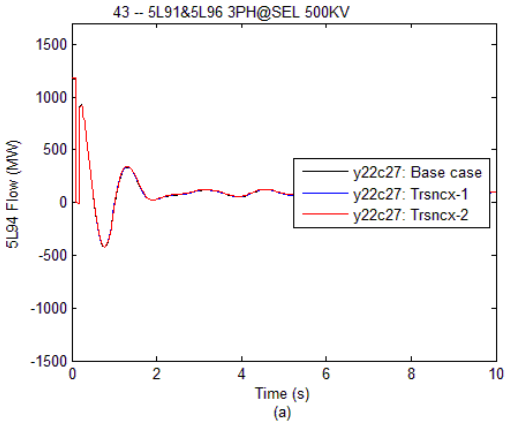


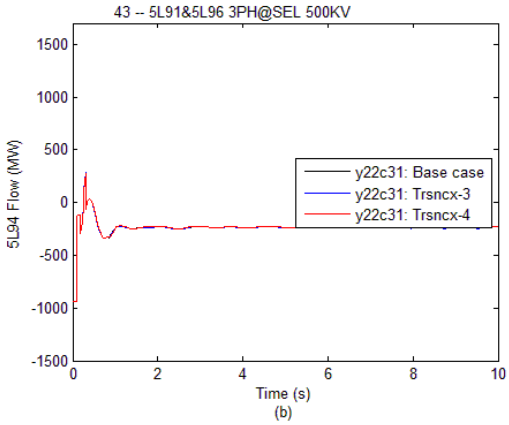


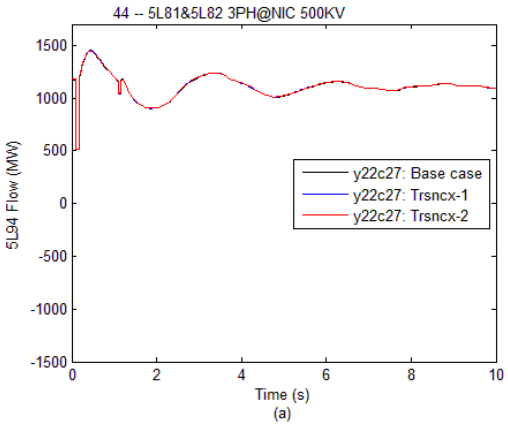




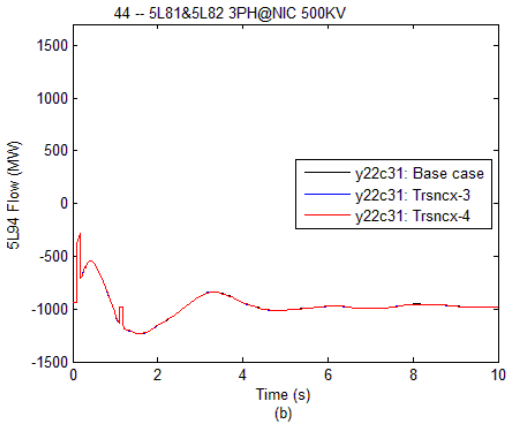




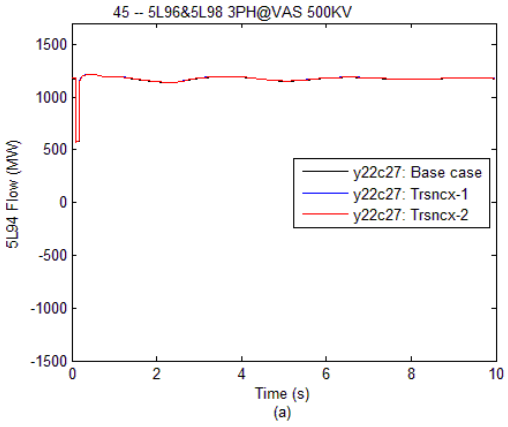




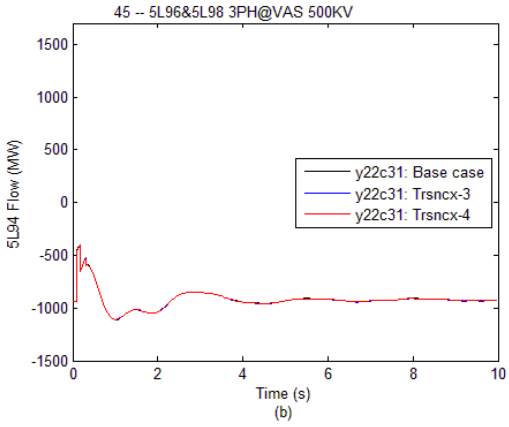
(a)



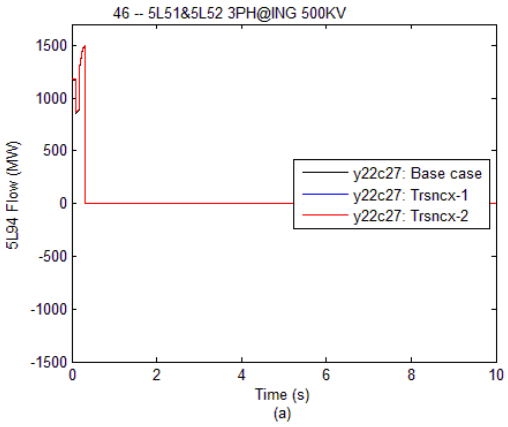
(b)



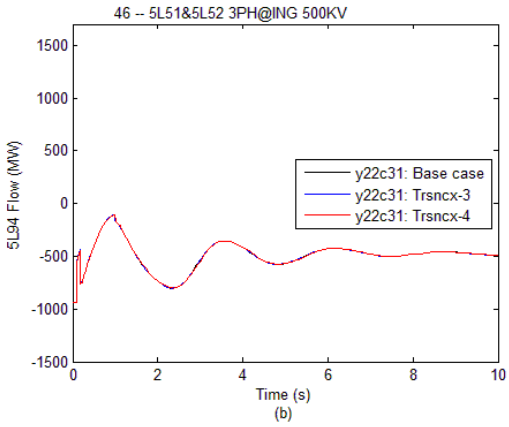
(a)



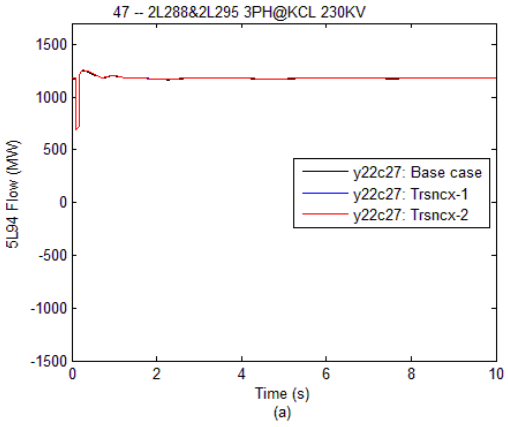
(b)



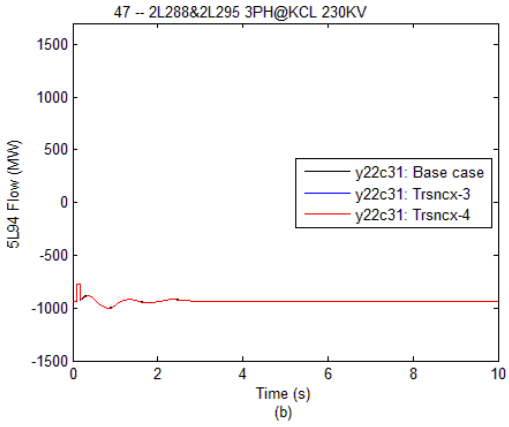
(a)



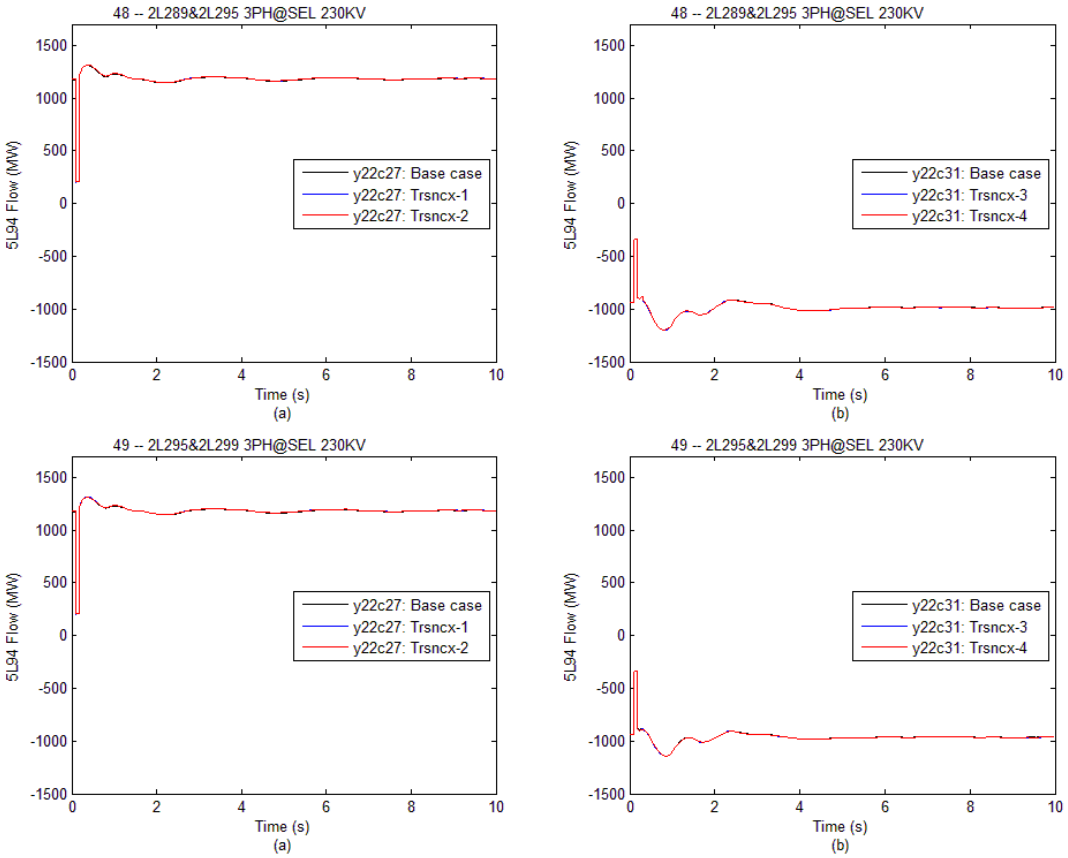
(b)



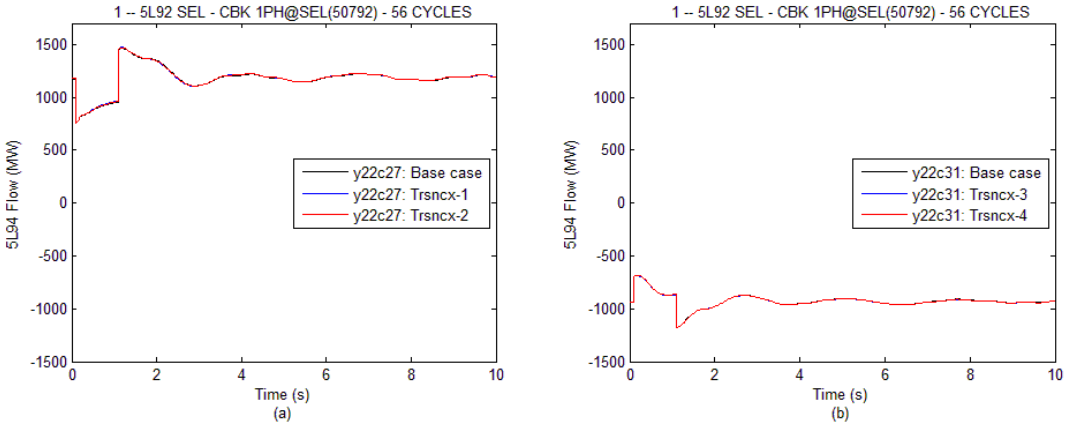
(a)

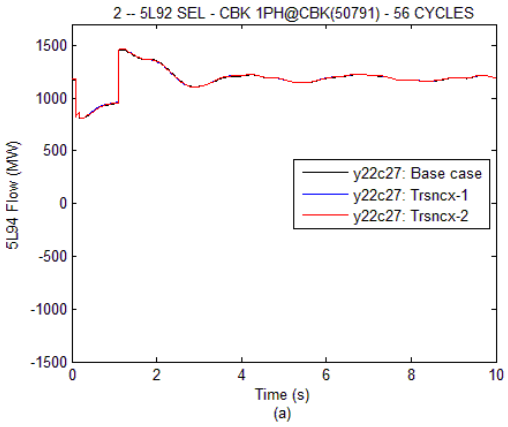


(b)

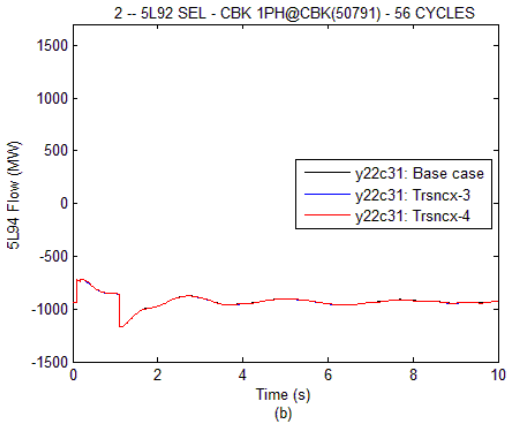


G.18.7 **5L94 MW Flows (SPR Contingencies)**

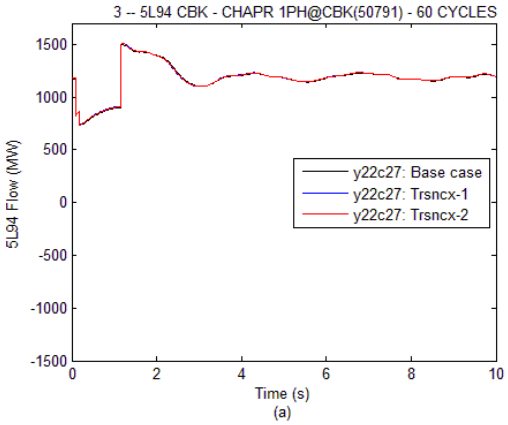




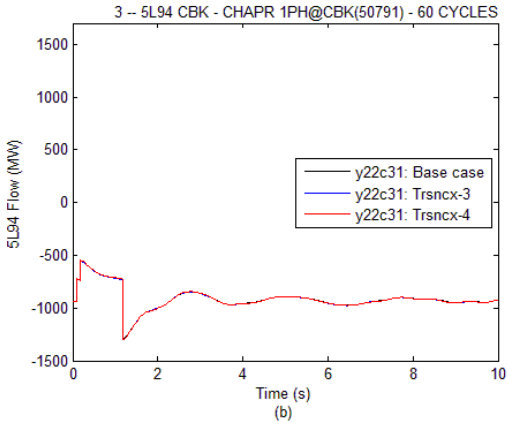
(a)



