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An Analysis of the Sensitivity of WECC Grid Planning Models to Assumptions Regarding the Composition of Loads

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Title:	**An Analysis of the Sensitivity of WECC Grid Planning Models to Assumptions Regarding the Composition of Loads**	
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EXECUTIVE SUMMARY

MEPPI performed "An Analysis of the Sensitivity of WECC Grid Planning Models to Assumptions Regarding the Composition of Loads" project in collaboration with the University of California Lawrence Berkeley National Laboratory (LBNL), the Western Electricity Coordination Council (WECC), and associated WECC members. The overall objective of this project is to conduct a parametric set of simulations that explore the sensitivity of WECC's planning models to uncertainties in the composition and behavior of loads. The results of the simulations performed in this study are expected to provide guidance that transmission planners can follow in refining the composition of loads used to conduct future planning studies.

The composite load model under study was developed, tested, and implemented in major software packages utilized by WECC (PSS/E, PSLF, and PowerWorld). The load data is currently built for 24 hours, four seasons, and various types of substations by a data management tool. The load model under study has been incorporated and is in use today in the Phase I portion of the model development. Phase 1 of the load model development includes all parameters for the step-down transformer, distribution equivalent, four types of motors, electric load such as fluorescent lighting, and static load. Phase 1 of the load model development ignores the stalling impact of air-conditioning motor loads, and therefore, is disabled by setting the Tstall parameter to a high value (e.g. 9999). MEPPI performed this study with the motor stalling impact for air-conditioner motor loads enabled by setting a realistic value for Tstall (referred to as Phase 2 of the load model development).

This analysis focused on the sensitivity of the composite load model to a variation of parameters that will impact the recovery of the system. Refer to Table ES-1 for the most influential parameters observed for Motor A, Motor B, and Motor C. Refer to Table ES-2 for the most influential parameters observed for Motor D.

Table ES-1
Motors A, B, and C Sensitivity to Parameters

Impact of Parameter Sensitivities Compared to Default NERC Data Set for Motor A, Motor B, and Motor C										
Parameter Name	**Parameter Description**	**Voltage Recovery (Impact on FIDVR)**		**Over Voltage Above 1.1 p.u. within 8 sec.**		**Over Voltage Above 1.1 p.u. b/w 8 and 30 sec.**		**Generation Trip**		**System Impact Significance Compared to NERC Default Data Set**
		NDDS (+)	**NDDS (-)**	**NDDS (+)**	**NDDS (-)**	**NDDS (+)**	**NDDS (-)**	**NDDS (+)**	**NDDS (-)**	
Ftr1	Percentage of motor loads that will trip on the first voltage trip setting (%)	↓ in observations	↑ in observations	Large ↑ in observations	Large ↓ in observations	Large ↑ in observations	Large ↓ in observations	Large ↑ in observations	No Change	- Increased percentage of motor loads that trip: improved system recovery - Decreased percentage of motor loads that trip: increased voltage recovery issues (FIDVR)
Ttr1	First low voltage trip delay time for three phase motors (secs)	Small ↑ in observations	Small ↓ in observations	Small ↓ in observations	No Change	Small ↓ in observations	No Change	No Change	Small ↑ in observations	- Increased trip delay time: increase FIDVR - Decreased trip delay time: improve system recovery
Vtr1	First low voltage trip setting for three phase motors (p.u.)	No Change	Large ↑ in observations	↑ in observations	↓ in observations	Small ↓ in observations	↑ in observations	Small ↑ in observations	Small ↓ in observations	- Increase voltage trip setting: improved system recovery - Decrease voltage trip setting: increase FIDVR (motors remain connected to system, stalling for longer duration)

* NDDS - NERC Default Data Set
** NDDS (+) - Parameter increase from NERC Default Data Set
*** NDDS (-) - Parameter decrease from NERC Default Data Set
**** ↑ - Increase, ↓ - Decrease

Table ES-2
Motor D Sensitivity to Parameters

Impact of Parameter Sensitivities Compared to Default NERC Data Set for Motor D										
Parameter Name	**Parameter Description**	**Voltage Recovery (Impact on FIDVR)**		**Over Voltage Above 1.1 p.u. within 8 sec.**		**Over Voltage Above 1.1 p.u. b/w 8 and 30 sec.**		**Generation Trip**		**System Impact Significance Compared to NERC Default Data Set**
		NDDS (+)	**NDDS (-)**	**NDDS (+)**	**NDDS (-)**	**NDDS (+)**	**NDDS (-)**	**NDDS (+)**	**NDDS (-)**	
Vstall	Stall voltage (p.u.)	Large ↑ in observations	Large ↓ in observations	Large ↓ in observations	Large ↑ in observations	↑ in observations	↓ in observations	↑ in observations	No Change	- Increased stalling voltage: increased voltage recovery issues (FIDVR) - Decreased stalling voltage: improved system recovery
Tstall	Stall delay time (sec)	Large ↓ in observations	Large ↑ in observations	Large ↑ in observations	No Change	Large ↓ in observations	Large ↑ in observations	No Change	Small ↑ in observations	- Increased stall delay time: improved system recovery - Decreased stall delay time: increase FIDVR
FmD	Motor D fraction of load	↑ in observations	↓ in observations	↑ in observations	↓ in observations	Large ↑ in observations	Large ↓ in observations	Small ↑ in observations	No Change	- Increase percentage of Motor D load: increase FIDVR - Decrease percentage of Motor D load: improved system recovery
Fuvr	Fraction of load with under voltage relay protection	↓ in observations	↑ in observations	↑ in observations	No Change	↓ in observations	↑ in observations	No Change	No Change	- Increase motors with under voltage protection: improved system recovery - Decrease motors with under voltage protection: increase FIDVR
Tth	Motor D thermal time constant (sec)	↑ in observations	↓ in observations	Large ↑ in observations	No Change	↓ in observations	↑ in observations	No Change	No Change	- Increase thermal time constant: increase FIDVR - Decrease thermal time constant: improved system recovery
Th1t	Motor D thermal protection trip start level (p.u. temp)	↑ in observations	↓ in observations	No Change	No Change	↑ in observations	↓ in observations	No Change	No Change	- Increase thermal trip protection start: increase FIDVR - Decrease thermal trip protection start: improved system recovery
Th2t	Motor D thermal protection trip completion level (p.u. temp)	↑ in observations	↓ in observations	No Change	Large ↑ in observations	↑ in observations	↓ in observations	No Change	No Change	- Increase thermal trip protection completion: increase FIDVR - Decrease thermal trip protection completion: improved system recovery

* NDDS - NERC Default Data Set
** NDDS (+) - Parameter increase from NERC Default Data Set
*** NDDS (-) - Parameter decrease from NERC Default Data Set
**** ↑ - Increase, ↓ - Decrease

MEPPI recommends Transmission Owners and Transmission Planners focus data collection on the following parameters:

- **Vstall**: Stall voltage, p.u.
- **Tstall**: Stall time delay, sec.
- **FmD**: Motor D fraction of load P
- **Fuvr**: Fraction of load with under voltage relay protection
- **Tth**: Motor D thermal time constant, sec.
- **Th1t**: Motor D thermal protection trip start level, p.u. temperature
- **Th2t**: Motor D thermal protection trip completion level, p.u. temperature

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SECTION 1. INTRODUCTION AND BACKGROUD

A power system is composed of generation, transmission, and loads. It is important to be able to accurately model the dynamic behavior of generation and loads for planning studies to accurately predict the response of the system. If optimistic models are utilized, the system may not be adequately designed to handle severe disturbance events on the system. If extremely conservative models are utilized, planning studies may require more restrictive operating procedures and unnecessary reactive devices leading to higher than necessary costs. There have been significant improvements in the modeling of generators, turbines, and associated systems over the years. Generator modeling parameters could be confirmed through generator testing. It is more difficult to accurately predict the response of a load to a dynamic event on a given feeder and as a result, load models are still being developed and researched.

As loads on the system start to have a more significant impact, the load models impact system stability with a greater degree. Resistive loads, such as incandescent lighting, which are voltage sensitive, are being replaced with fluorescent lights, plus electronic drives and electric chargers for vehicles are growing in numbers. The decrease in resistive loads and increase in electronic loads increases the stress on the system when voltages decline. Since electronic loads behave as constant power loads, as voltages decline, the electronic loads draw more current, further reducing the voltage and thus deteriorating stability of the system. Single-phase compressor motors (residential air-conditioners) have been understood to have an impact on fault-induced delayed voltage recovery (FIDVR) of a system, especially in load centers. After the compressor of the single-phase A/C motor stalls, the motor will remain stalled even after a fault or an event that depresses the voltages, is cleared. The stalled motor draws locked rotor current which subsequently puts more stress on an already compromised system. It has been recognized that these single-phase A/C motors cannot be modeled with three-phase motor models and require special modeling. Overall, it can be observed with the replacement of resistive loads, increase of electronic loads, and areas with dense air-conditioning loads, it is important to be able to accurately represent the response of a system to a large disturbance.

The WECC Modeling and Validation Work Group (MVWG) has taken on the task to develop a composite load model that includes data from 12 climate zones in WECC, a number of seasons, and various types of substations. The composite load model is intended to represent a feeder as an aggregated distribution of the load and not the specific detail of the load. The composite load model is composed of 130+ parameters, which include data for a step-down transformer, distribution feeder, three separate three-phase motors, a single-phase air-conditioning motor, electronic load, and static load. Because of the large number of parameters that make up this load model, there are uncertainties in the impacts of the parameters have on the response of the load. The existing implementation of the composite load model for planning and operational studies is in the first phase (Phase 1). Phase 1 includes the entire parameter list with the single-

phase A/C motor stalling disabled ("Tstall" set to 9999). Phase 2 of the model will have the single-phase A/C motor stalling enabled.

It is important to understand and model load profiles and load compositions correctly in planning studies. It has been seen in the past, that the level of modeling implemented for air-conditioning motor loads will impact system stability. Refer to Figure 1.0-1 for an illustration on the sensitivity of A/C motor load penetration and model implementation.

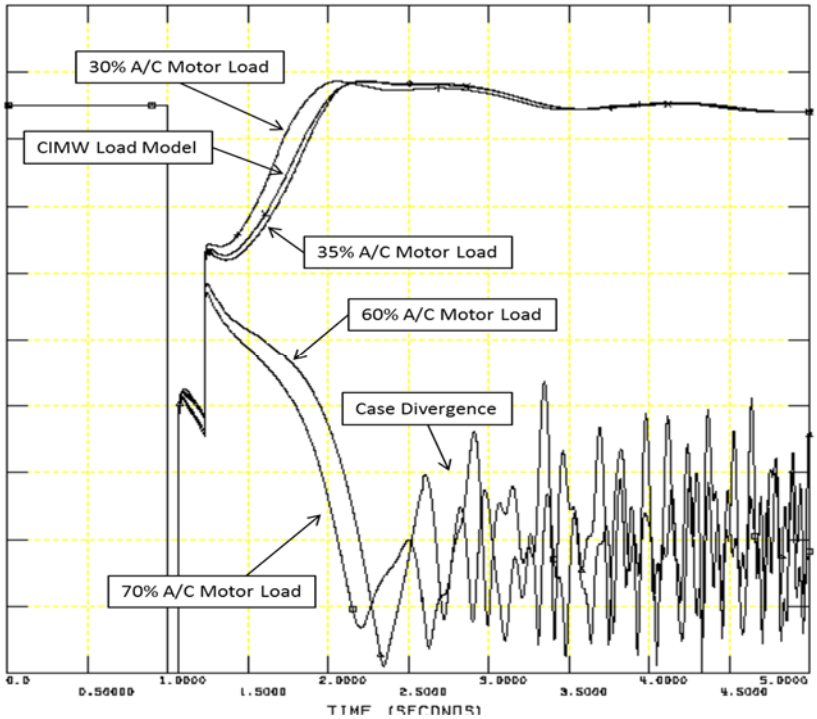

Figure 1.0-1: Example fault illustrating the impact of A/C motor load penetration and model selection on the stability of the system.

From Figure 1.0-1, it can be observed that the percentage of A/C motor load modeled has an impact of system stability. The higher the percentage of A/C motor load modeled, the more likely the system will become unstable.

The goal of this study is to explore the sensitivity of the composite load model to the uncertainty in the composition and behavior of the loads. Through the sensitivity analysis, this study is to provide guidance for future planning studies and to help transmission planners determine which model parameters are of importance when gathering data. MEPPI is working in partnership with Lawrence Berkeley National Labs (LBNL), WECC, and four participating WECC utilities: Pacific Gas and Electric (PG&E), PacifiCorp, Southern California Edison (SCE), and Salt River Project (SRP). The four utilities have agreed to provide MEPPI with planning models and dynamic models, which include the composite load model.

SECTION 2. OBJECTIVE AND APPROACH

The objective of this project is to conduct a parametric set of simulations that explore the sensitivity of WECC planning models to uncertainties in the composition and behavior of loads. The results of the simulations are expected to provide guidance for future planning studies.

For this analysis, MEPPI examined a heavy summer case and a stressed case for each of the four transmission providers. The heavy summer case was used to examine all contingencies provided from each transmission provider and the parameters that were thought to be most influential to the model (refer to Section 2.1). After results were tabulated for the analysis on the heavy summer case, an additional analysis was performed on the stressed case provided by each transmission provider that focused on Fault-Induced Delayed Voltage Recovery (FIDVR)-driven events. For the analysis on the Stressed Case, MEPPI examined a reduced set of contingencies and a more detailed list of parameter sensitivities for Motor A, B, C, and D models (refer to Section 2.2).

Observations for this study were based on voltage recovery and generator stability after a given fault or disturbance. The total number of observations will be compared to the Phase 2 Base Case (Tstall enabled), which will depict a sensitivity level for a given parameter. An aggregate of the contingencies will be used to compare the overall sensitivity level for all of the parameters.

For each analysis, MEPPI monitored the entire study area of all four transmission providers. The power flows and corresponding dynamics data were verified and stable initial conditions ("flat lines") were achieved for all four transmission providers. MEPPI performed the analysis using Siemen's PTI software, Power System Simulator for Engineering (PSS/E), Version 32.2.0 for PacifiCorp and General Electric's software, Positive Sequence Load Flow (PSLF), version 19.0 for PG&E, SCE, and SRP. MEPPI worked with PG&E, PacifiCorp, SCE, and SRP to gather power flow cases, dynamic data files, and to define targeted sensitivities. Each transmission provider supplied a heavy summer case and a stressed case to be examined along with a set of contingencies.

2.1. List of Key Parameters Varied For Heavy Summer Case

The CMPLDW model is comprised of 130+ parameters that define the characteristics for residential, commercial, and industrial 3-phase motors and single-phase air conditioning motors. To understand the model and the impact it has on the voltage recovery of a system, an analysis was performed by independently varying a set of model parameters. The following parameters listed here were varied independently for Motor D:

- **Vstall**: Stall voltage, p.u.
- **Tstall**: Stall time delay, sec.
- **FmA**: Motor A fraction of load P
- **FmB**: Motor B fraction of load P

- **FmC**: Motor D fraction of load P
- **FmD**: Motor D fraction of load P
- **Fel**: Electronic load fraction of P
- **Vtr1**: First under voltage trip level,p.u.
- **Ttr1**: First under voltage trip delay time, sec.
- **Fuvr**: Fraction of load with under voltage relay protection
- **Frst**: Fraction of load that can restart after stalling
- **Vrst**: Voltage at which restart can occur, p.u.
- **Trst**: Restart time delay, sec.
- **Vc1off**: Contactor voltage at which tripping starts, p.u.
- **Vc2off**: Contactor voltage at which tripping is complete, p.u.
- **Vc1on**: Contactor voltage at which reconnection starts, p.u.
- **Vc2on**: Contactor voltage at which reconnection is complete, p.u.
- **Tth**: Motor D thermal time constant, sec.
- **Th1t**: Motor D thermal protection trip start level, p.u. temperature
- **Th2t**: Motor D thermal protection trip completion level, p.u. temperature

Table 2.1-1 lists the key parameters that were analyzed for Motor D. The column labeled Phase 1 lists the values of the parameters as provided by each transmission provider in the dynamic data files (Tstall disabled). Note that the values listed here are for one instance of the CMPLDW model as an example. The column under Phase 2, "Tstall Enabled" lists the values of parameters used for Phase 2 with Tstall enabled. These two columns of data were used to simulate the two base cases (Phase 1 Base Case and Phase 2 Base Case) for the contingencies provided.

For the sensitivity of parameters, a minimum value and maximum value were selected for each parameter. Each minimum value and maximum value represents a separate sensitivity simulation for the contingencies provided. The Phase 2 "Tstall Enabled" data was utilized while varying a single parameter. For example, one sensitivity scenario would use the Phase 2 "Tstall Enabled" data while changing only Vstall to 0.3 p.u. Note that the minimum and maximum values for "Vc1off", "Vc2off", "Vc1on", and "Vc2on" were all varied simultaneously and are grouped as one sensitivity. These four parameters were grouped together to keep a linear relationship between the values. By varying all four parameters together, realistic results to the sensitivity of the parameters is able to be obtained. For example, with "Vc1off" set at 0.5 p.u., if only "Vc2on" were to be varied, a condition could exist ("Vc2on" set to 0.4 p.u.) where motor load begins to connect while the same motor loads would be tripping. An overlap in the settings would be present which is not realistic for field conditions.

The results compared the Phase 2 Base Case, Minimum Value, and Maximum Value for a given parameter. Note for the percent change in motor fractions, while increasing or decreasing the respective motor fraction, the overall motor load percentage does not change. The static load compensates for the change in a given motor fraction. For example, when increasing the Motor D fraction by 20% across all loads, the static load at each load bus was reduced to compensate for the increase in Motor D fraction.

Table 2.1-1
List of Key Parameters Varied for Heavy Summer Case

Ref. No.	Description of Parameter	Phase 1	Phase 2		
			Tstall Enabled	Minimum Value	Maximum Value
1	Vstall, Stall voltage, p.u.	0.5	0.5	0.3	0.8
2	Tstall, Stall time delay, sec.	9999	0.033	0.01667	0.25
3	Vc1off, Contactor voltage at which tripping starts, p.u.	0.5	0.5	0.3	0.7
4	Vc2off, Contactor voltage at which tripping is complete, p.u.	0.4	0.4	0.2	0.6
5	Vc1on – Contactor voltage at which reconnection is complete (pu)	0.6	0.6	0.4	0.8
6	Vc2on – Contactor voltage at which reconnection starts (pu)	0.5	0.5	0.3	0.7
7	Tth, Motor D thermal time constant, sec.	15	15	5	25
8	Th1t, Motor D thermal protection trip start level, p.u. temperature	0.7	0.7	0.4	0.9
9	Th2t, Motor D thermal protection trip completion level, p.u. temperature	1.9	1.9	1	3
10	FmA, Motor A fraction of load P (%)	0.167	0.167	-20%	+20%
11	FmB, Motor B fraction of load P (%)	0.135	0.135	-20%	+20%
12	FmC, Motor C fraction of load P (%)	0.061	0.061	-20%	+20%
13	FmD, Motor D fraction of load P (%)	0.113	0.113	-20%	+20%
14	Fel, Electronic load fraction of P (%)	0.173	0.173	-20%	+20%
15	Vtr1, First under voltage trip level, p.u.	0.6	0.6	0.4	0.8
16	Ttr1, First under voltage trip delay time, sec.	0.02	0.02	0.01667	0.25
17	Fuvr, Fraction of load with under voltage relay protection	0.1	0.1	0	0.5
18	Frst, Fraction of load that can restart after stalling	0.2	0.2	0	1
19	Vrst, Voltage at which restart can occur, p.u.	0.95	0.95	0.5	1
20	Trst, Restart time delay	0.3	0.3	0.1	1

2.2. List of Key Parameters Varied for Stressed Case

After performing the initial analysis on the heavy summer case, a reduced set of contingencies and more detailed list of parameters were selected to be analyzed on the stressed case. The contingencies selected for this analysis were based on the number of observations that were flagged for the entire contingency (i.e., the aggregate of all simulation runs for a given sensitivity parameter). Section 2.3 lists the sensitivity metrics used in the study. The following parameters listed here were varied on the stressed case for Motor D, and the list of parameters and sensitivity values is given in Table 2.2-1:

- **Vstall**: Stall voltage, p.u.
- **Tstall**: Stall time delay, sec.
- **Vc1off**: Contactor voltage at which tripping starts, p.u.
- **Vc2off**: Contactor voltage at which tripping is complete, p.u.
- **Vc1on**: Contactor voltage at which reconnection starts, p.u.
- **Vc2on**: Contactor voltage at which reconnection is complete, p.u.
- **Tth**: Motor D thermal time constant, sec.
- **Th1t**: Motor D thermal protection trip start level, p.u. temperature
- **Th2t**: Motor D thermal protection trip completion level, p.u. temperature
- **FmD**: Motor D fraction of load P
- **Fuvr**: Fraction of load with under voltage relay protection
- **Vrst**: Voltage at which restart can occur, p.u.

Table 2.2-1
List of Key Motor D Parameters Varied for Stressed Case

Ref. No.	Description of Parameter	Phase 1	Phase 2						
			Tstall Enabled	Minimum Value	Value 1	Value 2	Value 3	Value 4	Maximum Value
1	Vstall, Stall voltage, p.u.	0.5	0.5	0.3	0.4	0.45	0.55	0.6	0.8
2	Tstall, Stall time delay, sec.	9999	0.033	0.01667	0.0667	0.08335	0.1	0.1667	0.25
3	Vc1off, Contactor voltage at which tripping starts, p.u.	0.5	0.5	0.3	0.5	0.55	0.6	0.65	0.7
4	Vc2off, Contactor voltage at which tripping is complete, p.u.	0.4	0.4	0.2	0.3	0.35	0.4	0.5	0.6
5	Vc1on – Contactor voltage at which reconnection is complete (pu)	0.6	0.6	0.4	0.7	0.75	0.7	0.8	0.8
6	Vc2on – Contactor voltage at which reconnection starts (pu)	0.5	0.5	0.3	0.6	0.6	0.6	0.65	0.7
7	Tth, Motor D thermal time constant, sec.	15	15	5	10	12	17	20	25
8	Th1t, Motor D thermal protection trip start level, p.u. temperature	0.7	0.7	0.4	0.55	0.65	0.75	0.85	0.9
9	Th2t, Motor D thermal protection trip completion level, p.u. temperature	1.9	1.9	1	1.1	1.3	1.4	2	3
10	FmD, Motor D fraction of load P	0.113	0.113	-20%	-10%	-40%	+40%	+10%	+20%
11	Fuvr, Fraction of load with under voltage relay protection	0.1	0.1	0	0.05	0.15	0.2	0.25	0.5
12	Vrst, Voltage at which restart can occur, p.u.	0.95	0.95	0.5	0.7	0.8	0.85	0.9	1

The following list of parameters were varied independently on the stressed case for Motors A, B, and C (refer to Tables 2.2-2 through 2.2-4 for the list of parameters and sensitivity values):

- **Vtr1**: First low voltage trip level, p.u.
- **Ttr1**: First low voltage trip delay time, sec.
- **Ftr1**: First low voltage trip fraction
- **Vrc1**: First low voltage reconnection level, p.u. V
- **Vtr2**: Second low voltage trip level, p.u.
- **Ttr2**: Second low voltage trip delay time, sec.
- **Ftr2**: Second low voltage trip fraction
- **Vrc2**: Second low voltage reconnection level, p.u. V
- **Trc2**: Second low voltage reconnection delay time, sec.
- **H**: Inertia constant, sec.
- **Ls**: Synchronous reactance, p.u.
- **Tpo**: Transient open-circuit time constant, sec.

Table 2.2-2
List of Key Motor A Parameters Varied for Stressed Case

Ref. No.	Description of Parameter	Phase 2						
		Tstall Enabled			Value 1	Value 2	Value 3	Value 4
1	Vtr1, First low voltage trip level, p.u. V	0.7			-0.15	-0.05	+0.05	+0.15
2	Ttr1, First low voltage trip delay time, sec.	0.02	0.05	0.1	-0.05	+0.05	+0.25	+0.5
3	Ftr1, First low voltage trip fraction*	0.2	0.3	1	-0.2	-0.1	+0.1	+0.2
4	Vrc1, First low voltage reconnection level, p.u. V	1			-0.25	-0.15	-0.05	+0.05
5	Vtr2, Second low voltage trip level, p.u.	0.5	0.6		-0.15	-0.05	+0.05	+0.15
6	Ttr2, Second low voltage trip delay time, sec.	0.02	0.05	1	-0.05	+0.05	+0.25	+0.5
7	Ftr2, Second low voltage trip fraction	0	0.5	0.7	-0.2	-0.1	+0.1	+0.2
8	Vrc2, Second low voltage reconnection level, p.u. V	0.7	1		-0.2	-0.1	+0.1	+0.2
9	Trc2, Second low voltage reconnection delay time, sec.	0.1	0.25		-0.05	+0.05	+0.1	+0.25
10	H, Inertia constant, sec.	0.1	0.15	0.2	-50%	-25%	+50%	+100%
11	Ls, Synchronous reactance, p.u.	1.8	3.1		-50%	-25%	+50%	+100%
12	Tpo, Transient open-circuit time constant, sec.	0.095	0.8		-50%	-25%	+50%	+100%

*Note: Trip fraction must be below 1, simultaneously vary Ftr1 or Ftr2, respectively

Note the parameters listed under the “Tstall Enabled” column are all of the parameters observed in the dynamic data records for the corresponding parameter.

Table 2.2-3
List of Key Motor B Parameters Varied for Stressed Case

Ref. No.	Description of Parameter	Phase 2						
		Tstall Enabled			Value 1	Value 2	Value 3	Value 4
1	Vtr1, First low voltage trip level, p.u. V	0.6	0.7		-0.15	-0.05	+0.05	+0.15
2	Ttr1, First low voltage trip delay time, sec.	0.02	0.05	1	-0.05	+0.05	+0.25	+0.5
3	Ftr1, First low voltage trip fraction	0.2	0.3	0.4	-0.2	-0.1	+0.1	+0.2
4	Vrc1, First low voltage reconnection level, p.u. V	0.75	1		-0.25	-0.15	-0.05	+0.05
5	Vtr2, Second low voltage trip level, p.u.	0.5	0.6		-0.15	-0.05	-0.05	+0.15
6	Ttr2, Second low voltage trip delay time, sec.	0.02	0.05	0.1	-0.05	+0.05	+0.25	+0.5
7	Ftr2, Second low voltage trip fraction	0.3	0.5		-0.2	-0.1	+0.1	+0.2
8	Vrc2, Second low voltage reconnection level, p.u. V	0.65	0.75		-0.2	-0.1	+0.1	+0.2
9	Trc2, Second low voltage reconnection delay time, sec.	0.05	0.25		-0.05	+0.05	+0.1	+0.25
10	H, Inertia constant, sec.	0.5	1		-50%	-25%	+50%	+100%
11	Ls, Synchronous reactance, p.u.	1.8	3.1		-50%	-25%	+50%	+100%
12	Tpo, Transient open-circuit time constant, sec.	0.2	0.8		-50%	-25%	+50%	+100%

Table 2.2-4
List of Key Motor C Parameters Varied for Stressed Case

Ref. No.	Description of Parameter	Phase 2						
		Tstall Enabled			Value 1	Value 2	Value 3	Value 4
1	Vtr1, First low voltage trip level, p.u. V	0.65	0.7		-0.15	-0.05	+0.05	+0.15
2	Ttr1, First low voltage trip delay time, sec.	0.02	0.05	0.1	-0.05	+0.05	+0.25	+0.5
3	Ftr1, First low voltage trip fraction	0.2	0.3	0.4	-0.2	-0.1	+0.1	+0.2
4	Vrc1, First low voltage reconnection level, p.u. V	1			-0.25	-0.15	-0.05	+0.05
5	Vtr2, Second low voltage trip level, p.u.	0.5	0.6		-0.15	-0.05	-0.05	+0.15
6	Ttr2, Second low voltage trip delay time, sec.	0.02	0.05	0.1	-0.05	+0.05	+0.25	+0.5
7	Ftr2, Second low voltage trip fraction	0.3	0.5		-0.2	-0.1	+0.1	+0.2
8	Vrc2, Second low voltage reconnection level, p.u. V	0.65	0.75		-0.2	-0.1	+0.1	+0.2
9	Trc2, Second low voltage reconnection delay time, sec.	0.1	0.25		-0.05	+0.05	+0.1	+0.25
10	H, Inertia constant, sec.	0.1	0.2		-50%	-25%	+50%	+100%
11	Ls, Synchronous reactance, p.u.	1.8	3.1		-50%	-25%	+50%	+100%
12	Tpo, Transient open-circuit time constant, sec.	0.2	0.8		-50%	-25%	+50%	+100%

Note for the Phase 2 base case, there are multiple values for the parameters of Motor A, Motor B, and Motor C. The values that are observed in the base case are listed in the above tables in the "Tstall Enabled" column. The sensitivity parameters listed were each varied by the percentage listed in the value column.

2.3. Contingency Lists

Each transmission provider provided a contingency list to be examined. The contingency lists include three-phase normally cleared faults, single-phase normally cleared faults, stuck breaker faults, and loss of generation without a fault. Refer to Tables 2.3-1 through 2.3-8 for the contingencies examined on the heavy summer case and stressed case for PacifiCorp, PG&E, SCE, and SRP, respectively.

Table 2.3-1
Contingencies Examined on the Heavy Summer Case for PacifiCorp

External Contingency #	Fault Type	Fault Duration (Cycles)	External Contingency #	Fault Type	Fault Duration (Cycles)	External Contingency #	Fault Type	Fault Duration (Cycles)
1	3PH	7	56	3PH	5	111	3PH	3
2	3PH	5	57	3PH	7	112	3PH	4
3	3PH	4	58	3PH	7	113	3PH	4
4	3PH	7	59	3PH	7	114	3PH	4
5	3PH	6	60	3PH	5	115	3PH	4
6	3PH	3	61	3PH	6	116	3PH	4
7	3PH	7	62	3PH	5	117	3PH	4
8	3PH	7	63	3PH	5	118	3PH	4
9	3PH	4	64	3PH	5	119	3PH	5
10	3PH	7	65	3PH	5	120	3PH	3
11	3PH	7	66	3PH	5	121	3PH	5
12	3PH	5	67	3PH	5	122	3PH	5
13	3PH	5	68	3PH	5	123	3PH	5
14	3PH	5	69	3PH	5	124	3PH	5
15	3PH	7	70	3PH	5	125	3PH	5
16	3PH	5	71	3PH	6	126	3PH	5
17	3PH	5	72	3PH	7	127	3PH	5
18	3PH	5	73	3PH	5	128	3PH	5
19	3PH	7	74	3PH	5	129	3PH	5
20	3PH	5	75	3PH	7	130	3PH	5
21	3PH	5	76	3PH	7	131	3PH	5
22	3PH	5	77	3PH	7	132	3PH	5
23	3PH	5	78	3PH	7	133	3PH	5
24	3PH	7	79	3PH	5	134	3PH	5
25	3PH	5	80	3PH	5	135	3PH	5
26	3PH	4	81	3PH	5	136	3PH	5
27	3PH	6	82	3PH	5	137	3PH	5
28	3PH	5	83	3PH	5	138	3PH	5
29	3PH	7	84	3PH	5	139	SLG	4.5
30	3PH	5	85	3PH	5	140	SLG	4.5
31	3PH	7	86	3PH	5	141	SLG	6
32	3PH	6	87	3PH	5	142	SLG	4.5
33	3PH	7	88	3PH	5	143	SLG	6
34	3PH	5	89	3PH	4	144	SLG	5
35	3PH	5	90	3PH	3	145	SLG	6
36	3PH	7	91	3PH	4	146	SLG	4.5
37	3PH	5	92	3PH	4	147	SLG	6
38	3PH	7	93	3PH	3	148	SLG	4.5
39	3PH	5	94	3PH	4	149	SLG	4.5
40	3PH	7	95	3PH	4	150	SLG	5
41	3PH	5	96	3PH	4	151	SLG	3
42	3PH	7	97	3PH	4	152	SLG	6
43	3PH	7	98	3PH	4	153	SLG	6
44	3PH	5	99	3PH	3	154	SLG	4.5
45	3PH	5	100	3PH	4	155	SLG	4.5
46	3PH	5	101	3PH	4	156	SLG	4.5
47	3PH	5	102	3PH	4	157	SLG	5
48	3PH	5	103	3PH	4	158	SLG	6
49	3PH	7	104	3PH	4	159	SLG	4.5
50	3PH	7	105	3PH	4	160	SLG	6
51	3PH	5	106	3PH	4	161	SLG	4.5
52	3PH	7	107	3PH	4	162	SLG	4.5
53	3PH	7	108	3PH	4	163	SLG	4.5
54	3PH	7	109	3PH	4	164	SLG	6
55	3PH	7	110	3PH	4	165	SLG	5

Table 2.3-1 (continued)
Contingencies Examined on the Heavy Summer Case for PacifiCorp

External Contingency #	Fault Type	Fault Duration (Cycles)
166	SLG	5
167	SLG	5
168	SLG	4.5
169	SLG	6
170	SLG	4.5
171	SLG	4.5
172	SLG	6
173	SLG	6
174	SLG	4.5
175	SLG	6
176	SLG	5
177	SLG	5
178	SLG	5
179	SLG	6
180	SLG	6
181	SLG	5
182	SLG	6
183	SLG	6
184	SLG	5
185	SLG	5
186	SLG	5
187	SLG	6
188	SLG	6
189	SLG	6
190	SLG	6
191	SLG	6
192	SLG	6
193	SLG	5
194	SLG	3
195	SLG	6
196	SLG	6
197	SLG	6
198	SLG	6
199	SLG	5
200	SLG	6
201	SLG	6
202	SLG	6
203	SLG	6
204	SLG	6
205	SLG	6
206	SLG	6
207	SLG	6
208	SLG	4.5
209	SLG	6
210	SLG	4.5
211	SLG	6
212	SLG	6
213	SLG	6
214	SLG	6
215	SLG	6
216	SLG	6
217	SLG	5
218	SLG	5
219	SLG	5
220	SLG	18
221	SLG	16.5
222	SLG	18
223	SLG	17.5
224	SLG	18
225	SLG	18
226	SLG	18.5
227	SLG	15.5
228	SLG	17
229	SLG	116.4
230	SLG	18
231	SLG	18
232	SLG	18
233	SLG	18.5
234	SLG	17
235	SLG	17
236	SLG	18
237	SLG	18
238	SLG	17.5
239	SLG	18
240	SLG	19.5
241	SLG	19.5
242	SLG	19.5
243	SLG	19.5
244	SLG	19.5
245	SLG	24.5
246	SLG	24.5
247	SLG	19.5
248	SLG	19.5
249	SLG	19.5
250	SLG	19.5
251	SLG	19.5
252	SLG	24.5
253	SLG	19.5
254	SLG	19.5
255	SLG	19.5
256	SLG	19.5
257	SLG	19.5
258	SLG	19.5
259	SLG	19.5
260	SLG	19.5
261	SLG	19.5
262	SLG	19.5
263	SLG	19.5
264	SLG	25
265	SLG	25.5
266	SLG	19.5
267	SLG	19.5
268	SLG	19.5
269	SLG	19.5
270	SLG	19.5
271	SLG	19.5
272	SLG	19.5
273	SLG	19.5
274	SLG	19.5
275	SLG	19.5
276	SLG	19.5
277	SLG	19.5
278	SLG	19.5
279	SLG	17.5
280	SLG	19.5
281	SLG	17.5
282	SLG	19.5
283	SLG	19.5
284	SLG	19.5
285	SLG	19.5
286	SLG	19.5
287	SLG	19.5
288	SLG	14.5
289	SLG	19.5
290	SLG	19.5
291	SLG	19.5
292	SLG	9.5
293	SLG	19.5
294	SLG	20
295	SLG	19.5
296	SLG	17.5
297	SLG	28
298	SLG	19.5
299	SLG	19.5
300	SLG	19.5
301	SLG	19.5
302	SLG	17
303	SLG	19.5
304	SLG	17.5
305	SLG	19.5
306	SLG	19.5
307	SLG	19.5
308	SLG	19.5
309	SLG	19.5
310	SLG	19.5
311	SLG	19.5
312	SLG	21
313	SLG	19.5
314	SLG	19.5
315	SLG	19.5
316	SLG	19.5
317	3PH	3
318	3PH	3
319	3PH	3
320	3PH	3
321	3PH	3
322	SLG	27.7

Table 2.3-2
Contingencies Examined on the Stressed Case for PacifiCorp

External Contingency #	Fault Type	Fault Duration (Cycles)
15	3PH	7
19	3PH	7
24	3PH	7
44	3PH	5
58	3PH	7
73	3PH	5
74	3PH	5
78	3PH	7

Table 2.3-3
Contingencies Examined on the Heavy Summer Case for PG&E

External Contingency #	Fault Type	Fault Duration (Cycles)	Element(s) Lost
1	1PH Delayed Clear	120	3 x 230 kV Line 500/230 kV Transformer 2 x 230/115 kV Transformer
2	None	No Fault	2 x Generator
3	None	No Fault	2 x Generator
4	None	No Fault	Generator
5	3PH	4	500 kV Line
6	3PH	4	500 kV Line
7	3PH	4	500 kV Line
8	3PH	4	500 kV Line
9	3PH	4	500 kV Line
10	3PH	4	500 kV Line
11	3PH	4	500 kV Line
12	3PH	4	500 kV Line
13	3PH	4	500 kV Line
14	3PH	4	500 kV Line
15	3PH	4	500 kV Line
16	3PH	4	500 kV Line
17	3PH	4	500 kV Line
18	3PH	4	500 kV Line
19	3PH	4	500 kV Line
20	3PH	4	500 kV Line
21	3PH	4	500 kV Line
22	3PH	4	500 kV Line Generator
23	3PH	4	500 kV Line Generator
24	3PH	4	500 kV Line
25	3PH	4	500 kV Line
26	3PH	4	500/230 kV Transformer
27	3PH	4	500/230 kV Transformer
28	3PH	4	500/230 kV Transformer
29	3PH	4	500/230 kV Transformer
30	3PH	4	500/230 kV Transformer
31	3PH	4	500/230 kV Transformer
32	3PH	4	500/230 kV Transformer
33	3PH	4	500/230 kV Transformer
34	3PH	4	500/230 kV Transformer
35	3PH	4	500/230 kV Transformer
36	None	No Fault	DC Line
37	SLG Stuck Breaker	12	500 kV Line 500/230 kV Transformer
38	SLG Stuck Breaker	13	2 x 500 kV Line
39	SLG Stuck Breaker	13	2 x 500 kV Line
40	SLG Stuck Breaker	13	2 x 500 kV Line
41	SLG Stuck Breaker	13	2 x 500 kV Line
42	SLG Stuck Breaker	13	2 x 500 kV Line
43	SLG Stuck Breaker	13	2 x 500 kV Line
44	SLG Stuck Breaker	13	500 kV Line 500/230 kV Transformer
45	SLG Stuck Breaker	13	500 kV Line Generator
46	3PH	4	2 x 500 kV Line
47	3PH	4	2 x 500 kV Line
48	3PH	4	2 x 500 kV Line
49	3PH	4	2 x 500 kV Line
50	3PH	4	2 x 500 kV Line
51	3PH	4	2 x 500 kV Line
52	3PH	4	2 x 500 kV Line
53	3PH	4	2 x 500 kV Line

Table 2.3-4
Contingencies Examined on the Stressed Case for PG&E

External Contingency #	Fault Type	Fault Duration (Cycles)	Element(s) Lost
1	1PH Delayed Clear	120	3 x 230 kV Line 500/230 kV Transformer 2 x 230/115 kV Transformer
2	None	No Fault	2 x Generator
14	3PH	4	500 kV Line
48	3PH	4	2 x 500 kV Line
52	3PH	4	2 x 500 kV Line

Table 2.3-5
Contingencies Examined on the Heavy Summer Case for SCE

External Contingency #	Fault Type	Fault Duration (Cycles)	Element(s) Lost
1	3PH	6	500 kV Line
2	3PH	6	500 kV Line
3	3PH	6	2 x 500 kV Line
4	3PH	6	230 kV Line
5	3PH	6	500/230 kV Transformer
6	3PH	6	2 x 500 kV Line
7	3PH	6	2 x 500 kV Line
8	3PH	6	2 x 500 kV Line
9	3PH	6	2 x 500 kV Line
10	3PH	6	2 x 500 kV Line
11	3PH	6	2 x 500 kV Line
12	3PH	6	2 x 500 kV Line
13	3PH	6	2 x 500 kV Line
14	3PH	6	2 x 500 kV Line
15	3PH	6	2 x 500 kV Line
16	3PH	6	2 x 230 kV Line
17	3PH	6	2 x 230 kV Line

External Contingency #	Fault Type	Fault Duration (Cycles)	Element(s) Lost
18	SLG	15	500 kV Line
19	SLG	15	500 kV Line 500/230 kV Transformer
20	SLG	15	500 kV Line 500/230 kV Transformer
21	SLG	15	500 kV Line 500/230 kV Transformer
22	SLG	15	500 kV Line 500/230 kV Transformer
23	SLG	15	Line x2
24	SLG	17	Line x2
25	SLG	17	500/230 kV Transformer
26	3PH	15	2 x 500 kV Line
27	3PH	15	500 kV Line 500/230 kV Transformer
28	3PH	17	500/230 kV Transformer
29	3PH	6	230 kV Line
30	3PH	6	500/115 kV Transformer
31	3PH	6	500/115 kV Transformer
32	3PH	6	230/115 kV Transformer
33	3PH	6	230/69 kV Transformer
34	3PH	6	230/115 kV Transformer

Table 2.3-6
Contingencies Examined on the Stressed Case for SCE

External Contingency #	Internal Contingency #	Fault Type	Fault Duration (Cycles)	Element(s) Lost
1	03_B	3PH	6	500 kV Line
2	04_B2	3PH	6	500 kV Line
10	41_C	3PH	6	2 x 500 kV Line
26	65_D2	3PH	15	2 x 500 kV Line
35 (new)	21B_C3	3PH	6	2 x 500 kV Line
36 (new)	104B_5A	3PH	6	500/230 kV Transformer

Table 2.3-7
Contingencies Examined on the Heavy Summer Case for SRP

External Contingency #	Fault Type	Fault Duration (Cycles)	Element(s) Lost
1	3PH	4	230/69 kV Transformer
2	3PH	4	230/69 kV Transformer
3	3PH	4	230/69 kV Transformer
4	3PH	4	230 kV Line
5	3PH	4	230 kV Line
6	3PH	4	230 kV Line
7	3PH	4	230 kV Line
8	3PH	4	230 kV Line
9	3PH	4	230 kV Line
10	3PH	4	230 kV Line
11	3PH	4	230/69 kV Transformer
12	3PH	4	230 kV Line
13	3PH	4	230/69 kV Transformer
14	3PH	4	230 kV Line
15	3PH	4	230 kV Line
16	3PH	4	230 kV Line
17	3PH	4	230 kV Line
18	3PH	4	230 kV Line
19	3PH	4	230 kV Line
20	3PH	4	500/230 kV Transformer x 2
21	3PH	4	230/69 kV Transformer
22	3PH	4	230 kV Line
23	3PH	4	230 kV Line
24	3PH	4	230/69 kV Transformer
25	3PH	4	Generator
26	3PH	4	Generator x2
27	3PH	4	230 kV Line
28	3PH	4	230 kV Line
29	3PH	4	230/69 kV Transformer
30	3PH	4	230 kV Line
31	3PH	4	230 kV Line
32	3PH	4	230/115 kV Transformer
33	3PH	4	230 kV Line
34	3PH	4	230 kV Line
35	3PH	4	230/69 kV Transformer
36	3PH	4	230/69 kV Transformer
37	3PH	4	Generator x2
38	3PH	4	230 kV Line
39	3PH	4	500/230 kV Transformer
40	3PH	4	500/230 kV Transformer
41	3PH	4	500/230 kV Transformer
42	3PH	4	230 kV Line
43	3PH	4	230 kV Line
44	3PH	4	230 kV Line
45	3PH	4	230/69 kV Transformer
46	3PH	4	230 kV Line
47	3PH	4	230/69 kV Transformer
48	3PH	4	500/230 kV Transformer
49	3PH	4	230 kV Line
50	3PH	4	230 kV Line
51	3PH Stuck Breaker	12	500/230 kV Transformer 2 x 500 kV Line
52	3PH Stuck Breaker	12	500/230 kV Transformer 500 kV Line
53	3PH Stuck Breaker	12	500/230 kV Transformer 500 kV Line
54	SLG Stuck Breaker	12	500/345 kV Transformer 500 kV Line, 345 kV Line
55	SLG Stuck Breaker	12	500/345 kV Transformer 500 kV Line
56	3PH Stuck Breaker	12	500/345 kV Transformer 500 kV Line, Gen, Load
57	SLG Stuck Breaker	12	500/345 kV Transformer 500 kV Line, Gen, Load
58	SLG Stuck Breaker	12	500/69 kV Transformer 2 x 500 kV Line
59	SLG Stuck Breaker	12	500/69 kV Transformer 500 kV Line

Table 2.3-8
Contingencies Examined on the Stressed Case for SRP

External Contingency #	Fault Type	Fault Duration (Cycles)	Element(s) Lost
6	3PH	4	230 kV Line
52	3PH Stuck Breaker	12	500/230 kV Transformer 500 kV Line
56	3PH Stuck Breaker	12	500/345 kV Transformer 500 kV Line, Gen, Load
60 (new)	3PH	4	500 kV Line
61 (new)	3PH	4	500 kV Line
62 (new)	3PH	4	500 kV Line

2.4. Study Criteria (Thresholds)

The idea for the study criteria is the relative number and type of observations will provide a sensitivity value for each parameter. The main observations for this analysis will be voltage response (slow vs fast voltage recovery) and generator angles (transient stability). The criteria were chosen to measure the sensitivity of the model parameters and do not strictly match the typical region-specific planning criteria. Bus voltages and generators were flagged based on the study thresholds listed below:

- Transient voltage dips will be monitored and recorded for dips that exceed:
  - 25% at load buses and 30% at non-load buses
- Post-transient voltage deviations will be monitored and recorded for voltages exceeding 5% at any bus
- Voltage recovery to 70% of pre-contingency voltage within 1 second
- Voltage recovery to 80% of pre-contingency voltage within 3 seconds
- Voltage recovery to 90% of pre-contingency voltage within 5 seconds
- Voltage overshoot will be monitored.
  - Voltages will be flagged for any voltage overshoot over 1.1 p.u. and will be sorted in the following time sections (seconds after fault cleared):
    - 0 – 8 seconds
    - 8 – 15 seconds
    - 15 – 30 seconds
- Any non-consequential load loss
- Any generator that pulls out of synchronism and trips will be recorded

Note to produce relevant results and compare small changes in sensitivity parameters, strict voltage criteria was selected. The voltage criteria utilized for this study is not indicative of the

new recent developments in WECC voltage criteria used by WECC transmission planners. Rather it serves as a basis to capture the impacts of motor load stalling whereas the new WECC voltage criteria may not capture these impacts. Table 2.3-9 is a comparison of the criteria used in this study and new WECC voltage criteria defined in "TPL-001-WECC-CRT-3", effective September 21, 2016.

Table 2.3-9
Comparison of Voltage Criteria

Composite Load Model Study Criteria	**WECC Voltage Criteria TPL-001-WECC-CRT-3**
Voltage > 70% of pre-contingency voltage within 1 second	N/A
Voltage > 80% of pre-contingency voltage within 3 seconds	Voltage > 80% of pre-contingency voltage within 20 seconds
Voltage > 90% of pre-contingency voltage within 5 seconds	N/A
Transient Voltage Dips > 25% at load buses > 30% at non-load buses	Transient Voltage Dips > 70% for more than 0.5 seconds > 80% for more than 2 seconds
Post-transient voltage deviation > 5% at any bus	Post-transient voltage deviation > 8% at load buses for P1* events

*Note P1 events as defined by Table 1 of NERC Standard TPL-001-4, Transmission System Planning Performance Requirements

It can be observed the new WECC voltage criteria (TPL-001-WECC-CRT-3) may not capture range of impacts of motor load stalling and tripping. An important behavior of the composite load model is the initial stalling and subsequent voltage recovery to an acceptable level. The voltage criteria utilized in this study reports on bus voltage not recovering after a maximum of 5 seconds. The new WECC criteria only captures voltages not recovering above a certain threshold after 20 seconds.

SECTION 3. COMPOSITE LOAD MODEL

The composite load model was developed to represent the dynamic load behavior of three-phase compressor motors, fans, pumps, and induction motors. In the steady-state power flow, the model is represented by a constant power load and is modeled at a transmission level bus. The dynamic implementation of the model is shown in Figure 3.0-1. Any load in power flow can be represented in dynamic simulations by a single composite load model. The step-down transformer, "low-side bus," and "load bus" do not exist in the power flow and are added to the system during initialization of the model. The total constant power P and Q in the steady-state power flow is modeled by up to four motors and an electronic load: Motor A, Motor B, Motor C, Motor D, and electronic load as determined in the dynamic data set. The total sum of motor A, B, C, D, electronic, and static load fractions must be equal to one (1.0). Any load that is not modeled by one of the four motors (A, B, C or D) or electronic load up to one is modeled as static load (constant P and Q). For example, for a single instance of a motor load with a composition of 10% Motor A, 15% Motor B, 15% Motor C, 25% Motor D, and 10% electronic load, the static load would be modeled as 25%.

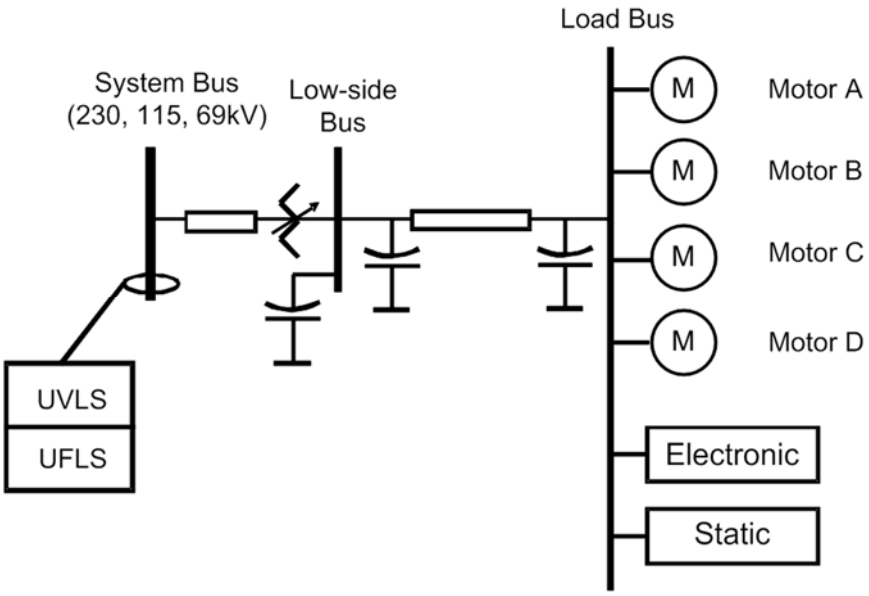

Figure 3.0-1: Composite load model one-line diagram

SECTION 4. RESULTS

The results presented in this section are the total observations for the Heavy Summer Case and the Stressed Case for each Transmission Provider. After examining the Heavy Summer Case, a reduced set of contingencies was analyzed on a Stressed Case. The results are presented in terms of a heat map table, analyzing the various criteria stated in the previous section. Contingencies observed to have a negative impact, i.e. increase the number of observations, will be color coded in red with a maximum change of +100%. Contingencies that have a positive impact on the results, i.e. decrease the number of observations, will be color coded in green with a maximum change of -50%.

Each row in the Results and Observations tables summarizes the system performance for all the contingencies examined for the utility varying only the single model parameter listed in that row. Note the parameters Vc1off, Vc2off, Vc1on and Vc2on are varied at the same time resulting in a total of 17 parameter variations (refer to Table 2.1-1 for the 17 variations).

4.1. PacifiCorp Heavy Summer and Stressed Case Results

For the Heavy Summer Case, there were 322 contingencies examined for 35 sensitivity parameter variations (17 parameter variations each with a minimum and maximum value, and the base case) for Motor D for a total of 11,270 contingencies processed. For each contingency processed, 475 bus voltages and 98 generators were monitored. The results for a given sensitivity parameter (e.g., fraction of Motor D increased by 20%) are an aggregate of all contingencies processed for that given sensitivity parameter. Table 4.1-1 lists the observations and results for PacifiCorp's Heavy Summer Case. The table lists the number of buses flagged by the criteria for the base case (Phase II composite load model) as well as a given sensitivity parameter. The "Delta (% Change)" column lists the percentage difference between the number of observations in the base case and the respective sensitivity parameter. For the voltage observation of a bus voltage recovering to 70% of the pre-fault voltage within 1 second, the base case flagged 368 buses that did not meet this criterion. For the same voltage criterion, when increasing the fraction of Motor D by 20%, 460 buses were flagged to not meet this criterion which is an increase of 25% from the base case. When decreasing the fraction of Motor D by 20%, 342 buses were flagged to not meet this criterion which is a decrease of 7% from the base case.

Refer to Figures 4.1-1 through 4.1-6 for representative plots of select sensitivity parameters for a three-phase fault. The plots include four bus voltages comparing the base case (Phase 2) to the maximum and minimum sensitivity parameter, respectively.

Table 4.1-1
PacifiCorp Results and Observations for the Heavy Summer Case

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u.	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	14321	-	7473	-	368	-	1576	-	12803	-	20424	-	14570	-
2	Fel	-20%	14156	-1%	7465	0%	368	0%	1585	1%	12722	-1%	19917	-2%	14432	-1%
3		20%	14332	0%	7363	-1%	364	-1%	1581	0%	12805	0%	20473	0%	15052	3%
4	FmA	-20%	14321	0%	7473	0%	368	0%	1576	0%	12804	0%	20422	0%	14567	0%
5		20%	13481	-6%	7430	-1%	360	-2%	1274	-19%	10895	-15%	22211	9%	19933	37%
6	FmB	-20%	14322	0%	8059	8%	373	1%	1624	3%	12823	0%	20228	-1%	13699	-6%
7		20%	14598	2%	7675	3%	355	-4%	1539	-2%	12836	0%	20355	0%	14881	2%
8	FmC	-20%	14110	-1%	7432	-1%	371	1%	1606	2%	12816	0%	19942	-2%	13853	-5%
9		20%	14616	2%	7871	5%	389	6%	1571	0%	12834	0%	20457	0%	15625	7%
10	FmD	-20%	11880	-17%	6155	-18%	342	-7%	797	-49%	7630	-40%	23241	14%	11612	-20%
11		20%	16462	15%	9840	32%	460	25%	2211	40%	15513	21%	23241	14%	16303	12%
12	Frst	0	14677	2%	7728	3%	368	0%	1576	0%	12813	0%	20466	0%	15664	8%
13	(0.2)	1	14664	2%	7712	3%	368	0%	1576	0%	12785	0%	19283	-6%	14481	-1%
14	Fuvr	0	15306	7%	9016	21%	408	11%	1957	24%	14261	11%	20576	1%	15041	3%
15	(0.1)	0.5	6747	-53%	4791	-36%	336	-9%	345	-78%	729	-94%	19132	-6%	22922	57%
16	Th1t	0.4	14331	0%	7481	0%	368	0%	1290	-18%	8258	-35%	20615	1%	14903	2%
17	(0.7)	0.9	14460	1%	7594	2%	368	0%	1577	0%	13622	6%	20320	-1%	15003	3%
18	Th2t	1	14328	0%	7477	0%	368	0%	1576	0%	7519	-41%	21289	4%	20060	38%
19	(1.2)	3	14340	0%	7495	0%	368	0%	1577	0%	13197	3%	14634	-28%	7547	-48%
20	Trst	0.1	14330	0%	7480	0%	368	0%	1576	0%	12806	0%	20356	0%	15063	3%
21	(0.3)	1	14342	0%	7488	0%	368	0%	1576	0%	12811	0%	20534	1%	15666	8%
22	Tstall	0.25	5748	-60%	4107	-45%	330	-10%	356	-77%	828	-94%	12094	-41%	27997	92%
23	(0.033)	0.0167	15541	9%	7819	5%	413	12%	1650	5%	14032	10%	22296	9%	13299	-9%
24	Tth	5	14520	1%	7654	2%	368	0%	508	-68%	450	-96%	21289	4%	20166	38%
25	(15)	25	14322	0%	7476	0%	368	0%	1577	0%	13644	7%	19855	-3%	13083	-10%
26	Ttr1	0.25	15437	8%	9175	23%	364	-1%	1727	10%	13892	9%	20587	1%	14746	1%
27	(0.02)	0.0167	14388	0%	7505	0%	368	0%	1576	0%	12761	0%	20274	-1%	15082	4%
28	Contactor	0.3	15621	9%	7690	3%	434	18%	1813	15%	13529	6%	21677	6%	14591	0%
29	(Vc1off)	0.7	11135	-22%	5982	-20%	331	-10%	583	-63%	2545	-80%	14239	-30%	20029	37%
30	Vrst	1	14342	0%	7495	0%	368	0%	1576	0%	12813	0%	20512	0%	15559	7%
31	(0.95)	0.5	14591	2%	7726	3%	346	-6%	943	-40%	8849	-31%	19570	-4%	10558	-28%
32	Vstall	0.3	7719	-46%	5518	-26%	331	-10%	401	-75%	1692	-87%	14576	-29%	21994	51%
33	(0.5)	0.8	36572	155%	13198	77%	517	40%	6141	290%	44651	249%	50101	145%	34616	138%
34	Vtr1	0.4	15233	6%	8095	8%	387	5%	1771	12%	13955	9%	20586	1%	14618	0%
35	(0.6)	0.8	13860	-3%	7233	-3%	368	0%	1552	-2%	12347	-4%	19447	-5%	16191	11%

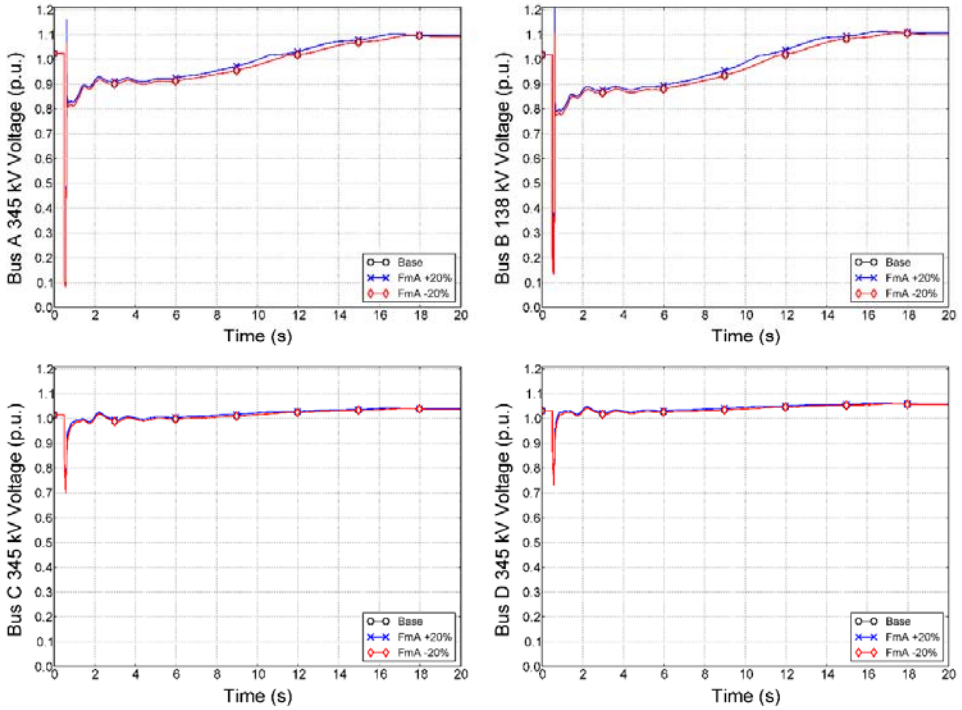

Figure 4.1-1: Bus voltages for sensitivity parameter FmA

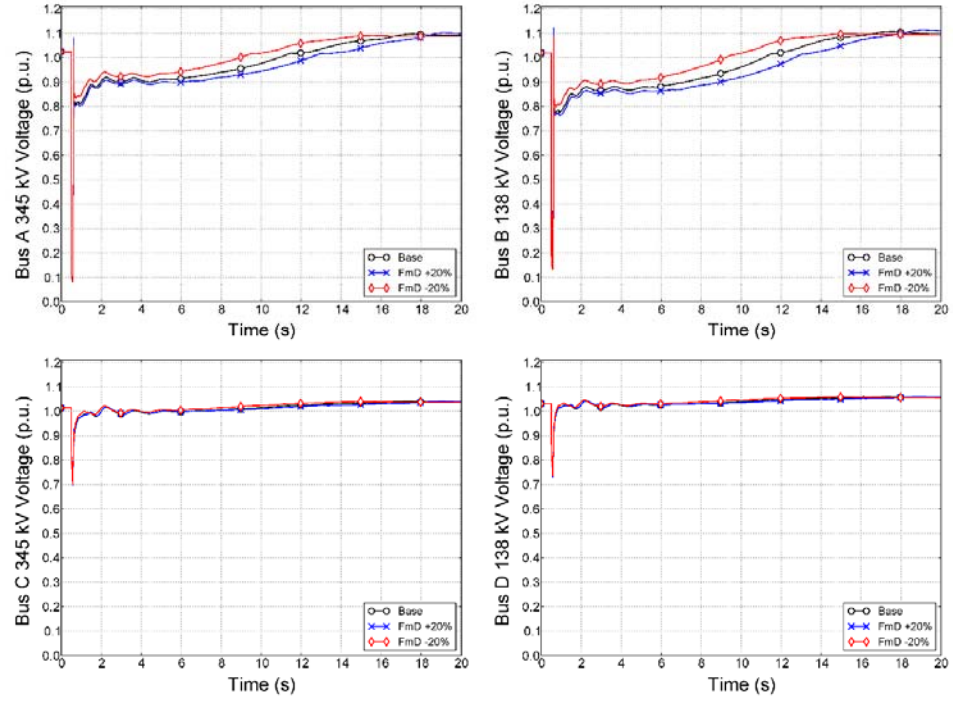

Figure 4.1-2: Bus voltages for sensitivity parameter FmD

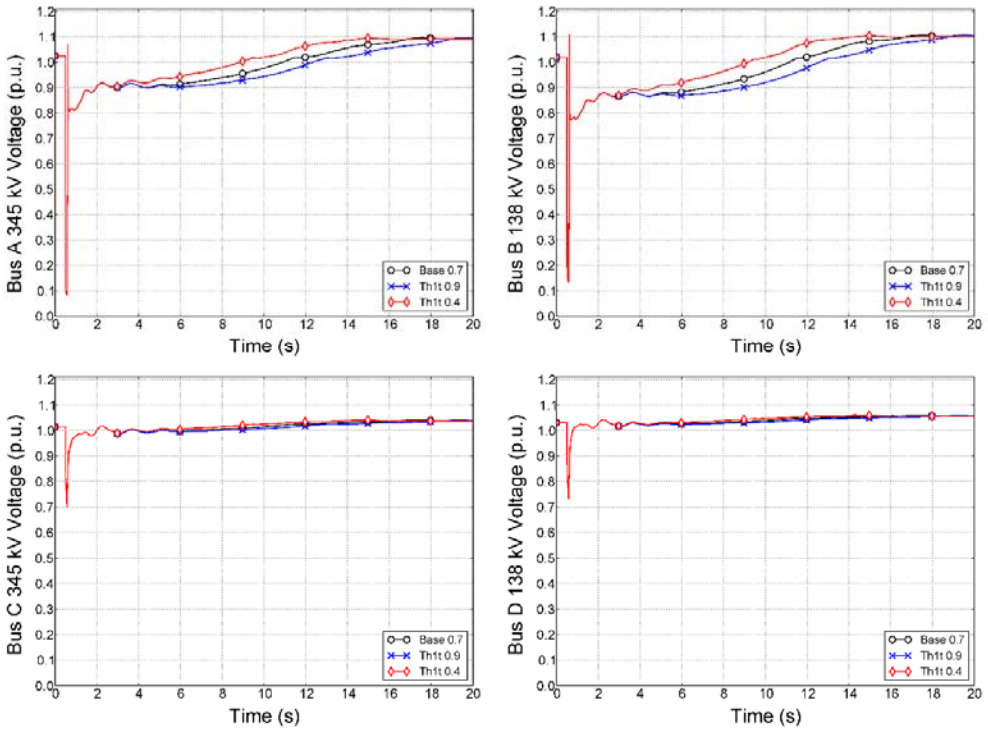

Figure 4.1-3: Bus voltages for sensitivity parameter Th1t

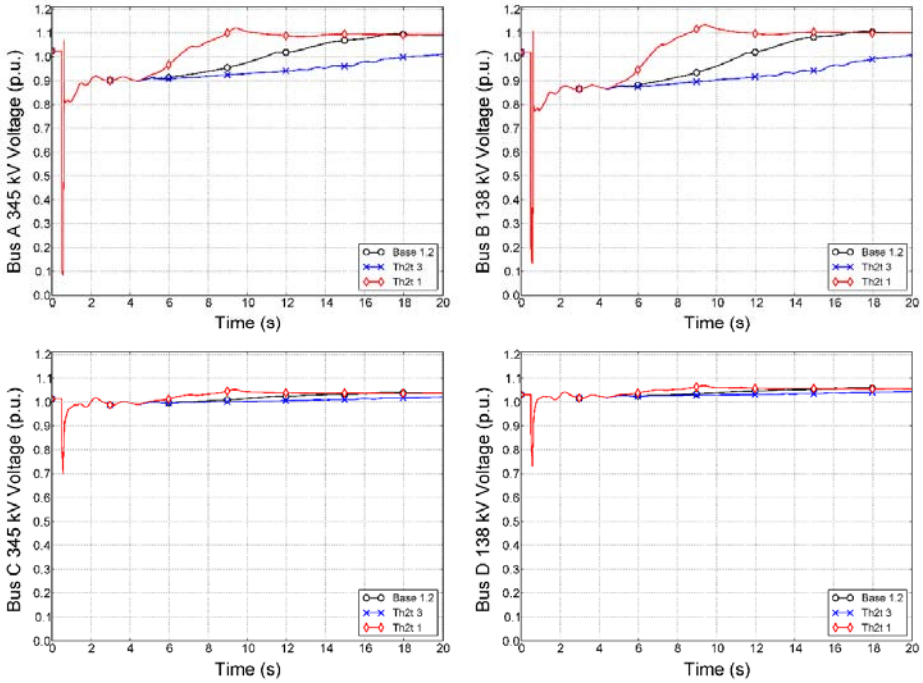

Figure 4.1-4: Bus voltages for sensitivity parameter Th2t

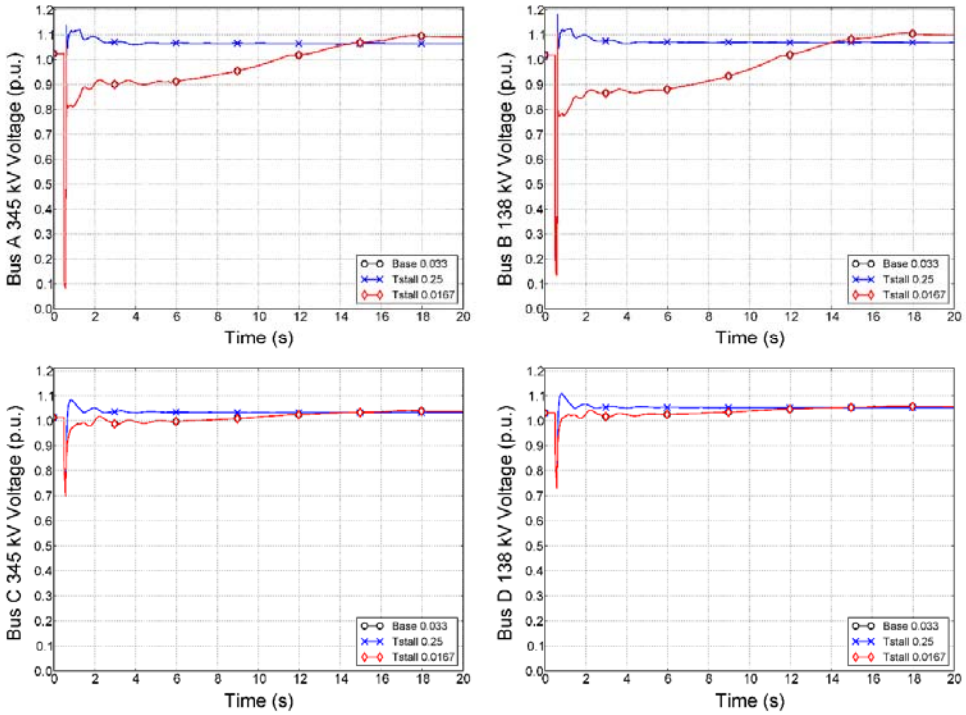

Figure 4.1-5: Bus voltages for sensitivity parameter Tstall

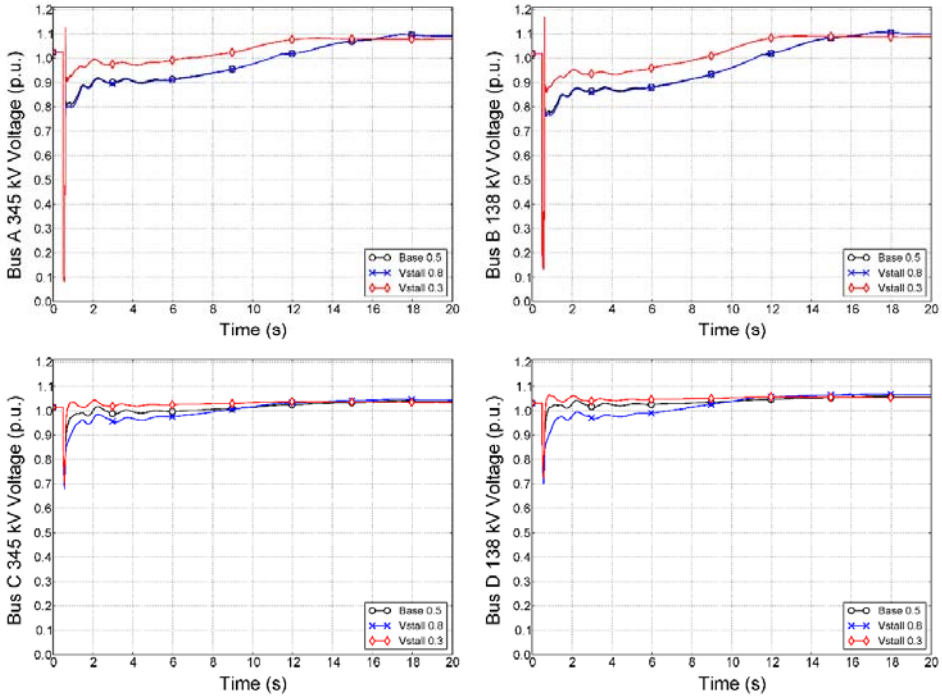

Figure 4.1-6: Bus voltages for sensitivity parameter Vstall

From the observations in Table 4.1-1 and the voltages in Figures 4.1-1 to 4.1-6, it can be observed that the following Motor D parameters have a significant impact on the results:

- **Vstall**: Stall voltage, p.u.
- **Tstall**: Stall time delay, sec.
- **FmD**: Motor D fraction of load P
- **Fuvr**: Fraction of load with under voltage relay protection
- **Vc1off**: Contactor voltage at which tripping starts, p.u.
- **Vc2off**: Contactor voltage at which tripping is complete, p.u.
- **Vc1on**: Contactor voltage at which reconnection starts, p.u.
- **Vc2on**: Contactor voltage at which reconnection is complete, p.u.
- **Tth**: Motor D thermal time constant, sec.
- **Th1t**: Motor D thermal protection trip start level, p.u. temperature
- **Th2t**: Motor D thermal protection trip completion level, p.u. temperature

For the Stressed Case, there were 8 contingencies examined for 198 sensitivity parameters:

- Motor A: 12 parameters (see Table 2.2-2) x 4 values = 48 sensitivity parameters
- Motor B: 12 parameters (see Table 2.2-3) x 4 values = 48 sensitivity parameters
- Motor C: 12 parameters (see Table 2.2-4) x 4 values = 48 sensitivity parameters
- Motor D: 9 parameters (see Table 2.2-1) x 6 values = 54 sensitivity parameters

For each contingency processed, 475 bus voltages and 98 generators were monitored. The results for a given sensitivity parameter (ex. fraction of Motor D increased by 20%) are an aggregate of all contingencies processed for that given sensitivity parameter. Tables 4.1-2 through 4.1-5 list the observations and results for the PacifiCorp Stressed Case for Motor A, Motor B, Motor C, and Motor D, respectively. The tables list the number of buses flagged by the criteria for the base case (Phase 2 composite load model) as well as a given sensitivity parameter. The "Delta (% Change)" column lists the percentage difference between the number of observations in the base case and the respective sensitivity parameter.

In Table 4.1-2, Motor A, the observation of a bus voltage recovering to 90% of the pre-fault voltage within 5 seconds, the base case flagged 1183 buses that did not meet this criterion. For the same voltage criteria, when increasing the fraction of motors that trip on the first low voltage trip setting by a factor of 0.2 (reference number 13 in Table 4.1-2), 1071 buses were flagged to not meet this criterion which is a decrease of 9% from the base case. When decreasing the fraction of motors that trip on the first low voltage trip setting by a factor of 0.1 (reference number 11 in Table 4.1-2), 1279 buses were flagged to not meet this criterion, which is an increase of 8% from the base case.

Table 4.1-2
PacifiCorp Results and Observations for the Stressed Case: Motor A

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator swings offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	1621	-	1509	-	12	-	20	-	197	-	1183	-	637	-	25	-	25	-	36	-
2	Vtr1 (0.7)	-0.15	0	1627	0%	1508	0%	12	0%	27	35%	236	20%	1247	5%	721	13%	25	0%	25	0%	40	11%
3		-0.05	0	1623	0%	1508	0%	12	0%	25	25%	202	3%	1267	7%	706	11%	19	-24%	30	20%	38	6%
4		+0.05	0	1618	0%	1507	0%	12	0%	19	-5%	193	-2%	1122	-5%	550	-14%	30	20%	21	-16%	36	0%
5		+0.15	0	1617	0%	1507	0%	12	0%	19	-5%	199	1%	1154	-2%	563	-12%	29	16%	25	0%	36	0%
6	Ttr1 (0.02 0.05 0.1)	-0.05	0	1620	0%	1507	0%	12	0%	14	-30%	189	-4%	1170	-1%	668	5%	29	16%	21	-16%	92	156%
7		+0.05	2	1100	0%	1018	0%	8	0%	12	71%	150	17%	855	8%	434	5%	14	8%	19	-17%	26	8%
8		+0.25	2	1096	1%	1024	1%	8	0%	26	271%	175	40%	883	13%	396	20%	6	-68%	19	6%	24	0%
9		+0.5	1	1623	19%	1505	19%	12	20%	25	79%	219	34%	1280	31%	653	34%	19	0%	24	0%	50	67%
10	Ftr1 (0.2 0.3 1)	-0.2	2	1088	0%	1022	0%	26	225%	15	114%	191	53%	877	13%	582	76%	14	-26%	134	644%	418	1642%
11		-0.1	0	1782	10%	1653	10%	12	0%	27	35%	247	25%	1279	8%	486	-24%	14	-44%	99	296%	421	1069%
12		+0.1	0	1622	0%	1505	0%	12	0%	20	0%	188	-5%	1183	0%	796	25%	26	4%	26	4%	40	11%
13		+0.2	0	1619	0%	1504	0%	12	0%	19	-5%	173	-12%	1071	-9%	947	49%	33	32%	20	-20%	39	8%
14	Vrc1 (1)	-0.25	5	264	0%	254	0%	2	0%	0	0%	28	0%	204	0%	87	0%	4	0%	6	0%	6	0%
15		-0.15	1	1357	0%	1255	0%	10	0%	20	0%	166	0%	979	0%	554	0%	21	0%	20	5%	36	20%
16		-0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	639	0%	25	0%	26	4%	42	17%
17		+0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	633	-1%	25	0%	25	0%	36	0%
18	Vtr2 (0.5 0.5)	-0.15	0	1632	1%	1512	0%	12	0%	19	-5%	208	6%	1181	0%	678	6%	31	24%	20	-20%	63	75%
19		-0.05	0	1621	0%	1511	0%	12	0%	21	5%	211	7%	1217	3%	639	0%	24	-4%	26	4%	48	33%
20		+0.05	1	1357	0%	1258	0%	10	0%	13	-7%	150	-8%	863	-12%	540	11%	24	26%	19	-21%	30	0%
21		+0.15	0	1609	-1%	1435	-5%	12	0%	19	-5%	147	-25%	1002	-15%	613	-4%	32	28%	20	-20%	36	0%
22	Ttr2 (0.02 0.05 0.1)	-0.05	0	1621	0%	1505	0%	12	0%	20	0%	196	-1%	1184	0%	670	5%	24	-4%	19	-24%	74	106%
23		+0.05	0	1634	1%	1513	0%	12	0%	19	-5%	199	1%	1164	-2%	724	14%	30	20%	20	-20%	36	0%
24		+0.25	3	885	10%	824	9%	24	300%	9	29%	120	24%	644	6%	192	-41%	8	0%	87	383%	292	1522%
25		+0.5	3	855	7%	770	2%	8	100%	9	29%	120	24%	641	6%	609	86%	8	0%	68	278%	435	2317%

* The contingencies that ran successfully in the Phase 2 base case but not in the parameter variation case, the base case observations for that set of contingencies were not included in the sensitivity computation, to provide a consistent comparison.