(b)



(a)



(b)

G.19 Chapel Rock Location and 500/240 kV Fixed-Tap Transformer Model Sensitivity

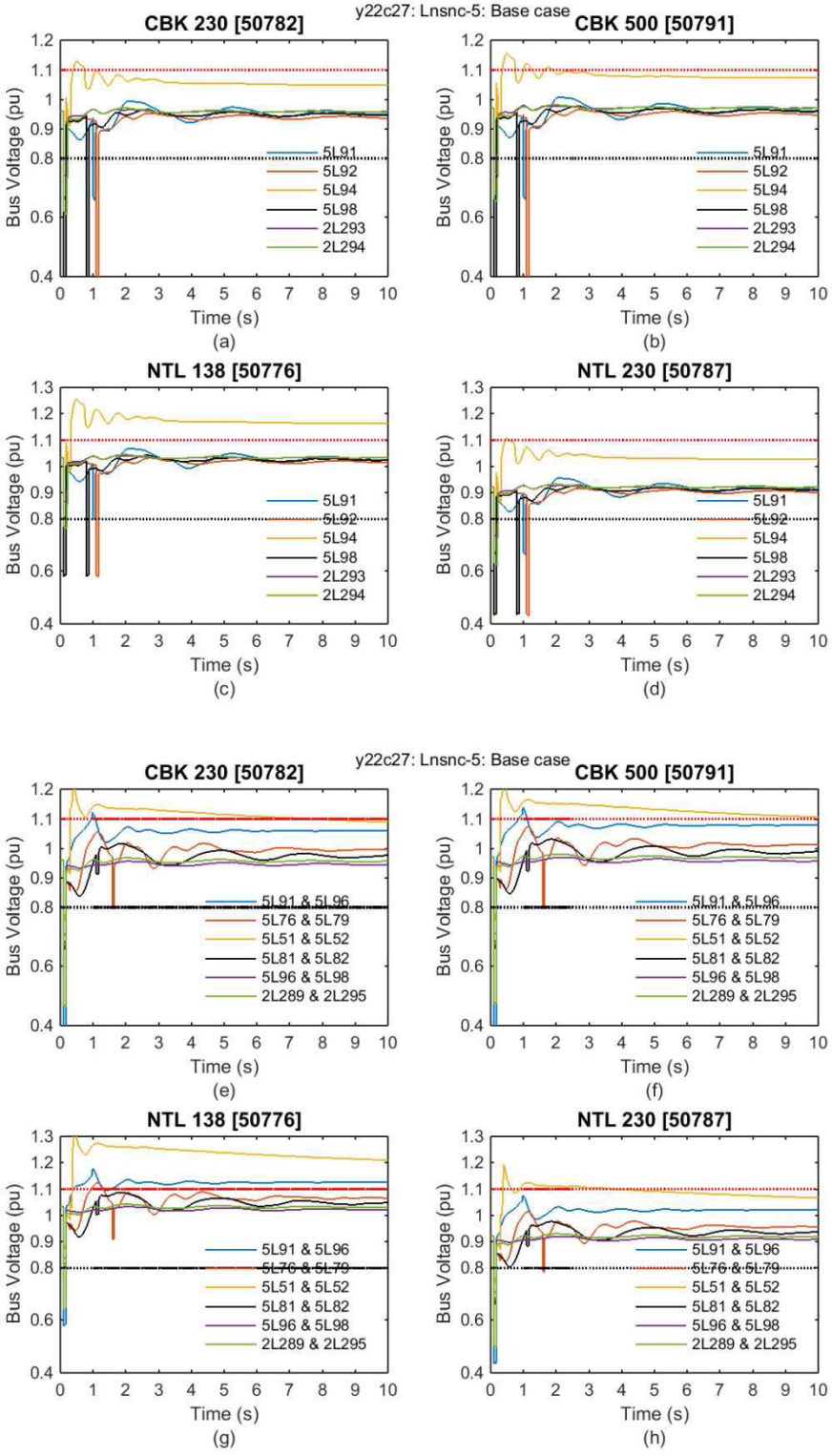
Case Name	Comments/ Notes
Y22C27_Lnsnc5	Base Case: Y22C27 Line Sensitivity Case-5 Chapel Rock 500/240 kV taps fixed at 1.0 Line Length 328 kM (CBK-CHAPR = 154 kM; CHAPR-BENNET = 174 kM)
Y22C31_Lnsnc6	Base Case: Y22C31 Line Sensitivity Case-6 Chapel Rock 500/240 kV taps fixed at 1.0 Line Length 328 kM (CBK-CHAPR = 154 kM; CHAPR-BENNET = 174 kM)

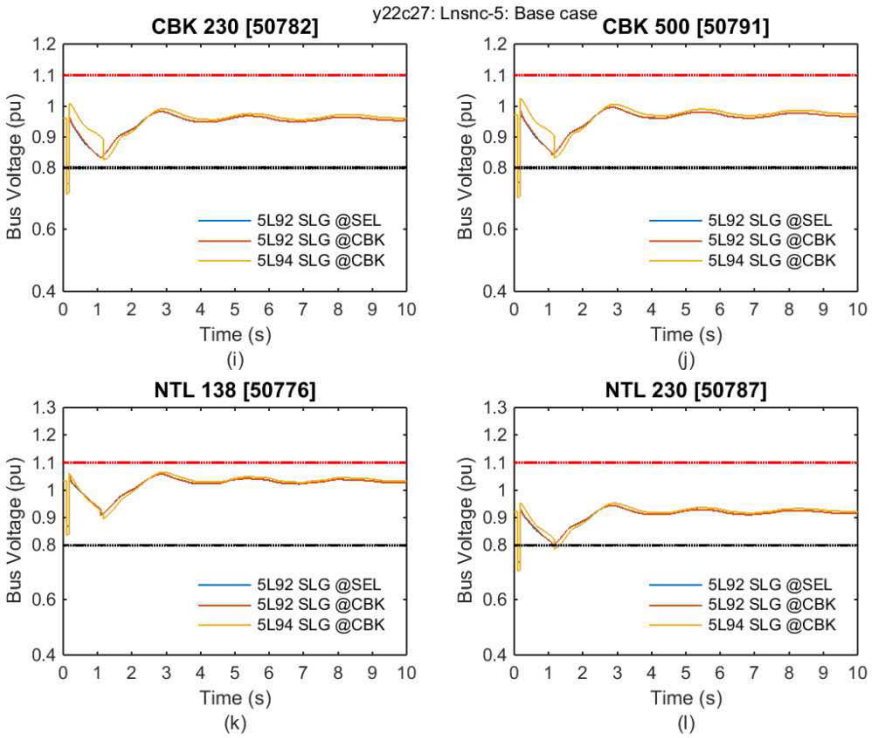
G.19.1 Power Flow Contingencies Results

y22c27 Lnsnc 5		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	0.960	0.960	0.000	0.973	0.973	0.000	1.034	1.034	0.000	0.922	0.922	0.000
N-1	SEL T1	0.960	0.955	0.005	0.972	0.967	0.006	1.034	1.030	0.004	0.921	0.917	0.005
	CBK T2+T6	0.960	0.959	0.001	0.969	0.969	0.004	1.035	1.035	-0.001	0.922	0.922	0.000
	SEL Shaft Trip T1	0.960	0.960	0.000	0.973	0.973	0.000	1.034	1.034	0.000	0.922	0.922	0.000
	5L75 REV-ACK	0.959	0.958	0.002	0.971	0.971	0.002	1.033	1.033	0.001	0.921	0.920	0.002
	5L91 ACK-SEL	0.948	0.941	0.019	0.961	0.954	0.019	1.026	1.037	-0.003	0.912	0.900	0.022
	5L92 CBK-SEL	1.188	0.979	-0.019	1.215	1.003	-0.030	1.350	1.030	0.004	1.177	0.962	-0.041
	5L94 CBK-LGN	1.075	1.019	-0.059	1.090	1.045	-0.072	1.212	1.033	0.001	1.060	1.004	-0.082
	5L96 VAS-SEL	0.954	0.951	0.009	0.966	0.963	0.010	1.030	1.036	-0.002	0.916	0.911	0.011
	5L98 NIC-VAS	0.958	0.954	0.006	0.970	0.967	0.006	1.033	1.038	-0.004	0.920	0.914	0.007
	2L112 NLY-BDY	0.959	0.958	0.002	0.972	0.971	0.002	1.033	1.033	0.001	0.920	0.920	0.001
	2L222 SEV-SEL	0.960	0.960	0.000	0.973	0.973	0.000	1.034	1.034	0.000	0.922	0.921	0.000
	2L258 CBK-INV	0.950	0.950	0.010	0.968	0.968	0.005	1.027	1.035	-0.001	0.913	0.910	0.012
	2L277 WAN-NLY	0.959	0.959	0.001	0.972	0.972	0.001	1.034	1.034	0.000	0.921	0.921	0.000
	2L288 KCL-BTS	0.960	0.960	0.000	0.972	0.972	0.001	1.034	1.034	0.000	0.921	0.921	0.000
	2L289 SEL-BTS	0.959	0.959	0.001	0.972	0.972	0.001	1.034	1.034	0.000	0.921	0.921	0.001
	2L293 SEL-NLY	0.961	0.961	-0.001	0.972	0.972	0.001	1.035	1.035	-0.001	0.922	0.923	-0.001
	2L294 CBK-NLY	0.948	0.946	0.015	0.960	0.958	0.015	1.026	1.032	0.002	0.912	0.907	0.015
	2L295 SEL-KCL	0.959	0.959	0.001	0.972	0.972	0.001	1.034	1.034	0.000	0.921	0.921	0.001
	1L274 NTL-POCATER	0.964	0.962	-0.002	0.976	0.973	0.000	1.053	1.041	-0.007	0.934	0.939	-0.017
	1L275 NTL-COLEMAN	0.964	0.959	0.001	0.974	0.968	0.005	1.078	1.033	0.001	0.946	0.942	-0.020
	5L82 NIC-MDN	0.958	0.958	0.002	0.970	0.970	0.003	1.033	1.033	0.001	0.920	0.920	0.002
N-2	5L76&5L79	0.977	0.955	0.005	0.991	0.968	0.005	1.049	1.031	0.003	0.938	0.918	0.003
	5L91&5L96	1.042	1.000	-0.040	1.059	1.029	-0.056	1.107	1.072	-0.038	1.004	0.959	-0.038
	5L81&5L82	0.970	0.957	0.003	0.984	0.970	0.003	1.043	1.032	0.002	0.932	0.919	0.002
	5L96&5L98	0.953	0.950	0.010	0.965	0.962	0.011	1.029	1.035	-0.001	0.916	0.910	0.011
	5L51&5L52	1.101	1.031	-0.071	1.116	1.060	-0.087	1.244	1.153	-0.119	1.087	1.012	-0.091
	2L288&2L295	0.959	0.959	0.001	0.972	0.971	0.002	1.034	1.033	0.001	0.921	0.921	0.001
	2L289&2L295	0.958	0.958	0.002	0.971	0.971	0.002	1.033	1.033	0.001	0.920	0.920	0.001
	2L295&2L299	0.958	0.958	0.002	0.971	0.971	0.002	1.033	1.033	0.001	0.920	0.920	0.001

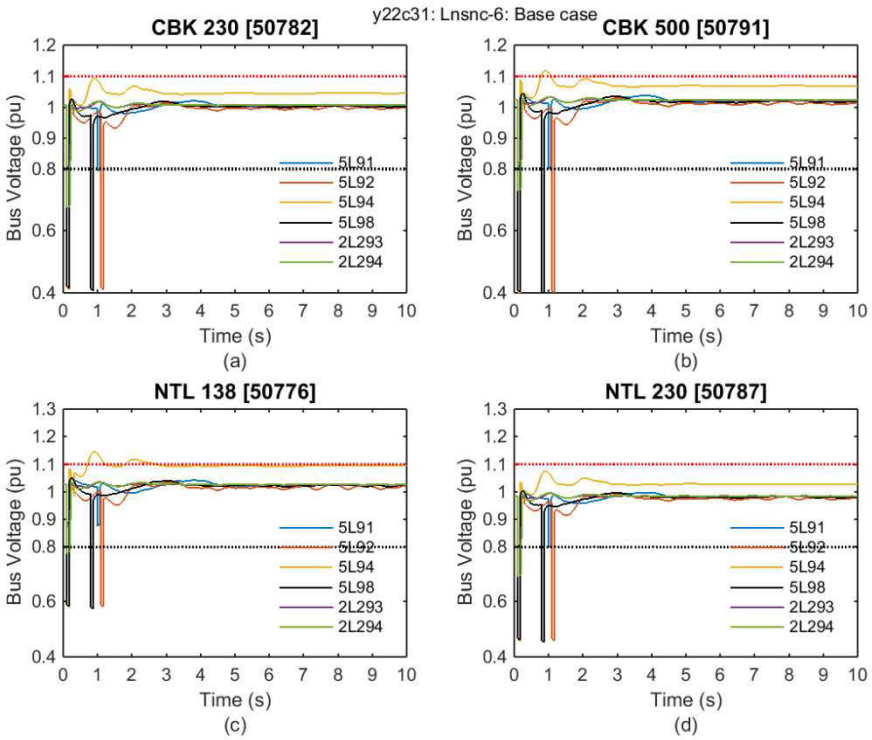
y22c31 Lnsnc 6		CBK 230 230. [50782]			CBK 500 500. [50791]			NTL 138 138. [50776]			NTL 230 230. [50787]		
Contingency		V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV	V_st	V_lt	dV
N-0	Pre Contingency	1.008	1.008	0.000	1.024	1.024	0.000	1.027	1.027	0.000	0.985	0.985	0.000
N-1	SEL T1	1.007	1.007	0.002	1.023	1.023	0.001	1.026	1.026	0.001	0.984	0.984	0.001
	CBK T2+T6	1.011	1.011	-0.003	1.023	1.023	0.002	1.028	1.029	-0.002	0.988	0.989	-0.004
	SEL Shaft Trip T1	1.008	1.006	0.002	1.024	1.023	0.001	1.026	1.026	0.001	0.985	0.984	0.001
	5L75 REV-ACK	1.006	1.006	0.002	1.022	1.022	0.002	1.026	1.026	0.001	0.984	0.984	0.001
	5L91 ACK-SEL	1.000	1.000	0.008	1.016	1.016	0.008	1.020	1.028	-0.001	0.979	0.977	0.008
	5L92 CBK-SEL	1.042	1.027	-0.019	1.066	1.051	-0.027	1.097	1.080	-0.053	1.026	1.011	-0.026
	5L94 CBK-LGN	1.034	1.025	-0.017	1.055	1.044	-0.020	1.088	1.078	-0.051	1.018	1.009	-0.024
	5L96 VAS-SEL	1.004	0.996	0.012	1.019	1.012	0.012	1.024	1.026	0.001	0.982	0.974	0.011
	5L98 NIC-VAS	1.009	1.006	0.002	1.025	1.023	0.001	1.027	1.026	0.001	0.986	0.984	0.001
	2L112 NLY-BDY	1.007	1.007	0.001	1.023	1.023	0.001	1.026	1.026	0.001	0.985	0.985	0.000
	2L222 SEV-SEL	1.007	1.006	0.002	1.024	1.022	0.002	1.026	1.026	0.001	0.985	0.984	0.001
	2L258 CBK-INV	0.998	0.998	0.011	1.019	1.018	0.006	1.021	1.027	0.000	0.978	0.975	0.010
	2L277 WAN-NLY	1.007	1.007	0.001	1.023	1.023	0.001	1.026	1.026	0.001	0.985	0.985	0.000
	2L288 KCL-BTS	1.007	1.007	0.001	1.024	1.024	0.000	1.027	1.026	0.001	0.985	0.985	0.000
	2L289 SEL-BTS	1.007	1.007	0.001	1.023	1.023	0.001	1.026	1.026	0.001	0.984	0.985	0.000
	2L293 SEL-NLY	1.007	1.008	0.000	1.023	1.024	0.000	1.027	1.027	0.000	0.985	0.985	0.000
	2L294 CBK-NLY	1.000	1.000	0.008	1.020	1.019	0.005	1.023	1.022	0.005	0.979	0.979	0.006
	2L295 SEL-KCL	1.007	1.007	0.002	1.023	1.023	0.001	1.026	1.026	0.001	0.984	0.984	0.001
	1L274 NTL-POCATER	1.008	1.007	0.001	1.023	1.023	0.001	1.042	1.035	-0.008	0.992	0.990	-0.005
	1L275 NTL-COLEMAN	1.009	1.009	-0.001	1.024	1.024	0.000	1.061	1.036	-0.009	0.994	0.994	-0.009
	5L82 NIC-MDN	1.007	1.007	0.001	1.023	1.023	0.001	1.027	1.026	0.001	0.985	0.984	0.001
N-2	5L76&5L79	1.039	1.025	-0.017	1.060	1.045	-0.021	1.093	1.078	-0.051	1.023	1.009	-0.024
	5L91&5L96	1.049	1.027	-0.019	1.070	1.048	-0.024	1.071	1.040	-0.013	1.023	1.002	-0.017
	5L81&5L82	1.005	1.006	0.002	1.021	1.022	0.002	1.023	1.025	0.002	0.983	0.984	0.001
	5L96&5L98	1.006	1.000	0.008	1.022	1.017	0.008	1.025	1.029	-0.002	0.984	0.977	0.008
	5L51&5L52	1.037	1.031	-0.023	1.057	1.053	-0.029	1.058	1.043	-0.016	1.012	1.005	-0.020
	2L288&2L295	1.006	1.006	0.002	1.022	1.022	0.002	1.026	1.026	0.001	0.984	0.984	0.001
	2L289&2L295	1.010	1.008	0.000	1.026	1.024	0.000	1.027	1.027	0.000	0.987	0.985	0.000
	2L295&2L299	1.008	1.006	0.002	1.024	1.022	0.002	1.026	1.025	0.002	0.985	0.984	0.001

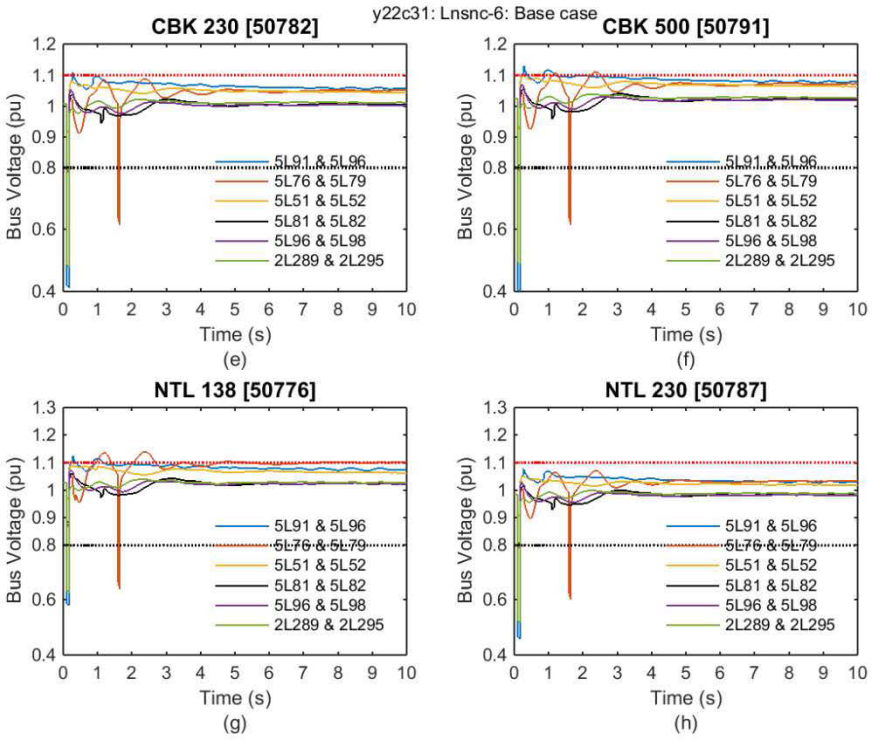
G.19.2 **Y22C27_Lnsnc5-Voltages**

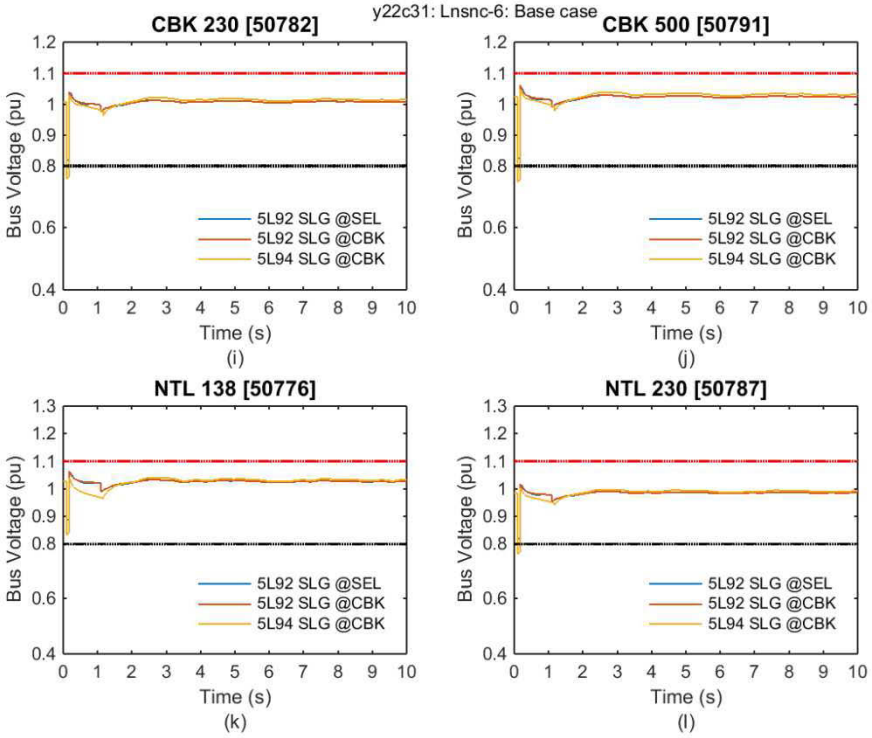




G.19.3 **Y22C31_Lnsnc6-Voltages**

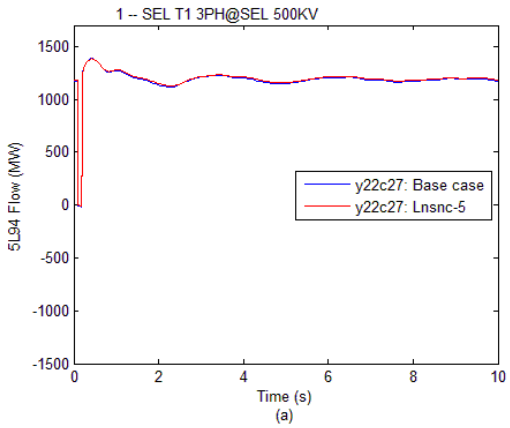


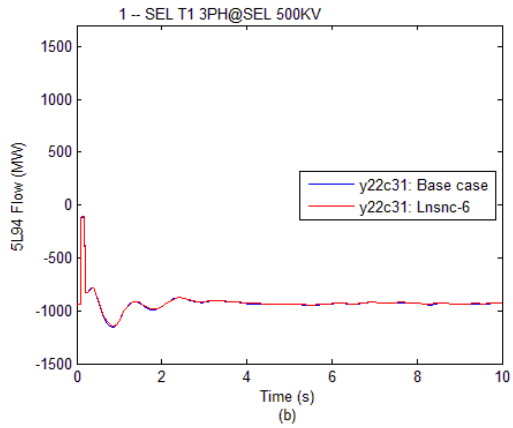


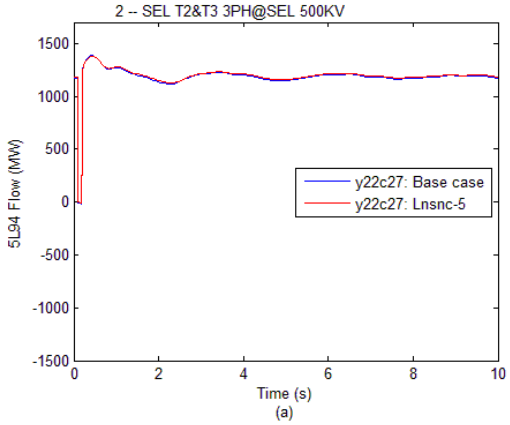


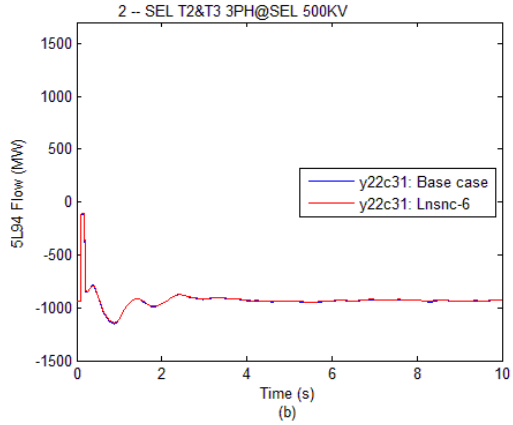
G.19.4 **5L94 MW Flows (N1 and N2 Contingencies)**

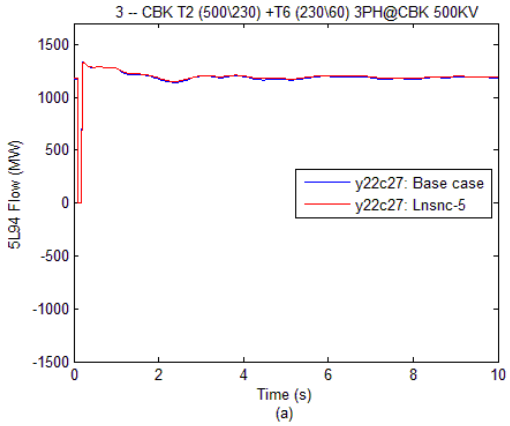
Y22C27_Lnsnc5, Y22C31_Lnsnc6

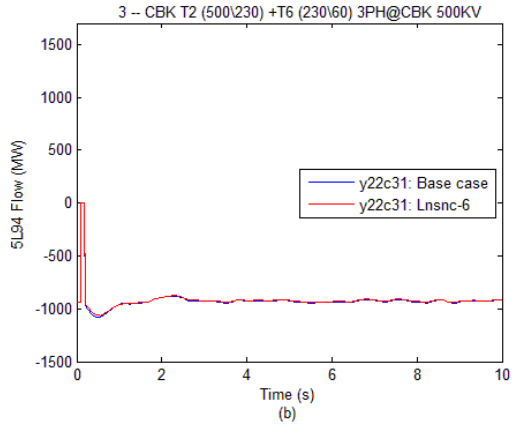


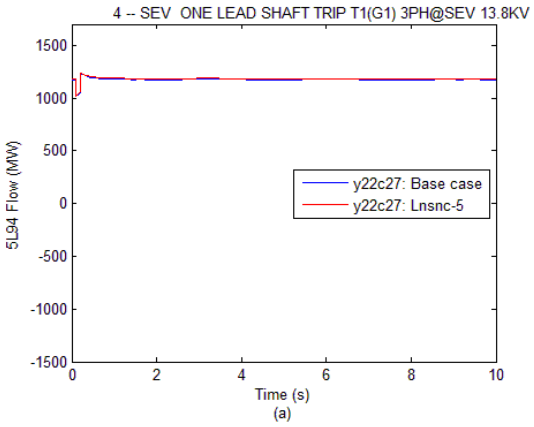




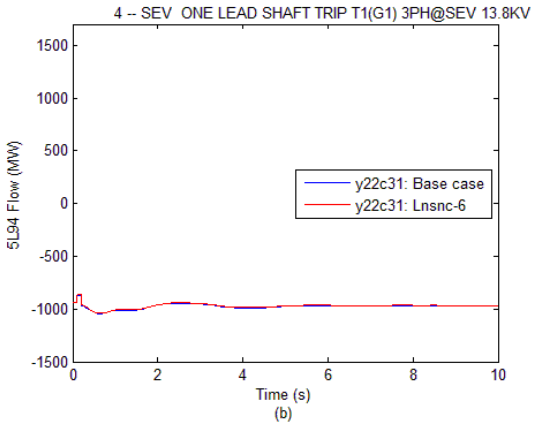




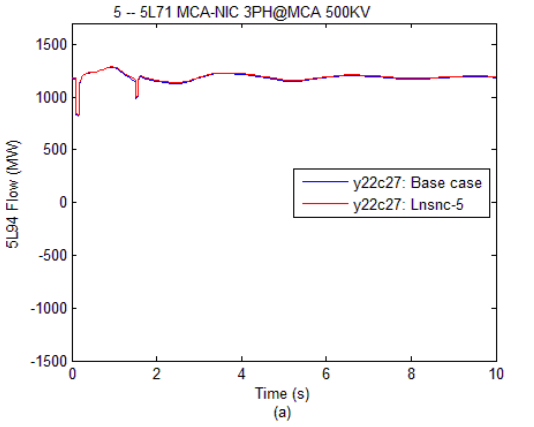




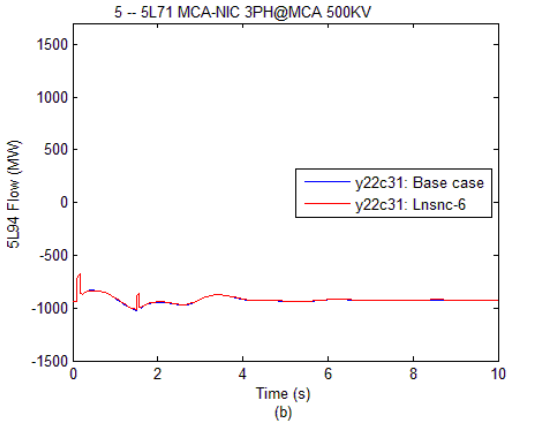
(a)