Table 4.1-2 (continued)
PacifiCorp Results and Observations for the Stressed Case: Motor A

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator swings offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	1621	-	1509	-	12	-	20	-	197	-	1183	-	637	-	25	-	25	-	36	-
26	Ftr2 (0 0.5 0.7)	-0.2	3	826	0%	773	1%	6	0%	0	0%	104	16%	621	4%	248	-4%	13	0%	17	0%	18	0%
27		-0.1	1	1360	0%	1261	0%	10	0%	14	0%	171	5%	999	2%	566	16%	19	0%	24	0%	74	147%
28		+0.1	0	1623	0%	1508	0%	12	0%	21	5%	212	8%	1275	8%	608	-5%	19	-24%	29	16%	80	122%
29		+0.2	0	1627	0%	1509	0%	12	0%	21	5%	248	26%	1287	9%	573	-10%	19	-24%	22	-12%	38	6%
30	Vrc2 (0.7 1)	-0.2	1	1363	0%	1260	0%	10	0%	14	8%	182	12%	1032	3%	620	10%	13	-32%	29	21%	210	600%
31		-0.1	1	1360	0%	1263	0%	10	0%	15	7%	171	5%	990	1%	494	2%	19	0%	24	0%	33	10%
32		+0.1	0	1621	0%	1509	0%	12	0%	19	-5%	188	-5%	1148	-3%	642	1%	26	4%	18	-28%	46	28%
33		+0.2	0	1621	0%	1509	0%	12	0%	19	-5%	170	-14%	1091	-8%	616	-3%	27	8%	25	0%	38	6%
34	Trc2 (0.1 0.25)	-0.05	0	1621	0%	1509	0%	12	0%	20	0%	198	1%	1184	0%	654	3%	25	0%	25	0%	38	6%
35		+0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	638	0%	25	0%	25	0%	38	6%
36		+0.1	0	1621	0%	1509	0%	12	0%	20	0%	199	1%	1182	0%	618	-3%	24	-4%	25	0%	46	28%
37		+0.25	0	1621	0%	1509	0%	12	0%	19	-5%	197	0%	1182	0%	611	-4%	24	-4%	25	0%	37	3%
38	H (0.1 0.15 0.2)	50%	1	1346	0%	1262	0%	11	10%	13	0%	159	0%	955	-3%	924	92%	25	0%	36	89%	475	1483%
39		75%	3	825	0%	769	0%	6	0%	0	0%	89	-1%	609	2%	245	-5%	13	0%	17	0%	18	0%
40		150%	0	1620	0%	1507	0%	10	-17%	19	-5%	195	-1%	1182	0%	723	14%	30	20%	15	-40%	30	-17%
41		200%	0	1618	0%	1504	0%	12	0%	19	-5%	198	1%	1203	2%	565	-11%	30	20%	20	-20%	36	0%
42	Ls (1.8 3.1)	50%	2	1096	0%	1012	0%	10	25%	10	43%	129	1%	780	-2%	670	62%	19	46%	99	330%	417	1638%
43		75%	1	1358	0%	1263	0%	10	0%	13	-7%	173	6%	997	2%	527	8%	19	0%	24	0%	32	7%
44		150%	1	1626	19%	1514	20%	12	20%	20	54%	194	20%	1171	17%	628	11%	24	26%	19	-21%	30	0%
45		200%	1	1359	0%	1258	0%	10	0%	13	-7%	159	-2%	959	-2%	488	0%	25	32%	19	-21%	30	0%
46	Tpo (0.095 0.8)	50%	2	1099	0%	1013	0%	8	0%	6	-14%	130	2%	800	1%	390	-6%	19	46%	18	-22%	24	0%
47		75%	1	1357	1%	1268	0%	10	0%	13	0%	153	-4%	948	-4%	432	-10%	24	-4%	19	0%	30	0%
48		150%	2	1084	0%	1016	0%	8	0%	11	57%	131	5%	829	6%	452	37%	19	0%	18	0%	43	79%
49		200%	1	1357	0%	1261	0%	10	0%	17	21%	172	6%	980	0%	763	57%	25	32%	26	8%	246	720%

* The contingencies that ran successfully in the Phase 2 base case but not in the parameter variation case, the base case observations for that set of contingencies were not included in the sensitivity computation, to provide a consistent comparison.

Table 4.1-3
PacifiCorp Results and Observations for the Stressed Case: Motor B

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator swings offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	1621	-	1509	-	12	-	20	-	197	-	1183	-	637	-	25	-	25	-	36	-
2	Vtr1 (0.7)	-0.15	0	1623	0%	1510	0%	12	0%	25	25%	222	13%	1263	7%	639	0%	19	-24%	30	20%	44	22%
3		-0.05	0	1621	0%	1509	0%	12	0%	20	0%	195	-1%	1212	2%	639	0%	25	0%	24	-4%	39	8%
4		+0.05	0	1618	0%	1509	0%	12	0%	19	-5%	201	2%	1214	3%	473	-26%	25	0%	26	4%	40	11%
5		+0.15	0	1617	0%	1504	0%	12	0%	19	-5%	199	1%	1217	3%	617	-3%	25	0%	25	0%	36	0%
6	Ttr1 (0.02, 0.05, 0.1)	-0.05	0	1625	0%	1507	0%	12	0%	19	-5%	192	-3%	1172	-1%	560	-12%	31	24%	19	-24%	36	0%
7		+0.05	0	1627	0%	1508	0%	12	0%	25	25%	234	19%	1288	9%	683	7%	19	-24%	31	24%	38	6%
8		+0.25	1	1377	1%	1265	0%	10	0%	26	86%	218	34%	1122	15%	883	82%	14	-26%	23	-4%	425	1317%
9		+0.5	2	1096	1%	1022	0%	13	63%	21	200%	175	40%	904	16%	519	57%	14	-26%	83	361%	348	1350%
10	Ftr1 (0.2, 0.3, 1)	-0.2	2	1100	0%	1018	0%	8	0%	19	171%	173	35%	880	11%	376	-9%	8	-38%	21	-9%	29	21%
11		-0.1	1	1360	0%	1261	0%	10	0%	20	43%	184	13%	1023	5%	458	-6%	14	-26%	23	-4%	31	3%
12		+0.1	0	1622	0%	1506	0%	12	0%	20	0%	196	-1%	1218	3%	605	-5%	31	24%	20	-20%	36	0%
13		+0.2	0	1621	0%	1507	0%	12	0%	20	0%	200	2%	1193	1%	556	-13%	24	-4%	18	-28%	38	6%
14	Vrc1 (1)	-0.25	0	1621	0%	1509	0%	12	0%	20	0%	206	5%	1228	4%	568	-11%	24	-4%	23	-8%	36	0%
15		-0.15	0	1621	0%	1509	0%	12	0%	20	0%	202	3%	1211	2%	621	-3%	25	0%	25	0%	36	0%
16		-0.05	0	1621	0%	1509	0%	12	0%	20	0%	198	1%	1190	1%	634	0%	25	0%	25	0%	37	3%
17		+0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1179	0%	631	-1%	25	0%	24	-4%	38	6%
18	Vtr2 (0.5, 0.6)	-0.15	0	1629	0%	1508	0%	12	0%	29	45%	277	41%	1353	14%	716	12%	19	-24%	28	12%	81	125%
19		-0.05	0	1623	0%	1508	0%	12	0%	21	5%	222	13%	1301	10%	679	7%	25	0%	23	-8%	39	8%
20		+0.05	0	1621	0%	1507	0%	12	0%	20	0%	200	2%	1216	3%	657	3%	25	0%	25	0%	37	3%
21		+0.15	1	1355	0%	1259	0%	10	0%	13	0%	162	0%	1003	0%	565	0%	19	0%	18	-25%	38	27%
22	Ttr2 (0.02, 0.05, 0.1)	-0.05	0	1621	0%	1505	0%	12	0%	20	0%	196	-1%	1184	0%	670	5%	24	-4%	19	-24%	74	106%
23		+0.05	0	1627	0%	1508	0%	12	0%	25	25%	234	19%	1288	9%	683	7%	19	-24%	31	24%	38	6%
24		+0.25	1	1377	1%	1265	0%	10	0%	26	86%	218	34%	1122	15%	883	82%	14	-26%	23	-4%	425	1317%
25		+0.5	2	1096	1%	1022	0%	13	63%	21	200%	175	40%	904	16%	519	57%	14	-26%	83	361%	348	1350%

* The contingencies that ran successfully in the Phase 2 base case but not in the parameter variation case, the base case observations for that set of contingencies were not included in the sensitivity computation, to provide a consistent comparison.

Table 4.1-3 (continued)
PacifiCorp Results and Observations for the Stressed Case: Motor B

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator swings offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	1621	-	1509	-	12	-	20	-	197	-	1183	-	637	-	25	-	25	-	36	-
26	Ftr2 (0, 0.5, 0.7)	-0.2	1	1361	0%	1266	0%	10	0%	27	93%	213	31%	1077	10%	537	10%	8	-58%	21	-13%	69	130%
27		-0.1	0	1622	0%	1506	0%	12	0%	27	35%	221	12%	1280	8%	609	-4%	14	-44%	30	20%	46	28%
28		+0.1	1	1364	0%	1258	0%	10	0%	7	-46%	129	-20%	887	-11%	567	1%	24	26%	30	25%	30	0%
29		+0.2	0	1630	1%	1506	0%	12	0%	4	-80%	82	-58%	952	-20%	648	2%	30	20%	36	44%	36	0%
30	Vrc2 (0.7, 1)	-0.2	0	1621	0%	1509	0%	12	0%	21	5%	230	17%	1278	8%	606	-5%	23	-8%	23	-8%	37	3%
31		-0.1	0	1621	0%	1509	0%	12	0%	20	0%	206	5%	1222	3%	628	-1%	24	-4%	23	-8%	37	3%
32		+0.1	0	1621	0%	1509	0%	12	0%	20	0%	196	-1%	1181	0%	629	-1%	24	-4%	24	-4%	36	0%
33		+0.2	0	1621	0%	1509	0%	12	0%	20	0%	194	-2%	1175	-1%	642	1%	24	-4%	24	-4%	37	3%
34	Trc2 (0.1, 0.25)	-0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1181	0%	633	-1%	25	0%	25	0%	37	3%
35		+0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	636	0%	25	0%	25	0%	37	3%
36		+0.1	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	633	-1%	25	0%	25	0%	37	3%
37		+0.25	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1184	0%	630	-1%	24	-4%	25	0%	37	3%
38	H (0.1, 0.15, 0.2)	50%	0	1626	0%	1515	0%	12	0%	27	35%	215	9%	1275	8%	737	16%	19	-24%	36	44%	64	78%
39		75%	0	1626	0%	1507	0%	12	0%	27	35%	217	10%	1255	6%	737	16%	14	-44%	31	24%	101	181%
40		150%	1	1323	0%	1246	0%	10	0%	19	-5%	169	2%	951	-4%	514	-7%	25	25%	20	0%	30	0%
41		200%	1	1321	0%	1245	0%	10	0%	13	-35%	160	-4%	965	-3%	530	-4%	23	15%	22	10%	28	-7%
42	Ls (1.8, 3.1)	50%	0	1619	0%	1504	0%	12	0%	27	35%	207	5%	1186	0%	591	-7%	17	-32%	36	44%	36	0%
43		75%	0	1619	0%	1506	0%	12	0%	27	35%	214	9%	1242	5%	657	3%	14	-44%	31	24%	44	22%
44		150%	0	1627	0%	1510	0%	12	0%	13	-35%	197	0%	1197	1%	709	11%	28	12%	35	40%	36	0%
45		200%	1	1360	0%	1263	0%	14	40%	2	-85%	157	-3%	964	-4%	856	52%	23	21%	335	1296%	436	1353%
46	Tpo (0.095, 0.8)	50%	1	1359	0%	1248	-1%	10	0%	3	-79%	153	-6%	973	0%	548	13%	22	16%	27	13%	33	10%
47		75%	0	1627	0%	1508	0%	12	0%	18	-10%	194	-2%	1180	0%	692	9%	28	12%	35	40%	36	0%
48		150%	1	1620	20%	1508	19%	12	20%	27	108%	212	33%	1246	26%	549	14%	18	-28%	31	63%	37	23%
49		200%	1	1345	0%	1263	0%	10	0%	20	54%	169	6%	1022	4%	585	21%	11	-56%	27	42%	63	110%

* The contingencies that ran successfully in the Phase 2 base case but not in the parameter variation case, the base case observations for that set of contingencies were not included in the sensitivity computation, to provide a consistent comparison.

Table 4.1-4
PacifiCorp Results and Observations for the Stressed Case: Motor C

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator swings offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage overshoot over 1.1 p.u.		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	1621	-	1509	-	12	-	20	-	197	-	1183	-	36	-	25	-	25	-	36	-
2	Vtr1 (0.7)	-0.15	0	1622	0%	1507	0%	12	0%	24	20%	205	4%	1211	2%	58	61%	24	-4%	23	-8%	58	61%
3		-0.05	0	1621	0%	1509	0%	12	0%	20	0%	199	1%	1202	2%	58	61%	25	0%	24	-4%	58	61%
4		+0.05	0	1618	0%	1509	0%	12	0%	19	-5%	197	0%	1209	2%	38	6%	24	-4%	27	8%	38	6%
5		+0.15	0	1618	0%	1505	0%	12	0%	19	-5%	196	-1%	1177	-1%	36	0%	30	20%	21	-16%	36	0%
6	Ttr1 (0.02 0.05 0.1)	-0.05	1	1620	19%	1504	20%	12	20%	20	0%	198	19%	1217	24%	40	33%	24	14%	26	37%	40	33%
7		+0.05	0	1622	0%	1506	0%	12	0%	24	20%	202	3%	1200	1%	36	0%	25	0%	25	0%	36	0%
8		+0.25	1	1360	0%	1261	0%	10	0%	20	43%	182	12%	1017	4%	25	-17%	14	-26%	19	-21%	25	-17%
9		+0.5	1	1361	0%	1261	0%	10	0%	20	43%	182	12%	1018	4%	32	7%	14	-26%	23	-4%	32	7%
10	Ftr1 (0.2 0.3 1)	-0.2	0	1621	0%	1507	0%	12	0%	28	40%	221	12%	1219	3%	59	64%	8	-68%	22	-12%	59	64%
11		-0.1	1	1361	0%	1262	0%	10	0%	20	43%	182	12%	1037	6%	32	7%	14	-26%	23	-4%	32	7%
12		+0.1	0	1621	0%	1508	0%	12	0%	20	0%	195	-1%	1189	1%	103	186%	25	0%	24	-4%	103	186%
13		+0.2	0	1621	0%	1506	0%	12	0%	20	0%	196	-1%	1213	3%	101	181%	25	0%	25	0%	101	181%
14	Vrc1 (1)	-0.25	0	1621	0%	1509	0%	12	0%	20	0%	200	2%	1194	1%	36	0%	25	0%	25	0%	36	0%
15		-0.15	0	1621	0%	1509	0%	12	0%	20	0%	201	2%	1192	1%	36	0%	25	0%	25	0%	36	0%
16		-0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	37	3%	25	0%	25	0%	37	3%
17		+0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	38	6%	25	0%	25	0%	38	6%
18	Vtr2 (0.5 0.5)	-0.15	0	1623	0%	1508	0%	12	0%	25	25%	220	12%	1252	6%	94	161%	19	-24%	28	12%	94	161%
19		-0.05	0	1623	0%	1508	0%	12	0%	20	0%	209	6%	1221	3%	39	8%	24	-4%	23	-8%	39	8%
20		+0.05	0	1621	0%	1507	0%	11	-8%	19	-5%	198	1%	1188	0%	47	31%	24	-4%	27	8%	47	31%
21		+0.15	1	1320	0%	1244	0%	10	0%	19	-5%	164	-1%	968	-3%	33	10%	25	25%	15	-25%	33	10%
22	Ttr2 (0.02 0.05 0.1)	-0.05	0	1627	0%	1506	0%	12	0%	20	0%	199	1%	1226	4%	45	25%	24	-4%	25	0%	45	25%
23		+0.05	0	1623	0%	1508	0%	12	0%	26	30%	217	10%	1249	6%	38	6%	19	-24%	30	20%	38	6%
24		+0.25	0	1624	0%	1511	0%	12	0%	29	45%	238	21%	1250	6%	44	22%	14	-44%	30	20%	44	22%
25		+0.5	0	1624	0%	1511	0%	12	0%	30	50%	239	21%	1247	5%	36	0%	14	-44%	29	16%	36	0%

* The contingencies that ran successfully in the Phase 2 base case but not in the parameter variation case, the base case observations for that set of contingencies were not included in the sensitivity computation, to provide a consistent comparison.

Table 4.1-4 (continued)
PacifiCorp Results and Observations for the Stressed Case: Motor C

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator swings offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage overshoot over 1.1 p.u.		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	1621	-	1509	-	12	-	20	-	197	-	1183	-	36	-	25	-	25	-	36	-
26	Ftr2 (0 0.5 0.7)	-0.2	0	1623	0%	1506	0%	12	0%	28	40%	229	16%	1291	9%	111	208%	8	-68%	33	32%	111	208%
27		-0.1	1	1361	0%	1262	0%	10	0%	20	43%	183	12%	1022	5%	33	10%	14	-26%	23	-4%	33	10%
28		+0.1	0	1621	0%	1509	0%	12	0%	20	0%	198	1%	1208	2%	36	0%	24	-4%	25	0%	36	0%
29		+0.2	0	1621	0%	1510	0%	12	0%	20	0%	196	-1%	1196	1%	102	183%	24	-4%	25	0%	102	183%
30	Vrc2 (0.7 1)	-0.2	0	1621	0%	1509	0%	12	0%	21	5%	231	17%	1276	8%	38	6%	23	-8%	23	-8%	38	6%
31		-0.1	0	1621	0%	1509	0%	12	0%	20	0%	206	5%	1222	3%	37	3%	25	0%	23	-8%	37	3%
32		+0.1	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1182	0%	37	3%	25	0%	24	-4%	37	3%
33		+0.2	0	1621	0%	1509	0%	12	0%	20	0%	194	-2%	1175	-1%	37	3%	25	0%	24	-4%	37	3%
34	Trc2 (0.1 0.25)	-0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1180	0%	88	144%	25	0%	19	-24%	88	144%
35		+0.05	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	38	6%	25	0%	25	0%	38	6%
36		+0.1	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	37	3%	25	0%	25	0%	37	3%
37		+0.25	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	37	3%	25	0%	25	0%	37	3%
38	H (0.1 0.15 0.2)	50%	0	1622	0%	1503	0%	13	8%	26	30%	226	15%	1254	6%	174	383%	19	-24%	75	200%	174	383%
39		75%	0	1621	0%	1504	0%	12	0%	24	20%	195	-1%	1183	0%	37	3%	25	0%	25	0%	37	3%
40		150%	1	1324	0%	1248	0%	10	0%	19	-5%	166	0%	983	-1%	33	10%	26	30%	15	-25%	33	10%
41		200%	0	1624	0%	1507	0%	12	0%	14	-30%	190	-4%	1174	-1%	36	0%	29	16%	25	0%	36	0%
42	Ls (1.8 3.1)	50%	1	1358	0%	1258	0%	10	0%	19	46%	183	13%	1035	3%	245	717%	13	-32%	66	175%	245	717%
43		75%	0	1619	0%	1506	0%	13	8%	26	30%	201	2%	1172	-1%	182	406%	25	0%	91	264%	181	403%
44		150%	0	1626	0%	1512	0%	12	0%	14	-30%	190	-4%	1211	2%	39	8%	27	8%	32	28%	39	8%
45		200%	2	1099	0%	1012	0%	8	0%	1	-86%	122	-5%	801	1%	24	0%	17	31%	24	4%	24	0%
46	Tpo (0.095 0.8)	50%	1	1329	0%	1249	0%	10	0%	4	-80%	154	-7%	962	-3%	36	20%	23	15%	30	50%	36	20%
47		75%	1	1329	0%	1247	0%	10	0%	19	-5%	173	4%	1031	4%	30	0%	25	25%	16	-20%	30	0%
48		150%	1	1358	0%	1258	0%	10	0%	19	46%	178	10%	1021	2%	31	3%	13	-32%	27	13%	30	0%
49		200%	1	1358	0%	1260	0%	10	0%	19	46%	198	22%	1082	8%	37	23%	13	-32%	25	4%	37	23%

* The contingencies that ran successfully in the Phase 2 base case but not in the parameter variation case, the base case observations for that set of contingencies were not included in the sensitivity computation, to provide a consistent comparison.

Table 4.1-5
PacifiCorp Results and Observations for the Stressed Case: Motor D

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator swings offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	1621	-	1509	-	12	-	20	-	197	-	1183	-	25	-	25	-	36	-
2	Vstall (0.5)	0.4	0	1621	0%	1515	0%	12	0%	19	-5%	107	-46%	581	-51%	35	40%	19	-24%	34	-6%
3		0.45	0	1620	0%	1506	0%	12	0%	19	-5%	115	-42%	634	-46%	32	28%	18	-28%	36	0%
4		0.55	0	1620	0%	1504	0%	12	0%	19	-5%	180	-9%	1038	-12%	33	32%	20	-20%	40	11%
5		0.6	0	1624	0%	1508	0%	12	0%	21	5%	236	20%	1308	11%	23	-8%	27	8%	112	211%
6	Tstall (0.033)	0.0667	0	1620	0%	1508	0%	12	0%	19	-5%	174	-12%	1023	-14%	32	28%	20	-20%	36	0%
7		0.08335	0	1620	0%	1506	0%	12	0%	19	-5%	80	-59%	432	-63%	95	280%	17	-32%	33	-8%
8		0.1	0	1620	0%	1506	0%	12	0%	19	-5%	80	-59%	422	-64%	95	280%	17	-32%	33	-8%
9		0.1667	0	1620	0%	1506	0%	12	0%	4	-80%	4	-98%	4	-100%	277	1008%	30	20%	30	-17%
10	Vc1Vc2 (0.4, 0.5,0.6)	(0.5,0.3,0.7,0.6)	1	1386	2%	1275	1%	10	0%	18	29%	127	-22%	1047	7%	19	0%	64	167%	79	163%
11		(0.55,0.35,0.75,0.6)	0	1624	0%	1507	0%	12	0%	19	-5%	77	-61%	1124	-5%	33	32%	19	-24%	36	0%
12		(0.6,0.4,0.7,0.6)	2	1059	0%	974	-3%	8	0%	12	-14%	53	-60%	789	0%	19	36%	18	-5%	24	0%
13		(0.65,0.5,0.8,0.65)	1	1341	-1%	1204	-4%	10	0%	2	-85%	2	-99%	368	-63%	25	32%	51	113%	30	0%
14	Tth (15)	10	0	1621	0%	1509	0%	12	0%	20	0%	194	-2%	728	-38%	33	32%	51	104%	51	42%
15		12	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1021	-14%	25	0%	26	4%	46	28%
16		17	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1221	3%	24	-4%	8	-68%	36	0%
17		20	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1245	5%	24	-4%	12	-52%	38	6%
18	Th1t (0.7)	0.55	0	1621	0%	1509	0%	12	0%	20	0%	196	-1%	1028	-13%	25	0%	26	4%	37	3%
19		0.65	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1155	-2%	25	0%	25	0%	36	0%
20		0.75	0	1621	0%	1509	0%	12	0%	20	0%	196	-1%	1206	2%	25	0%	24	-4%	37	3%
21		0.85	0	1621	0%	1509	0%	12	0%	20	0%	196	-1%	1241	5%	24	-4%	23	-8%	36	0%
22	Th2t (1.9)	1.1	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1046	-12%	152	508%	250	900%	60	67%
23		1.3	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1120	-5%	27	8%	98	292%	56	56%
24		1.4	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1134	-4%	25	0%	43	72%	51	42%
25		2	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1186	0%	25	0%	23	-8%	36	0%
26	FmD (0.113)	-40	1	1347	-1%	1216	-3%	10	0%	8	-60%	9	-95%	201	-79%	27	29%	10	-47%	30	0%
27		-10	0	1618	0%	1505	0%	12	0%	19	-5%	153	-22%	1013	-14%	33	32%	19	-24%	36	0%
28		10	0	1628	0%	1509	0%	12	0%	26	30%	247	25%	1281	8%	24	-4%	17	-32%	118	228%
29		40	1	1364	0%	1269	0%	10	0%	37	164%	217	33%	1056	8%	9	-53%	5	-79%	130	333%
30	Fuvr (0.1)	0.05	1	1360	0%	1262	0%	10	0%	18	29%	199	22%	1066	9%	18	-5%	22	-8%	31	3%
31		0.15	0	1622	0%	1506	0%	12	0%	19	-5%	174	-12%	1144	-3%	27	8%	28	12%	39	8%
32		0.2	1	1359	0%	1256	0%	10	0%	12	-8%	95	-41%	788	-21%	27	42%	18	-25%	30	0%
33		0.25	2	1060	0%	998	0%	8	0%	13	-7%	57	-57%	497	-37%	22	57%	12	-37%	24	0%
34	Vrst (0.95)	0.7	0	1621	0%	1509	0%	12	0%	20	0%	189	-4%	1115	-6%	27	8%	25	0%	36	0%
35		0.8	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1178	0%	25	0%	24	-4%	36	0%
36		0.85	0	1621	0%	1509	0%	12	0%	20	0%	197	0%	1183	0%	25	0%	26	4%	38	6%
37		0.9	0	1621	0%	1509	0%	12	0%	20	0%	196	-1%	1183	0%	25	0%	27	8%	40	11%

* The contingencies that ran successfully in the Phase 2 base case but not in the parameter variation case, the base case observations for that set of contingencies were not included in the sensitivity computation, to provide a consistent comparison.

4.2. PG&E Heavy Summer and Stressed Case Results

For the Heavy Summer Case, there were 53 contingencies examined for 35 sensitivity parameters (17 parameter variations each with a minimum and maximum value and the base case) for Motor D for a total of 1,855 contingencies processed. For each contingency processed, 3,297 bus voltages and 1,134 generators were monitored. The results for a given sensitivity parameter (ex. fraction of Motor D increased by 20%) are an aggregate of all contingencies processed for that given sensitivity parameter. Table 4.2-1 lists the observations and results for PG&E's Heavy Summer Case. The table lists the number of buses flagged by the criteria for the base case (Phase II composite load model) as well as a given sensitivity parameter. The "Delta (% Change)" column lists the percentage difference between the number of observations in the base case and the respective sensitivity parameter. For the observation of a bus voltage recovering to 70% of the pre-fault voltage within 1 second, the base case flagged 78 buses that did not meet this criterion. For the same voltage criteria, when increasing the fraction of Motor D (Fmd) by 20%, 219 buses were flagged to not meet this criteria which is an increase of 181% from the base case. When decreasing the fraction of Motor D (Fmd) by 20%, 19 buses were flagged to not meet this criterion which is a decrease of 76% from the base case.

Refer to Figures 4.2-1 through 4.2-16 for representative plots of select sensitivity parameters for a three-phase fault resulting in the loss of a 500 kV line and loss of a generator. The plots include up to eight bus voltages and four generator angles comparing the base case (Phase 2) to the maximum and minimum sensitivity parameter, respectively. Refer to Appendix A for a representative set of voltage plots and generator plots for each contingency.

Table 4.2-1
PG&E Results and Observations for the Heavy Summer Case

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Angle Swings Offline (+/-180)		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u.	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	39613	-	31391	-	167	-	78	-	1011	-	4506	-	2670	-	3194	-
2	Fel	-20%	39159	-1%	30971	-1%	150	-10%	22	-72%	946	-6%	4450	-1%	1957	-27%	2503	-22%
3		20%	40078	1%	31856	1%	177	6%	164	110%	1035	2%	4715	5%	2751	3%	3634	14%
4	Fma	-20%	38941	-2%	30685	-2%	113	-32%	19	-76%	1255	24%	5150	14%	1625	-39%	2153	-33%
5		20%	41286	4%	32927	5%	314	88%	211	171%	882	-13%	4151	-8%	3883	45%	4582	43%
6	Fmb	-20%	39520	0%	31281	0%	144	-14%	20	-74%	1043	3%	4631	3%	1979	-26%	2523	-21%
7		20%	39673	0%	31474	0%	171	2%	151	94%	1049	4%	4392	-3%	2457	-8%	3480	9%
8	Fmc	-20%	38200	-4%	30142	-4%	155	-7%	22	-72%	1076	6%	4552	1%	2229	-17%	2811	-12%
9		20%	39869	1%	31708	1%	180	8%	101	29%	1005	-1%	4558	1%	2800	5%	3466	9%
10	Fmd	-20%	37613	-5%	29390	-6%	136	-19%	19	-76%	415	-59%	2928	-35%	1273	-52%	2015	-37%
11		20%	41429	5%	33610	7%	169	1%	219	181%	1623	61%	5504	22%	3989	49%	3829	20%
12	Frst	0	39613	0%	31391	0%	172	3%	78	0%	1011	0%	4518	0%	2964	11%	3302	3%
13		1	39613	0%	31391	0%	161	-4%	78	0%	1011	0%	4518	0%	1724	-35%	2930	-8%
14	Fuvr	0	39756	0%	31602	1%	119	-29%	78	0%	1472	46%	5637	25%	2301	-14%	2571	-20%
15		0.5	37754	-5%	29659	-6%	266	59%	78	0%	27	-97%	66	-99%	3127	17%	6428	101%
16	Th1t	0.4	39613	0%	31391	0%	203	22%	78	0%	1011	0%	4432	-2%	2914	9%	3199	0%
17		0.9	39613	0%	31391	0%	139	-17%	78	0%	1011	0%	4506	0%	2653	-1%	3142	-2%
18	Th2t	1	39613	0%	31391	0%	245	47%	78	0%	1011	0%	4505	0%	2828	6%	5196	63%
19		3	39613	0%	31391	0%	73	-56%	78	0%	1011	0%	4506	0%	831	-69%	1406	-56%
20	Trst	1	39613	0%	31391	0%	167	0%	78	0%	1011	0%	4518	0%	2670	0%	3176	-1%
21		0.1	39613	0%	31391	0%	167	0%	78	0%	1011	0%	4518	0%	2670	0%	3265	2%
22	Tstall	0.25	39613	0%	31390	0%	213	28%	78	0%	27	-97%	62	-99%	76	-97%	8600	169%
23		0.1667	39675	0%	31439	0%	184	10%	210	169%	5404	435%	13919	209%	9038	239%	8121	154%
24	Tth	5	39613	0%	31391	0%	258	54%	78	0%	1011	0%	4148	-8%	2890	8%	5948	86%
25		25	39613	0%	31391	0%	97	-42%	78	0%	1011	0%	4506	0%	2518	-6%	2668	-16%
26	Ttr1	0.25	39755	0%	31601	1%	119	-29%	78	0%	1452	44%	5578	24%	2309	-14%	2674	-16%
27		0.1667	39591	0%	31392	0%	170	2%	78	0%	1020	1%	4501	0%	3162	18%	3292	3%
28	Vc1Vc2	Max	35952	-9%	26640	-15%	122	-27%	18	-77%	133	-87%	3392	-25%	2822	6%	3599	13%
29		Min	40101	1%	32161	2%	121	-28%	148	90%	2693	166%	7498	66%	5759	116%	3815	19%
30	Vrst	1	39613	0%	31391	0%	173	4%	78	0%	1011	0%	4518	0%	2833	6%	3276	3%
31		0.5	39613	0%	31391	0%	183	10%	78	0%	340	-66%	3477	-23%	2182	-18%	3049	-5%
32	Vstall	0.3	40433	2%	32640	4%	189	13%	78	0%	27	-97%	171	-96%	115	-96%	7688	141%
33		0.8	49677	25%	39210	25%	571	242%	4822	6082%	32667	3131%	49106	990%	35195	1218%	25291	692%
34	Vtr1	0.4	39756	0%	31602	1%	124	-26%	78	0%	1385	37%	5622	25%	2264	-15%	2588	-19%
35		0.8	38616	-3%	30386	-3%	176	5%	20	-74%	999	-1%	4763	6%	2178	-18%	3179	0%

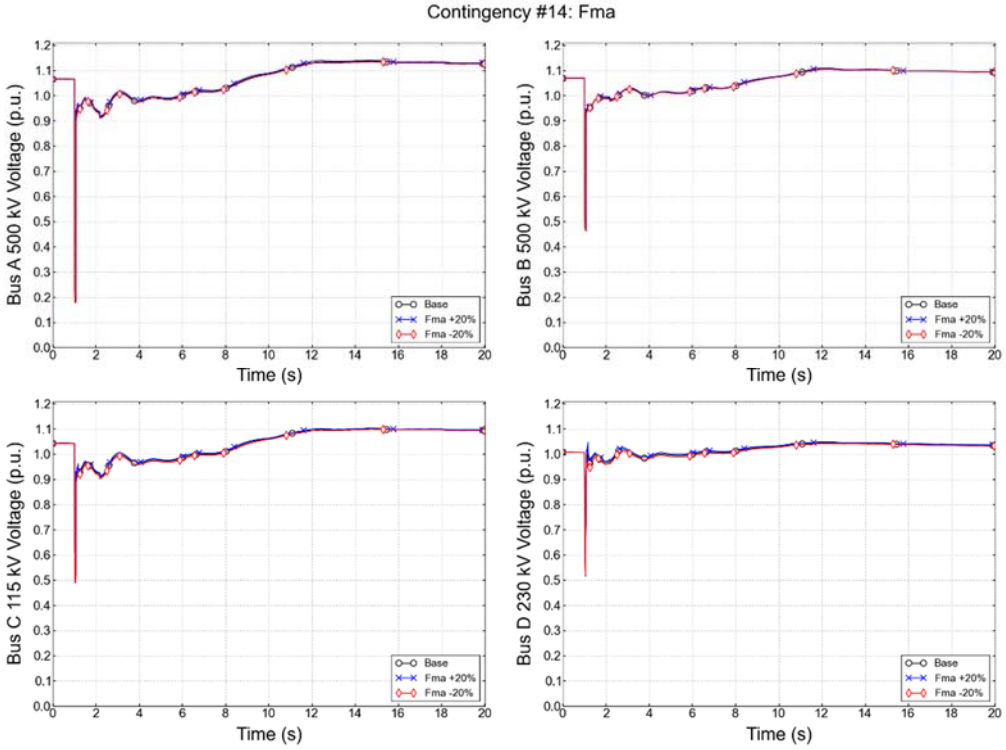

Figure 4.2-1: Bus voltages for sensitivity parameter FmA.

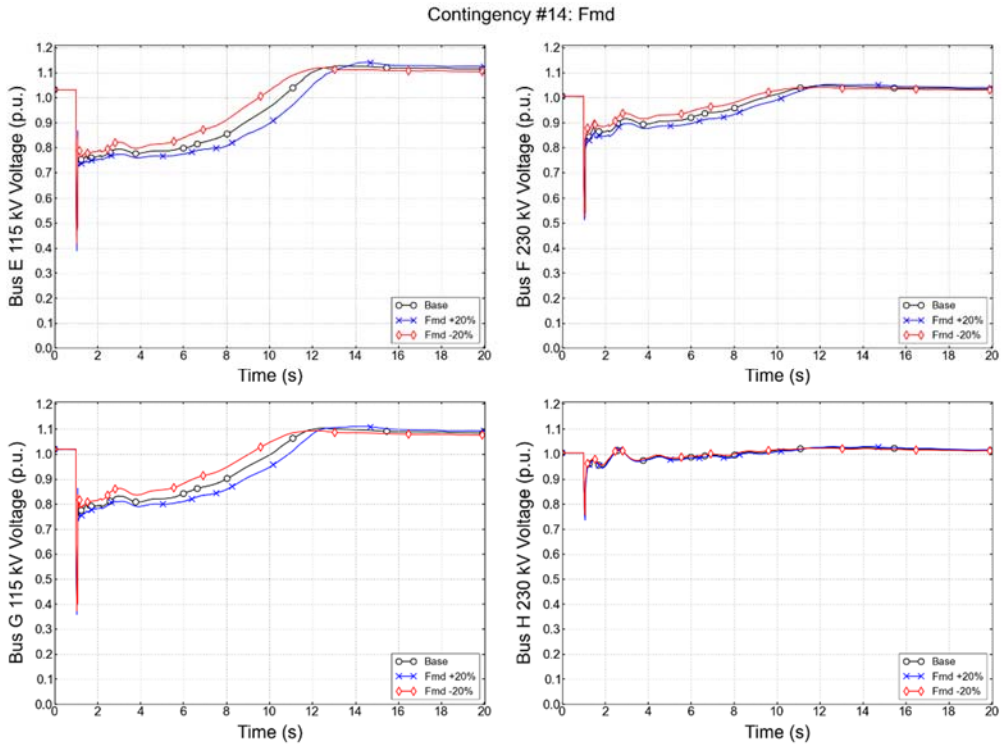

Figure 4.2-2: Bus voltages for sensitivity parameter FmD.

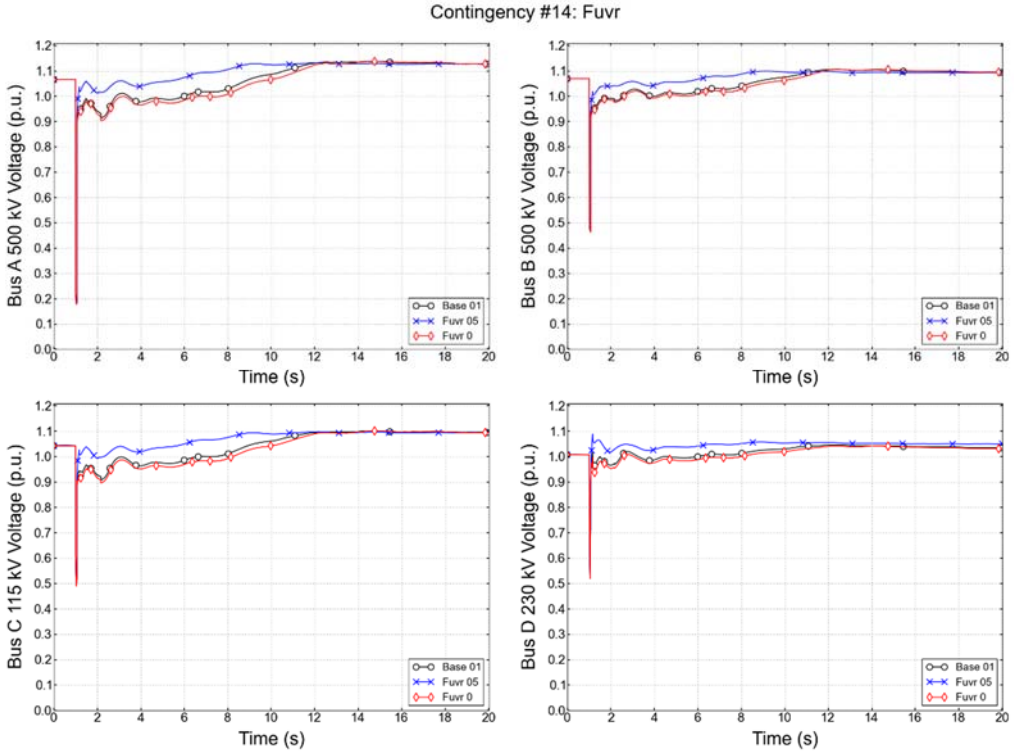

Figure 4.2-3: Bus voltages for sensitivity parameter Fuvr.

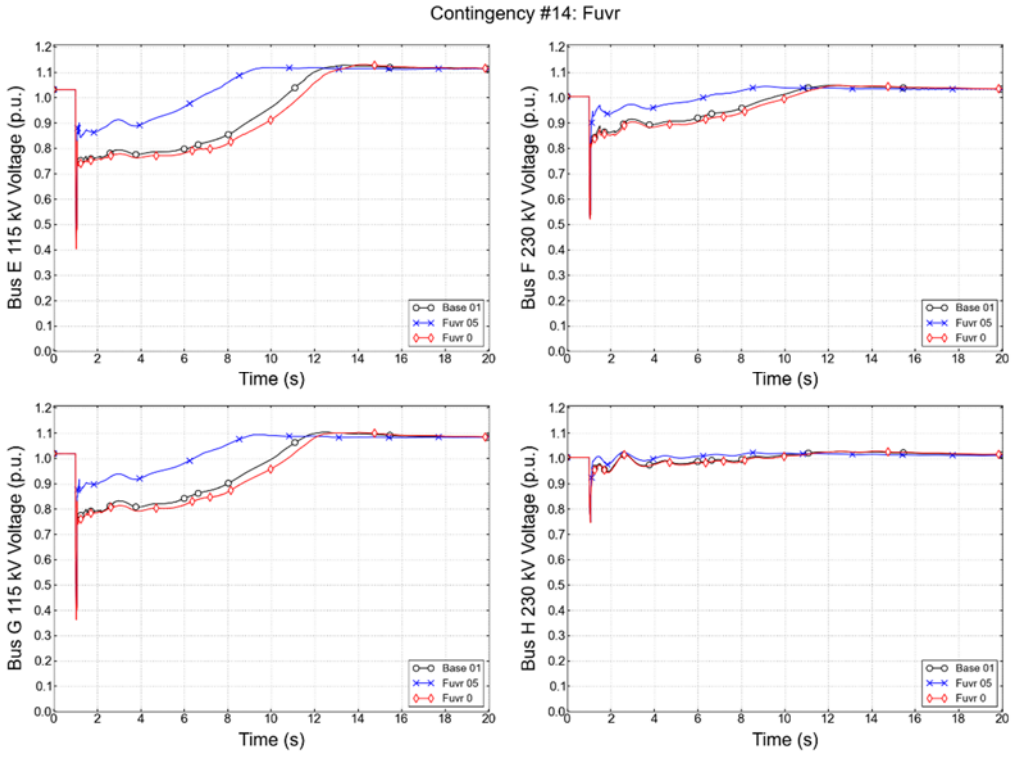

Figure 4.2-4: Bus voltages for sensitivity parameter Fuvr.

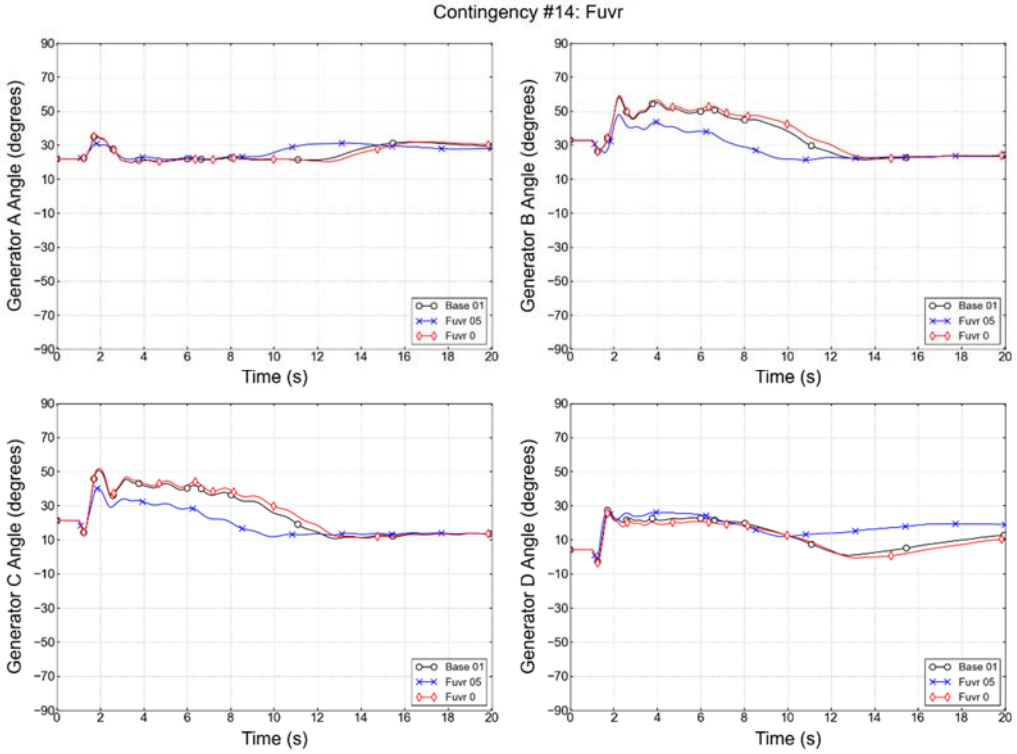

Figure 4.2-5: Generator angles for sensitivity parameter Fuvr.

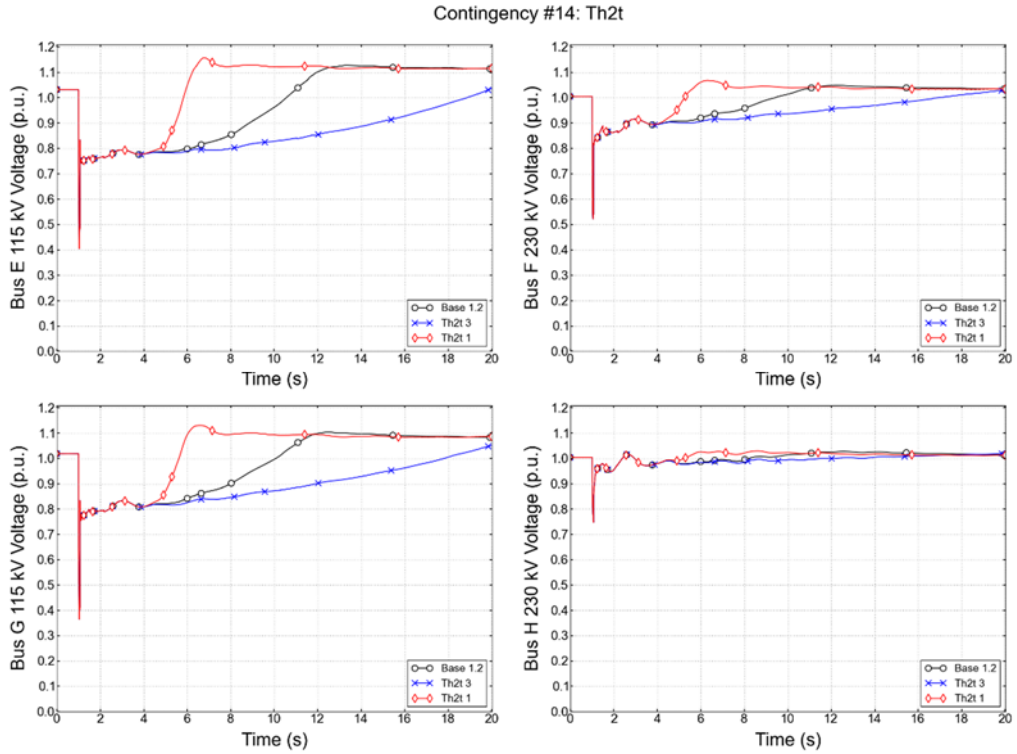

Figure 4.2-6: Bus voltages for sensitivity parameter Th2t.

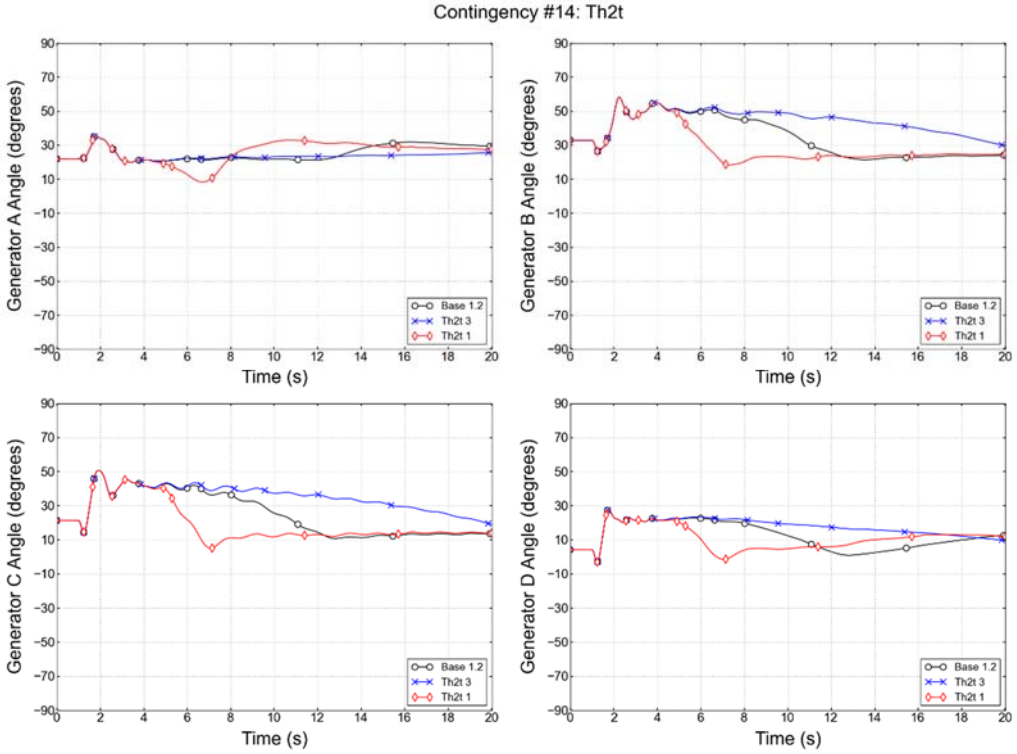

Figure 4.2-7: Generator angles for sensitivity parameter Th2t.

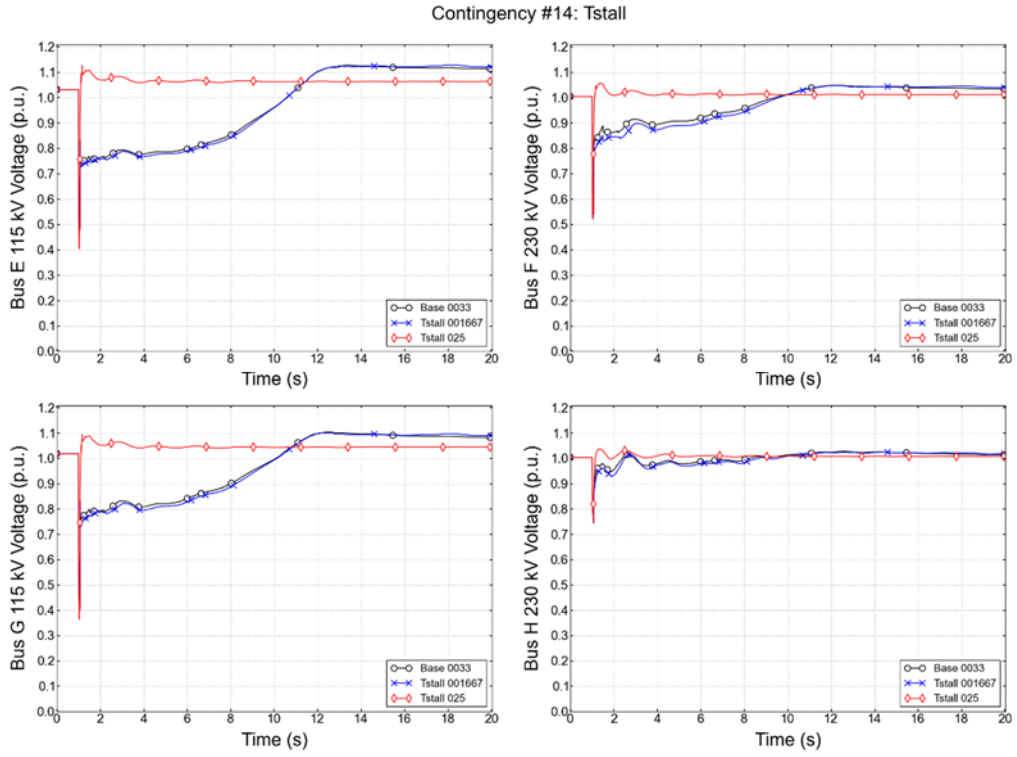

Figure 4.2-8: Bus voltages for sensitivity parameter Tstall.

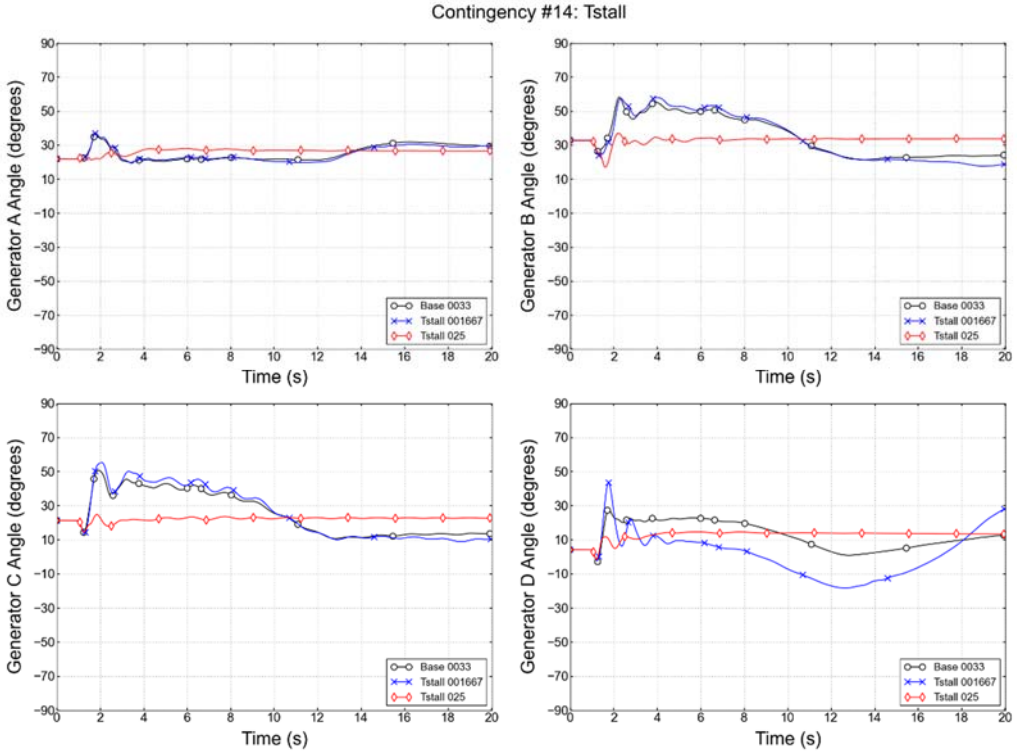

Figure 4.2-9: Generator angles for sensitivity parameter Tstall.

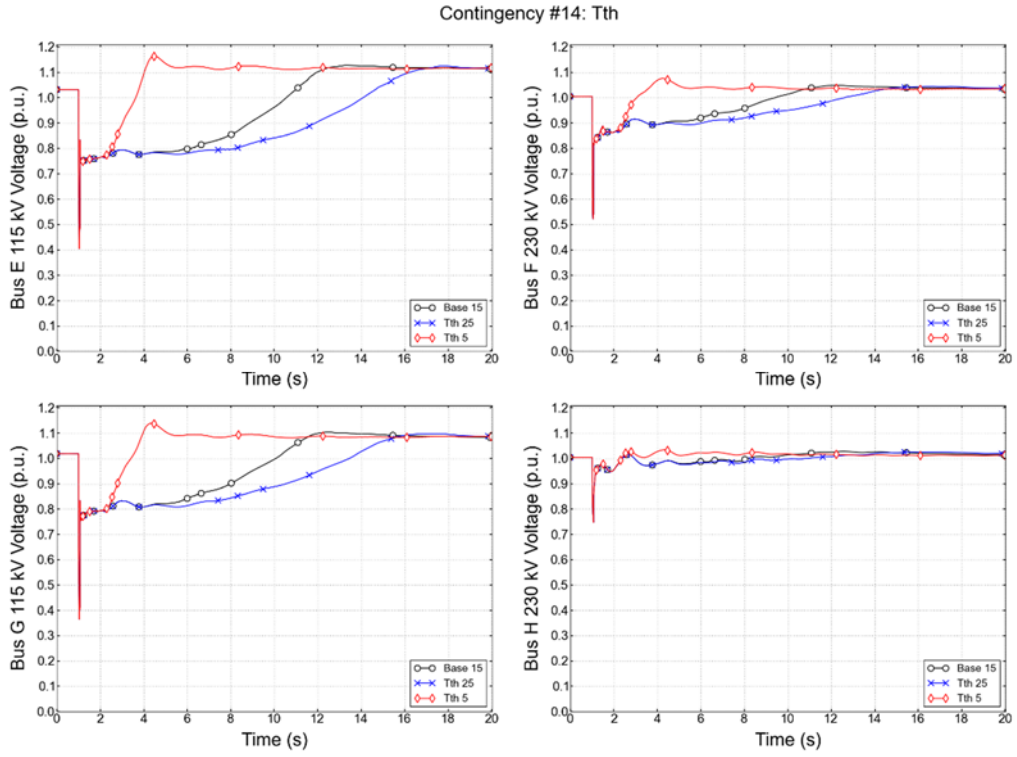

Figure 4.2-10: Bus voltages for sensitivity parameter Tth.

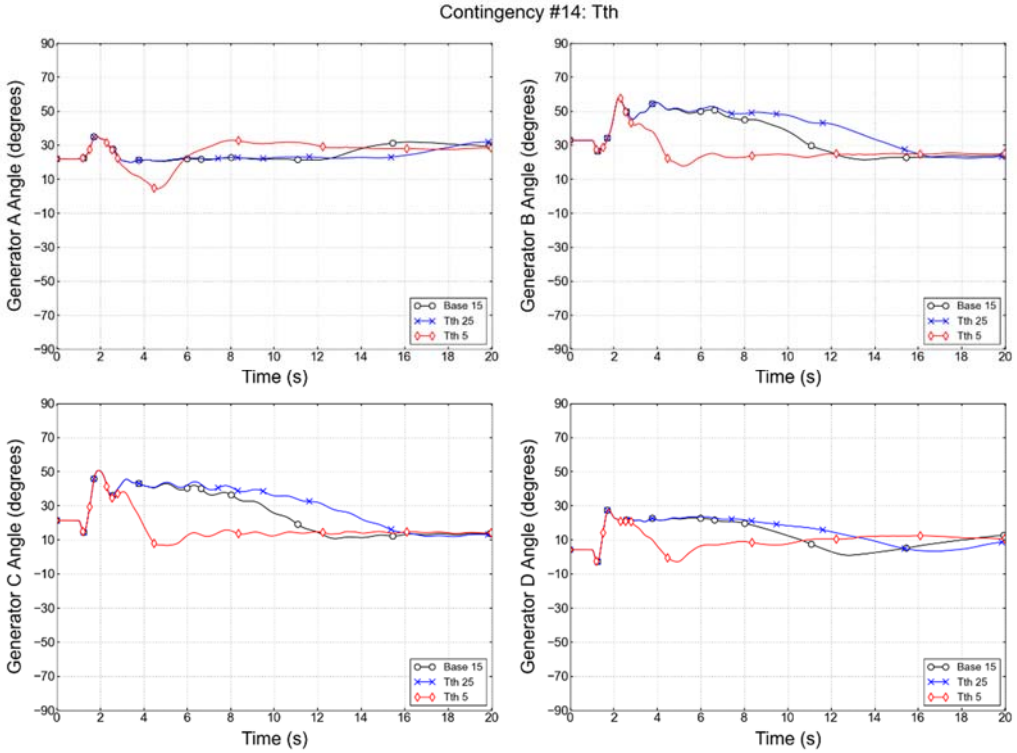

Figure 4.2-11: Generator angles for sensitivity parameter Tth.

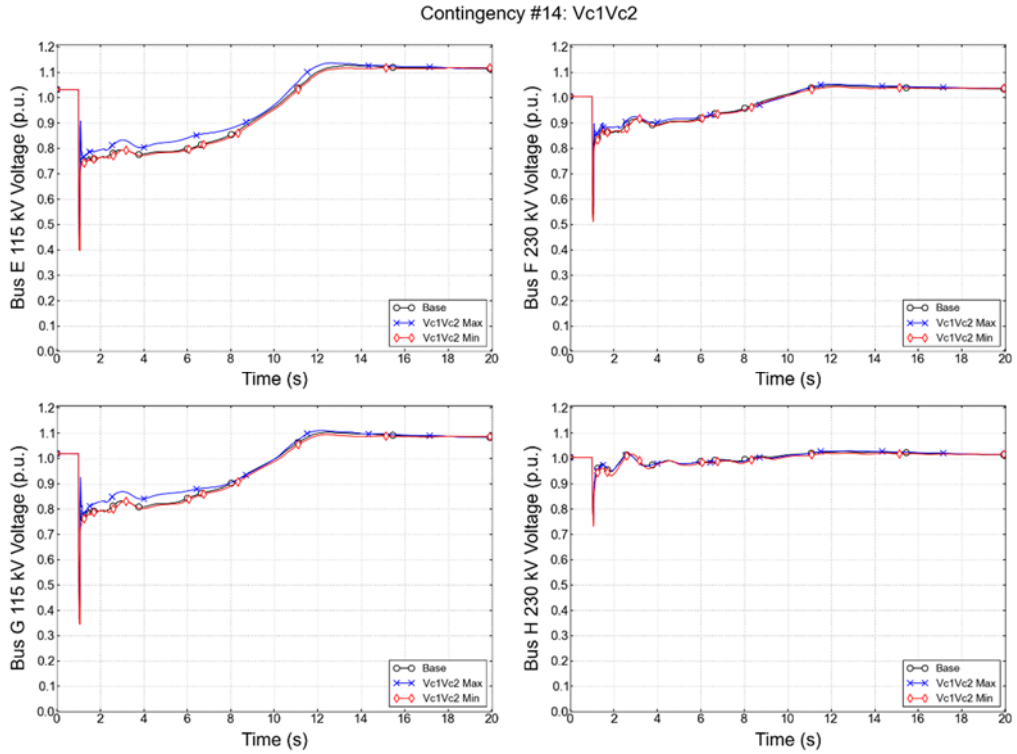

Figure 4.2-12: Bus voltages for sensitivity parameter Vc1Vc2.

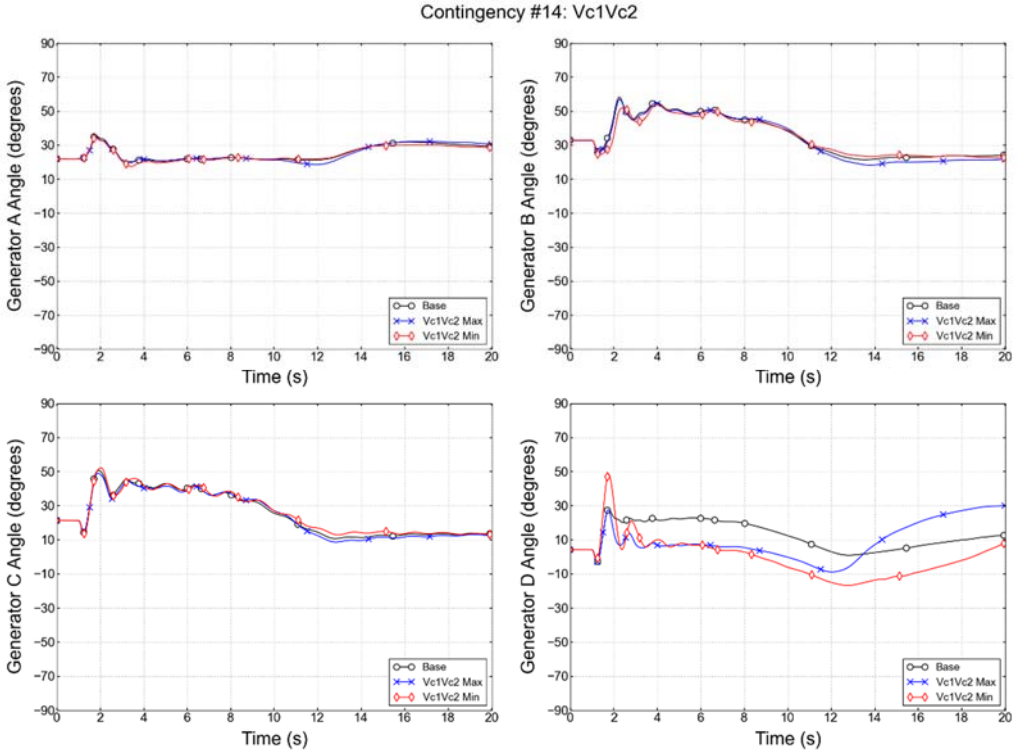

Figure 4.2-13: Generator angles for sensitivity parameter Vc1Vc2.

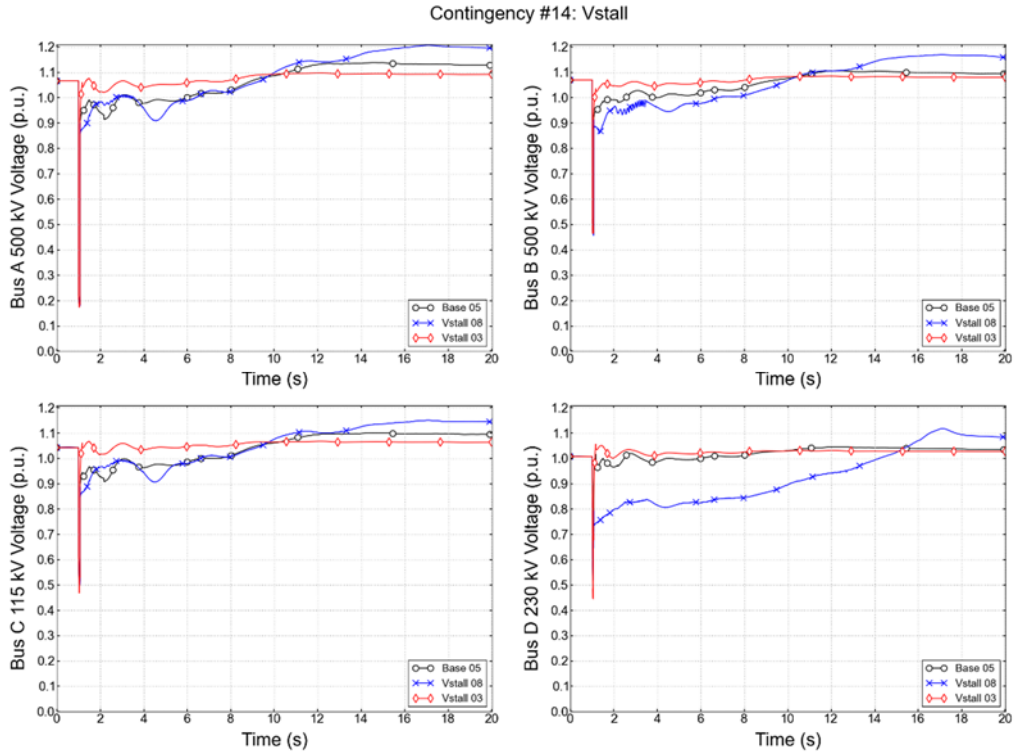

Figure 4.2-14: Bus voltages for sensitivity parameter Vstall.

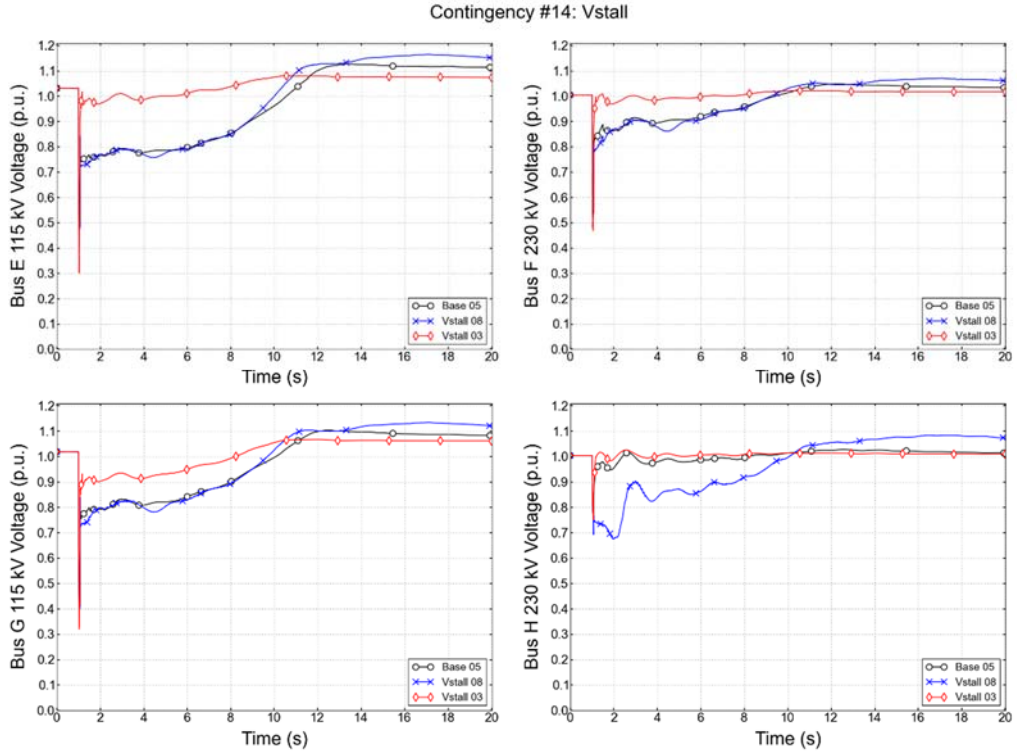

Figure 4.2-15: Bus voltages for sensitivity parameter Vstall.

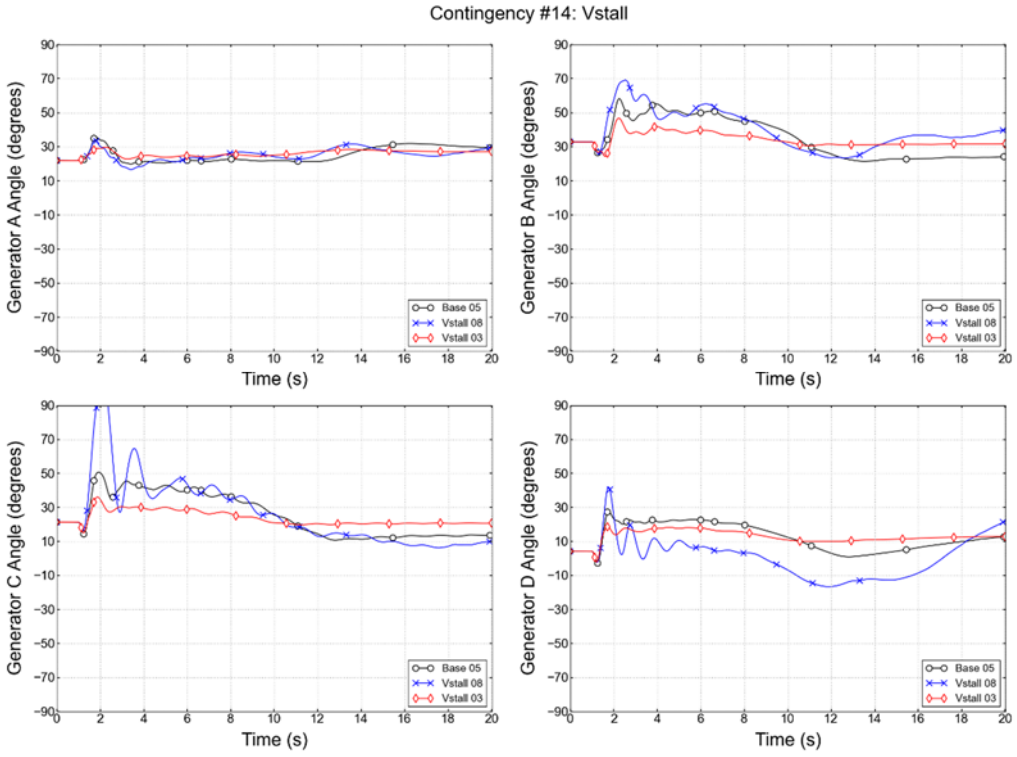

Figure 4.2-16: Generator angles for sensitivity parameter Vstall.

From the observations in Table 4.2-1 and the voltages and generator angles in Figures 4.2-1 to 4.2-16, it can be observed that the following Motor D parameters have a significant impact on the outcome of results:

- **Vstall**: Stall voltage, p.u.
- **Tstall**: Stall time delay, sec.
- **FmD**: Motor D fraction of load P
- **Fuvr**: Fraction of load with under voltage relay protection
- **Tth**: Motor D thermal time constant, sec.
- **Th1t**: Motor D thermal protection trip start level, p.u. temperature
- **Th2t**: Motor D thermal protection trip completion level, p.u. temperature
- **Vc1off**: Contactor voltage at which tripping starts, p.u.
- **Vc2off**: Contactor voltage at which tripping is complete, p.u.
- **Vc1on**: Contactor voltage at which reconnection starts, p.u.
- **Vc2on**: Contactor voltage at which reconnection is complete, p.u.

For the Stressed Case, there were 5 contingencies examined for 198 sensitivity parameters:

- Motor A: 12 parameters (see Table 2.2-2) x 4 values = 48 sensitivity parameters
- Motor B: 12 parameters (see Table 2.2-3) x 4 values = 48 sensitivity parameters
- Motor C: 12 parameters (see Table 2.2-4) x 4 values = 48 sensitivity parameters
- Motor D: 9 parameters (see Table 2.2-1) x 6 values = 54 sensitivity parameters

For each contingency processed, 3,297 bus voltages and 1,134 generators were monitored. The results for a given sensitivity parameter (ex. fraction of Motor D increased by 20%) are an aggregate of all contingencies processed for that given sensitivity parameter. Tables 4.2-2 through 4.2-5 list the observations and results for PG&E's Stressed Case for Motor A, Motor B, Motor C, and Motor D, respectively. The tables list the number of buses flagged by the criteria for the base case (Phase 2 composite load model) as well as a given sensitivity parameter. The "Delta (% Change)" column lists the percentage difference between the number of observations in the base case and the respective sensitivity parameter.

In Table 4.2-2, Motor A, the observation of a bus voltage recovering to 90% of the pre-fault voltage within 5 seconds, the base case flagged 792 buses that did not meet this criterion. For the same voltage criteria, when increasing the fraction of motors that trip on the first low voltage trip setting by a factor of 0.1 (reference number 4 in Table 4.2-2), 387 buses were flagged to not meet this criterion which is a decrease of 51% from the base case. Note for this sensitivity, a threshold is met and increasing the parameter value of Ftr1 by more than 0.1 per load does not have an impact on the results. When decreasing the fraction of motors that trip on the first low voltage trip setting by a factor of 0.1 (reference number 3 in Table 4.2-2), 955 buses were flagged to not meet this criterion, which is an increase of 21% from the base case. Similar, when

decreasing the fraction of motors that trip on the first low voltage trip setting by a factor of 0.2, 1054 buses were flagged to not meet this criterion which is an increase of 33% from the base case. For this sensitivity, decreasing the fraction of motors that may trip after the first voltage setting has a negative impact on the system. Since more motors are remaining online during low voltages, more motors are stalling that will draw more reactive power, thus resulting in low voltages.