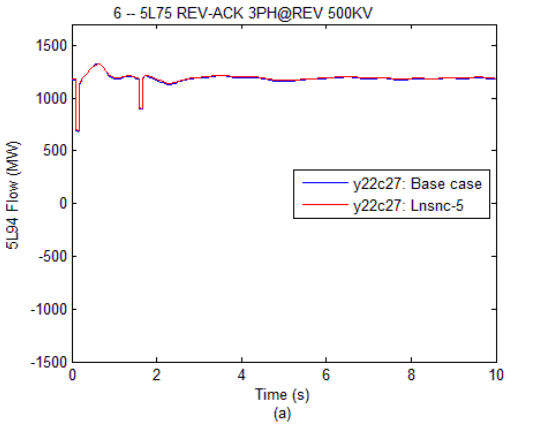
(b)



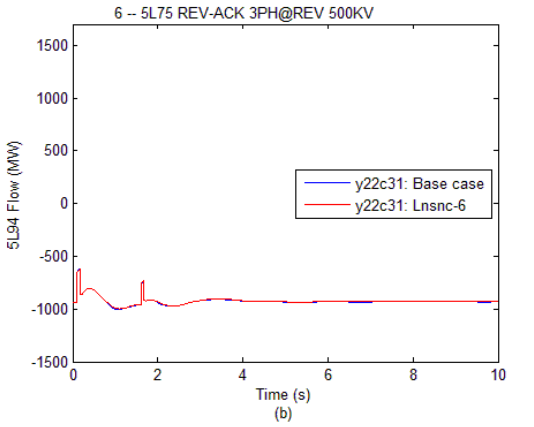
(a)



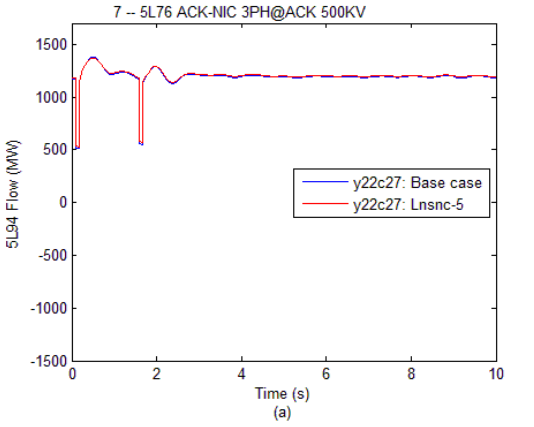
(b)



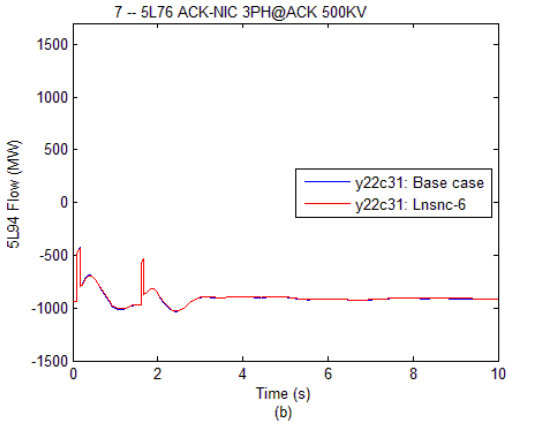
(a)



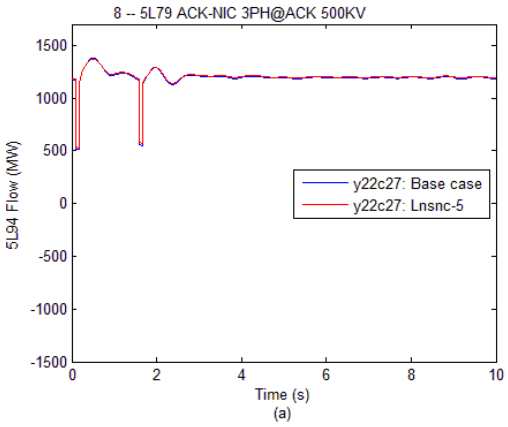
(b)



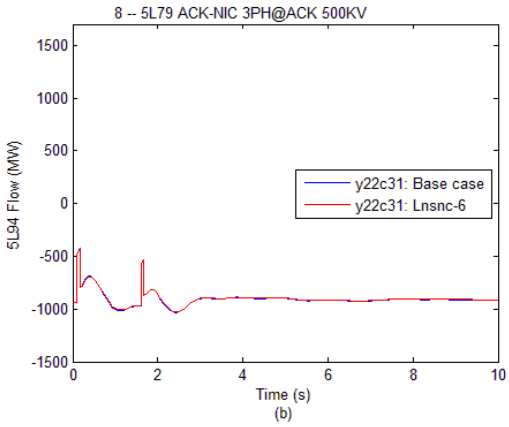
(a)



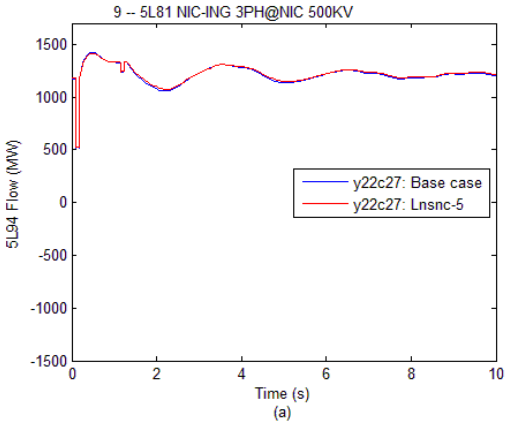
(b)



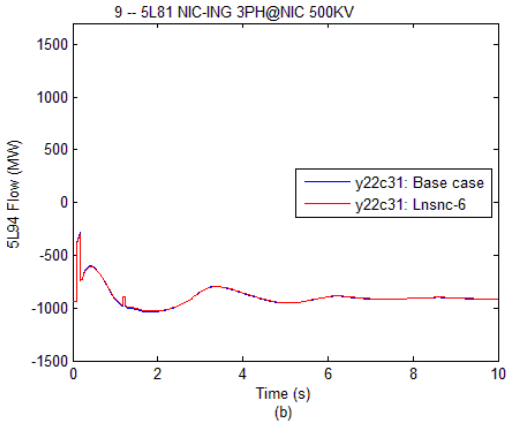
(a)



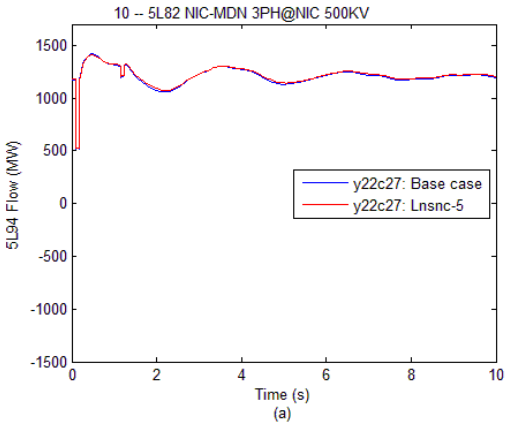
(b)



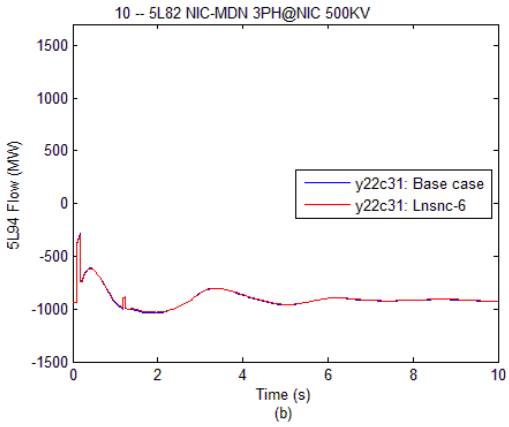
(a)



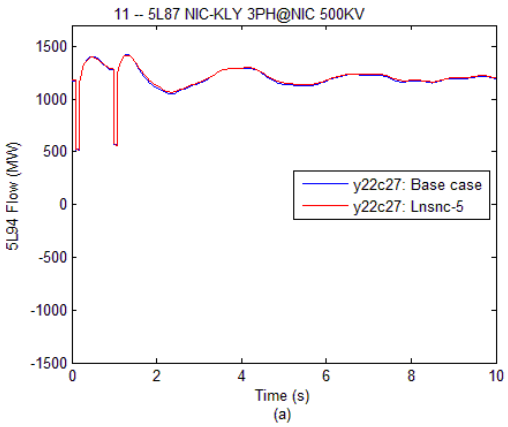
(b)



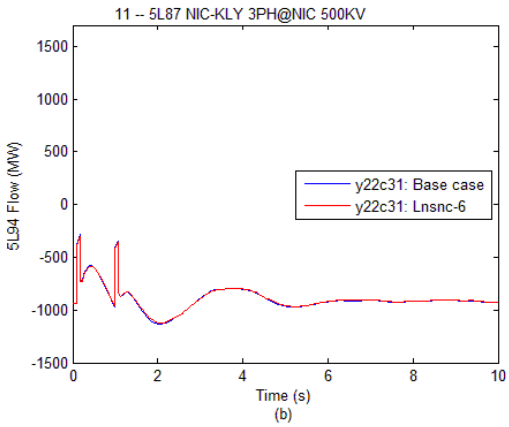
(a)



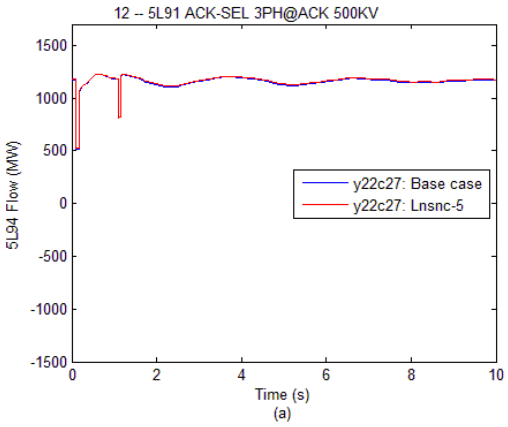
(b)



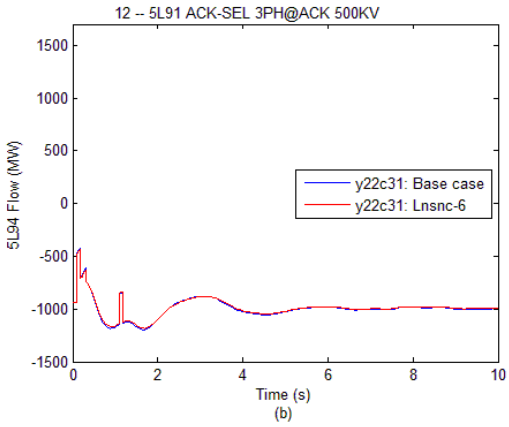
(a)



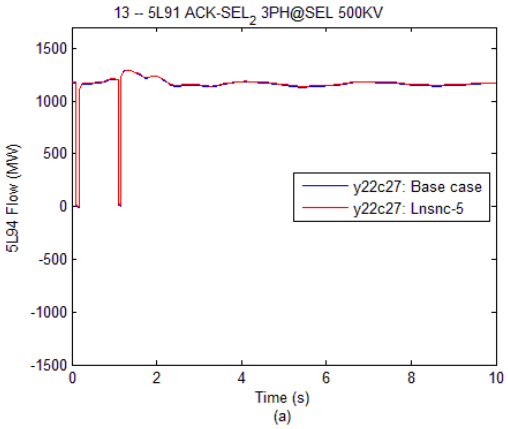
(b)



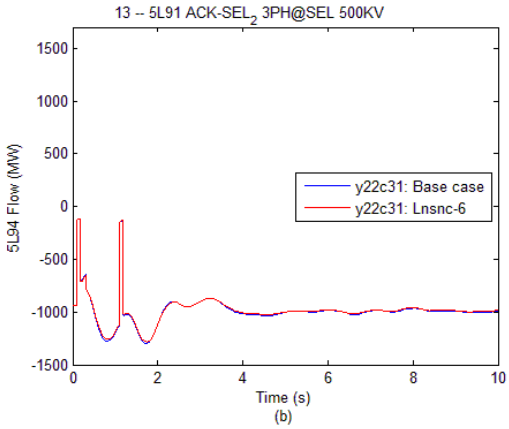
(a)



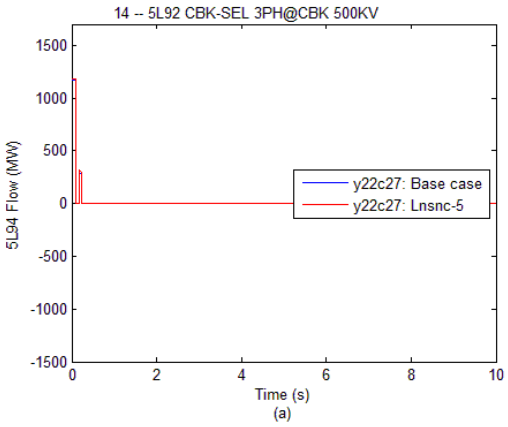
(b)



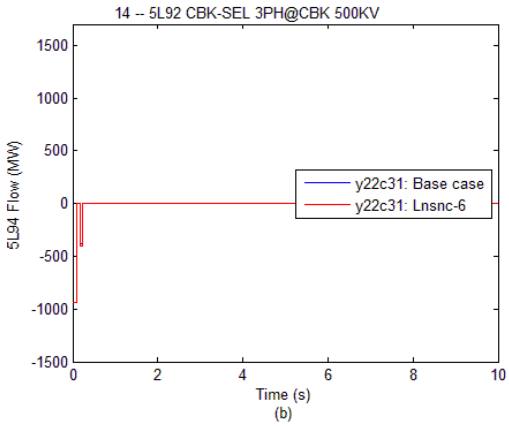
(a)



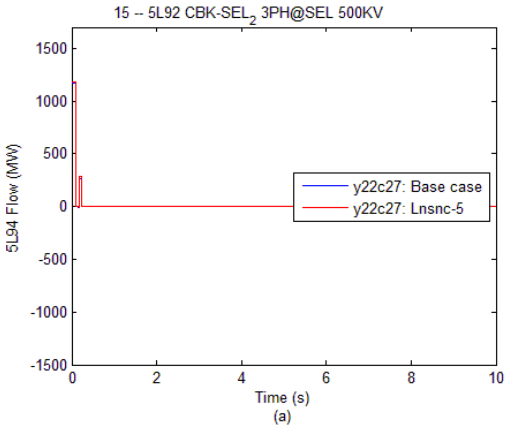
(b)



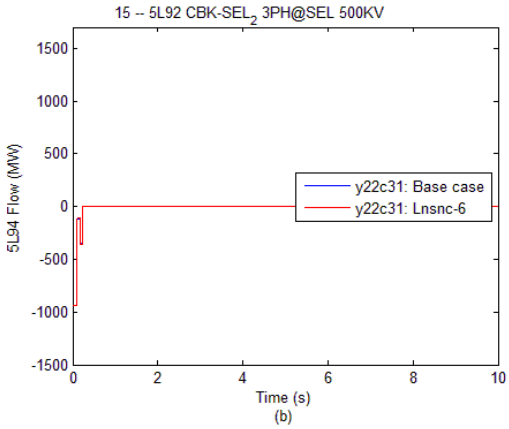
(a)



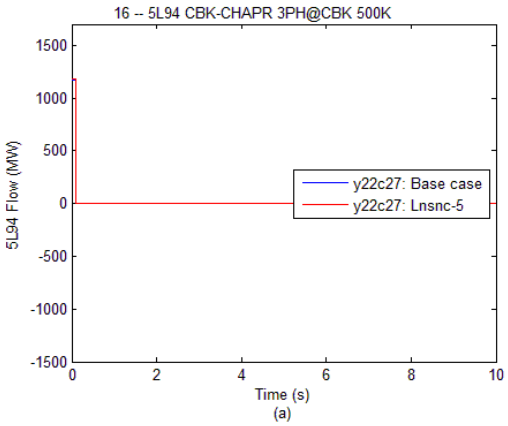
(b)



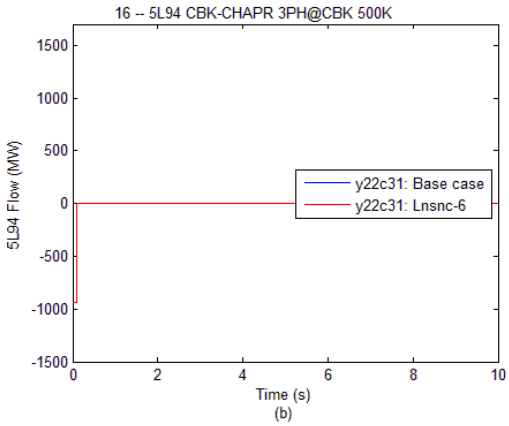
(a)



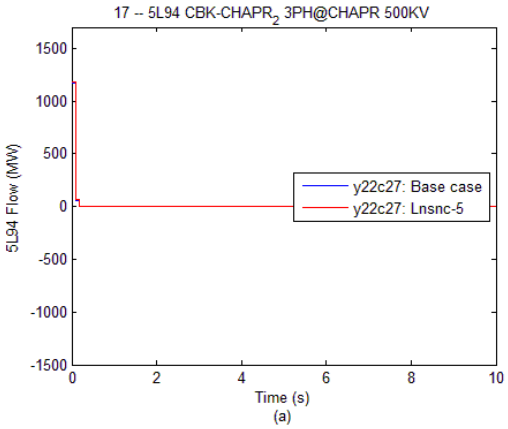
(b)



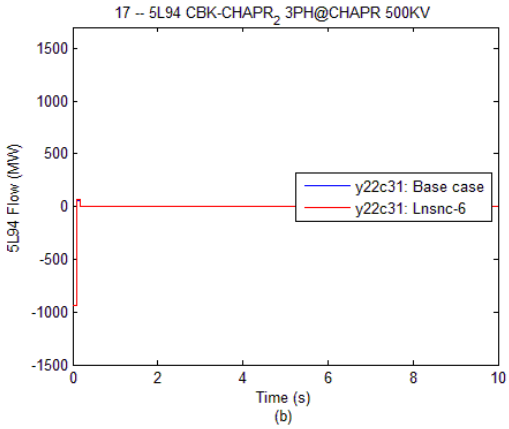
(a)



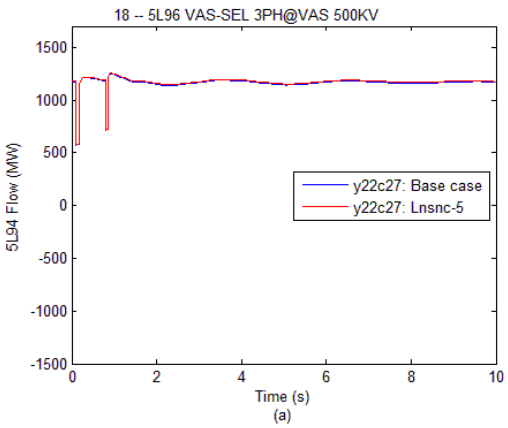
(b)



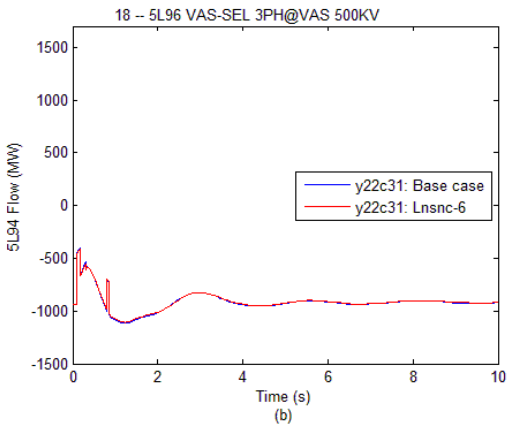
(a)



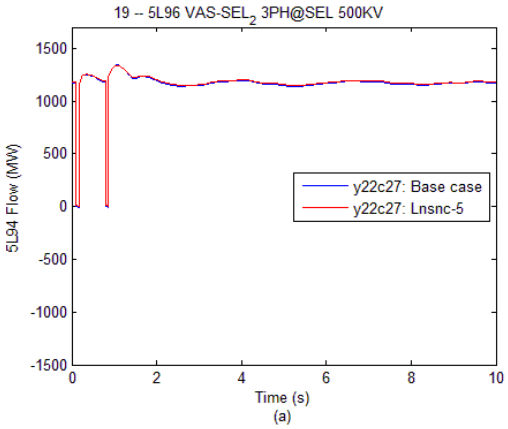
(b)



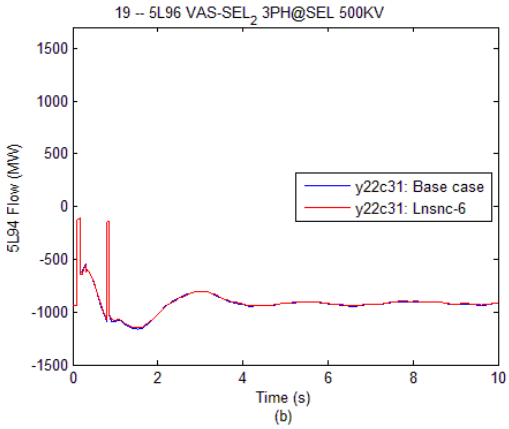
(a)



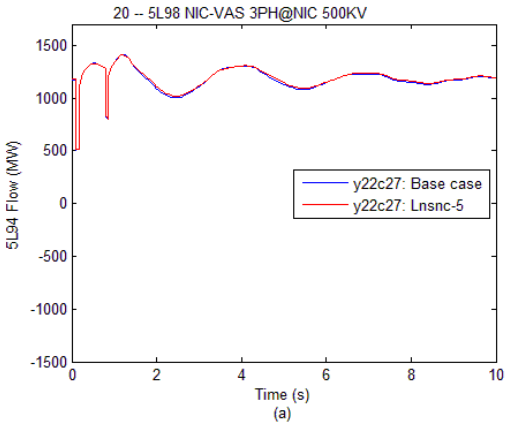
(b)



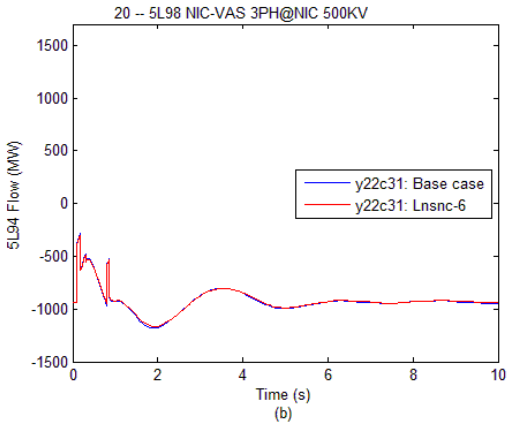
(a)



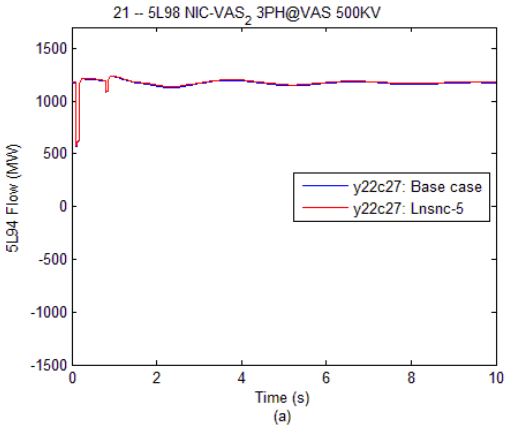
(b)



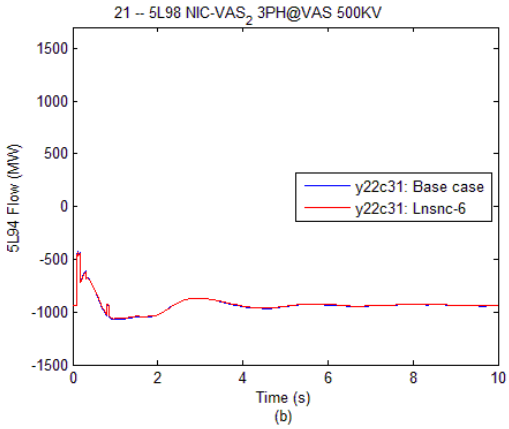
(a)



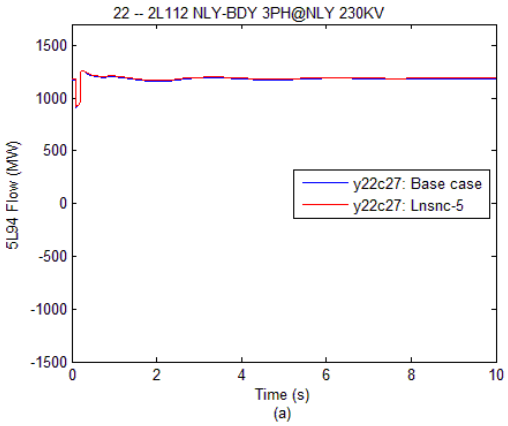
(b)



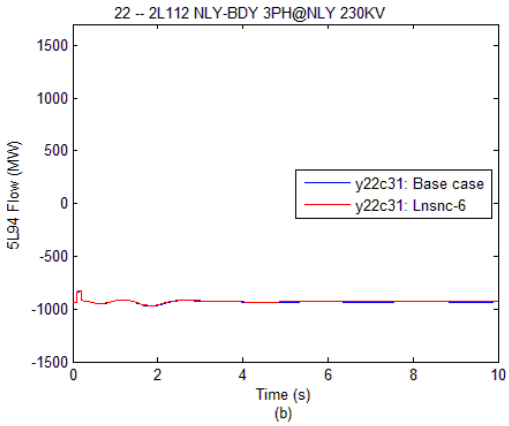
(a)



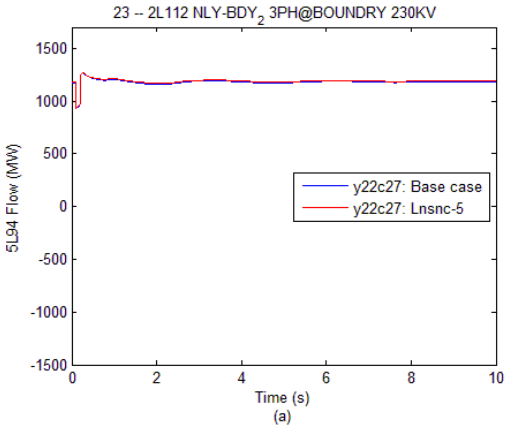
(b)



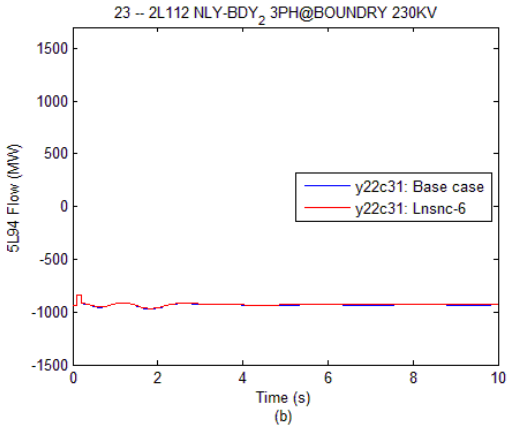
(a)