Table 4.2-2
PG&E Results and Observations for the Stressed Case: Motor A

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	496	-	87	-	72	-	365	-	532	-	792	-	215	-	369	-	171	-	70	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	807	63%	323	271%	71	-1%	386	6%	659	24%	1054	33%	57	-73%	236	-36%	46	-73%	29	-59%
3		-0.1	648	31%	183	110%	73	1%	372	2%	598	12%	955	21%	134	-38%	339	-8%	99	-42%	47	-33%
4		+0.1	306	-38%	65	-25%	118	64%	363	-1%	372	-30%	387	-51%	1055	391%	799	117%	778	355%	607	767%
5		+0.2	290	-42%	62	-29%	124	72%	363	-1%	370	-30%	385	-51%	1089	407%	807	119%	799	367%	633	804%
6	Ftr2 (0, 0.5, 0.7)	-0.2	726	46%	254	192%	81	13%	378	4%	585	10%	869	10%	261	21%	370	0%	186	9%	119	70%
7		-0.1	591	19%	157	80%	76	6%	372	2%	558	5%	843	6%	239	11%	369	0%	178	4%	97	39%
8		+0.1	447	-10%	79	-9%	69	-4%	364	0%	531	0%	784	-1%	202	-6%	351	-5%	167	-2%	54	-23%
9		+0.2	429	-14%	70	-20%	60	-17%	363	-1%	528	-1%	770	-3%	101	-53%	342	-7%	92	-46%	27	-61%
10	H (0.1, 0.15, 0.2)	-50%	569	15%	109	25%	73	1%	370	1%	557	5%	809	2%	217	1%	358	-3%	176	3%	73	4%
11		-25%	524	6%	90	3%	77	7%	368	1%	539	1%	794	0%	219	2%	360	-2%	175	2%	73	4%
12		+50%	480	-3%	82	-6%	68	-6%	365	0%	531	0%	776	-2%	220	2%	371	1%	170	-1%	63	-10%
13		+100%	458	-8%	78	-10%	66	-8%	362	-1%	523	-2%	765	-3%	218	1%	374	1%	167	-2%	55	-21%
14	Ls (1.8, 3.1)	-50%	394	-21%	72	-17%	73	1%	365	0%	481	-10%	700	-12%	255	19%	332	-10%	211	23%	105	50%
15		-25%	431	-13%	83	-5%	77	7%	365	0%	536	1%	780	-2%	236	10%	331	-10%	189	11%	106	51%
16		+50%	522	5%	94	8%	68	-6%	365	0%	552	4%	836	6%	207	-4%	377	2%	135	-21%	66	-6%
17		+100%	565	14%	104	20%	69	-4%	365	0%	554	4%	882	11%	199	-7%	396	7%	120	-30%	66	-6%
18	Tpo (0.095, 0.8)	-50%	394	-21%	63	-28%	64	-11%	365	0%	540	2%	810	2%	236	10%	368	0%	177	4%	92	31%
19		-25%	426	-14%	70	-20%	65	-10%	365	0%	533	0%	798	1%	227	6%	368	0%	171	0%	73	4%
20		+50%	588	19%	110	26%	74	3%	366	0%	542	2%	782	-1%	216	0%	362	-2%	167	-2%	63	-10%
21		+100%	587	18%	144	66%	74	3%	372	2%	541	2%	768	-3%	215	0%	347	-6%	163	-5%	53	-24%
22	Trc2 (0.1, 0.25)	-0.05	514	4%	100	15%	72	0%	365	0%	546	3%	793	0%	222	3%	362	-2%	171	0%	69	-1%
23		+0.05	490	-1%	86	-1%	74	3%	365	0%	530	0%	789	0%	222	3%	373	1%	171	0%	72	3%
24		+0.1	489	-1%	86	-1%	74	3%	365	0%	527	-1%	802	1%	222	3%	379	3%	172	1%	72	3%
25		+0.25	478	-4%	86	-1%	74	3%	365	0%	516	-3%	811	2%	222	3%	396	7%	173	1%	72	3%
26	Ttr1 (0.02, 0.05, 0.1)	-0.05	269	-46%	70	-20%	80	11%	365	0%	456	-14%	656	-17%	219	2%	385	4%	174	2%	43	-39%
27		+0.05	794	60%	344	295%	70	-3%	366	0%	609	14%	923	17%	118	-45%	296	-20%	156	-9%	71	1%
28		+0.25	799	61%	344	295%	68	-6%	368	1%	609	14%	946	19%	226	5%	237	-36%	94	-45%	74	6%
29		+0.5	808	63%	347	299%	67	-7%	372	2%	603	13%	958	21%	231	7%	232	-37%	80	-53%	84	20%

Table 4.2-2 (continued)
PG&E Results and Observations for the Stressed Case: Motor A

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	496	-	87	-	72	-	365	-	532	-	792	-	215	-	369	-	171	-	70	-
30	Ttr2 (0.02, 0.05, 0.1)	-0.05	425	-14%	68	-22%	82	14%	364	0%	526	-1%	690	-13%	272	27%	332	-10%	192	12%	62	-11%
31		+0.05	1171	136%	614	606%	90	25%	402	10%	643	21%	1030	30%	313	46%	376	2%	167	-2%	146	109%
32		+0.25	1175	137%	616	608%	85	18%	405	11%	646	21%	1051	33%	320	49%	380	3%	167	-2%	147	110%
33		+0.5	1186	139%	619	611%	84	17%	419	15%	647	22%	1064	34%	324	51%	388	5%	168	-2%	147	110%
34	Vrc1 (1)	-0.25	496	0%	87	0%	72	0%	365	0%	532	0%	792	0%	221	3%	363	-2%	171	0%	70	0%
35		-0.15	496	0%	87	0%	72	0%	365	0%	532	0%	792	0%	221	3%	363	-2%	171	0%	70	0%
36		-0.05	496	0%	87	0%	72	0%	365	0%	532	0%	792	0%	221	3%	363	-2%	171	0%	70	0%
37		+0.05	496	0%	87	0%	72	0%	365	0%	532	0%	792	0%	221	3%	363	-2%	171	0%	70	0%
38	Vrc2 (0.7, 1)	-0.2	575	16%	240	176%	77	7%	444	22%	615	16%	836	6%	211	-2%	344	-7%	166	-3%	68	-3%
39		-0.1	562	13%	230	164%	75	4%	419	15%	598	12%	826	4%	213	-1%	354	-4%	166	-3%	68	-3%
40		+0.1	486	-2%	86	-1%	74	3%	363	-1%	404	-24%	630	-20%	238	11%	379	3%	172	1%	79	13%
41		+0.2	486	-2%	86	-1%	77	7%	363	-1%	388	-27%	441	-44%	238	11%	404	9%	190	11%	83	19%
42	Vtr1 (0.7)	-0.15	620	25%	188	116%	66	-8%	380	4%	587	10%	846	7%	64	-70%	280	-24%	33	-81%	27	-61%
43		-0.05	581	17%	140	61%	68	-6%	367	1%	570	7%	802	1%	63	-71%	312	-15%	39	-77%	25	-64%
44		+0.05	413	-17%	66	-24%	77	7%	365	0%	524	-2%	771	-3%	223	4%	381	3%	174	2%	71	1%
45		+0.15	389	-22%	58	-33%	84	17%	365	0%	518	-3%	768	-3%	255	19%	421	14%	204	19%	103	47%
46	Vtr2 (0.5, 0.6)	-0.15	1114	125%	541	522%	91	26%	382	5%	669	26%	1065	34%	312	45%	315	-15%	184	8%	149	113%
47		-0.05	905	82%	299	244%	81	13%	368	1%	599	13%	987	25%	293	36%	338	-8%	183	7%	130	86%
48		+0.05	482	-3%	74	-15%	72	0%	365	0%	531	0%	790	0%	215	0%	386	5%	171	0%	67	-4%
49		+0.15	354	-29%	61	-30%	69	-4%	364	0%	513	-4%	764	-4%	213	-1%	404	9%	171	0%	55	-21%

Table 4.2-3
PG&E Results and Observations for the Stressed Case: Motor B

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	496	-	87	-	72	-	365	-	532	-	792	-	215	-	369	-	171	-	70	-
2	Ftr1 (0.2, 0.3, 0.4)	-0.2	611	23%	169	94%	76	6%	368	1%	593	11%	909	15%	214	0%	394	7%	168	-2%	87	24%
3		-0.1	573	16%	115	32%	73	1%	366	0%	560	5%	830	5%	215	0%	386	5%	166	-3%	77	10%
4		+0.1	437	-12%	79	-9%	69	-4%	364	0%	498	-6%	771	-3%	235	9%	368	0%	175	2%	65	-7%
5		+0.2	386	-22%	72	-17%	68	-6%	364	0%	474	-11%	742	-6%	238	11%	363	-2%	208	22%	57	-19%
6	Ftr2 (0.3, 0.5)	-0.2	607	22%	177	103%	78	8%	368	1%	550	3%	852	8%	243	13%	395	7%	169	-1%	103	47%
7		-0.1	567	14%	105	21%	74	3%	366	0%	543	2%	818	3%	221	3%	386	5%	170	-1%	90	29%
8		+0.1	457	-8%	79	-9%	69	-4%	365	0%	524	-2%	779	-2%	212	-1%	365	-1%	171	0%	65	-7%
9		+0.2	425	-14%	75	-14%	68	-6%	364	0%	487	-8%	743	-6%	209	-3%	360	-2%	197	15%	64	-9%
10	H (0.5, 1)	-50%	607	22%	118	36%	76	6%	365	0%	536	1%	795	0%	212	-1%	402	9%	174	2%	70	0%
11		-25%	556	12%	90	3%	75	4%	365	0%	533	0%	793	0%	212	-1%	393	7%	173	1%	70	0%
12		+50%	468	-6%	78	-10%	68	-6%	365	0%	530	0%	817	3%	212	-1%	360	-2%	165	-4%	69	-1%
13		+100%	414	-17%	70	-20%	71	-1%	365	0%	523	-2%	822	4%	216	0%	350	-5%	162	-5%	68	-3%
14	Ls (1.8, 3.1)	-50%	545	10%	218	151%	65	-10%	366	0%	493	-7%	692	-13%	213	-1%	417	13%	129	-25%	31	-56%
15		-25%	520	5%	167	92%	67	-7%	366	0%	518	-3%	747	-6%	213	-1%	398	8%	164	-4%	58	-17%
16		+50%	429	-14%	72	-17%	73	1%	365	0%	532	0%	799	1%	215	0%	355	-4%	173	1%	71	1%
17		+100%	373	-25%	66	-24%	79	10%	364	0%	531	0%	836	6%	215	0%	347	-6%	175	2%	71	1%
18	Tpo (0.2, 0.8)	-50%	288	-42%	66	-24%	75	4%	374	2%	512	-4%	798	1%	214	0%	340	-8%	173	1%	70	0%
19		-25%	421	-15%	68	-22%	71	-1%	365	0%	521	-2%	797	1%	215	0%	343	-7%	171	0%	70	0%
20		+50%	610	23%	222	155%	74	3%	364	0%	534	0%	769	-3%	208	-3%	397	8%	167	-2%	61	-13%
21		+100%	664	34%	263	202%	72	0%	364	0%	541	2%	740	-7%	208	-3%	407	10%	165	-4%	49	-30%
22	Trc2 (0.05, 0.25)	-0.05	369	-26%	71	-18%	73	1%	366	0%	525	-1%	790	0%	211	-2%	359	-3%	170	-1%	67	-4%
23		+0.05	498	0%	88	1%	74	3%	365	0%	531	0%	789	0%	212	-1%	388	5%	171	0%	72	3%
24		+0.1	499	1%	89	2%	74	3%	365	0%	532	0%	789	0%	214	0%	394	7%	171	0%	72	3%
25		+0.25	513	3%	90	3%	74	3%	365	0%	530	0%	792	0%	211	-2%	399	8%	171	0%	71	1%
26	Ttr1 (0.02, 0.05, 1)	-0.05	299	-40%	87	0%	74	3%	367	1%	474	-11%	684	-14%	206	-4%	367	-1%	136	-20%	44	-37%
27		+0.05	605	22%	164	89%	74	3%	365	0%	570	7%	907	15%	214	0%	391	6%	171	0%	91	30%
28		+0.25	605	22%	164	89%	74	3%	365	0%	572	8%	910	15%	214	0%	394	7%	171	0%	91	30%
29		+0.5	604	22%	167	92%	74	3%	366	0%	577	8%	911	15%	213	-1%	399	8%	171	0%	92	31%

Table 4.2-3 (continued)
PG&E Results and Observations for the Stressed Case: Motor B

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	496	-	87	-	72	-	365	-	532	-	792	-	215	-	369	-	171	-	70	-
30	Ttr2 (0.02, 0.05, 1)	-0.05	451	-9%	68	-22%	69	-4%	365	0%	515	-3%	744	-6%	213	-1%	368	0%	167	-2%	54	-23%
31		+0.05	684	38%	243	179%	77	7%	365	0%	570	7%	886	12%	256	19%	392	6%	180	5%	117	67%
32		+0.25	685	38%	251	189%	77	7%	365	0%	574	8%	887	12%	256	19%	397	8%	180	5%	117	67%
33		+0.5	687	39%	252	190%	77	7%	366	0%	574	8%	886	12%	256	19%	390	6%	180	5%	117	67%
34	Vrc1 (0.75, 1)	-0.25	518	4%	116	33%	74	3%	366	0%	544	2%	806	2%	207	-4%	377	2%	186	9%	71	1%
35		-0.15	514	4%	109	25%	74	3%	366	0%	546	3%	805	2%	210	-2%	376	2%	185	8%	71	1%
36		-0.05	507	2%	87	0%	73	1%	365	0%	550	3%	809	2%	210	-2%	374	1%	185	8%	70	0%
37		+0.05	493	-1%	87	0%	72	0%	365	0%	532	0%	779	-2%	216	0%	368	0%	170	-1%	59	-16%
38	Vrc2 (0.65, 0.75)	-0.2	508	2%	104	20%	73	1%	374	2%	541	2%	794	0%	212	-1%	364	-1%	170	-1%	68	-3%
39		-0.1	506	2%	103	18%	73	1%	372	2%	540	2%	795	0%	211	-2%	366	-1%	171	0%	69	-1%
40		+0.1	490	-1%	87	0%	73	1%	365	0%	487	-8%	756	-5%	211	-2%	386	5%	172	1%	77	10%
41		+0.2	487	-2%	87	0%	73	1%	365	0%	468	-12%	646	-18%	218	1%	393	7%	173	1%	92	31%
42	Vtr1 (0.6, 0.7)	-0.15	558	13%	105	21%	74	3%	368	1%	577	8%	863	9%	209	-3%	395	7%	154	-10%	57	-19%
43		-0.05	504	2%	90	3%	72	0%	365	0%	556	5%	797	1%	209	-3%	381	3%	160	-6%	65	-7%
44		+0.05	480	-3%	74	-15%	70	-3%	365	0%	531	0%	780	-2%	216	0%	359	-3%	172	1%	77	10%
45		+0.15	412	-17%	65	-25%	74	3%	365	0%	487	-8%	560	-29%	246	14%	348	-6%	173	1%	95	36%
46	Vtr2 (0.5, 0.6)	-0.15	667	34%	227	161%	76	6%	367	1%	571	7%	888	12%	256	19%	402	9%	188	10%	117	67%
47		-0.05	608	23%	113	30%	76	6%	365	0%	567	7%	882	11%	245	14%	397	8%	184	8%	114	63%
48		+0.05	485	-2%	83	-5%	73	1%	365	0%	528	-1%	790	0%	210	-2%	366	-1%	168	-2%	69	-1%
49		+0.15	420	-15%	68	-22%	79	10%	365	0%	476	-11%	571	-28%	205	-5%	345	-7%	168	-2%	51	-27%

Table 4.2-4
PG&E Results and Observations for the Stressed Case: Motor C

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	496	-	87	-	72	-	365	-	532	-	792	-	221	-	363	-	171	-	70	-
2	Ftr1 (0.2, 0.3, 0.4)	-0.2	603	22%	158	82%	73	1%	368	1%	583	10%	858	8%	139	-37%	365	1%	110	-36%	41	-41%
3		-0.1	564	14%	97	11%	74	3%	366	0%	556	5%	815	3%	177	-20%	363	0%	136	-20%	52	-26%
4		+0.1	446	-10%	74	-15%	75	4%	365	0%	508	-5%	764	-4%	248	12%	362	0%	203	19%	105	50%
5		+0.2	394	-21%	72	-17%	79	10%	365	0%	478	-10%	723	-9%	286	29%	360	-1%	235	37%	149	113%
6	Ftr2 (0.3, 0.5)	-0.2	574	16%	148	70%	79	10%	366	0%	546	3%	819	3%	233	5%	376	4%	171	0%	92	31%
7		-0.1	558	13%	100	15%	73	1%	366	0%	536	1%	795	0%	223	1%	374	3%	171	0%	71	1%
8		+0.1	468	-6%	85	-2%	72	0%	365	0%	525	-1%	782	-1%	217	-2%	361	-1%	171	0%	64	-9%
9		+0.2	444	-10%	76	-13%	71	-1%	365	0%	495	-7%	761	-4%	215	-3%	359	-1%	199	16%	60	-14%
10	H (0.1, 0.2)	-50%	483	-3%	87	0%	71	-1%	365	0%	529	-1%	789	0%	216	-2%	373	3%	175	2%	69	-1%
11		-25%	487	-2%	87	0%	72	0%	365	0%	530	0%	792	0%	217	-2%	369	2%	172	1%	69	-1%
12		+50%	533	7%	87	0%	74	3%	365	0%	533	0%	793	0%	224	1%	361	-1%	169	-1%	72	3%
13		+100%	558	13%	94	8%	74	3%	366	0%	541	2%	817	3%	225	2%	359	-1%	166	-3%	82	17%
14	Ls (1.8, 3.1)	-50%	529	7%	98	13%	73	1%	368	1%	543	2%	803	1%	254	15%	352	-3%	193	13%	115	64%
15		-25%	511	3%	92	6%	69	-4%	367	1%	543	2%	794	0%	237	7%	356	-2%	183	7%	92	31%
16		+50%	470	-5%	80	-8%	71	-1%	365	0%	527	-1%	788	-1%	213	-4%	367	1%	166	-3%	63	-10%
17		+100%	445	-10%	72	-17%	71	-1%	365	0%	526	-1%	788	-1%	212	-4%	364	0%	155	-9%	60	-14%
18	Tpo (0.2, 0.8)	-50%	428	-14%	68	-22%	70	-3%	365	0%	528	-1%	786	-1%	216	-2%	364	0%	172	1%	70	0%
19		-25%	471	-5%	81	-7%	72	0%	365	0%	528	-1%	790	0%	218	-1%	364	0%	172	1%	70	0%
20		+50%	528	6%	90	3%	74	3%	365	0%	542	2%	797	1%	225	2%	363	0%	167	-2%	76	9%
21		+100%	568	15%	127	46%	69	-4%	368	1%	558	5%	824	4%	224	1%	354	-2%	166	-3%	75	7%
22	Trc2 (0.1, 0.25)	-0.05	513	3%	108	24%	72	0%	365	0%	531	0%	794	0%	222	0%	359	-1%	171	0%	70	0%
23		+0.05	493	-1%	86	-1%	74	3%	365	0%	527	-1%	782	-1%	221	0%	370	2%	171	0%	71	1%
24		+0.1	493	-1%	86	-1%	74	3%	365	0%	524	-2%	782	-1%	220	0%	370	2%	171	0%	71	1%
25		+0.25	492	-1%	86	-1%	74	3%	365	0%	517	-3%	783	-1%	218	-1%	374	3%	171	0%	71	1%
26	Ttr1 (0.02, 0.05, 1)	-0.05	328	-34%	79	-9%	76	6%	367	1%	470	-12%	675	-15%	217	-2%	410	13%	173	1%	70	0%
27		+0.05	606	22%	153	76%	72	0%	365	0%	558	5%	836	6%	179	-19%	351	-3%	126	-26%	31	-56%
28		+0.25	601	21%	154	77%	72	0%	365	0%	561	5%	838	6%	174	-21%	345	-5%	124	-27%	31	-56%
29		+0.5	599	21%	155	78%	72	0%	365	0%	562	6%	843	6%	139	-37%	340	-6%	116	-32%	33	-53%

Table 4.2-4 (continued)
PG&E Results and Observations for the Stressed Case: Motor C

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	496	-	87	-	72	-	365	-	532	-	792	-	221	-	363	-	171	-	70	-
30	Ttr2 (0.02, 0.05, 1)	-0.05	439	-11%	77	-11%	71	-1%	365	0%	510	-4%	738	-7%	219	-1%	402	11%	169	-1%	51	-27%
31		+0.05	627	26%	204	134%	77	7%	366	0%	560	5%	879	11%	252	14%	359	-1%	181	6%	115	64%
32		+0.25	627	26%	206	137%	77	7%	366	0%	563	6%	879	11%	252	14%	353	-3%	181	6%	115	64%
33		+0.5	630	27%	208	139%	78	8%	367	1%	567	7%	879	11%	251	14%	348	-4%	181	6%	115	64%
34	Vrc1 (1)	-0.25	496	0%	87	0%	72	0%	365	0%	532	0%	792	0%	221	0%	363	0%	171	0%	70	0%
35		-0.15	496	0%	87	0%	72	0%	365	0%	532	0%	792	0%	221	0%	363	0%	171	0%	70	0%
36		-0.05	496	0%	87	0%	72	0%	365	0%	532	0%	792	0%	221	0%	363	0%	171	0%	70	0%
37		+0.05	496	0%	87	0%	72	0%	365	0%	532	0%	792	0%	221	0%	363	0%	171	0%	70	0%
38	Vrc2 (0.65, 0.75)	-0.2	493	-1%	87	0%	72	0%	366	0%	540	2%	793	0%	217	-2%	363	0%	171	0%	70	0%
39		-0.1	493	-1%	87	0%	72	0%	366	0%	539	1%	793	0%	219	-1%	363	0%	171	0%	70	0%
40		+0.1	501	1%	87	0%	75	4%	365	0%	501	-6%	763	-4%	222	0%	363	0%	169	-1%	74	6%
41		+0.2	501	1%	87	0%	75	4%	365	0%	478	-10%	727	-8%	226	2%	363	0%	170	-1%	95	36%
42	Vtr1 (0.65, 0.7)	-0.15	532	7%	93	7%	73	1%	366	0%	546	3%	799	1%	184	-17%	347	-4%	149	-13%	50	-29%
43		-0.05	527	6%	91	5%	75	4%	366	0%	545	2%	798	1%	211	-5%	356	-2%	158	-8%	53	-24%
44		+0.05	466	-6%	74	-15%	73	1%	365	0%	532	0%	779	-2%	220	0%	363	0%	172	1%	70	0%
45		+0.15	400	-19%	66	-24%	78	8%	365	0%	525	-1%	768	-3%	230	4%	374	3%	182	6%	70	0%
46	Vtr2 (0.5, 0.6)	-0.15	603	22%	158	82%	77	7%	365	0%	553	4%	854	8%	251	14%	377	4%	183	7%	111	59%
47		-0.05	567	14%	102	17%	75	4%	365	0%	549	3%	828	5%	229	4%	377	4%	174	2%	76	9%
48		+0.05	486	-2%	83	-5%	72	0%	365	0%	528	-1%	787	-1%	219	-1%	348	-4%	168	-2%	68	-3%
49		+0.15	434	-13%	68	-22%	72	0%	365	0%	508	-5%	733	-7%	215	-3%	329	-9%	165	-4%	55	-21%

Table 4.2-5
PG&E Results and Observations for the Stressed Case: Motor D

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	496	-	87	-	72	-	365	-	532	-	792	-	221	-	363	-	171	-	70	-
2	FmD (varies)	-40%	199	-60%	68	-22%	63	-13%	363	-1%	374	-30%	413	-48%	46	-79%	340	-6%	25	-85%	17	-76%
3		-20%	347	-30%	78	-10%	71	-1%	363	-1%	451	-15%	584	-26%	117	-47%	340	-6%	71	-58%	22	-69%
4		-10%	403	-19%	79	-9%	71	-1%	363	-1%	481	-10%	763	-4%	175	-21%	350	-4%	106	-38%	27	-61%
5		+10%	592	19%	136	56%	81	13%	368	1%	570	7%	932	18%	283	28%	376	4%	219	28%	128	83%
6		+20%	727	47%	221	154%	87	21%	372	2%	600	13%	993	25%	355	61%	417	15%	242	42%	163	133%
7		+40%	1009	103%	420	383%	91	26%	378	4%	645	21%	1134	43%	453	105%	426	17%	289	69%	287	310%
8	Fuvr (0.1)	0	591	19%	150	72%	74	3%	372	2%	591	11%	966	22%	234	6%	343	-6%	176	3%	96	37%
9		0.05	548	10%	115	32%	73	1%	368	1%	553	4%	891	13%	229	4%	354	-2%	180	5%	82	17%
10		0.15	447	-10%	84	-3%	70	-3%	363	-1%	484	-9%	770	-3%	222	0%	385	6%	170	-1%	48	-31%
11		0.2	382	-23%	81	-7%	70	-3%	363	-1%	467	-12%	712	-10%	220	0%	402	11%	165	-4%	37	-47%
12		0.25	358	-28%	80	-8%	71	-1%	363	-1%	452	-15%	566	-29%	214	-3%	414	14%	158	-8%	33	-53%
13		0.5	239	-52%	72	-17%	76	6%	363	-1%	365	-31%	396	-50%	208	-6%	587	62%	158	-8%	29	-59%
14	Th1t (0.7)	0.4	490	-1%	87	0%	70	-3%	365	0%	448	-16%	530	-33%	226	2%	361	-1%	166	-3%	35	-50%
15		0.55	490	-1%	87	0%	69	-4%	365	0%	487	-8%	676	-15%	226	2%	362	0%	168	-2%	48	-31%
16		0.65	496	0%	87	0%	67	-7%	366	0%	511	-4%	784	-1%	226	2%	362	0%	171	0%	62	-11%
17		0.75	497	0%	87	0%	69	-4%	366	0%	544	2%	851	7%	225	2%	381	5%	173	1%	84	20%
18		0.85	497	0%	87	0%	69	-4%	366	0%	555	4%	902	14%	225	2%	381	5%	175	2%	86	23%
19		0.9	497	0%	87	0%	69	-4%	366	0%	562	6%	921	16%	210	-5%	381	5%	182	6%	88	26%
20	Th2t (1.9)	1	490	-1%	87	0%	78	8%	365	0%	511	-4%	396	-50%	244	10%	881	143%	134	-22%	56	-20%
21		1.1	490	-1%	87	0%	77	7%	365	0%	512	-4%	406	-49%	240	9%	808	123%	159	-7%	56	-20%
22		1.3	496	0%	87	0%	72	0%	366	0%	537	1%	801	1%	224	1%	363	0%	263	54%	72	3%
23		1.4	497	0%	87	0%	72	0%	366	0%	540	2%	814	3%	227	3%	363	0%	265	55%	76	9%
24		2	497	0%	87	0%	70	-3%	366	0%	547	3%	839	6%	229	4%	363	0%	266	56%	78	11%
25		3	497	0%	87	0%	71	-1%	366	0%	549	3%	892	13%	209	-5%	363	0%	275	61%	79	13%
26	Tstall (0.033)	0.01667	883	78%	169	94%	88	22%	365	0%	677	27%	1294	63%	494	124%	335	-8%	245	43%	199	184%
27		0.0667	285	-43%	81	-7%	64	-11%	363	-1%	396	-26%	472	-40%	45	-80%	534	47%	21	-88%	20	-71%
28		0.08335	266	-46%	80	-8%	64	-11%	363	-1%	393	-26%	459	-42%	46	-79%	534	47%	21	-88%	20	-71%
29		0.1	266	-46%	73	-16%	64	-11%	363	-1%	391	-27%	442	-44%	45	-80%	527	45%	21	-88%	20	-71%
30		0.1667	265	-47%	75	-14%	63	-13%	363	-1%	390	-27%	426	-46%	45	-80%	534	47%	21	-88%	20	-71%
31		0.25	265	-47%	75	-14%	63	-13%	363	-1%	390	-27%	425	-46%	45	-80%	534	47%	21	-88%	20	-71%

Table 4.2-5 (continued)
PG&E Results and Observations for the Stressed Case: Motor D

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	496	-	87	-	72	-	365	-	532	-	792	-	221	-	363	-	171	-	70	-
32	Tth (15)	5	487	-2%	87	0%	72	0%	364	0%	364	-32%	377	-52%	243	10%	969	167%	254	49%	44	-37%
33		10	490	-1%	87	0%	73	1%	364	0%	460	-14%	454	-43%	228	3%	596	64%	254	49%	46	-34%
34		12	490	-1%	87	0%	73	1%	364	0%	499	-6%	586	-26%	228	3%	402	11%	223	30%	49	-30%
35		17	497	0%	87	0%	72	0%	366	0%	542	2%	884	12%	223	1%	358	-1%	136	-20%	86	23%
36		20	497	0%	87	0%	74	3%	366	0%	547	3%	928	17%	209	-5%	350	-4%	53	-69%	88	26%
37		25	497	0%	87	0%	76	6%	366	0%	549	3%	949	20%	210	-5%	348	-4%	13	-92%	90	29%
38	Vc1Vc2	Min	923	86%	120	38%	87	21%	381	4%	578	9%	929	17%	304	38%	376	4%	195	14%	129	84%
39		R1	593	20%	107	23%	69	-4%	376	3%	571	7%	845	7%	230	4%	374	3%	195	14%	84	20%
40		R2	590	19%	94	8%	69	-4%	369	1%	559	5%	846	7%	230	4%	369	2%	195	14%	84	20%
41		R3	406	-18%	77	-11%	67	-7%	364	0%	471	-11%	746	-6%	177	-20%	339	-7%	118	-31%	44	-37%
42		R4	328	-34%	76	-13%	68	-6%	364	0%	451	-15%	618	-22%	123	-44%	338	-7%	102	-40%	24	-66%
43		Max	310	-38%	75	-14%	67	-7%	364	0%	435	-18%	621	-22%	117	-47%	324	-11%	98	-43%	22	-69%
44	Vrst (0.95)	0.5	485	-2%	85	-2%	69	-4%	379	4%	465	-13%	651	-18%	187	-15%	404	11%	120	-30%	27	-61%
45		0.7	496	0%	86	-1%	69	-4%	365	0%	467	-12%	669	-16%	189	-14%	392	8%	108	-37%	27	-61%
46		0.8	496	0%	86	-1%	69	-4%	365	0%	507	-5%	679	-14%	205	-7%	382	5%	132	-23%	38	-46%
47		0.85	496	0%	86	-1%	69	-4%	365	0%	511	-4%	694	-12%	214	-3%	365	1%	140	-18%	50	-29%
48		0.9	496	0%	86	-1%	70	-3%	365	0%	511	-4%	720	-9%	222	0%	365	1%	157	-8%	54	-23%
49		1	497	0%	87	0%	69	-4%	366	0%	546	3%	831	5%	234	6%	363	0%	184	8%	81	16%
50	Vstall (0.5)	0.3	234	-53%	72	-17%	69	-4%	363	-1%	371	-30%	432	-45%	45	-80%	822	126%	19	-89%	17	-76%
51		0.4	299	-40%	72	-17%	69	-4%	363	-1%	371	-30%	436	-45%	46	-79%	637	75%	19	-89%	17	-76%
52		0.45	337	-32%	74	-15%	75	4%	363	-1%	410	-23%	510	-36%	114	-48%	606	67%	38	-78%	20	-71%
53		0.55	560	13%	95	9%	74	3%	369	1%	576	8%	875	10%	235	6%	352	-3%	181	6%	84	20%
54		0.6	704	42%	129	48%	83	15%	370	1%	615	16%	1048	32%	296	34%	346	-5%	229	34%	159	127%
55		0.8	1807	264%	712	718%	122	69%	379	4%	1225	130%	2557	223%	1089	393%	332	-9%	769	350%	743	961%

The amount of total load loss at each load bus in PG&E for each contingency and sensitivity parameter analyzed for the Stressed Case was recorded. Tables 4.2-6 through 4.2-9 list the total load loss for each of the five contingencies and sensitivities examined for Motor A, Motor B, Motor C, and Motor D, respectively. The tables list the contingency, the amount of load loss, the percent change from the Phase 2 base case and the respective sensitivity parameter.

For Motor A Contingency #4 in Table 4.2-6, the Phase 2 base case loss total was 3,459 MW. For sensitivity parameter Ftr1, 5,797 MW of load was loss after increasing each motor trip fraction by a factor of 0.2, which is an increase of 68% from the Phase 2 base case. For the same contingency and parameter, 3,117 MW of load was loss after decreasing each motor trip fraction by a factor of 0.2, which is a decrease of 10% from the Phase 2 base case.

Table 4.2-6
PG&E Results and Observations for the Stressed Case: Motor A Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #5	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	1953	-	592	-	292	-	3459	-	1404	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	1998	2%	593	0%	292	0%	3117	-10%	795	-43%
3		-0.1	1977	1%	593	0%	292	0%	3429	-1%	1118	-20%
4		+0.1	1727	-12%	593	0%	292	0%	5769	67%	2238	59%
5		+0.2	1706	-13%	593	0%	292	0%	5797	68%	2437	74%
6	Ftr2 (0, 0.5, 0.7)	-0.2	1971	1%	593	0%	292	0%	3741	8%	1458	4%
7		-0.1	1963	1%	593	0%	292	0%	3732	8%	1441	3%
8		+0.1	1812	-7%	593	0%	292	0%	3344	-3%	1369	-3%
9		+0.2	1736	-11%	593	0%	292	0%	2969	-14%	1059	-25%
10	H (0.1, 0.15, 0.2)	-50%	2039	4%	590	0%	289	-1%	3402	-2%	1679	20%
11		-25%	1960	0%	591	0%	290	-1%	3457	0%	1503	7%
12		+50%	1874	-4%	596	1%	294	1%	3461	0%	1337	-5%
13		+100%	1810	-7%	598	1%	296	2%	3328	-4%	1210	-14%
14	Ls (1.8, 3.1)	-50%	1294	-34%	600	1%	293	0%	3019	-13%	1114	-21%
15		-25%	1823	-7%	594	0%	291	0%	3364	-3%	1336	-5%
16		+50%	1973	1%	591	0%	292	0%	3757	9%	1391	-1%
17		+100%	1917	-2%	591	0%	294	1%	3951	14%	1378	-2%
18	Tpo (0.095, 0.8)	-50%	1812	-7%	598	1%	297	2%	3706	7%	1303	-7%
19		-25%	1890	-3%	595	0%	294	1%	3471	0%	1358	-3%
20		+50%	1959	0%	589	-1%	287	-1%	3436	-1%	1424	1%
21		+100%	2013	3%	585	-1%	285	-2%	3328	-4%	1465	4%
22	Trc2 (0.1, 0.25)	-0.05	1955	0%	593	0%	292	0%	3459	0%	1404	0%
23		+0.05	1879	-4%	593	0%	292	0%	3468	0%	1419	1%
24		+0.1	1879	-4%	593	0%	292	0%	3470	0%	1419	1%
25		+0.25	1879	-4%	593	0%	292	0%	3469	0%	1418	1%
26	Ttr1 (0.02, 0.05, 1)	-0.05	1804	-8%	593	0%	292	0%	3356	-3%	2365	68%
27		+0.05	2134	9%	593	0%	292	0%	3566	3%	767	-45%
28		+0.25	2148	10%	593	0%	292	0%	3578	3%	767	-45%
29		+0.5	2341	20%	593	0%	292	0%	3607	4%	775	-45%
30	Ttr2 (0.02, 0.05, 1)	-0.05	1895	-3%	593	0%	292	0%	3412	-1%	1346	-4%
31		+0.05	1964	1%	593	0%	292	0%	4236	22%	1533	9%
32		+0.25	2165	11%	593	0%	292	0%	4236	22%	1533	9%
33		+0.5	2258	16%	593	0%	292	0%	4236	22%	1533	9%
34	Vrc1 (1)	-0.25	1953	0%	593	0%	292	0%	3459	0%	1404	0%
35		-0.15	1953	0%	593	0%	292	0%	3459	0%	1404	0%
36		-0.05	1953	0%	593	0%	292	0%	3459	0%	1404	0%
37		+0.05	1953	0%	593	0%	292	0%	3459	0%	1404	0%
38	Vrc2 (0.7, 1)	-0.2	1964	1%	593	0%	292	0%	3476	1%	1405	0%
39		-0.1	1957	0%	593	0%	292	0%	3477	1%	1404	0%
40		+0.1	1952	0%	593	0%	292	0%	3420	-1%	1404	0%
41		+0.2	1952	0%	593	0%	292	0%	3427	-1%	1403	0%
42	Vtr1 (0.7)	-0.15	2095	7%	593	0%	292	0%	3419	-1%	992	-29%
43		-0.05	1972	1%	593	0%	292	0%	3462	0%	1213	-14%
44		+0.05	1354	-31%	593	0%	292	0%	3591	4%	1695	21%
45		+0.15	1414	-28%	593	0%	292	0%	3929	14%	2134	52%
46	Vtr2 (0.5, 0.6)	-0.15	2239	15%	593	0%	292	0%	4239	23%	1512	8%
47		-0.05	2066	6%	593	0%	292	0%	4040	17%	1498	7%
48		+0.05	1935	-1%	593	0%	292	0%	3429	-1%	1395	-1%
49		+0.15	1285	-34%	593	0%	292	0%	3346	-3%	1317	-6%

Table 4.2-7
PG&E Results and Observations for the Stressed Case: Motor B Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #5	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	1953	-	592	-	292	-	3459	-	1404	-
2	Ftr1 (0.2, 0.3, 0.4)	-0.2	2027	4%	593	0%	292	0%	3723	8%	1447	3%
3		-0.1	1951	0%	593	0%	292	0%	3667	6%	1425	1%
4		+0.1	1907	-2%	593	0%	292	0%	3400	-2%	1397	-1%
5		+0.2	1764	-10%	593	0%	292	0%	3435	-1%	1386	-1%
6	Ftr2 (0.3, 0.5)	-0.2	1962	1%	593	0%	292	0%	3725	8%	1460	4%
7		-0.1	1959	0%	593	0%	292	0%	3692	7%	1427	2%
8		+0.1	1837	-6%	593	0%	292	0%	3397	-2%	1396	-1%
9		+0.2	1720	-12%	593	0%	292	0%	3422	-1%	1395	-1%
10	H (0.5, 1)	-50%	2065	6%	589	-1%	288	-1%	3432	-1%	1652	18%
11		-25%	1963	1%	591	0%	290	0%	3449	0%	1507	7%
12		+50%	1817	-7%	593	0%	293	0%	3591	4%	1308	-7%
13		+100%	1387	-29%	593	0%	293	0%	3634	5%	1251	-11%
14	Ls (1.8, 3.1)	-50%	1983	2%	599	1%	321	10%	3051	-12%	1095	-22%
15		-25%	1961	0%	670	13%	321	10%	3270	-5%	1230	-12%
16		+50%	1788	-8%	591	0%	291	0%	3558	3%	1474	5%
17		+100%	1324	-32%	591	0%	292	0%	3531	2%	1531	9%
18	Tpo (0.2, 0.8)	-50%	1297	-34%	596	1%	295	1%	3513	2%	1465	4%
19		-25%	1812	-7%	594	0%	293	0%	3456	0%	1434	2%
20		+50%	2006	3%	591	0%	291	0%	3358	-3%	1391	-1%
21		+100%	2033	4%	590	0%	289	-1%	3202	-7%	1340	-5%
22	Trc2 (0.05, 0.25)	-0.05	1953	0%	593	0%	292	0%	3460	0%	1381	-2%
23		+0.05	1879	-4%	593	0%	292	0%	3468	0%	1418	1%
24		+0.1	1879	-4%	593	0%	292	0%	3468	0%	1419	1%
25		+0.25	1879	-4%	593	0%	292	0%	3469	0%	1418	1%
26	Ttr1 (0.02, 0.05, 1)	-0.05	1839	-6%	667	13%	321	10%	3272	-5%	1813	29%
27		+0.05	2015	3%	593	0%	292	0%	3711	7%	1441	3%
28		+0.25	2008	3%	593	0%	292	0%	3711	7%	1441	3%
29		+0.5	2010	3%	593	0%	292	0%	3711	7%	1441	3%
30	Ttr2 (0.02, 0.05, 1)	-0.05	1878	-4%	667	13%	321	10%	3416	-1%	1175	-16%
31		+0.05	1967	1%	593	0%	292	0%	3746	8%	1491	6%
32		+0.25	1965	1%	593	0%	292	0%	3746	8%	1491	6%
33		+0.5	1965	1%	593	0%	292	0%	3746	8%	1491	6%
34	Vrc1 (0.75, 1)	-0.25	1958	0%	593	0%	292	0%	3464	0%	1405	0%
35		-0.15	1956	0%	593	0%	292	0%	3463	0%	1405	0%
36		-0.05	1955	0%	593	0%	292	0%	3462	0%	1405	0%
37		+0.05	1953	0%	593	0%	292	0%	3459	0%	1404	0%
38	Vrc2 (0.65, 0.75)	-0.2	1962	0%	593	0%	292	0%	3459	0%	1404	0%
39		-0.1	1956	0%	593	0%	292	0%	3459	0%	1404	0%
40		+0.1	1952	0%	593	0%	292	0%	3458	0%	1404	0%
41		+0.2	1952	0%	593	0%	292	0%	3443	0%	1404	0%
42	Vtr1 (0.6, 0.7)	-0.15	2015	3%	593	0%	292	0%	3310	-4%	1384	-1%
43		-0.05	1991	2%	593	0%	292	0%	3380	-2%	1403	0%
44		+0.05	1798	-8%	593	0%	292	0%	3515	2%	1403	0%
45		+0.15	1170	-40%	593	0%	292	0%	3624	5%	1451	3%
46	Vtr2 (0.5, 0.6)	-0.15	1966	1%	593	0%	292	0%	3748	8%	1487	6%
47		-0.05	1967	1%	593	0%	292	0%	3743	8%	1451	3%
48		+0.05	1959	0%	593	0%	292	0%	3446	0%	1396	-1%
49		+0.15	1277	-35%	593	0%	292	0%	3413	-1%	1355	-4%

Table 4.2-8
PG&E Results and Observations for the Stressed Case: Motor C Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #5	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	1953	-	592	-	292	-	3459	-	1404	-
2	Ftr1 (0.2, 0.3, 0.4)	-0.2	1875	-4%	593	0%	292	0%	3404	-2%	1287	-8%
3		-0.1	1906	-2%	593	0%	292	0%	3412	-1%	1350	-4%
4		+0.1	1961	0%	593	0%	292	0%	3542	2%	1464	4%
5		+0.2	1965	1%	593	0%	292	0%	3690	7%	1520	8%
6	Ftr2 (0.3, 0.5)	-0.2	1956	0%	593	0%	292	0%	3697	7%	1461	4%
7		-0.1	1954	0%	593	0%	292	0%	3535	2%	1415	1%
8		+0.1	1950	0%	593	0%	292	0%	3401	-2%	1398	0%
9		+0.2	1950	0%	593	0%	292	0%	3386	-2%	1395	-1%
10	H (0.1, 0.2)	-50%	1956	0%	592	0%	291	0%	3469	0%	1444	3%
11		-25%	1954	0%	592	0%	291	0%	3470	0%	1420	1%
12		+50%	1892	-3%	593	0%	293	0%	3601	4%	1371	-2%
13		+100%	1891	-3%	594	0%	293	0%	3659	6%	1352	-4%
14	Ls (1.8, 3.1)	-50%	1974	1%	595	1%	292	0%	2981	-14%	1054	-25%
15		-25%	1958	0%	592	0%	292	0%	3061	-12%	1271	-9%
16		+50%	1893	-3%	592	0%	292	0%	3479	1%	1433	2%
17		+100%	1838	-6%	593	0%	293	0%	3501	1%	1432	2%
18	Tpo (0.2, 0.8)	-50%	1818	-7%	595	0%	293	1%	3466	0%	1428	2%
19		-25%	1945	0%	593	0%	292	0%	3466	0%	1423	1%
20		+50%	1960	0%	591	0%	290	0%	3621	5%	1332	-5%
21		+100%	1983	2%	591	0%	290	0%	3645	5%	1289	-8%
22	Trc2 (0.1, 0.25)	-0.05	1953	0%	593	0%	292	0%	3460	0%	1404	0%
23		+0.05	1879	-4%	593	0%	292	0%	3468	0%	1418	1%
24		+0.1	1879	-4%	593	0%	292	0%	3468	0%	1418	1%
25		+0.25	1879	-4%	593	0%	292	0%	3468	0%	1418	1%
26	Ttr1 (0.02, 0.05, 1)	-0.05	1963	1%	667	13%	321	10%	3283	-5%	2089	49%
27		+0.05	1900	-3%	593	0%	292	0%	3444	0%	1283	-9%
28		+0.25	1915	-2%	593	0%	292	0%	3444	0%	1283	-9%
29		+0.5	1924	-1%	593	0%	292	0%	3444	0%	1283	-9%
30	Ttr2 (0.02, 0.05, 1)	-0.05	1879	-4%	667	13%	321	10%	3314	-4%	1175	-16%
31		+0.05	1962	0%	593	0%	292	0%	3736	8%	1486	6%
32		+0.25	1962	0%	593	0%	292	0%	3736	8%	1486	6%
33		+0.5	1959	0%	593	0%	292	0%	3736	8%	1486	6%
34	Vrc1 (1)	-0.25	1953	0%	593	0%	292	0%	3459	0%	1404	0%
35		-0.15	1953	0%	593	0%	292	0%	3459	0%	1404	0%
36		-0.05	1953	0%	593	0%	292	0%	3459	0%	1404	0%
37		+0.05	1953	0%	593	0%	292	0%	3459	0%	1404	0%
38	Vrc2 (0.65, 0.75)	-0.2	1956	0%	593	0%	292	0%	3459	0%	1404	0%
39		-0.1	1953	0%	593	0%	292	0%	3459	0%	1404	0%
40		+0.1	1953	0%	593	0%	292	0%	3457	0%	1403	0%
41		+0.2	1953	0%	593	0%	292	0%	3446	0%	1405	0%
42	Vtr1 (0.65, 0.7)	-0.15	1986	2%	593	0%	292	0%	3338	-4%	1335	-5%
43		-0.05	1967	1%	593	0%	292	0%	3409	-1%	1371	-2%
44		+0.05	1837	-6%	593	0%	292	0%	3479	1%	1472	5%
45		+0.15	1417	-27%	593	0%	292	0%	3591	4%	1602	14%
46	Vtr2 (0.5, 0.6)	-0.15	1962	0%	593	0%	292	0%	3728	8%	1482	6%
47		-0.05	1960	0%	593	0%	292	0%	3654	6%	1451	3%
48		+0.05	1953	0%	593	0%	292	0%	3442	0%	1396	-1%
49		+0.15	1696	-13%	593	0%	292	0%	3442	0%	1365	-3%