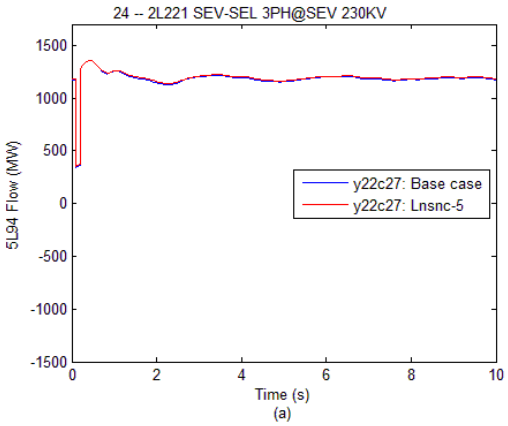
(b)



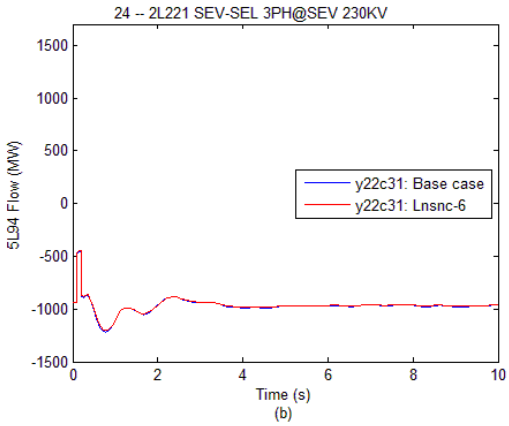
(a)



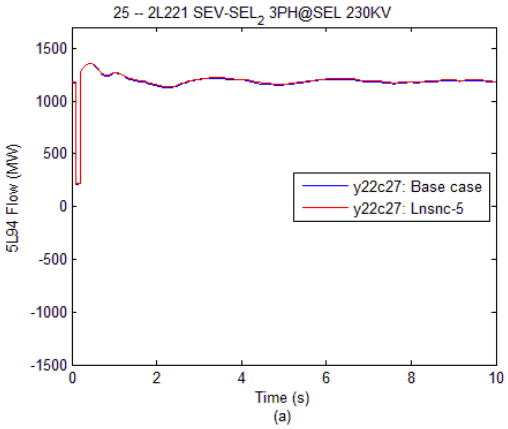
(b)



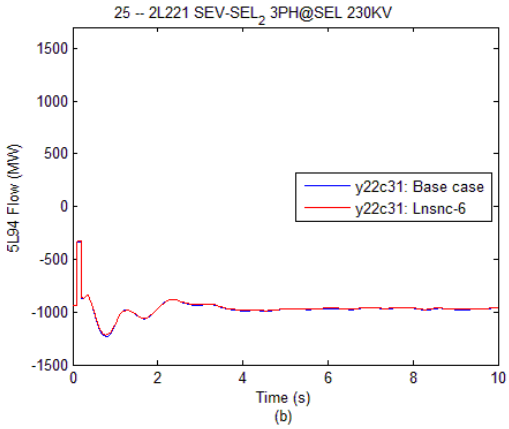
(a)



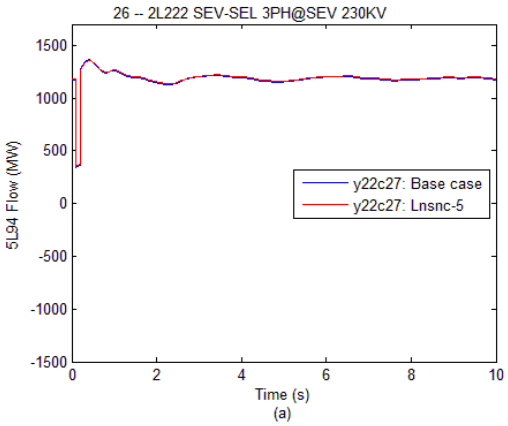
(b)



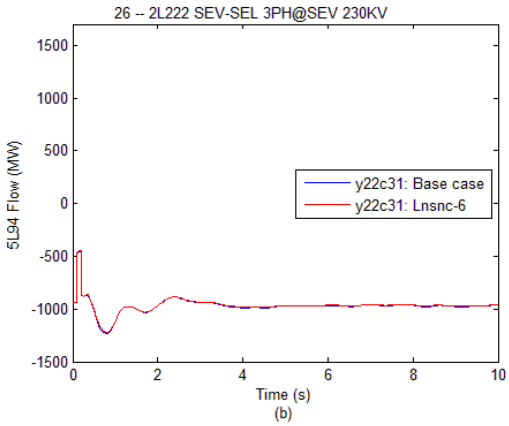
(a)



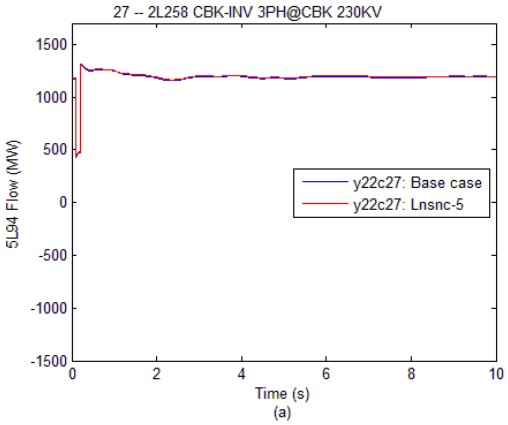
(b)



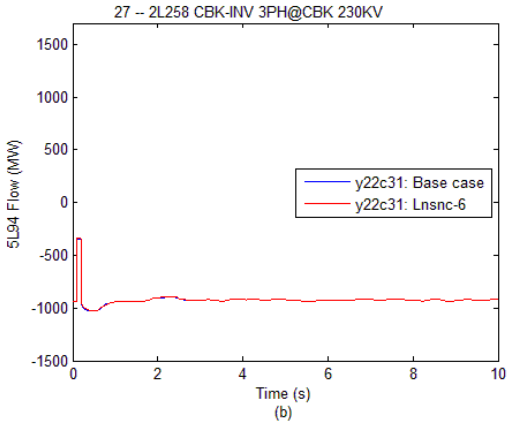
(a)



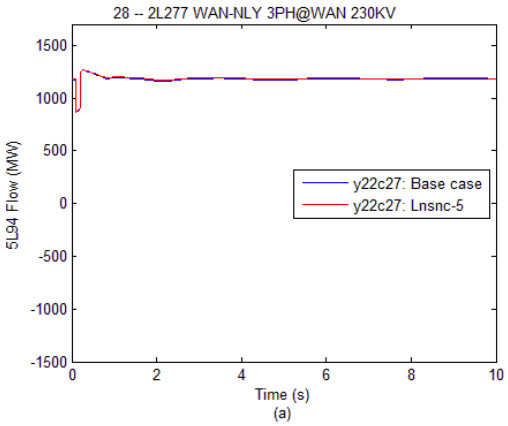
(b)



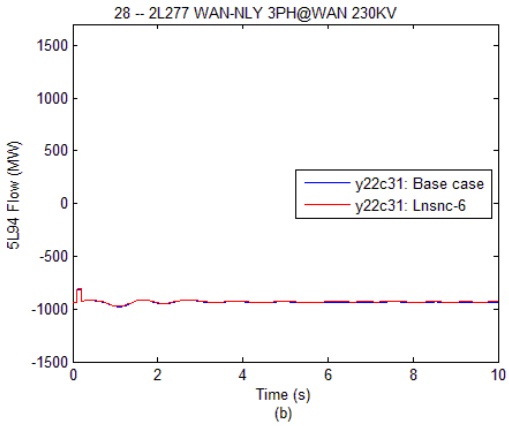
(a)



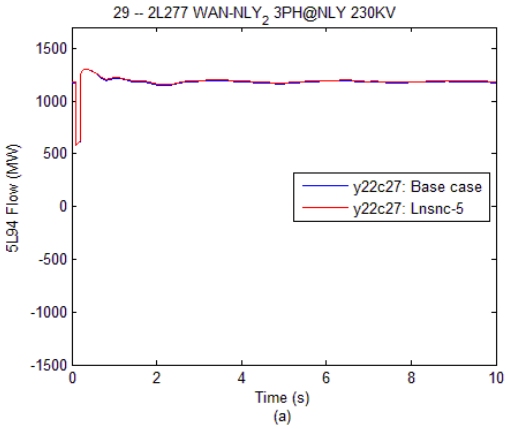
(b)



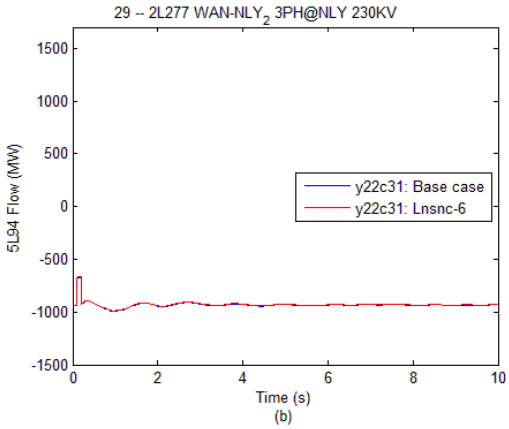
(a)



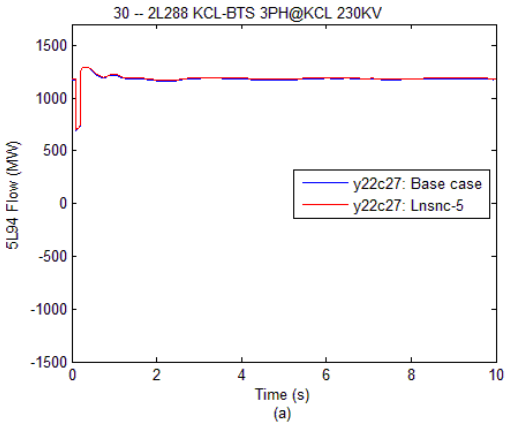
(b)



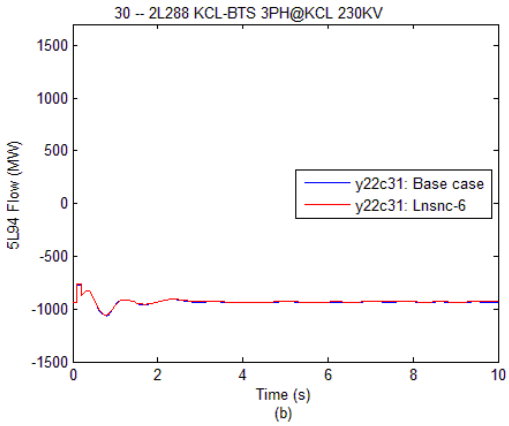
(a)



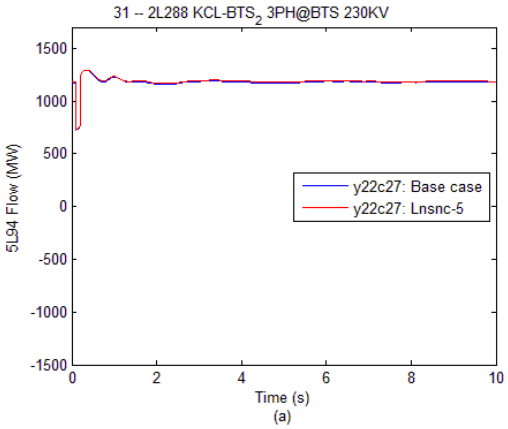
(b)



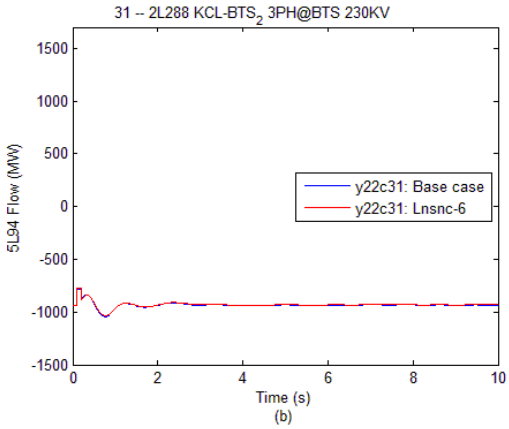
(a)



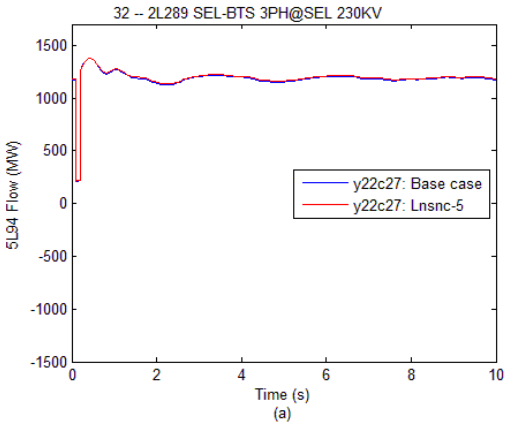
(b)



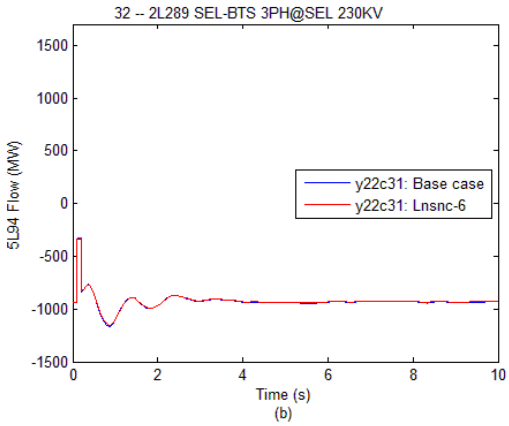
(a)



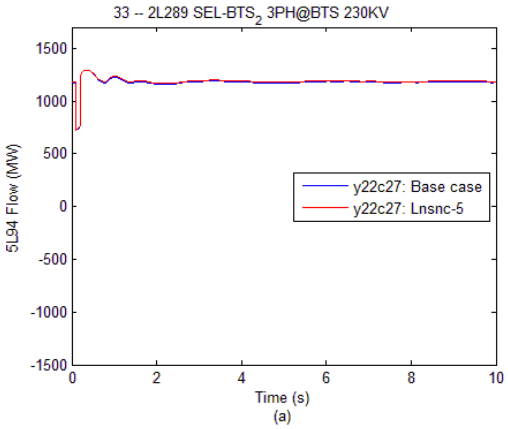
(b)



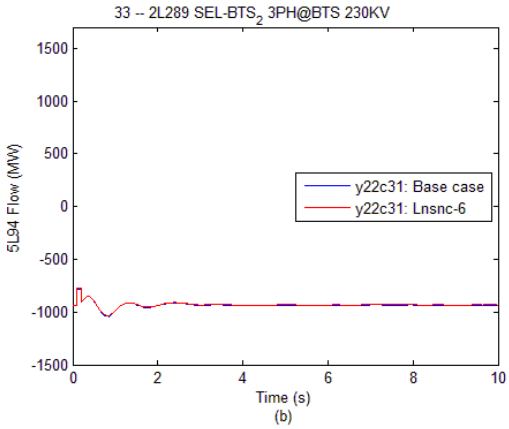
(a)



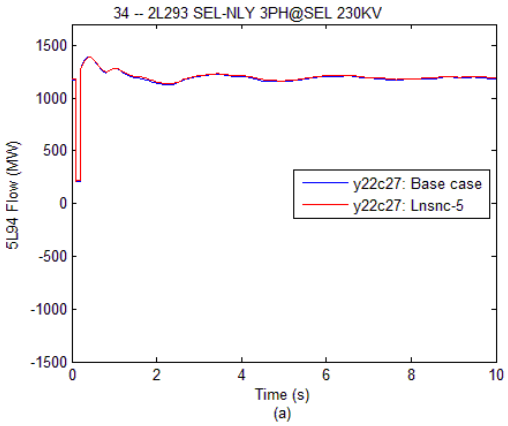
(b)



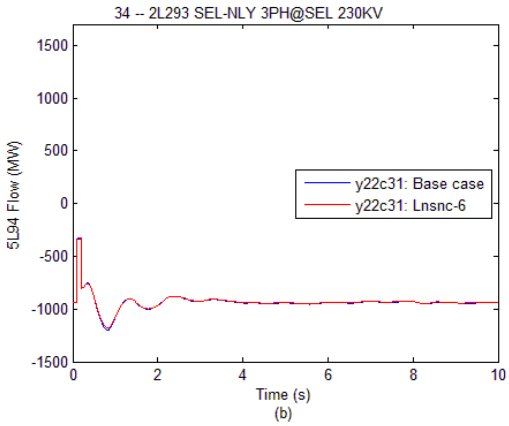
(a)



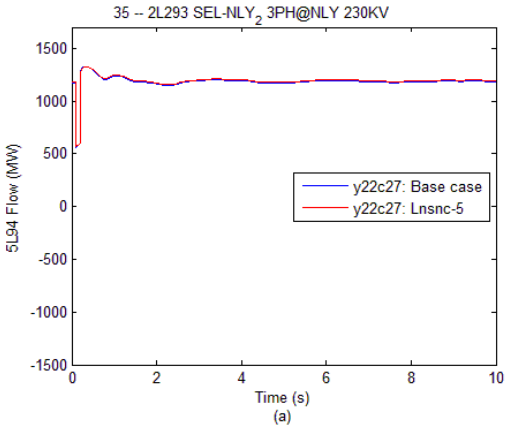
(b)



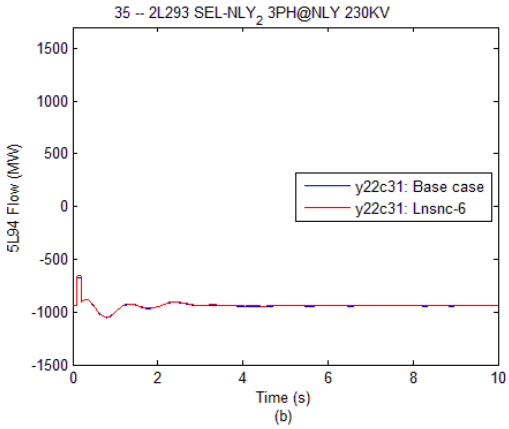
(a)



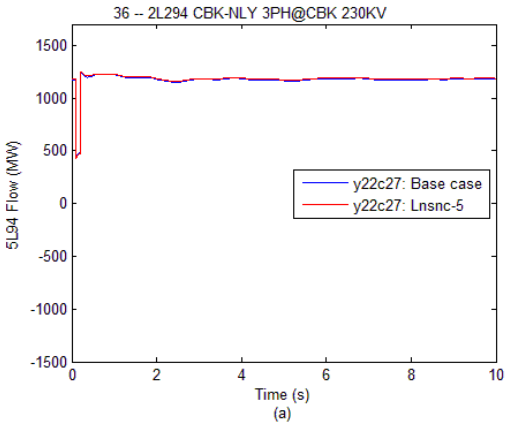
(b)



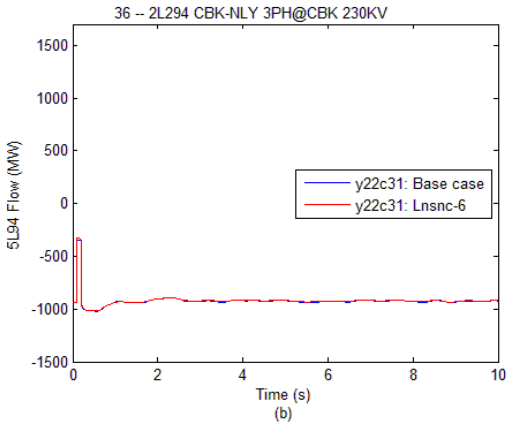
(a)



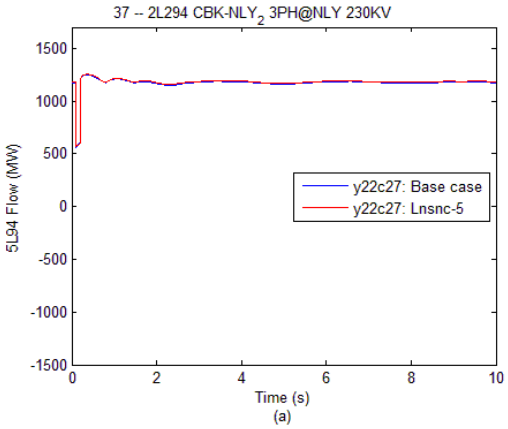
(b)



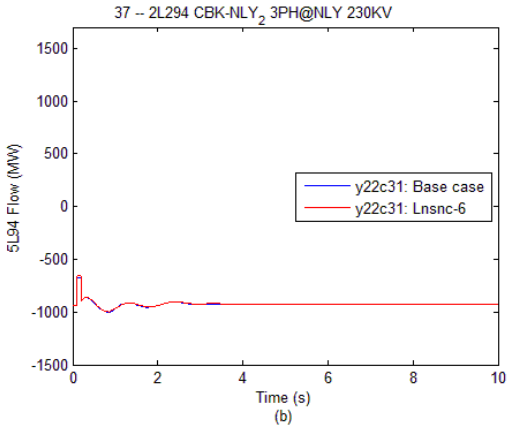
(a)



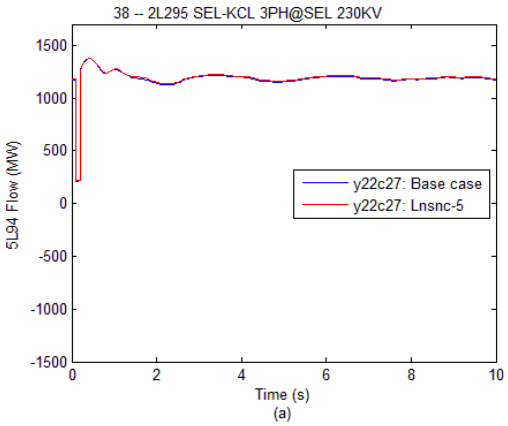
(b)



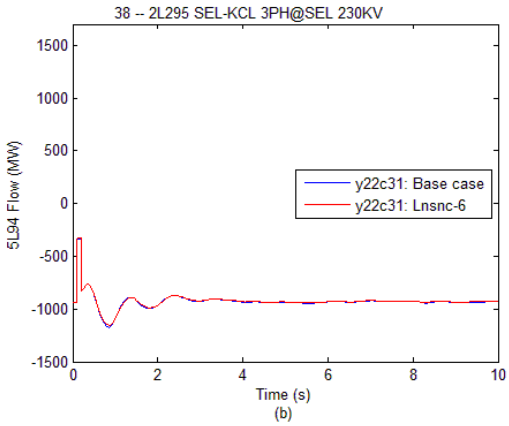
(a)



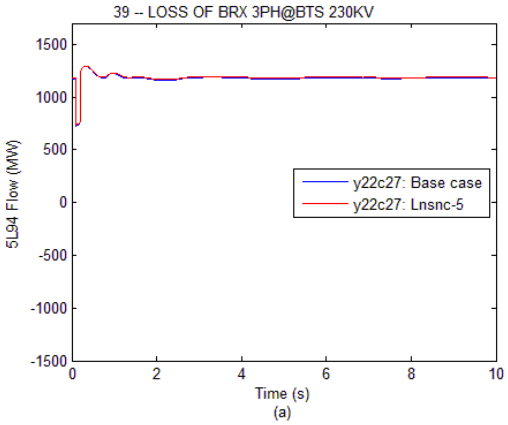
(b)



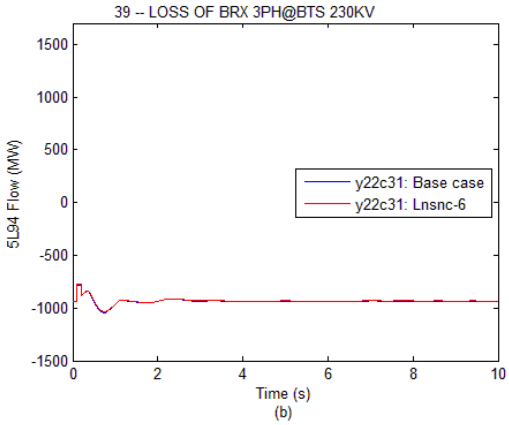
(a)



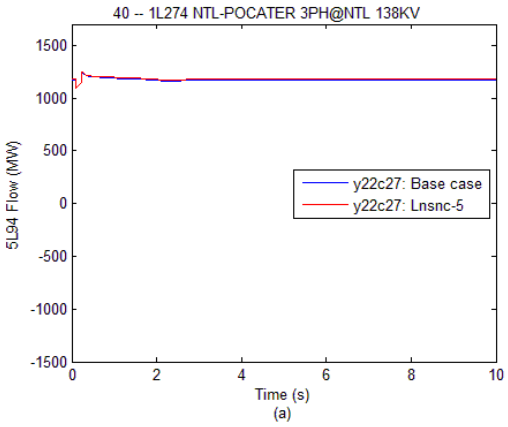
(b)



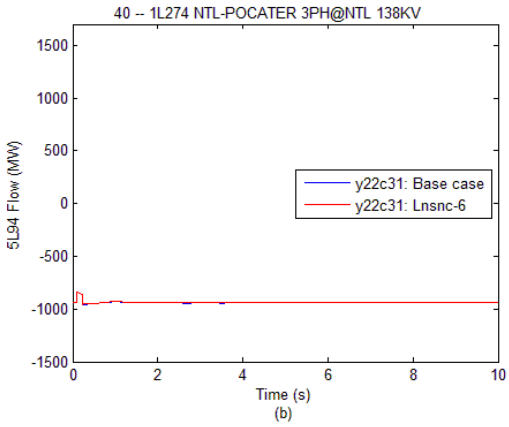
(a)



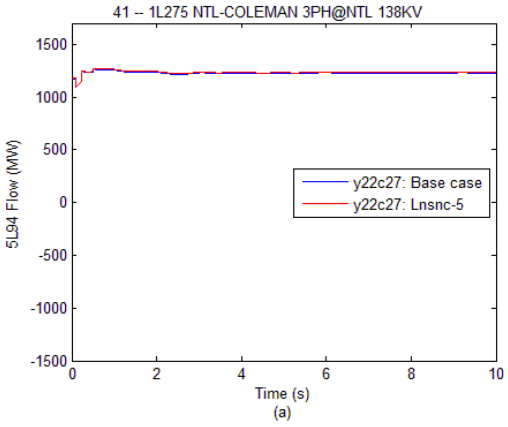
(b)



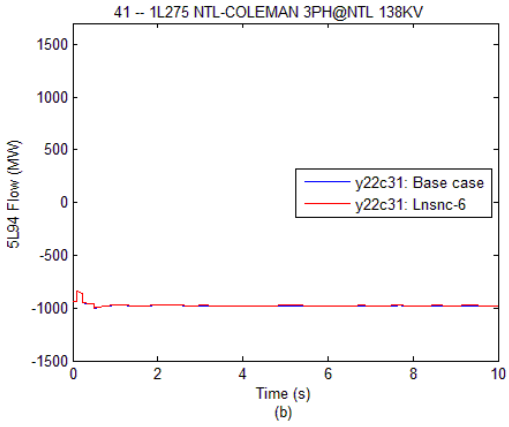
(a)



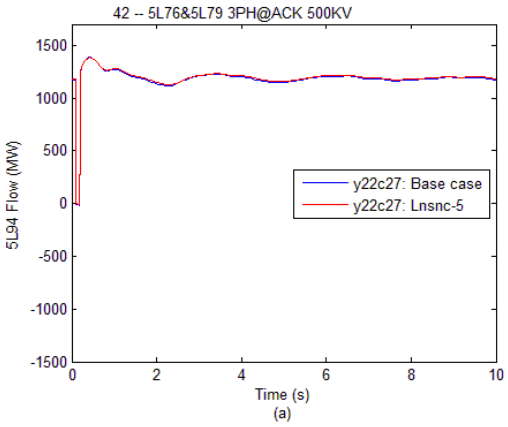
(b)



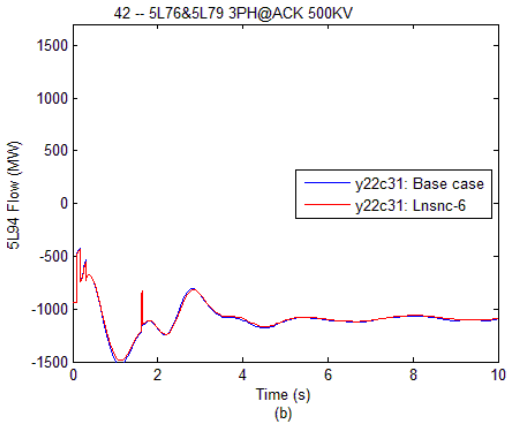
(a)



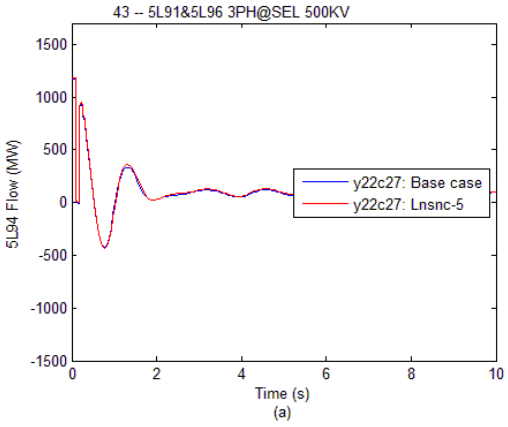
(b)