Table 4.2-9
PG&E Results and Observations for the Stressed Case: Motor D Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #5	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	1953	-	592	-	292	-	3459	-	1404	-
2	FmD (varies)	-40%	890	-54%	549	-7%	283	-3%	2194	-37%	886	-37%
3		-20%	1174	-40%	571	-4%	288	-1%	2675	-23%	1052	-25%
4		-10%	1302	-33%	582	-2%	290	-1%	3003	-13%	1181	-16%
5		+10%	2146	10%	601	1%	294	1%	3514	2%	1513	8%
6		+20%	2565	31%	611	3%	295	1%	3763	9%	2293	63%
7		+40%	3108	59%	628	6%	298	2%	4353	26%	2303	64%
8	Fuvr (0.1)	0	2031	4%	592	0%	292	0%	3259	-6%	1140	-19%
9		0.05	1984	2%	592	0%	292	0%	3190	-8%	1187	-15%
10		0.15	1779	-9%	592	0%	292	0%	3286	-5%	1270	-10%
11		0.2	1794	-8%	592	0%	292	0%	3341	-3%	1312	-7%
12		0.25	1786	-9%	592	0%	292	0%	3373	-2%	1362	-3%
13		0.5	1544	-21%	592	0%	292	0%	3664	6%	1596	14%
14	Th1t (0.7)	0.4	1947	0%	592	0%	292	0%	3447	0%	1384	-1%
15		0.55	1951	0%	592	0%	292	0%	3451	0%	1395	-1%
16		0.65	1952	0%	592	0%	292	0%	3456	0%	1399	0%
17		0.75	1952	0%	592	0%	292	0%	3465	0%	1409	0%
18		0.85	1959	0%	592	0%	292	0%	3471	0%	1413	1%
19		0.9	1961	0%	592	0%	292	0%	3476	0%	1420	1%
20	Th2t (1.2)	1	1974	1%	592	0%	292	0%	3494	1%	1423	1%
21		1.1	1964	1%	592	0%	292	0%	3476	0%	1414	1%
22		1.3	1894	-3%	592	0%	292	0%	3255	-6%	1222	-13%
23		1.4	1891	-3%	592	0%	292	0%	3248	-6%	1221	-13%
24		2	1883	-4%	592	0%	292	0%	3242	-6%	1219	-13%
25		3	1461	-25%	592	0%	292	0%	3248	-6%	1210	-14%
26	Tstall (0.033)	0.01667	2136	9%	592	0%	292	0%	4421	28%	2142	53%
27		0.0667	1505	-23%	592	0%	292	0%	1568	-55%	973	-31%
28		0.08335	1449	-26%	592	0%	292	0%	1563	-55%	973	-31%
29		0.1	1429	-27%	592	0%	292	0%	1563	-55%	973	-31%
30		0.1667	1405	-28%	592	0%	292	0%	1563	-55%	973	-31%
31		0.25	1404	-28%	592	0%	292	0%	1563	-55%	973	-31%
32	Tth (15)	5	1965	1%	592	0%	292	0%	3447	0%	192	-86%
33		10	1953	0%	592	0%	292	0%	3454	0%	1411	0%
34		12	1953	0%	592	0%	292	0%	3454	0%	1405	0%
35		17	1951	0%	592	0%	292	0%	3468	0%	1403	0%
36		20	1947	0%	592	0%	292	0%	3483	1%	192	-86%
37		25	1910	-2%	592	0%	292	0%	3478	1%	1402	0%
38	Vc1Vc2	Min	2055	5%	592	0%	292	0%	3870	12%	1561	11%
39		R1	1951	0%	592	0%	292	0%	3687	7%	1494	6%
40		R2	1951	0%	592	0%	292	0%	3563	3%	1456	4%
41		R3	1441	-26%	592	0%	292	0%	2992	-14%	1236	-12%
42		R4	1348	-31%	592	0%	292	0%	2821	-18%	1219	-13%
43		Max	1157	-41%	592	0%	292	0%	2713	-22%	1202	-14%
44	Vrst (0.95)	0.5	1761	-10%	592	0%	292	0%	3013	-13%	1185	-16%
45		0.7	1798	-8%	592	0%	292	0%	3021	-13%	1186	-16%
46		0.8	1840	-6%	592	0%	292	0%	3109	-10%	1181	-16%
47		0.85	1855	-5%	592	0%	292	0%	3158	-9%	1187	-15%
48		0.9	1870	-4%	592	0%	292	0%	3201	-7%	1201	-14%
49		1	1989	2%	592	0%	292	0%	3641	5%	1496	7%
50	Vstall (0.5)	0.3	1287	-34%	592	0%	292	0%	2043	-41%	1109	-21%
51		0.4	1288	-34%	592	0%	292	0%	2005	-42%	1072	-24%
52		0.45	1266	-35%	592	0%	292	0%	2408	-30%	1079	-23%
53		0.55	1963	1%	592	0%	292	0%	3769	9%	1569	12%
54		0.6	2046	5%	592	0%	292	0%	3943	14%	1616	15%
55		0.8	2163	11%	592	0%	292	0%	5772	67%	6133	337%

Refer to Figures 4.2-17 through 4.2-29 for representative plots of select sensitivity parameters of Motor A, Motor B, and Motor D for a three-phase fault resulting in the loss of a 500 kV line and loss of a generator. The plots include up to eight bus voltages and four generator angles comparing the base case (Phase 2) to the multiple sensitivity parameters.

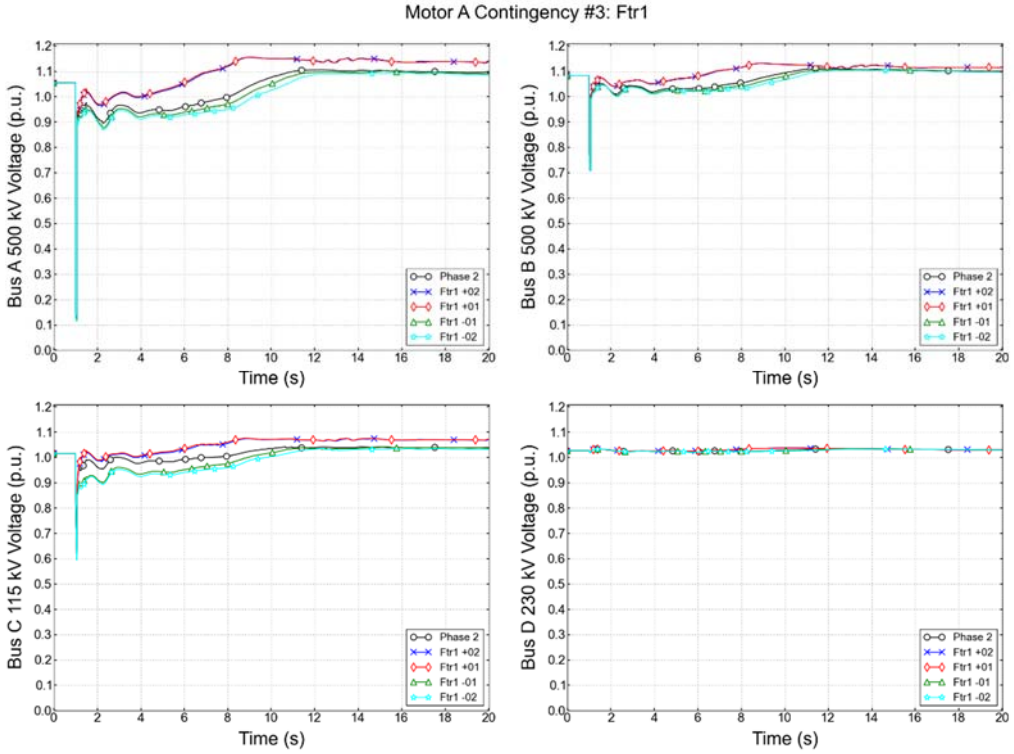

Figure 4.2-17: Bus voltages for Motor A sensitivity parameter Ftr1.

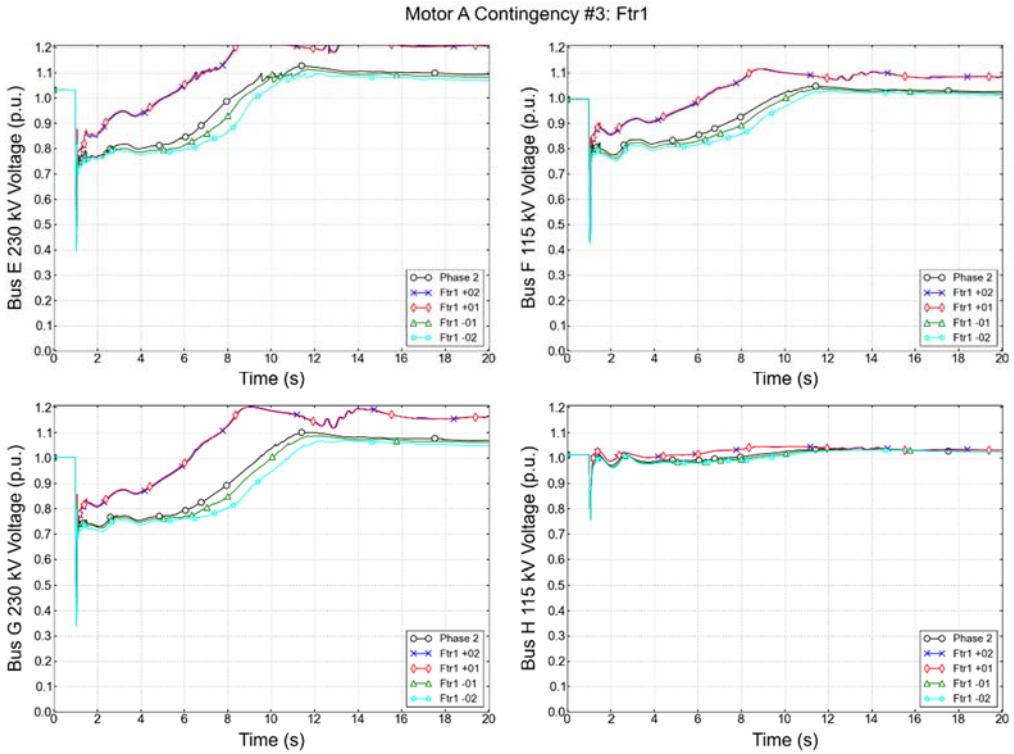

Figure 4.2-18: Bus voltages for Motor A sensitivity parameter Ftr1.

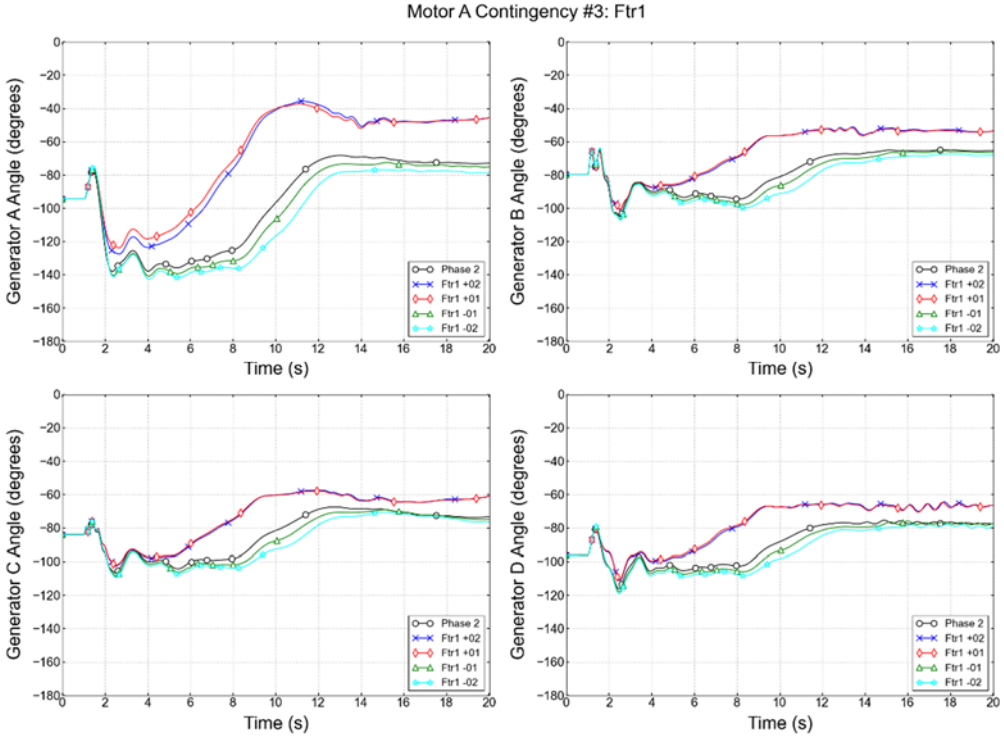

Figure 4.2-19: Generator angles for Motor A sensitivity parameter Ftr1.

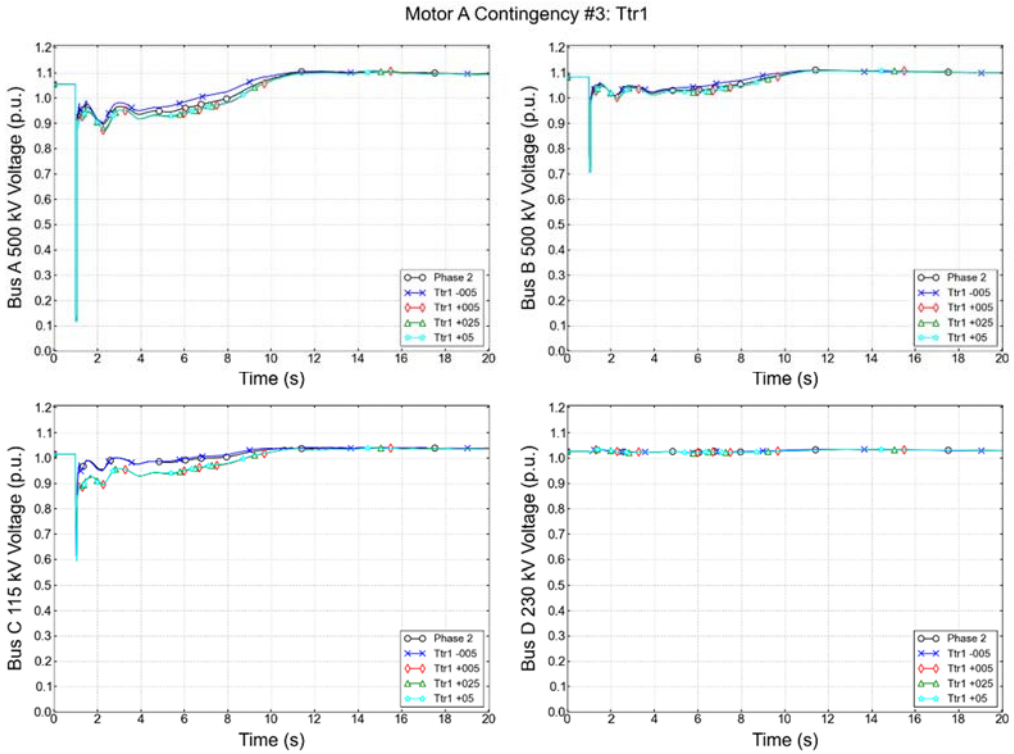

Figure 4.2-20: Bus voltages for Motor A sensitivity parameter Ttr1.

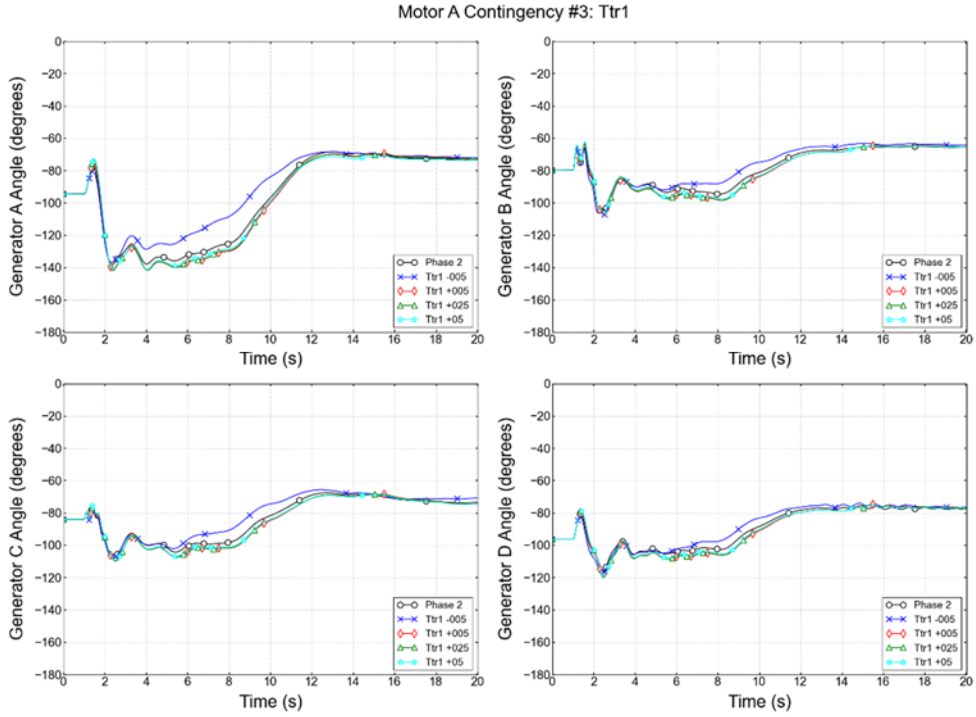

Figure 4.2-21: Generator angles for Motor A sensitivity parameter Ttr1.

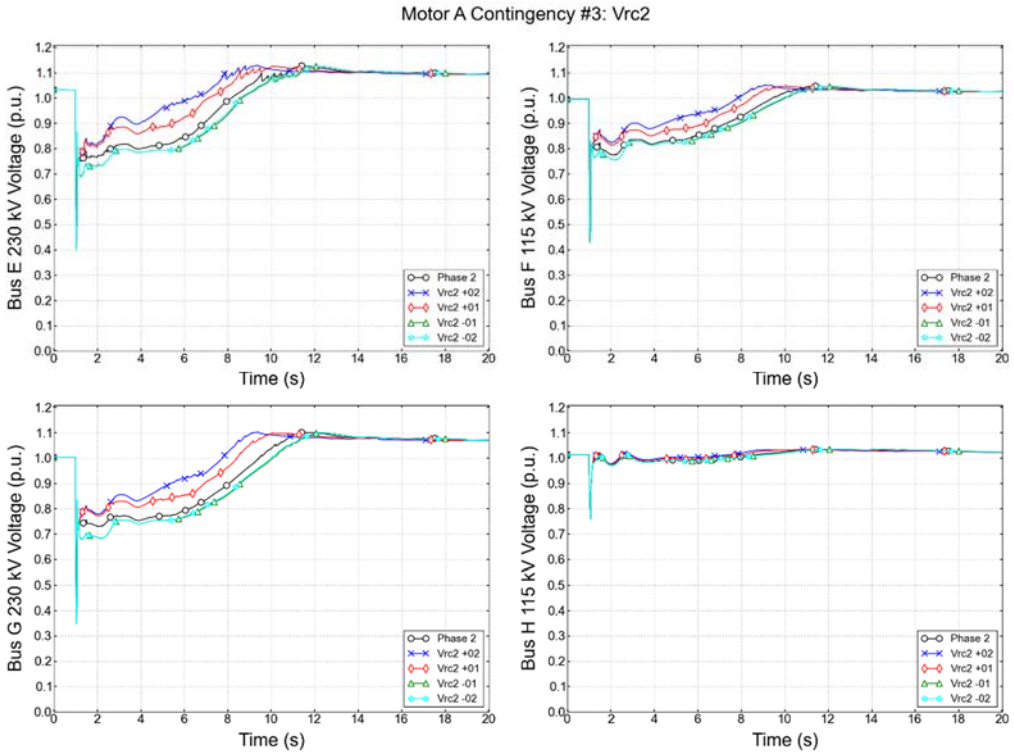

Figure 4.2-22: Bus voltages for Motor A sensitivity parameter Vrc2.

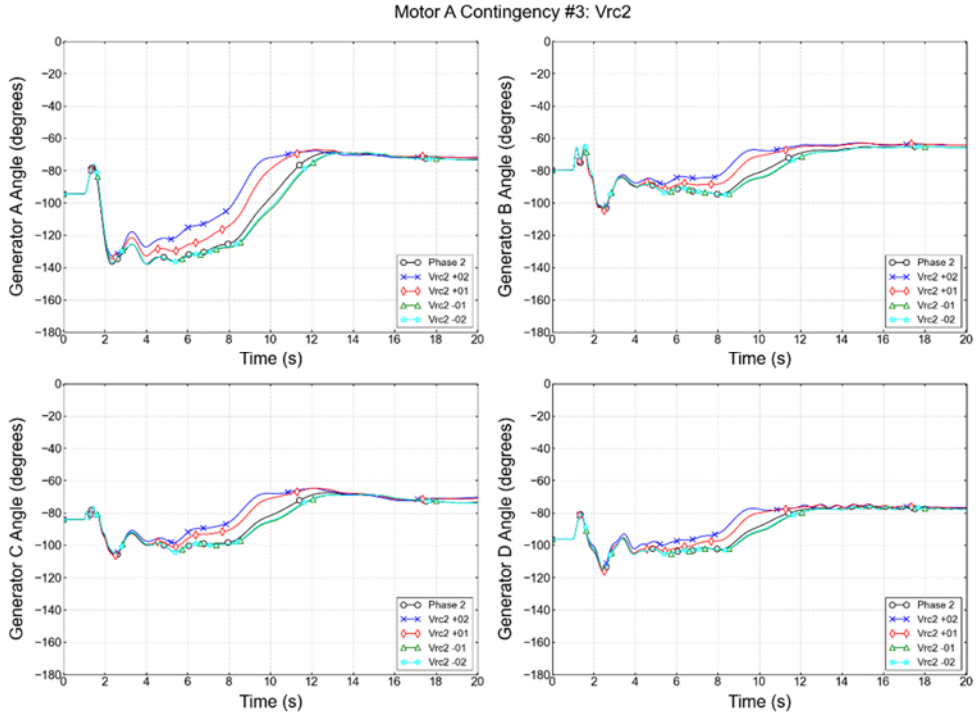

Figure 4.2-23: Generator angles for Motor A sensitivity parameter Vrc2.

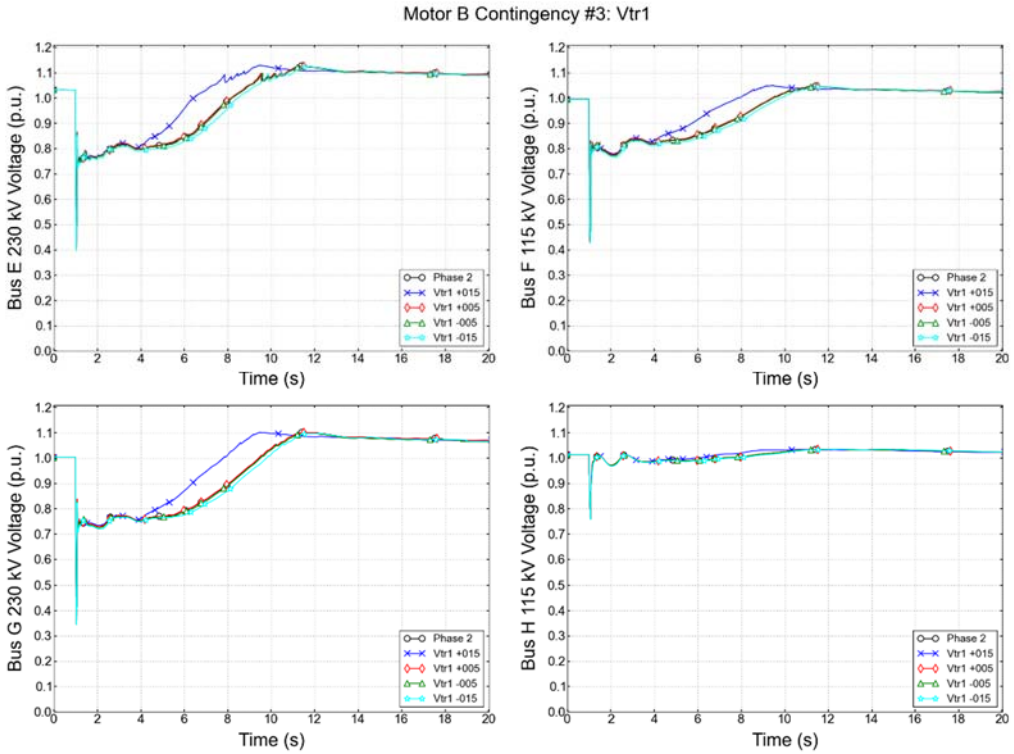

Figure 4.2-24: Bus voltages for Motor B sensitivity parameter Vtr1.

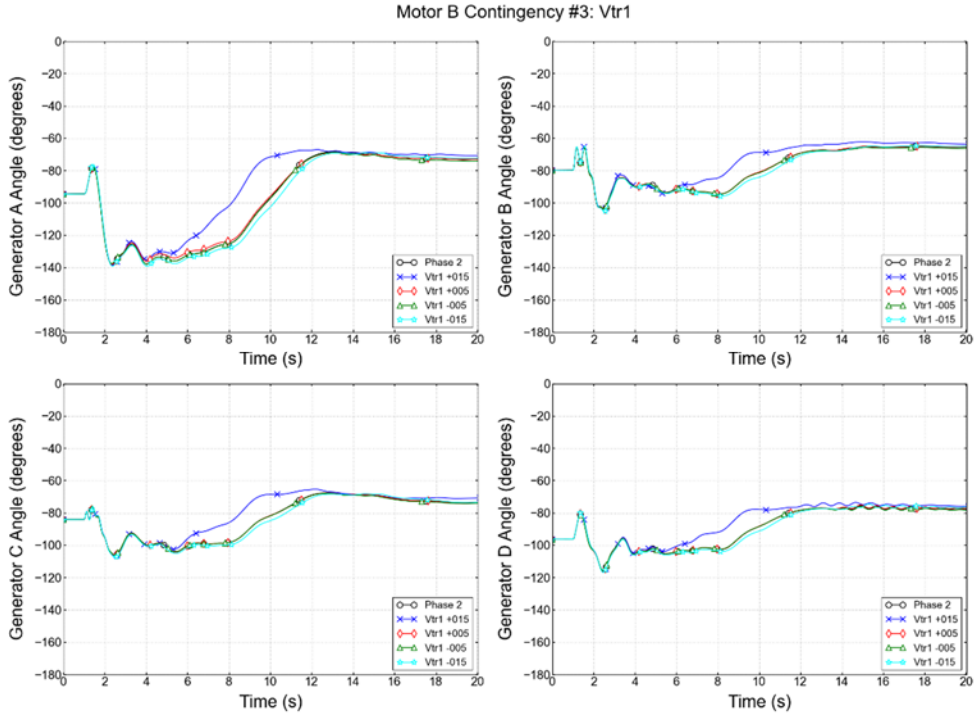

Figure 4.2-25: Generator angles for Motor B sensitivity parameter Vtr1.

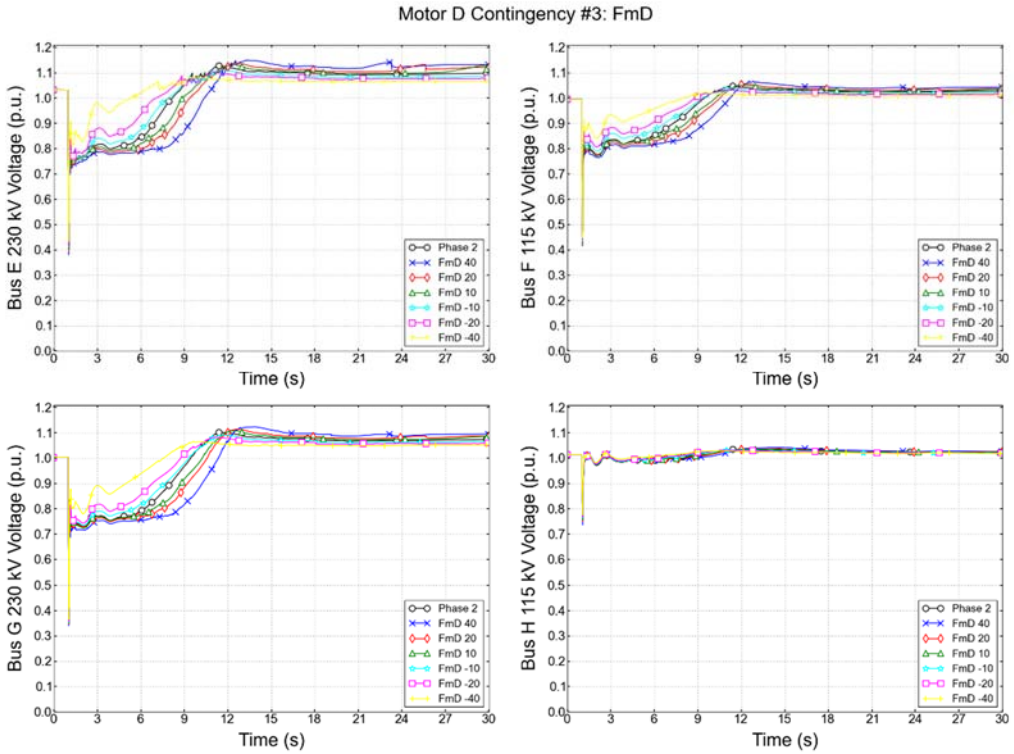

Figure 4.2-26: Bus voltages for Motor D sensitivity parameter FmD.

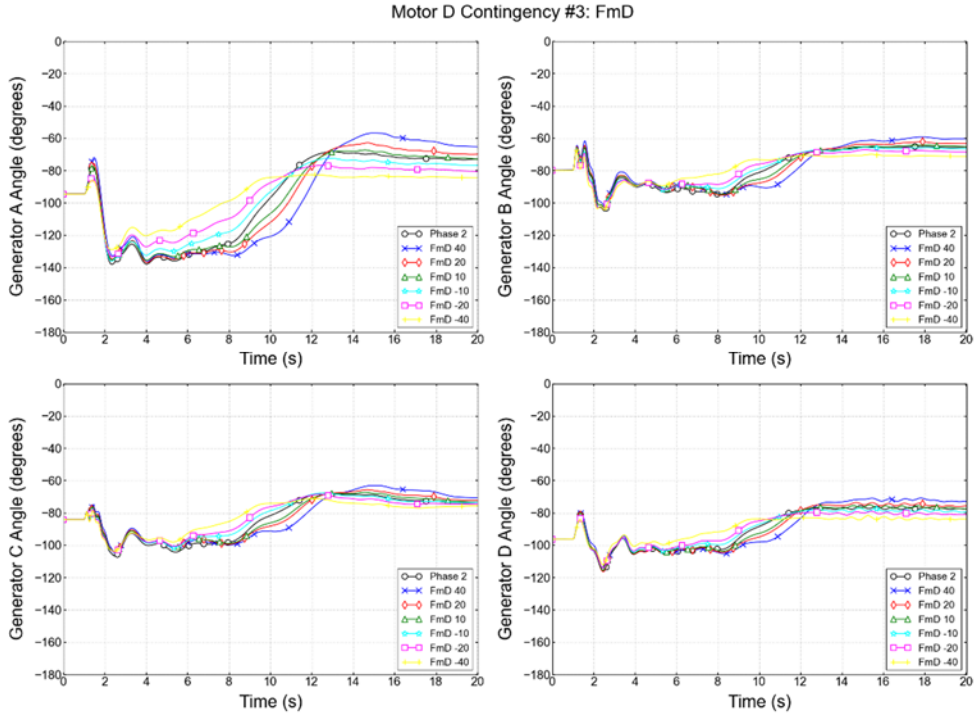

Figure 4.2-27: Generator angles for Motor D sensitivity parameter FmD.

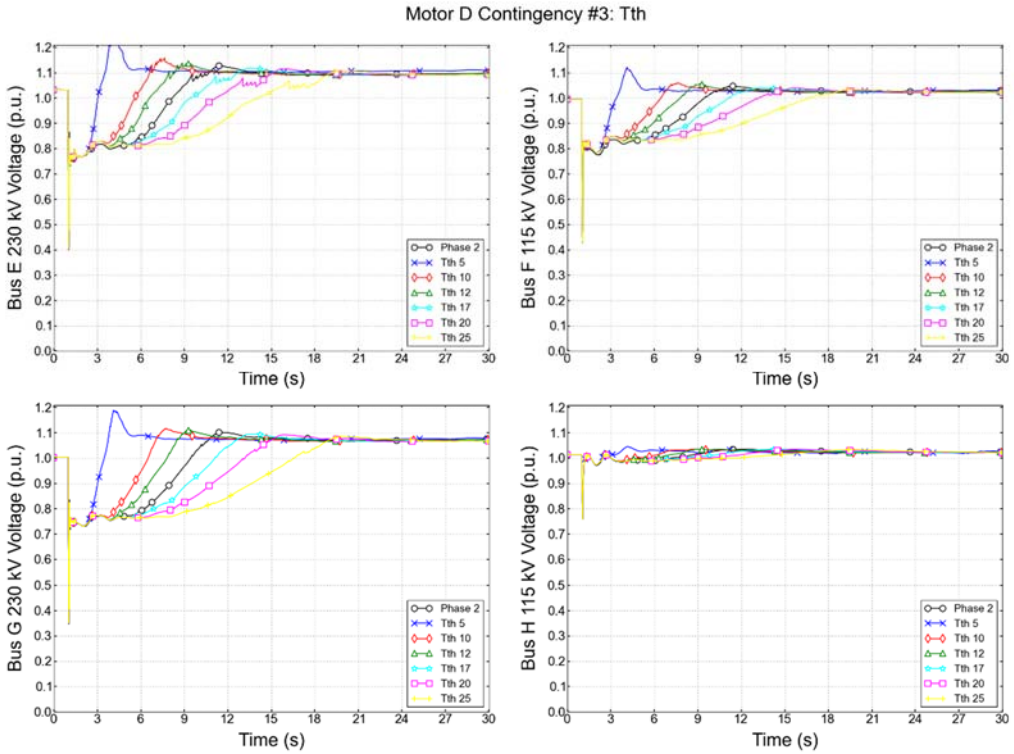

Figure 4.2-28: Bus voltages for Motor D sensitivity parameter Tth.

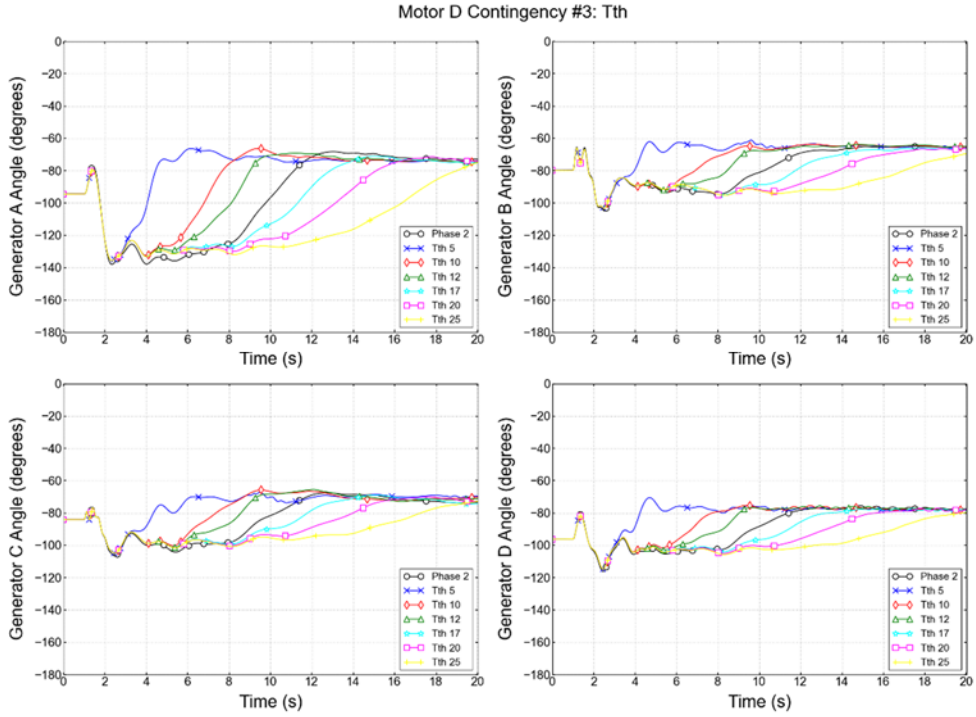

Figure 4.2-29: Generator angles for Motor D sensitivity parameter Tth.

4.3. SCE Heavy Summer and Stressed Case Results

For the Heavy Summer Case, there were 34 contingencies examined for 35 sensitivity parameters (20 parameters each with a minimum and maximum value) for Motor D for a total of 1,190 contingencies processed (include Phase 2 base case). For each contingency processed, 2,545 bus voltages and 813 generators were monitored. The results for a given sensitivity parameter (ex. fraction of Motor D increased by 20%) are an aggregate of all contingencies processed for that given sensitivity parameter. Table 4.3-1 lists the observations and results for SCE's Heavy Summer Case. The table lists the number of buses flagged by the criteria for the base case (Phase 2 composite load model) as well as a given sensitivity parameter. The "Delta (% Change)" column lists the percentage difference between the number of observations in the base case and the respective sensitivity parameter. For the observation of a bus voltage recovering to 70% of the pre-fault voltage within 1 second, the base case flagged 2,127 buses that did not meet this criterion. For the same voltage criteria, when increasing stalling voltage to 0.8 p.u. from 0.5 p.u., 4,271 buses were flagged to not meet this criterion, which is an increase of 101% from the base case. When decreasing the stalling voltage to 0.3 p.u. from 0.5 p.u., 1,748 buses were flagged to not meet this criterion, which is a decrease of 18% from the base case.