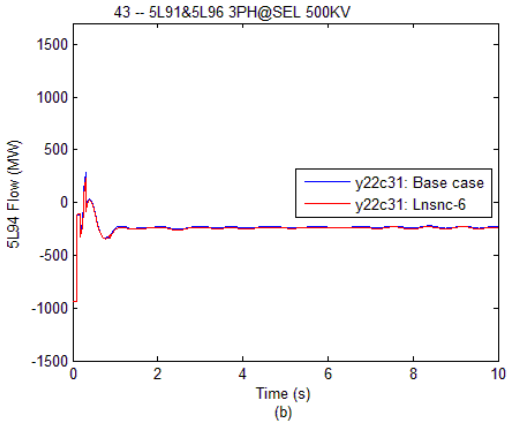
(a)



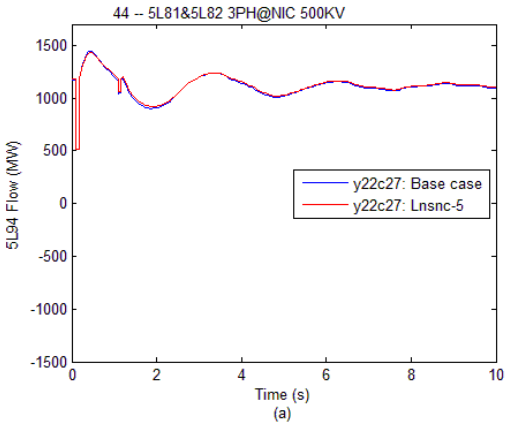
(b)



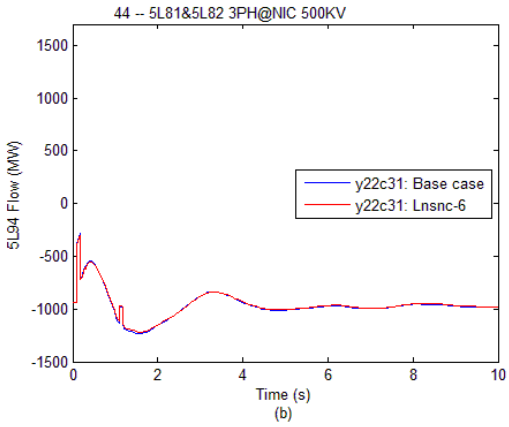
(a)



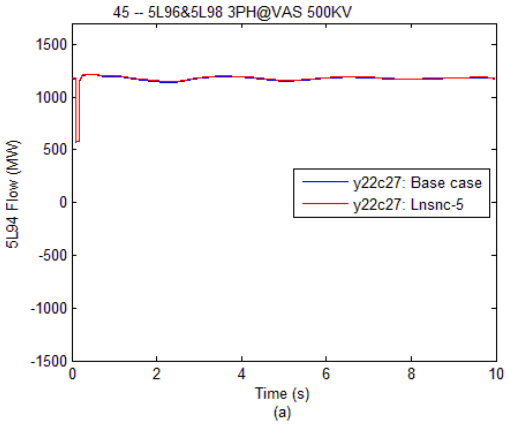
(b)



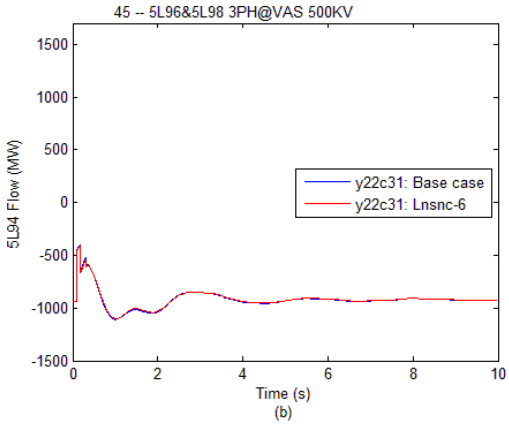
(a)



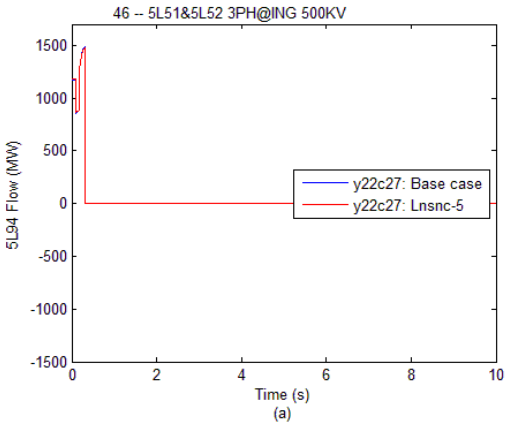
(b)



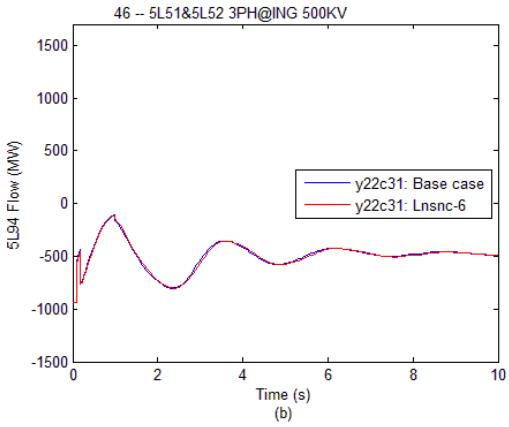
(a)



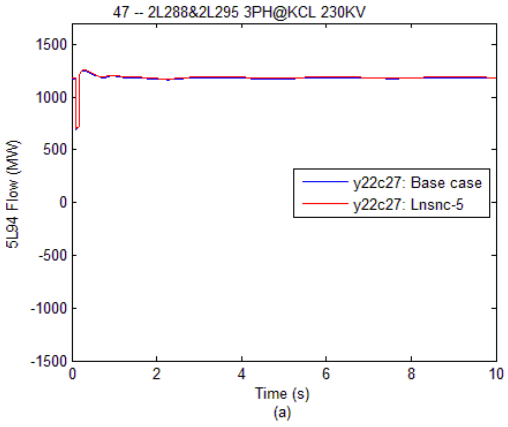
(b)



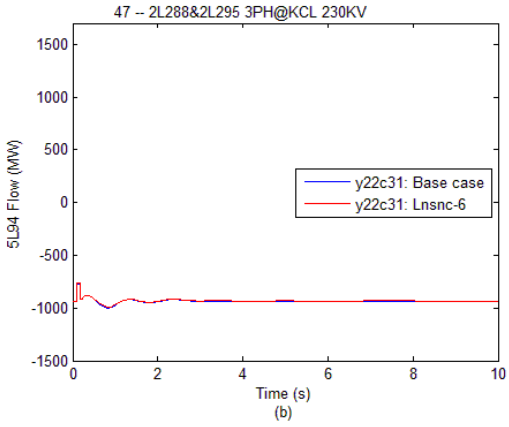
(a)



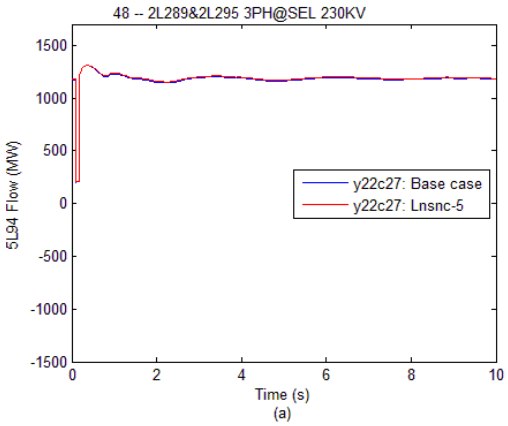
(b)

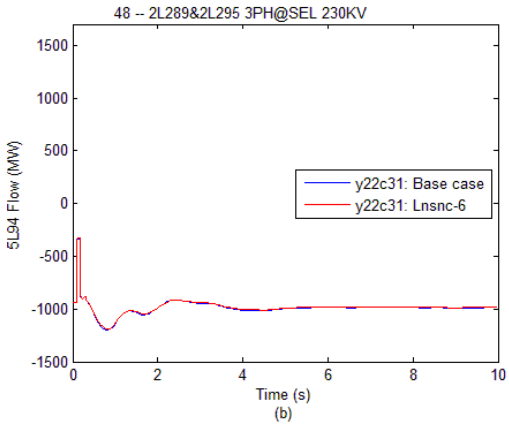


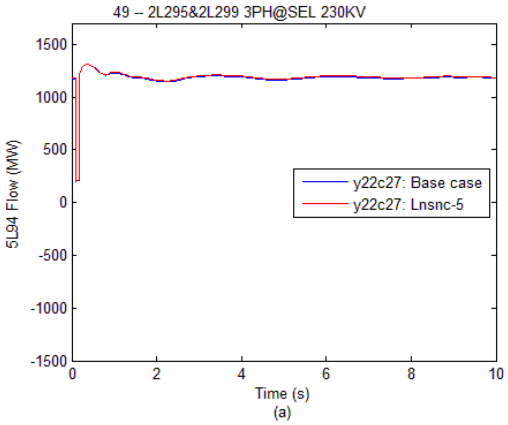
(a)

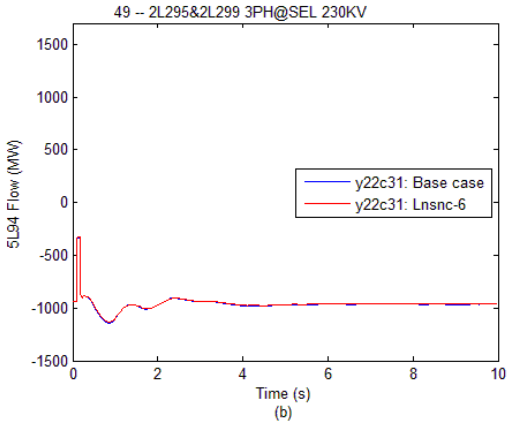


(b)

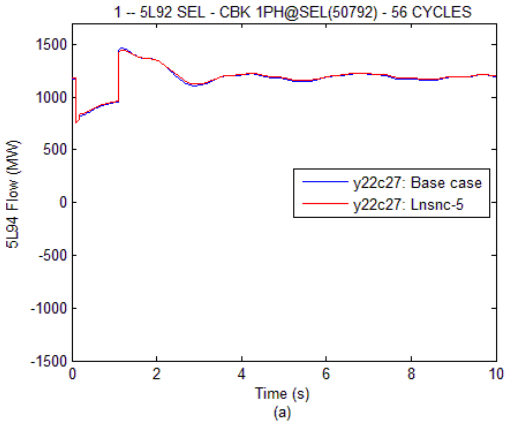


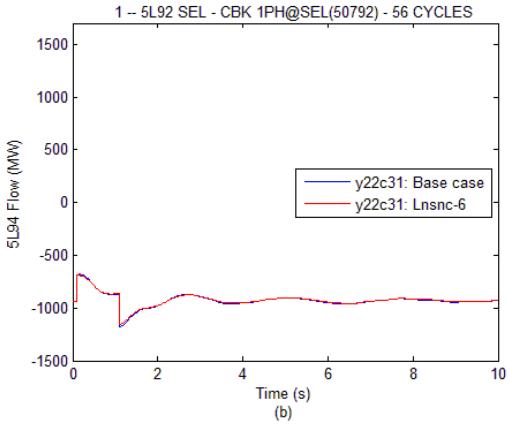


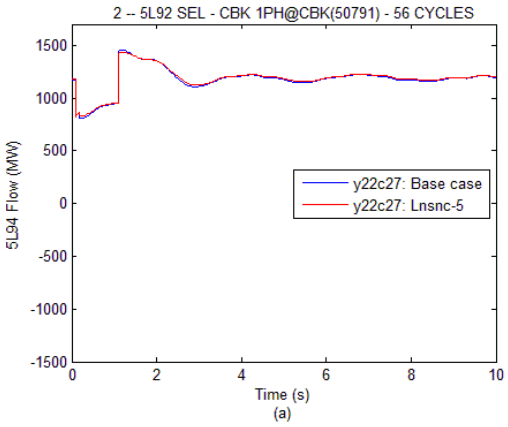




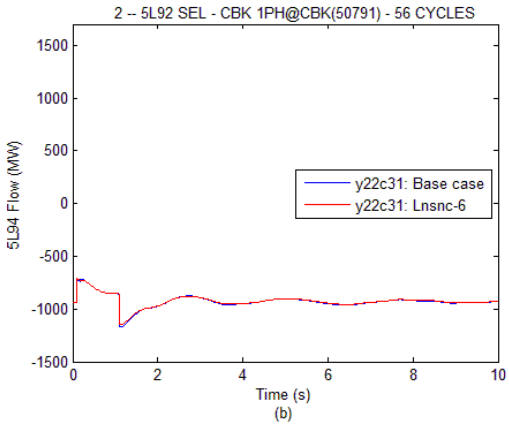
G.19.5 **5L94 MW Flows (SPR Contingencies)**



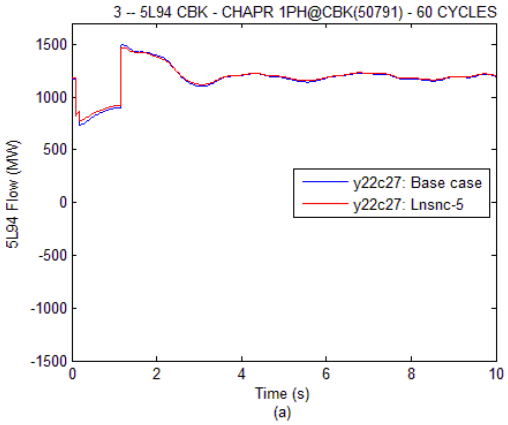




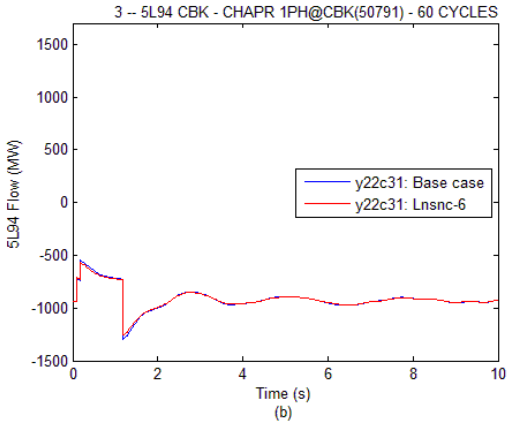
(a)



(b)



(a)



(b)