Refer to Figures 4.3-1 through 4.3-12 for representative plots of select sensitivity parameters for a three-phase fault resulting in the loss of two 500 kV transmission lines. The plots include up to eight bus voltages and four generator angles comparing the base case (Phase 2) to the maximum and minimum sensitivity parameter, respectively.

Table 4.3-1
SCE Results and Observations for the Heavy Summer Case: Voltage Criteria

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Angle Swings Offline (+/-180)		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u.	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	8537	-	6734	-	69	-	2127	-	2025	-	3092	-	5606	-	2680	-
2	Fel	-20%	8463	-1%	6676	-1%	65	-6%	2097	-1%	2087	3%	3050	-1%	5062	-10%	2370	-12%
3		20%	8627	1%	6807	1%	78	13%	2132	0%	2170	7%	3289	6%	5881	5%	2875	7%
4	FmA	-20%	8404	-2%	6608	-2%	67	-3%	2322	9%	2256	11%	3554	15%	5376	-4%	2657	-1%
5		20%	8676	2%	6869	2%	89	29%	1925	-9%	1959	-3%	3021	-2%	5923	6%	2946	10%
6	FmB	-20%	8374	-2%	6614	-2%	66	-4%	2066	-3%	1990	-2%	2993	-3%	5159	-8%	2373	-11%
7		20%	8669	2%	6854	2%	84	22%	2150	1%	2246	11%	3362	9%	5828	4%	2934	9%
8	FmC	-20%	8459	-1%	6669	-1%	65	-6%	2106	-1%	2016	0%	3059	-1%	5208	-7%	2493	-7%
9		20%	8625	1%	6810	1%	85	23%	2096	-1%	2100	4%	3232	5%	5689	1%	2793	4%
10	FmD	-20%	7974	-7%	6213	-8%	63	-9%	1960	-8%	1524	-25%	2616	-15%	4122	-26%	1846	-31%
11		20%	8956	5%	7220	7%	78	13%	2137	0%	2297	13%	3311	7%	5219	-7%	2485	-7%
12	Frst (0.2)	0	8537	0%	6734	0%	70	1%	2127	0%	2020	0%	3104	0%	5684	1%	2733	2%
13		1	8537	0%	6734	0%	65	-6%	2127	0%	2019	0%	3088	0%	5144	-8%	2670	0%
14	Fuvr (0.1)	0	8621	1%	6840	2%	58	-16%	2433	14%	2738	35%	4075	32%	5394	-4%	2655	-1%
15		0.5	8119	-5%	6382	-5%	215	212%	1332	-37%	359	-82%	920	-70%	5943	6%	4248	59%
16	Th1t (0.7)	0.4	8538	0%	6737	0%	102	48%	2128	0%	2018	0%	3058	-1%	5377	-4%	2778	4%
17		0.9	8537	0%	6734	0%	33	-52%	2128	0%	2019	0%	3094	0%	4306	-23%	1825	-32%
18	Th2t (1.2)	1	8541	0%	6749	0%	189	174%	2127	0%	2019	0%	3096	0%	6138	9%	5426	102%
19		3	8537	0%	6734	0%	20	-71%	2128	0%	2019	0%	3094	0%	2578	-54%	174	-94%
20	Trst	1	8537	0%	6734	0%	69	0%	2127	0%	2019	0%	3096	0%	5544	-1%	2624	-2%
21		0.1	8537	0%	6734	0%	69	0%	2127	0%	2019	0%	3096	0%	5649	1%	2736	2%
22	Tstall (0.033)	0.25	8447	-1%	6670	-1%	26	-62%	1264	-41%	106	-95%	59	-98%	1212	-78%	5079	90%
23		0.01667	8598	1%	6785	1%	148	114%	2882	35%	3104	53%	5100	65%	7807	39%	4877	82%
24	Tth (15)	5	8540	0%	6747	0%	284	312%	2127	0%	2010	-1%	2905	-6%	6053	8%	5361	100%
25		25	8537	0%	6734	0%	21	-70%	2127	0%	2019	0%	3097	0%	2148	-62%	204	-92%
26	Ttr1 (0.02)	0.25	8618	1%	6836	2%	93	35%	2432	14%	2676	32%	3985	29%	6182	10%	3308	23%
27		0.01667	8525	0%	6733	0%	72	4%	2158	1%	2065	2%	3097	0%	5625	0%	2679	0%
28	Vc1off (0.5)	Max	6776	-21%	4985	-26%	58	-16%	1101	-48%	559	-72%	1291	-58%	3350	-40%	2992	12%
29		Min	9048	6%	7261	8%	105	52%	3165	49%	3663	81%	5533	79%	6456	15%	3580	34%
30	Vrst (0.95)	1	8537	0%	6734	0%	69	0%	2127	0%	2019	0%	3096	0%	5673	1%	2722	2%
31		0.5	8545	0%	6736	0%	82	19%	2125	0%	1898	-6%	3042	-2%	4786	-15%	2156	-20%
32	Vstall (0.5)	0.3	9293	9%	7629	13%	24	-65%	1748	-18%	264	-87%	418	-86%	1844	-67%	3578	34%
33		0.8	10222	20%	8391	25%	314	355%	4271	101%	6946	243%	10086	226%	11505	105%	8070	201%
34	Vtr1 (0.6)	0.4	8625	1%	6844	2%	68	-1%	2415	14%	2726	35%	4126	33%	5433	-3%	2804	5%
35		0.8	8207	-4%	6414	-5%	84	22%	2369	11%	2140	6%	3500	13%	6363	14%	3152	18%

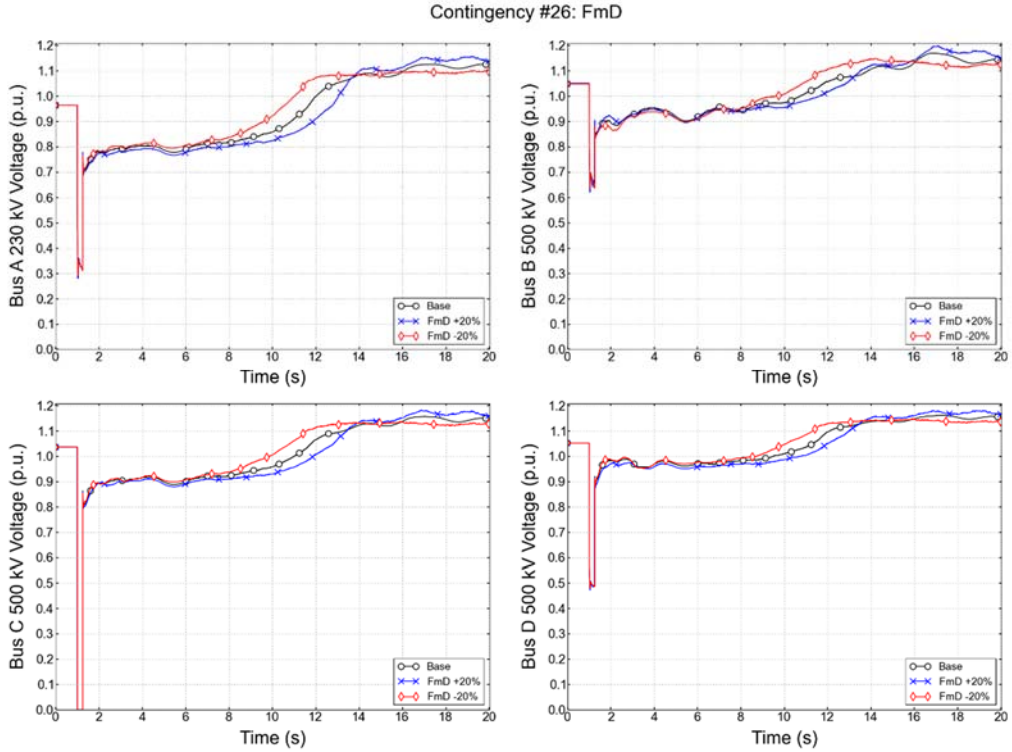

Figure 4.3-1: Bus voltages for sensitivity parameter FmD.

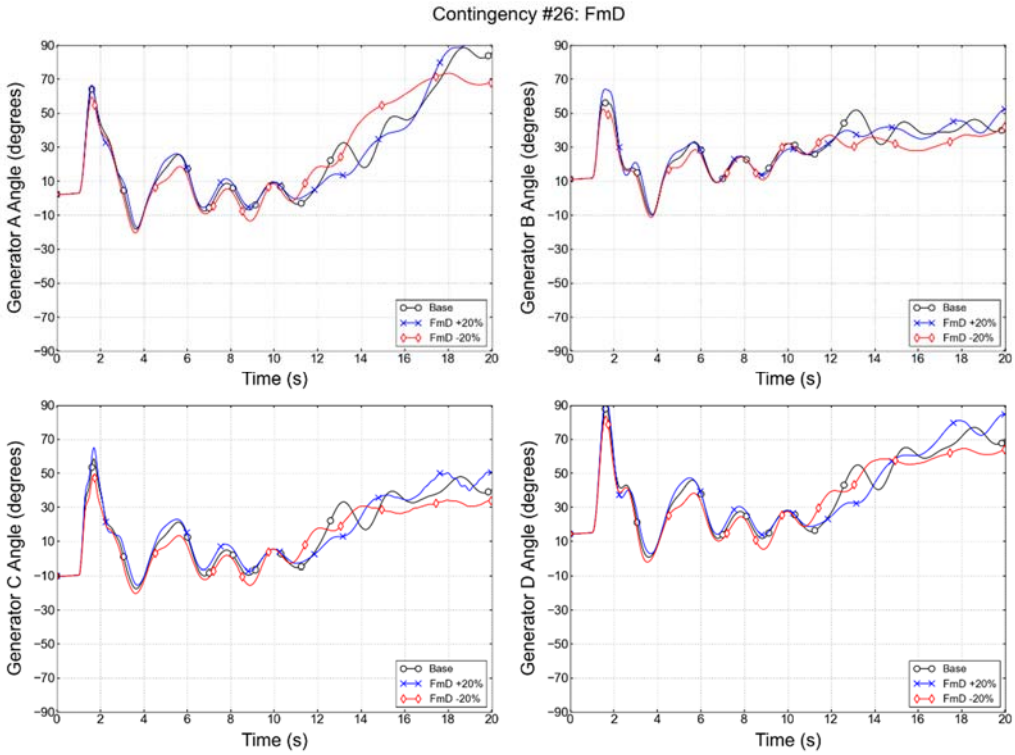

Figure 4.3-2: Generator angles for sensitivity parameter FmD.

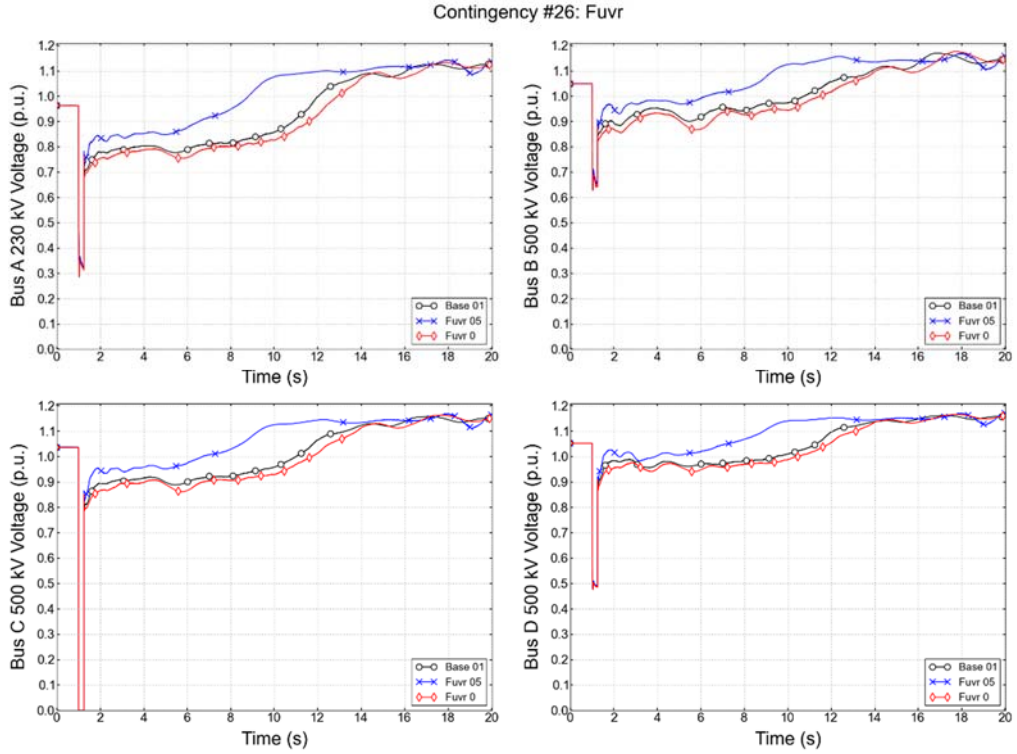

Figure 4.3-3: Bus voltages for sensitivity parameter Fuvr.

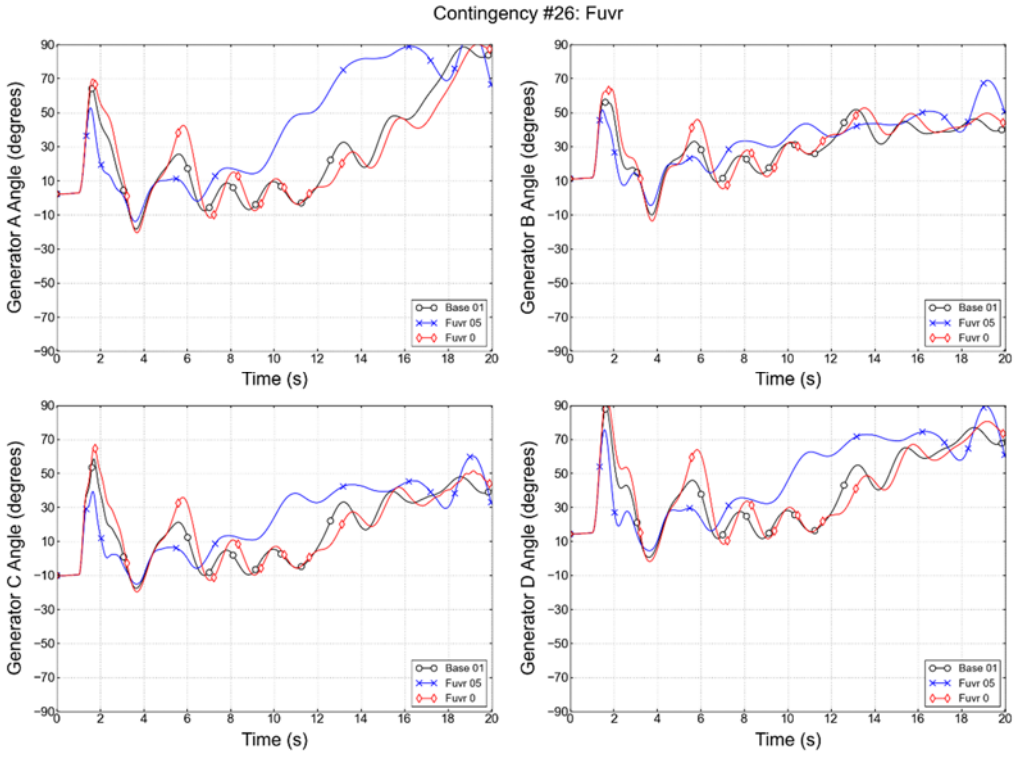

Figure 4.3-4: Generator angles for sensitivity parameter Fuvr.

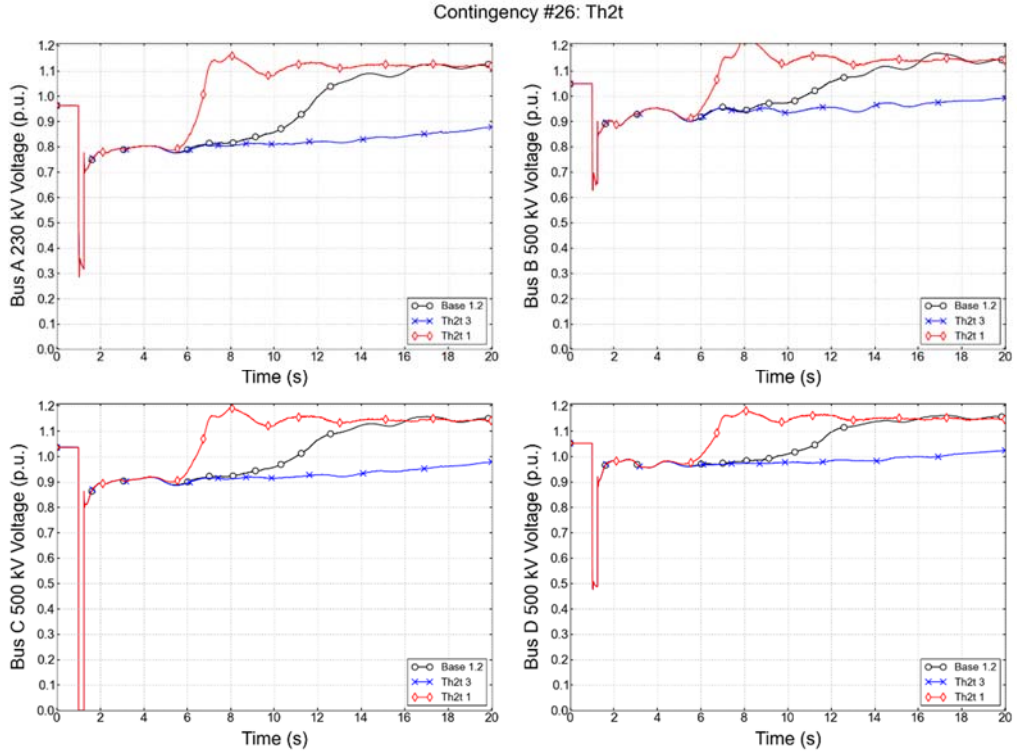

Figure 4.3-5: Bus voltages for sensitivity parameter Th2t.

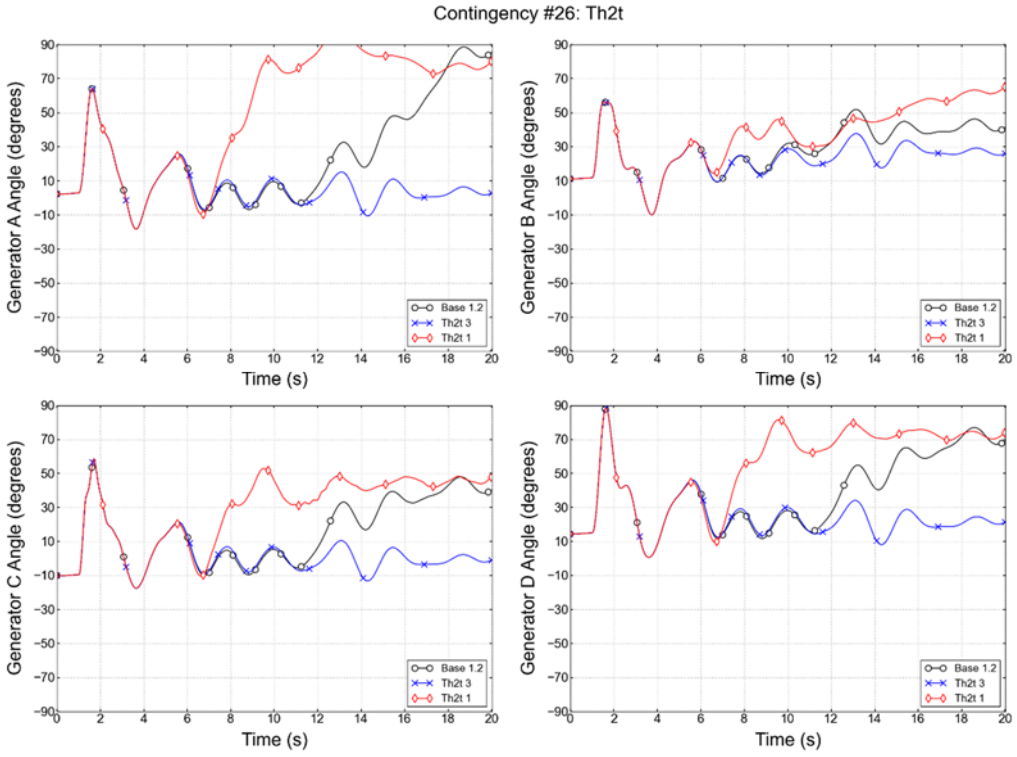

Figure 4.3-6: Generator angles for sensitivity parameter Th2t.

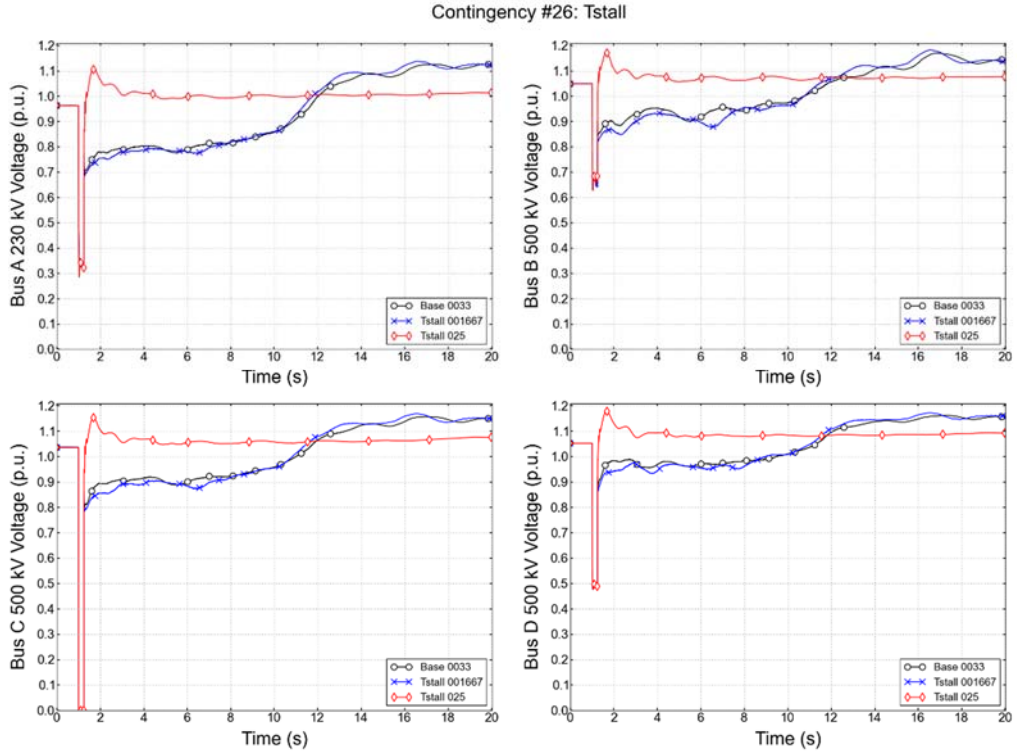

Figure 4.3-7: Bus voltages for sensitivity parameter Tstall.

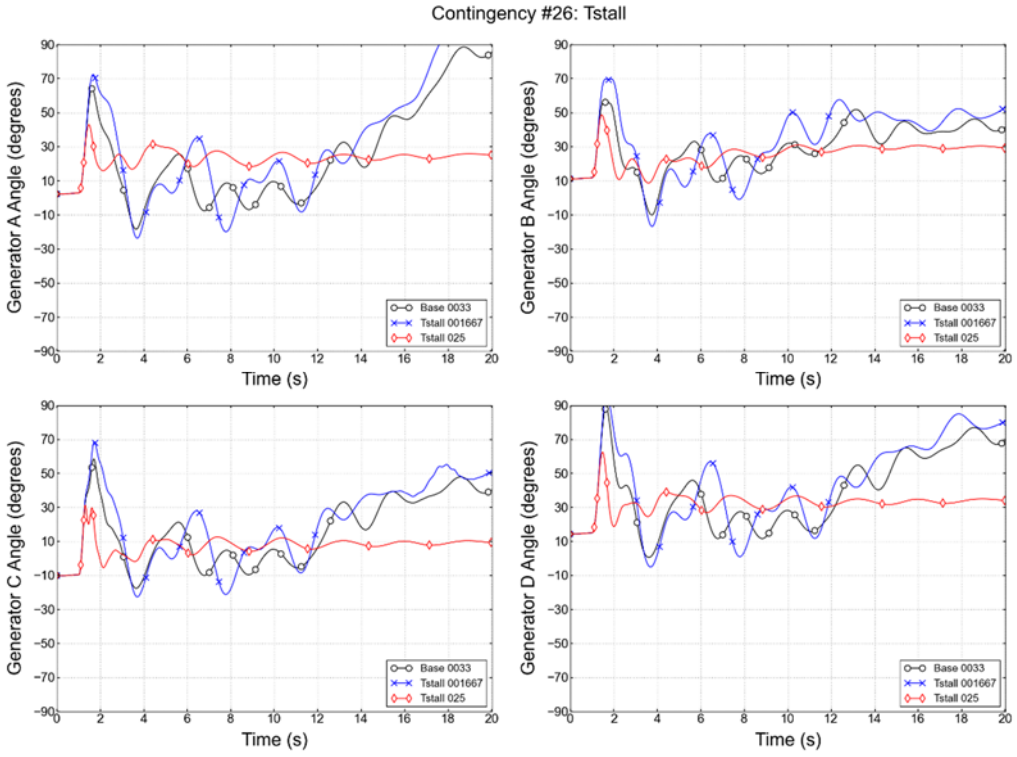

Figure 4.3-8: Generator angles for sensitivity parameter Tstall.

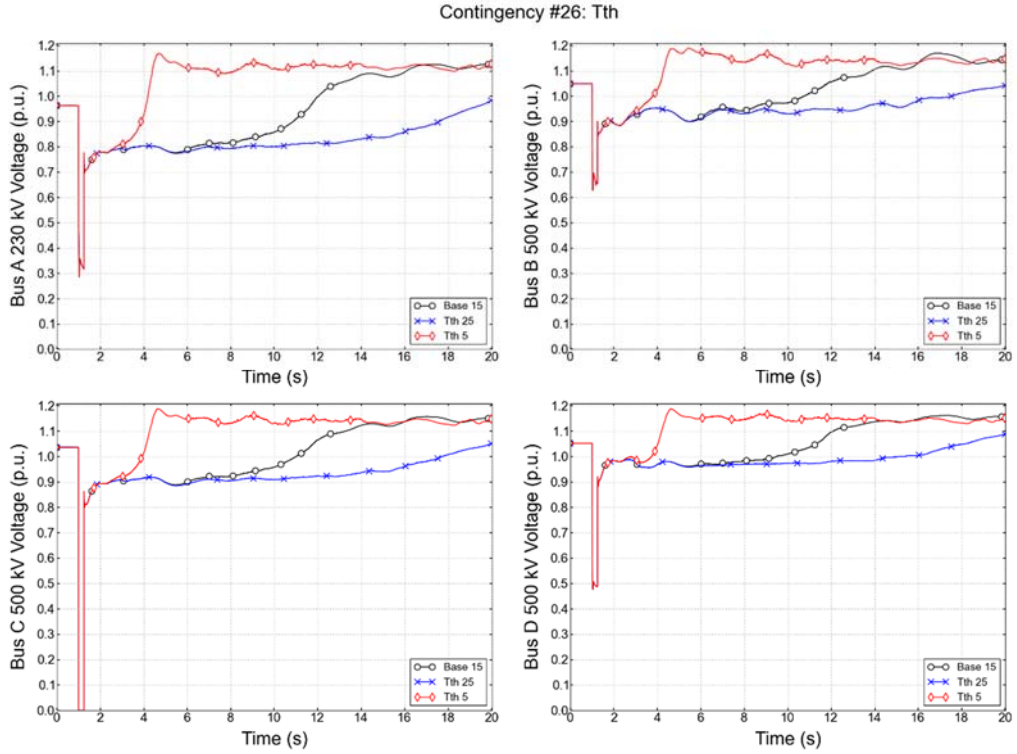

Figure 4.3-9: Bus voltages for sensitivity parameter Tth.

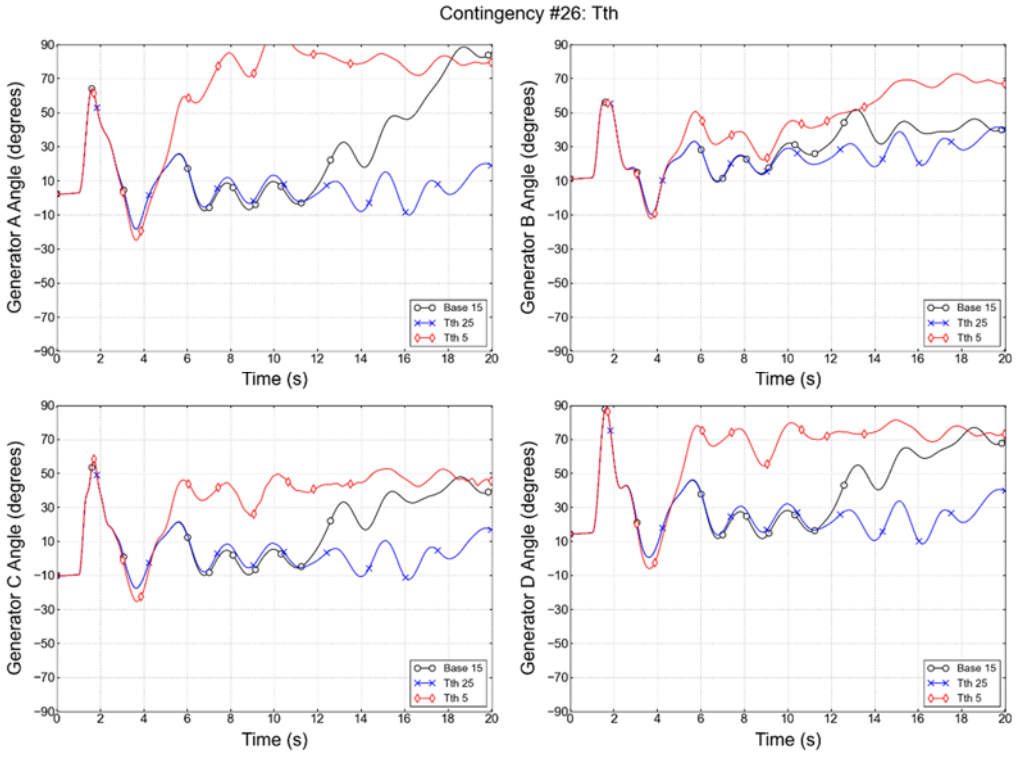

Figure 4.3-10: Generator angles for sensitivity parameter Tth.

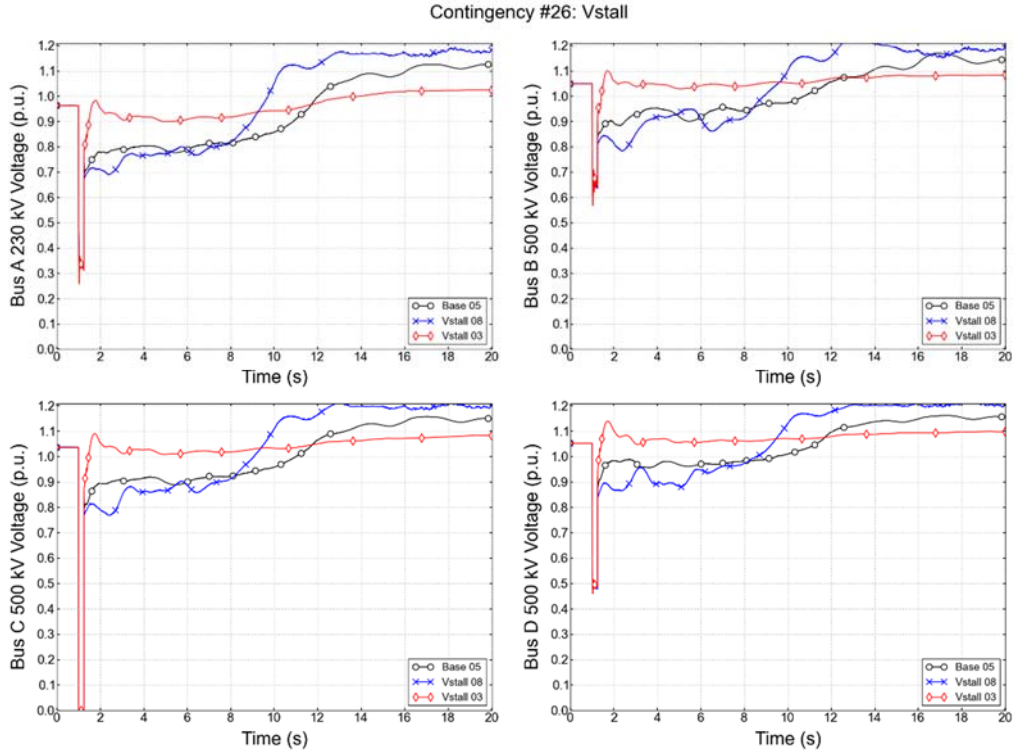

Figure 4.3-11: Bus voltages for sensitivity parameter Vstall.

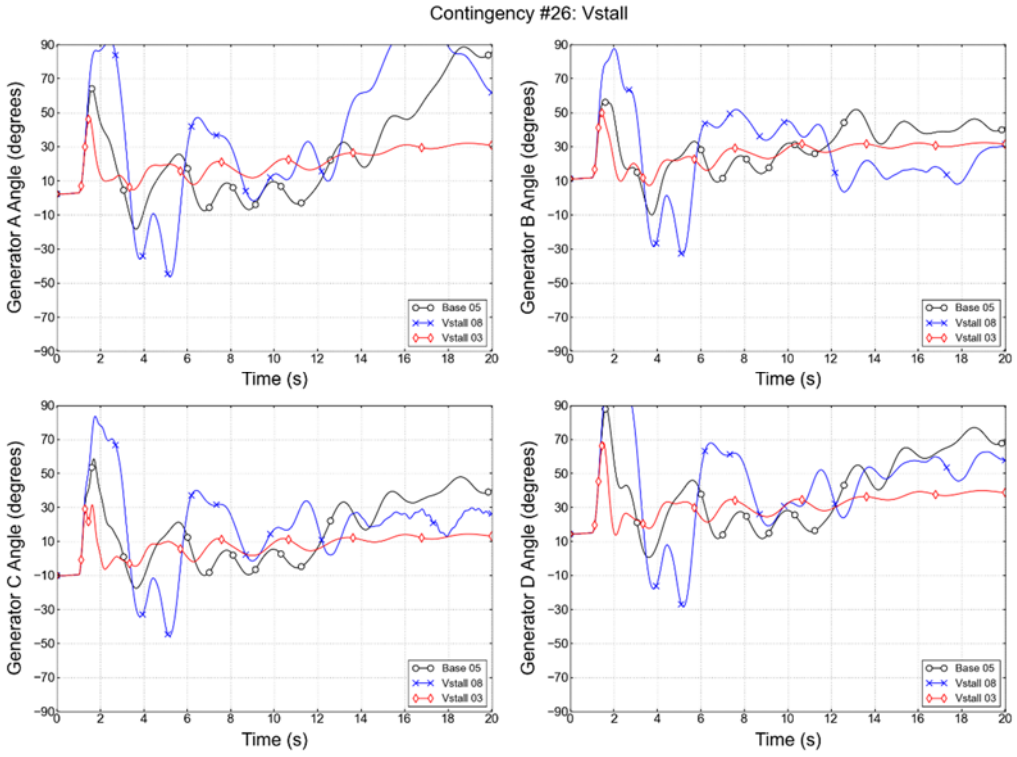

Figure 4.3-12: Generator angles for sensitivity parameter Vstall.

From the observations in Table 4.3-1 and the voltages and generator angles in Figures 4.3-1 through 4.3-12, it can be observed that the following parameters have a significant impact on the outcome of results:

- **Vstall**: Stall voltage, p.u.
- **Tstall**: Stall time delay, sec.
- **FmD**: Motor D fraction of load P
- **Fuvr**: Fraction of load with under voltage relay protection
- **Tth**: Motor D thermal time constant, sec.
- **Th1t**: Motor D thermal protection trip start level, p.u. temperature
- **Th2t**: Motor D thermal protection trip completion level, p.u. temperature
- **Vc1off**: Contactor voltage at which tripping starts, p.u.
- **Vc2off**: Contactor voltage at which tripping is complete, p.u.
- **Vc1on**: Contactor voltage at which reconnection starts, p.u.
- **Vc2on**: Contactor voltage at which reconnection is complete, p.u.

For the Stressed Case, there were 6 contingencies examined for 198 sensitivity parameters:

- Motor A: 12 parameters (see Table 2.2-2) x 4 values = 48 sensitivity parameters
- Motor B: 12 parameters (see Table 2.2-3) x 4 values = 48 sensitivity parameters
- Motor C: 12 parameters (see Table 2.2-4) x 4 values = 48 sensitivity parameters
- Motor D: 9 parameters (see Table 2.2-1) x 6 values = 54 sensitivity parameters

For each contingency processed, 2,545 bus voltages and 813 generators were monitored. The results for a given sensitivity parameter (ex. fraction of Motor D increased by 20%) are an aggregate of all contingencies processed for that given sensitivity parameter. Tables 4.3-2 through 4.3-5 list the observations and results for SCE's Stressed Case for Motor A, Motor B, Motor C, and Motor D, respectively. The tables list the number of buses flagged by the criteria for the base case (Phase II composite load model) as well as a given sensitivity parameter. The "Delta (% Change)" column lists the percentage difference between the number of observations in the base case and the respective sensitivity parameter.

In Table 4.3-2, Motor A, the observation of a bus voltage recovering to 90% of the pre-fault voltage within 5 seconds, the base case flagged 2088 buses that did not meet this criterion. For the same voltage criteria, when increasing the fraction of motors that trip on the first low voltage trip setting by a factor of 0.1, 1,441 buses were flagged to not meet this criterion, which is a decrease of 31% from the base case. Note for this sensitivity, a threshold is met and increasing the parameter value for Ftr1 by more than 0.1 per load does not have an impact on the results. When decreasing the fraction of motors that trip on the first low voltage trip setting by a factor of 0.1, 2,294 buses were flagged to not meet this criterion, which is an increase of 10% from the base case. Similar, when decreasing the fraction of motors that trip on the first low voltage trip

setting by a factor of 0.2, 2,332 buses were flagged to not meet this criterion which is an increase of 12% from the base case. For this sensitivity, decreasing the fraction of motors that may trip after the first voltage setting has a negative impact on the system. Since more motors are remaining online during low voltages, more motors are stalling that will draw more reactive power, resulting in low voltages.

Table 4.3-2
SCE Results and Observations for the Stressed Case: Motor A

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	1327	-	410	-	47	-	378	-	382	-	2088	-	627	-	1327	-	430	-	419	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	1566	18%	553	35%	43	-9%	387	2%	420	10%	2332	12%	371	-41%	1303	-2%	230	-47%	356	-15%
3		-0.1	1599	20%	681	66%	50	6%	501	33%	396	4%	2294	10%	510	-19%	1234	-7%	335	-22%	372	-11%
4		+0.1	1114	-16%	331	-19%	135	187%	354	-6%	338	-12%	1441	-31%	1952	211%	1432	8%	1100	156%	1276	205%
5		+0.2	1020	-23%	275	-33%	133	183%	299	-21%	336	-12%	1318	-37%	1958	212%	1475	11%	1089	153%	1267	202%
6	Ftr2 (0, 0.5, 0.7)	-0.2	1809	36%	773	89%	49	4%	515	36%	422	10%	2252	8%	832	33%	1424	7%	518	20%	575	37%
7		-0.1	1491	12%	542	32%	44	-6%	426	13%	395	3%	2177	4%	719	15%	1379	4%	467	9%	470	12%
8		+0.1	1200	-10%	352	-14%	46	-2%	361	-4%	363	-5%	2025	-3%	594	-5%	1277	-4%	371	-14%	379	-10%
9		+0.2	1168	-12%	363	-11%	44	-6%	371	-2%	357	-7%	1971	-6%	382	-39%	1254	-6%	317	-26%	348	-17%
10	H (0.1, 0.15, 0.2)	-50%	1216	-8%	377	-8%	46	-2%	393	4%	370	-3%	1927	-8%	602	-4%	1371	3%	462	7%	373	-11%
11		-25%	1293	-3%	385	-6%	48	2%	389	3%	375	-2%	2023	-3%	614	-2%	1349	2%	446	4%	390	-7%
12		+50%	1355	2%	425	4%	46	-2%	376	-1%	384	1%	2144	3%	646	3%	1291	-3%	372	-13%	452	8%
13		+100%	1380	4%	430	5%	44	-6%	367	-3%	385	1%	2167	4%	672	7%	1264	-5%	333	-23%	483	15%
14	Ls (1.8, 3.1)	-50%	987	-26%	269	-34%	39	-17%	314	-17%	348	-9%	1467	-30%	712	14%	898	-32%	318	-26%	322	-23%
15		-25%	1102	-17%	327	-20%	44	-6%	361	-4%	348	-9%	1892	-9%	608	-3%	1207	-9%	385	-10%	380	-9%
16		+50%	1509	14%	514	25%	47	0%	413	9%	404	6%	2180	4%	608	-3%	1409	6%	460	7%	460	10%
17		+100%	1609	21%	583	42%	48	2%	432	14%	411	8%	2217	6%	578	-8%	1485	12%	482	12%	476	14%
18	Tpo (0.095, 0.8)	-50%	1362	3%	438	7%	48	2%	369	-2%	386	1%	2119	1%	651	4%	1302	-2%	455	6%	441	5%
19		-25%	1358	2%	430	5%	48	2%	371	-2%	386	1%	2128	2%	674	7%	1314	-1%	448	4%	444	6%
20		+50%	1264	-5%	397	-3%	46	-2%	386	2%	365	-4%	2018	-3%	592	-6%	1327	0%	379	-12%	398	-5%
21		+100%	1225	-8%	375	-9%	45	-4%	388	3%	364	-5%	2003	-4%	578	-8%	1331	0%	338	-21%	387	-8%
22	Trc2 (0.1, 0.25)	-0.05	1345	1%	411	0%	47	0%	377	0%	382	0%	2101	1%	632	1%	1318	-1%	428	0%	424	1%
23		+0.05	1317	-1%	407	-1%	47	0%	378	0%	379	-1%	2089	0%	622	-1%	1338	1%	432	0%	421	0%
24		+0.1	1316	-1%	406	-1%	46	-2%	378	0%	379	-1%	2085	0%	623	-1%	1344	1%	435	1%	407	-3%
25		+0.25	1290	-3%	404	-1%	47	0%	378	0%	380	-1%	2067	-1%	629	0%	1361	3%	436	1%	404	-4%
26	Ttr1 (0.02, 0.05, 1)	-0.05	1207	-9%	356	-13%	49	4%	367	-3%	345	-10%	1930	-8%	511	-19%	1358	2%	335	-22%	333	-21%
27		+0.05	1451	9%	459	12%	46	-2%	383	1%	400	5%	2169	4%	672	7%	1287	-3%	440	2%	449	7%
28		+0.25	1687	27%	617	50%	45	-4%	409	8%	405	6%	2217	6%	663	6%	1273	-4%	454	6%	488	16%
29		+0.5	2364	78%	1198	192%	50	6%	528	40%	409	7%	2224	7%	713	14%	1090	-18%	540	26%	556	33%
30	Ttr2 (0.02, 0.05, 1)	-0.05	1298	-2%	381	-7%	41	-13%	374	-1%	357	-7%	2025	-3%	630	0%	1492	12%	391	-9%	388	-7%
31		+0.05	1791	35%	643	57%	43	-9%	424	12%	426	12%	2340	12%	793	26%	1304	-2%	444	3%	495	18%
32		+0.25	2103	58%	994	142%	44	-6%	673	78%	473	24%	2742	31%	814	30%	1263	-5%	448	4%	531	27%
33		+0.5	2525	90%	1377	236%	97	106%	664	76%	854	124%	2456	18%	944	51%	851	-36%	522	21%	896	114%
34	Vrc1 (1)	-0.25	1327	0%	410	0%	47	0%	378	0%	382	0%	2088	0%	627	0%	1327	0%	430	0%	419	0%
35		-0.15	1327	0%	410	0%	47	0%	378	0%	382	0%	2088	0%	627	0%	1327	0%	430	0%	419	0%
36		-0.05	1327	0%	410	0%	47	0%	378	0%	382	0%	2088	0%	627	0%	1327	0%	430	0%	419	0%
37		+0.05	1327	0%	410	0%	47	0%	378	0%	382	0%	2088	0%	627	0%	1327	0%	430	0%	419	0%

Table 4.3-2 (continued)
SCE Results and Observations for the Stressed Case: Motor A

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	1327	-	410	-	47	-	378	-	382	-	2088	-	627	-	1327	-	430	-	419	-
38	Vrc2 (0.7, 1)	-0.2	1860	40%	975	138%	48	2%	696	84%	458	20%	2459	18%	669	7%	1420	7%	146	-66%	496	18%
39		-0.1	1438	8%	501	22%	46	-2%	422	12%	448	17%	2320	11%	634	1%	1314	-1%	209	-51%	466	11%
40		+0.1	1287	-3%	403	-2%	48	2%	378	0%	357	-7%	1808	-13%	616	-2%	1342	1%	450	5%	250	-40%
41		+0.2	1282	-3%	398	-3%	47	0%	378	0%	354	-7%	1773	-15%	603	-4%	1339	1%	457	6%	234	-44%
42	Vtr1 (0.7)	-0.15	1580	19%	655	60%	43	-9%	499	32%	375	-2%	2125	2%	576	-8%	1268	-4%	299	-30%	303	-28%
43		-0.05	1373	3%	441	8%	46	-2%	398	5%	380	-1%	2128	2%	637	2%	1311	-1%	372	-13%	370	-12%
44		+0.05	1260	-5%	400	-2%	47	0%	376	-1%	385	1%	2062	-1%	646	3%	1365	3%	450	5%	443	6%
45		+0.15	1120	-16%	374	-9%	60	28%	362	-4%	381	0%	1764	-16%	748	19%	1423	7%	489	14%	483	15%
46	Vtr2 (0.5, 0.6)	-0.15	1953	47%	778	90%	42	-11%	469	24%	458	20%	2542	22%	795	27%	1285	-3%	470	9%	531	27%
47		-0.05	2299	73%	1267	209%	92	96%	613	62%	1075	181%	2312	11%	924	47%	967	-27%	479	11%	839	100%
48		+0.05	1035	-22%	334	-19%	45	-4%	347	-8%	373	-2%	1984	-5%	686	9%	1423	7%	345	-20%	394	-6%
49		+0.15	886	-33%	250	-39%	43	-9%	294	-22%	357	-7%	1312	-37%	609	-3%	1637	23%	252	-41%	311	-26%

Table 4.3-3
SCE Results and Observations for the Stressed Case: Motor B

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	1327	-	410	-	47	-	378	-	382	-	2088	-	626	-	1326	-	428	-	421	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	1480	12%	520	27%	46	-2%	384	2%	397	4%	2247	8%	671	7%	1389	5%	450	5%	470	12%
3		-0.1	1564	18%	630	54%	47	0%	484	28%	390	2%	2188	5%	658	5%	1381	4%	472	10%	478	14%
4		+0.1	1176	-11%	359	-12%	47	0%	353	-7%	365	-4%	1923	-8%	610	-3%	1238	-7%	392	-8%	384	-9%
5		+0.2	1025	-23%	259	-37%	43	-9%	298	-21%	361	-5%	1571	-25%	647	3%	974	-27%	348	-19%	346	-18%
6	Ftr2 (0, 0.5, 0.7)	-0.2	1868	41%	777	90%	49	4%	511	35%	395	3%	2188	5%	801	28%	1431	8%	474	11%	500	19%
7		-0.1	1449	9%	526	28%	46	-2%	418	11%	382	0%	2136	2%	696	11%	1374	4%	453	6%	442	5%
8		+0.1	1173	-12%	353	-14%	46	-2%	358	-5%	377	-1%	1945	-7%	609	-3%	1252	-6%	386	-10%	390	-7%
9		+0.2	1023	-23%	285	-30%	42	-11%	329	-13%	362	-5%	1835	-12%	594	-5%	1145	-14%	371	-13%	361	-14%
10	H (0.1, 0.15, 0.2)	-50%	1353	2%	435	6%	49	4%	382	1%	387	1%	2074	-1%	619	-1%	1367	3%	448	5%	440	5%
11		-25%	1336	1%	416	1%	49	4%	378	0%	385	1%	2090	0%	619	-1%	1358	2%	439	3%	434	3%
12		+50%	1311	-1%	398	-3%	50	6%	367	-3%	378	-1%	2063	-1%	627	0%	1263	-5%	398	-7%	400	-5%
13		+100%	1228	-7%	388	-5%	48	2%	365	-3%	373	-2%	1938	-7%	618	-1%	1242	-6%	357	-17%	362	-14%
14	Ls (1.8, 3.1)	-50%	1426	7%	519	27%	47	0%	430	14%	387	1%	2132	2%	642	3%	1430	8%	433	1%	430	2%
15		-25%	1371	3%	421	3%	48	2%	399	6%	383	0%	2117	1%	630	1%	1367	3%	429	0%	425	1%
16		+50%	1277	-4%	387	-6%	48	2%	366	-3%	378	-1%	2069	-1%	624	0%	1271	-4%	414	-3%	399	-5%
17		+100%	1199	-10%	378	-8%	47	0%	363	-4%	368	-4%	1966	-6%	594	-5%	1260	-5%	375	-12%	382	-9%
18	Tpo (0.095, 0.8)	-50%	1131	-15%	350	-15%	47	0%	349	-8%	364	-5%	1865	-11%	581	-7%	1163	-12%	371	-13%	375	-11%
19		-25%	1227	-8%	383	-7%	50	6%	364	-4%	371	-3%	2019	-3%	617	-1%	1249	-6%	390	-9%	390	-7%
20		+50%	1517	14%	592	44%	49	4%	437	16%	385	1%	2142	3%	663	6%	1498	13%	472	10%	473	12%
21		+100%	1394	5%	455	11%	48	2%	382	1%	392	3%	2222	6%	706	13%	1475	11%	480	12%	484	15%
22	Trc2 (0.1, 0.25)	-0.05	1430	8%	464	13%	47	0%	386	2%	388	2%	2136	2%	626	0%	1368	3%	392	-8%	406	-4%
23		+0.05	1295	-2%	399	-3%	47	0%	377	0%	384	1%	2080	0%	635	1%	1318	-1%	433	1%	429	2%
24		+0.1	1283	-3%	385	-6%	47	0%	376	-1%	381	0%	2071	-1%	629	0%	1303	-2%	437	2%	435	3%
25		+0.25	1270	-4%	386	-6%	47	0%	374	-1%	381	0%	2075	-1%	630	1%	1294	-2%	447	4%	436	4%
26	Ttr1 (0.02, 0.05, 1)	-0.05	1302	-2%	399	-3%	48	2%	378	0%	380	-1%	2043	-2%	656	5%	1372	3%	405	-5%	401	-5%
27		+0.05	1513	14%	462	13%	45	-4%	401	6%	389	2%	2153	3%	676	8%	1270	-4%	458	7%	479	14%
28		+0.25	1625	22%	677	65%	48	2%	463	22%	394	3%	2230	7%	681	9%	1155	-13%	482	13%	499	19%
29		+0.5	1900	43%	822	100%	54	15%	507	34%	396	4%	2252	8%	737	18%	1089	-18%	489	14%	502	19%
30	Ttr2 (0.02, 0.05, 1)	-0.05	1292	-3%	400	-2%	48	2%	369	-2%	381	0%	2012	-4%	706	13%	1451	9%	508	19%	505	20%
31		+0.05	1680	27%	656	60%	45	-4%	450	19%	394	3%	2221	6%	770	23%	1267	-4%	412	-4%	415	-1%
32		+0.25	1805	36%	719	75%	47	0%	502	33%	398	4%	2290	10%	817	31%	1248	-6%	396	-7%	414	-2%
33		+0.5	1597	20%	531	30%	44	-6%	390	3%	396	4%	2259	8%	759	21%	1305	-2%	398	-7%	411	-2%
34	Vrc1 (1)	-0.25	1396	5%	507	24%	47	0%	416	10%	391	2%	2148	3%	661	6%	1266	-5%	413	-4%	337	-20%
35		-0.15	1357	2%	428	4%	48	2%	393	4%	390	2%	2135	2%	655	5%	1318	-1%	420	-2%	373	-11%
36		-0.05	1333	0%	418	2%	49	4%	378	0%	386	1%	2116	1%	648	4%	1324	0%	422	-1%	414	-2%
37		+0.05	1302	-2%	399	-3%	47	0%	372	-2%	382	0%	2075	-1%	623	0%	1325	0%	445	4%	432	3%

Table 4.3-3 (continued)
SCE Results and Observations for the Stressed Case: Motor B

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	1327	-	410	-	47	-	378	-	382	-	2088	-	626	-	1326	-	428	-	421	-
38	Vrc2 (0.7, 1)	-0.2	1621	22%	729	78%	47	0%	493	30%	390	2%	2190	5%	648	4%	1464	10%	467	9%	458	9%
39		-0.1	1574	19%	658	60%	47	0%	443	17%	389	2%	2185	5%	646	3%	1410	6%	426	0%	444	5%
40		+0.1	1274	-4%	386	-6%	47	0%	374	-1%	364	-5%	2015	-3%	622	-1%	1320	0%	406	-5%	394	-6%
41		+0.2	1267	-5%	385	-6%	47	0%	374	-1%	360	-6%	1950	-7%	625	0%	1315	-1%	403	-6%	284	-33%
42	Vtr1 (0.7)	-0.15	1430	8%	475	16%	47	0%	379	0%	394	3%	2191	5%	674	8%	1351	2%	451	5%	481	14%
43		-0.05	1470	11%	562	37%	48	2%	470	24%	387	1%	2142	3%	626	0%	1415	7%	471	10%	497	18%
44		+0.05	1306	-2%	401	-2%	47	0%	371	-2%	382	0%	2071	-1%	638	2%	1289	-3%	422	-1%	415	-1%
45		+0.15	1217	-8%	385	-6%	44	-6%	354	-6%	378	-1%	1852	-11%	615	-2%	1240	-6%	408	-5%	286	-32%
46	Vtr2 (0.5, 0.6)	-0.15	1577	19%	529	29%	44	-6%	389	3%	395	3%	2253	8%	762	22%	1417	7%	483	13%	470	12%
47		-0.05	1496	13%	472	15%	42	-11%	381	1%	391	2%	2183	5%	763	22%	1344	1%	451	5%	469	11%
48		+0.05	1234	-7%	387	-6%	48	2%	340	-10%	381	0%	1958	-6%	658	5%	1300	-2%	423	-1%	395	-6%
49		+0.15	1198	-10%	334	-19%	46	-2%	299	-21%	367	-4%	1653	-21%	617	-1%	1182	-11%	397	-7%	275	-35%

Table 4.3-4
SCE Results and Observations for the Stressed Case: Motor C

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	1327	-	410	-	47	-	378	-	382	-	2088	-	626	-	1326	-	428	-	421	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	1519	14%	575	40%	48	2%	433	15%	387	1%	2209	6%	526	-16%	1405	6%	391	-9%	403	-4%
3		-0.1	1375	4%	460	12%	47	0%	407	8%	385	1%	2167	4%	597	-5%	1359	2%	402	-6%	413	-2%
4		+0.1	1276	-4%	384	-6%	44	-6%	364	-4%	378	-1%	2029	-3%	730	17%	1294	-2%	460	7%	437	4%
5		+0.2	1169	-12%	355	-13%	43	-9%	357	-6%	362	-5%	1933	-7%	815	30%	1294	-2%	481	12%	447	6%
6	Ftr2 (0, 0.5, 0.7)	-0.2	1465	10%	515	26%	43	-9%	407	8%	386	1%	2141	3%	710	13%	1381	4%	455	6%	451	7%
7		-0.1	1394	5%	438	7%	45	-4%	399	6%	385	1%	2138	2%	697	11%	1363	3%	444	4%	440	5%
8		+0.1	1264	-5%	388	-5%	47	0%	366	-3%	374	-2%	2057	-1%	609	-3%	1259	-5%	405	-5%	400	-5%
9		+0.2	1181	-11%	355	-13%	40	-15%	362	-4%	374	-2%	1956	-6%	668	7%	1260	-5%	391	-9%	388	-8%
10	H (0.1, 0.15, 0.2)	-50%	1301	-2%	406	-1%	43	-9%	380	1%	383	0%	2103	1%	666	6%	1351	2%	438	2%	432	3%
11		-25%	1318	-1%	410	0%	45	-4%	378	0%	382	0%	2099	1%	652	4%	1328	0%	435	2%	425	1%
12		+50%	1335	1%	411	0%	46	-2%	376	-1%	381	0%	2049	-2%	644	3%	1297	-2%	423	-1%	410	-3%
13		+100%	1371	3%	425	4%	51	9%	372	-2%	382	0%	2065	-1%	621	-1%	1288	-3%	416	-3%	408	-3%
14	Ls (1.8, 3.1)	-50%	1405	6%	489	19%	44	-6%	420	11%	382	0%	2123	2%	697	11%	1412	6%	455	6%	445	6%
15		-25%	1354	2%	418	2%	45	-4%	399	6%	382	0%	2110	1%	643	3%	1347	2%	443	4%	433	3%
16		+50%	1304	-2%	394	-4%	49	4%	373	-1%	383	0%	2114	1%	605	-3%	1289	-3%	402	-6%	402	-5%
17		+100%	1313	-1%	402	-2%	46	-2%	368	-3%	383	0%	2111	1%	613	-2%	1281	-3%	403	-6%	393	-7%
18	Tpo (0.095, 0.8)	-50%	1280	-4%	379	-8%	49	4%	365	-3%	382	0%	2146	3%	628	0%	1277	-4%	398	-7%	395	-6%
19		-25%	1281	-3%	399	-3%	47	0%	368	-3%	382	0%	2109	1%	619	-1%	1287	-3%	418	-2%	407	-3%
20		+50%	1379	4%	478	17%	47	0%	407	8%	379	-1%	2079	0%	662	6%	1369	3%	438	2%	434	3%
21		+100%	1560	18%	637	55%	49	4%	462	22%	380	-1%	2076	-1%	628	0%	1469	11%	450	5%	449	7%
22	Trc2 (0.1, 0.25)	-0.05	1339	1%	418	2%	47	0%	380	1%	385	1%	2110	1%	628	0%	1296	-2%	399	-7%	430	2%
23		+0.05	1332	0%	410	0%	47	0%	378	0%	382	0%	2093	0%	628	0%	1325	0%	427	0%	422	0%
24		+0.1	1316	-1%	410	0%	48	2%	371	-2%	382	0%	2077	-1%	650	4%	1327	0%	449	5%	415	-1%
25		+0.25	1310	-1%	410	0%	47	0%	372	-2%	382	0%	2073	-1%	650	4%	1327	0%	446	4%	410	-3%
26	Ttr1 (0.02, 0.05, 1)	-0.05	1305	-2%	396	-3%	46	-2%	376	-1%	376	-2%	2088	0%	641	2%	1315	-1%	422	-1%	404	-4%
27		+0.05	1409	6%	426	4%	49	4%	394	4%	383	0%	2148	3%	656	5%	1345	1%	443	4%	433	3%
28		+0.25	1434	8%	475	16%	48	2%	398	5%	385	1%	2161	3%	644	3%	1351	2%	453	6%	435	3%
29		+0.5	1487	12%	552	35%	50	6%	424	12%	387	1%	2165	4%	637	2%	1418	7%	458	7%	454	8%
30	Ttr2 (0.02, 0.05, 1)	-0.05	1321	0%	409	0%	48	2%	371	-2%	385	1%	2182	5%	697	11%	1318	-1%	415	-3%	416	-1%
31		+0.05	1453	9%	467	14%	45	-4%	401	6%	381	0%	2070	-1%	718	15%	1371	3%	460	7%	460	9%
32		+0.25	1542	16%	535	30%	45	-4%	427	13%	380	-1%	2047	-2%	716	14%	1448	9%	467	9%	474	13%
33		+0.5	1606	21%	616	50%	45	-4%	436	15%	379	-1%	2035	-3%	716	14%	1469	11%	466	9%	482	14%
34	Vrc1 (1)	-0.25	1327	0%	410	0%	47	0%	378	0%	382	0%	2087	0%	627	0%	1326	0%	428	0%	421	0%
35		-0.15	1327	0%	410	0%	47	0%	378	0%	382	0%	2087	0%	627	0%	1326	0%	428	0%	421	0%
36		-0.05	1327	0%	410	0%	47	0%	378	0%	382	0%	2087	0%	627	0%	1326	0%	428	0%	421	0%
37		+0.05	1327	0%	410	0%	47	0%	378	0%	382	0%	2087	0%	627	0%	1326	0%	428	0%	421	0%

Table 4.3-4 (continued)
SCE Results and Observations for the Stressed Case: Motor C

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	1327	-	410	-	47	-	378	-	382	-	2088	-	626	-	1326	-	428	-	421	-
38	Vrc2 (0.7, 1)	-0.2	1353	2%	457	11%	50	6%	405	7%	385	1%	2131	2%	631	1%	1380	4%	406	-5%	433	3%
39		-0.1	1354	2%	454	11%	48	2%	400	6%	385	1%	2124	2%	629	0%	1355	2%	400	-7%	429	2%
40		+0.1	1293	-3%	394	-4%	47	0%	373	-1%	370	-3%	2056	-2%	625	0%	1296	-2%	455	6%	383	-9%
41		+0.2	1293	-3%	393	-4%	46	-2%	376	-1%	370	-3%	2053	-2%	620	-1%	1306	-2%	462	8%	347	-18%
42	Vtr1 (0.7)	-0.15	1350	2%	431	5%	48	2%	408	8%	384	1%	2133	2%	610	-3%	1364	3%	413	-4%	395	-6%
43		-0.05	1344	1%	412	0%	47	0%	379	0%	383	0%	2105	1%	622	-1%	1355	2%	427	0%	408	-3%
44		+0.05	1286	-3%	385	-6%	48	2%	368	-3%	382	0%	2064	-1%	635	1%	1273	-4%	427	0%	423	0%
45		+0.15	1258	-5%	382	-7%	49	4%	365	-3%	381	0%	2011	-4%	665	6%	1277	-4%	431	1%	446	6%
46	Vtr2 (0.5, 0.6)	-0.15	1558	17%	590	44%	45	-4%	431	14%	387	1%	2178	4%	715	14%	1451	9%	403	-6%	474	13%
47		-0.05	1490	12%	516	26%	42	-11%	417	10%	386	1%	2158	3%	738	18%	1376	4%	412	-4%	462	10%
48		+0.05	1300	-2%	408	0%	49	4%	377	0%	380	-1%	2054	-2%	668	7%	1308	-1%	450	5%	414	-2%
49		+0.15	1284	-3%	387	-6%	47	0%	363	-4%	377	-1%	1971	-6%	656	5%	1292	-3%	452	6%	356	-15%

Table 4.3-5
SCE Results and Observations for the Stressed Case: Motor D

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. within 8 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	1287	-	394	-	47	-	377	-	374	-	2020	-	565	-	1315	-	400	-	404	-
2	FmD (varies)	-40%	803	-38%	248	-37%	35	-26%	351	-7%	319	-15%	1170	-42%	130	-77%	1068	-19%	289	-28%	201	-50%
3		-20%	1011	-21%	319	-19%	40	-15%	352	-7%	337	-10%	1525	-25%	367	-35%	935	-29%	322	-20%	242	-40%
4		-10%	1128	-12%	372	-6%	42	-11%	355	-6%	351	-6%	1780	-12%	417	-26%	1083	-18%	344	-14%	296	-27%
5		+10%	1556	21%	539	37%	47	0%	439	16%	389	4%	2528	25%	681	21%	1614	23%	436	9%	516	28%
6		+20%	2011	56%	786	99%	59	26%	561	49%	432	16%	2533	25%	863	53%	1669	27%	426	6%	569	41%
7		+40%	2674	108%	1390	253%	122	160%	899	138%	996	166%	3346	66%	1549	174%	1881	43%	618	55%	1416	250%
8	Fuvr (0.1)	0	1571	22%	528	34%	46	-2%	444	18%	398	6%	2574	27%	655	16%	977	-26%	248	-38%	471	17%
9		0.05	1484	15%	470	19%	46	-2%	419	11%	384	3%	2396	19%	638	13%	987	-25%	317	-21%	472	17%
10		0.15	1174	-9%	383	-3%	46	-2%	366	-3%	359	-4%	1893	-6%	582	3%	1356	3%	411	3%	356	-12%
11		0.2	1044	-19%	341	-13%	47	0%	352	-7%	346	-7%	1655	-18%	525	-7%	1386	5%	417	4%	287	-29%
12		0.25	972	-24%	317	-20%	47	0%	351	-7%	339	-9%	1437	-29%	500	-12%	1556	18%	430	8%	275	-32%
13		0.5	673	-48%	188	-52%	39	-17%	351	-7%	313	-16%	805	-60%	510	-10%	1677	28%	437	9%	230	-43%
14	Th1t (0.7)	0.4	1287	0%	394	0%	46	-2%	377	0%	349	-7%	1566	-22%	615	9%	1345	2%	461	15%	286	-29%
15		0.55	1287	0%	394	0%	47	0%	377	0%	373	0%	1729	-14%	617	9%	1319	0%	433	8%	300	-26%
16		0.65	1287	0%	394	0%	47	0%	377	0%	374	0%	1929	-5%	634	12%	1318	0%	425	6%	352	-13%
17		0.75	1287	0%	394	0%	46	-2%	377	0%	374	0%	2087	3%	633	12%	1315	0%	320	-20%	445	10%
18		0.85	1287	0%	394	0%	46	-2%	377	0%	374	0%	2161	7%	617	9%	1315	0%	236	-41%	457	13%
19		0.9	1287	0%	394	0%	46	-2%	377	0%	374	0%	2175	8%	598	6%	1315	0%	185	-54%	457	13%
20	Th2t (1.2)	1	1287	0%	394	0%	63	34%	377	0%	374	0%	1349	-33%	526	-7%	2930	123%	1219	205%	293	-27%
21		1.1	1287	0%	394	0%	62	32%	377	0%	374	0%	1532	-24%	504	-11%	2295	75%	1585	296%	304	-25%
22		1.3	1287	0%	394	0%	68	45%	377	0%	374	0%	2038	1%	566	0%	1298	-1%	352	-12%	410	1%
23		1.4	1287	0%	394	0%	62	32%	377	0%	374	0%	2091	4%	583	3%	1294	-2%	305	-24%	422	4%
24		2	1287	0%	394	0%	44	-6%	377	0%	374	0%	2175	8%	630	12%	1277	-3%	244	-39%	449	11%
25		3	1287	0%	394	0%	25	-47%	377	0%	374	0%	2220	10%	366	-35%	1272	-3%	101	-75%	479	19%
26	Tstall (0.033)	0.01667	1777	38%	646	64%	51	9%	481	28%	382	2%	2608	29%	607	7%	1078	-18%	513	28%	533	32%
27		0.0667	1019	-21%	363	-8%	49	4%	352	-7%	337	-10%	1413	-30%	393	-30%	1706	30%	228	-43%	286	-29%
28		0.08335	833	-35%	314	-20%	41	-13%	352	-7%	322	-14%	1060	-48%	131	-77%	2125	62%	187	-53%	206	-49%
29		0.1	706	-45%	274	-30%	41	-13%	352	-7%	315	-16%	953	-53%	99	-82%	2402	83%	177	-56%	187	-54%
30		0.1667	653	-49%	248	-37%	40	-15%	352	-7%	315	-16%	925	-54%	96	-83%	3032	131%	145	-64%	178	-56%
31		0.25	509	-60%	217	-45%	37	-21%	352	-7%	312	-17%	778	-61%	-13	-102%	3684	180%	162	-60%	136	-66%
32	Tth (15)	5	1286	0%	394	0%	57	21%	377	0%	312	-17%	777	-62%	532	-6%	3158	140%	615	54%	287	-29%
33		10	1287	0%	394	0%	55	17%	377	0%	367	-2%	1411	-30%	567	0%	1391	6%	668	67%	264	-35%
34		12	1287	0%	394	0%	52	11%	377	0%	374	0%	1703	-16%	614	9%	1354	3%	605	51%	305	-25%
35		17	1287	0%	394	0%	44	-6%	377	0%	374	0%	2123	5%	602	7%	1311	0%	156	-61%	442	9%
36		20	1287	0%	394	0%	29	-38%	377	0%	374	0%	2172	8%	569	1%	1309	0%	115	-71%	455	13%
37		25	1287	0%	394	0%	30	-36%	377	0%	374	0%	2191	8%	447	-21%	1305	-1%	100	-75%	474	17%

Table 4.3-5 (continued)
SCE Results and Observations for the Stressed Case: Motor D

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. within 8 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	1287	-	394	-	47	-	377	-	374	-	2020	-	565	-	1315	-	400	-	404	-
38	Vc1Vc2	Min	2764	115%	1416	259%	103	119%	649	72%	1272	240%	2483	23%	1081	91%	1014	-23%	554	39%	886	119%
39		R1	1006	-22%	327	-17%	51	9%	372	-1%	345	-8%	1748	-13%	666	18%	1135	-14%	537	34%	402	0%
40		R2	1006	-22%	327	-17%	51	9%	372	-1%	345	-8%	1748	-13%	666	18%	1135	-14%	537	34%	402	0%
41		R3	798	-38%	276	-30%	43	-9%	353	-6%	332	-11%	1502	-26%	513	-9%	923	-30%	407	2%	322	-20%
42		R4	527	-59%	181	-54%	44	-6%	351	-7%	316	-16%	1000	-50%	422	-25%	1467	12%	383	-4%	220	-46%
43		Max	717	-44%	225	-43%	43	-9%	352	-7%	325	-13%	1207	-40%	621	10%	1118	-15%	440	10%	291	-28%
44	Vrst (0.95)	0.5	1245	-3%	392	-1%	46	-2%	360	-5%	356	-5%	1797	-11%	470	-17%	1333	1%	373	-7%	313	-23%
45		0.7	1287	0%	394	0%	47	0%	377	0%	374	0%	1910	-5%	457	-19%	1346	2%	368	-8%	321	-21%
46		0.8	1287	0%	394	0%	48	2%	377	0%	374	0%	1992	-1%	551	-2%	1337	2%	364	-9%	372	-8%
47		0.85	1287	0%	394	0%	48	2%	377	0%	374	0%	1993	-1%	573	1%	1332	1%	373	-7%	386	-4%
48		0.9	1287	0%	394	0%	48	2%	377	0%	374	0%	2002	-1%	598	6%	1330	1%	380	-5%	399	-1%
49		1	1287	0%	394	0%	47	0%	377	0%	374	0%	2024	0%	659	17%	1310	0%	424	6%	448	11%
50	Vstall (0.5)	0.3	608	-53%	279	-29%	37	-21%	352	-7%	314	-16%	837	-59%	138	-76%	2358	79%	159	-60%	134	-67%
51		0.4	598	-54%	256	-35%	36	-23%	352	-7%	313	-16%	859	-57%	134	-76%	2124	62%	154	-62%	141	-65%
52		0.45	713	-45%	267	-32%	37	-21%	352	-7%	313	-16%	886	-56%	159	-72%	1939	47%	155	-61%	151	-63%
53		0.55	1476	15%	487	24%	50	6%	412	9%	381	2%	2207	9%	597	6%	1291	-2%	431	8%	458	13%
54		0.6	1458	13%	452	15%	49	4%	380	1%	391	5%	2193	9%	656	16%	1277	-3%	447	12%	457	13%
55		0.8	4376	240%	1546	292%	199	323%	592	57%	925	147%	4251	110%	2642	388%	1252	-5%	2183	446%	2057	409%

The amount of total load loss at each load bus in SCE for each contingency and sensitivity parameter analyzed for the Stressed Case was recorded. Tables 4.3-6 through 4.3-9 list the total load loss for each of the five contingencies and sensitivities examined for Motor A, Motor B, Motor C, and Motor D, respectively. The tables list the contingency, the amount of load loss, the percent change from the Phase 2 base case and the respective sensitivity parameter. For Motor A Contingency #6 in Table 4.3-6, the Phase 2 base case loss total was 4,792 MW. For sensitivity parameter Ftr1, 6,560 MW of load was loss after increasing each motor trip fraction by a factor of 0.2, which is an increase of 37% from the Phase 2 base case. For the same contingency and parameter, 4,701 MW of load was loss after decreasing each motor trip fraction by a factor of 0.2, which is a decrease of 2% from the Phase 2 base case.

Table 4.3-6
SCE Results and Observations for the Stressed Case: Motor A Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #5		Contingency #6	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	6381	-	5224	-	5334	-	5226	-	5702	-	4792	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	-	N/A	4744	-9%	4844	-9%	4755	-9%	5338	-6%	4701	-2%
3		-0.1	6132	-4%	5001	-4%	5092	-5%	4990	-5%	5528	-3%	4787	0%
4		+0.1	8078	27%	6485	24%	6638	24%	6350	22%	6932	22%	6402	34%
5		+0.2	7610	19%	6525	25%	6654	25%	6448	23%	7049	24%	6560	37%
6	Ftr2 (0, 0.5, 0.7)	-0.2	7444	17%	5292	1%	5391	1%	5284	1%	5854	3%	5266	10%
7		-0.1	6525	2%	5246	0%	5358	0%	5244	0%	5814	2%	5035	5%
8		+0.1	6274	-2%	5191	-1%	5300	-1%	5180	-1%	5634	-1%	4536	-5%
9		+0.2	6234	-2%	4920	-6%	5039	-6%	4901	-6%	5353	-6%	4143	-14%
10	H (0.1, 0.15, 0.2)	-50%	6863	8%	5216	0%	5330	0%	5219	0%	5721	0%	4423	-8%
11		-25%	6745	6%	5220	0%	5334	0%	5226	0%	5715	0%	4638	-3%
12		+50%	6307	-1%	5269	1%	5379	1%	5263	1%	5633	-1%	4945	3%
13		+100%	6123	-4%	5257	1%	5370	1%	5291	1%	5585	-2%	4997	4%
14	Ls (1.8, 3.1)	-50%	5822	-9%	4875	-7%	4993	-6%	4882	-7%	5321	-7%	4233	-12%
15		-25%	6198	-3%	4913	-6%	5256	-1%	4946	-5%	5606	-2%	4485	-6%
16		+50%	6456	1%	5319	2%	5434	2%	5316	2%	5868	3%	5195	8%
17		+100%	6513	2%	5372	3%	5484	3%	5390	3%	5788	2%	5199	9%
18	Tpo (0.095, 0.8)	-50%	6295	-1%	5269	1%	5380	1%	5263	1%	5613	-2%	5013	5%
19		-25%	6342	-1%	5274	1%	5386	1%	5266	1%	5671	-1%	5036	5%
20		+50%	6451	1%	5100	-2%	5215	-2%	5094	-3%	5733	1%	4610	-4%
21		+100%	6820	7%	5095	-2%	5209	-2%	5083	-3%	5783	1%	4422	-8%
22	Trc2 (0.1, 0.25)	-0.05	6352	0%	5245	0%	5348	0%	5228	0%	5643	-1%	4792	0%
23		+0.05	6384	0%	5236	0%	5349	0%	5228	0%	5744	1%	4792	0%
24		+0.1	6427	1%	5246	0%	5349	0%	5228	0%	5742	1%	4792	0%
25		+0.25	6665	4%	5235	0%	5349	0%	5227	0%	5742	1%	4792	0%
26	Ttr1 (0.02, 0.05, 1)	-0.05	6368	0%	5234	0%	5341	0%	5224	0%	5648	-1%	4642	-3%
27		+0.05	6392	0%	5236	0%	5343	0%	5242	0%	5763	1%	5196	8%
28		+0.25	7127	12%	5188	-1%	5279	-1%	5191	-1%	5819	2%	5164	8%
29		+0.5	8765	37%	5168	-1%	5264	-1%	5172	-1%	5838	2%	5152	8%
30	Ttr2 (0.02, 0.05, 1)	-0.05	6143	-4%	5212	0%	5285	-1%	5173	-1%	5737	1%	4761	-1%
31		+0.05	6546	3%	5357	3%	5457	2%	5359	3%	5822	2%	5304	11%
32		+0.25	7441	17%	5381	3%	5503	3%	5461	5%	6208	9%	5308	11%
33		+0.5	8765	37%	5381	3%	5503	3%	5461	5%	-	N/A	5308	11%
34	Vrc1 (1)	-0.25	6398	0%	5236	0%	5348	0%	5226	0%	5743	1%	4809	0%
35		-0.15	6398	0%	5236	0%	5348	0%	5226	0%	5743	1%	4809	0%
36		-0.05	6398	0%	5236	0%	5348	0%	5226	0%	5743	1%	4809	0%
37		+0.05	6398	0%	5236	0%	5348	0%	5226	0%	5743	1%	4809	0%
38	Vrc2 (0.7, 1)	-0.2	6274	-2%	5258	1%	5411	1%	5264	1%	5795	2%	5222	9%
39		-0.1	6350	0%	5254	1%	5377	1%	5258	1%	5762	1%	4809	0%
40		+0.1	6672	5%	5243	0%	5328	0%	5228	0%	5643	-1%	4795	0%
41		+0.2	6491	2%	5245	0%	5314	0%	5235	0%	5652	-1%	4793	0%
42	Vtr1 (0.7)	-0.15	6357	0%	5193	-1%	5275	-1%	5182	-1%	5654	-1%	4534	-5%
43		-0.05	6371	0%	5227	0%	5310	0%	5212	0%	5667	-1%	4715	-2%
44		+0.05	6388	0%	5256	1%	5354	0%	5245	0%	5810	2%	4935	3%
45		+0.15	7505	18%	5521	6%	5623	5%	5514	6%	5944	4%	4947	3%
46	Vtr2 (0.5, 0.6)	-0.15	-	N/A	5373	3%	5495	3%	5406	3%	5932	4%	5312	11%
47		-0.05	8211	29%	5323	2%	5435	2%	5314	2%	5833	2%	5296	11%
48		+0.05	5463	-14%	5123	-2%	5271	-1%	5156	-1%	5600	-2%	4729	-1%
49		+0.15	3740	-41%	5029	-4%	5143	-4%	5025	-4%	5392	-5%	4678	-2%

Table 4.3-7
SCE Results and Observations for the Stressed Case: Motor B Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #5		Contingency #6	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	6381	-	5224	-	5334	-	5226	-	5702	-	4792	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	-	N/A	5256	1%	5651	6%	5246	0%	5724	0%	4952	3%
3		-0.1	7130	12%	5245	0%	5571	4%	5237	0%	5709	0%	4890	2%
4		+0.1	6331	-1%	5259	1%	5164	-3%	5250	0%	5725	0%	4674	-2%
5		+0.2	5608	-12%	5210	0%	5093	-5%	5196	-1%	5669	-1%	4661	-3%
6	Ftr2 (0, 0.5, 0.7)	-0.2	7837	23%	5253	1%	5748	8%	5239	0%	5721	0%	4915	3%
7		-0.1	6434	1%	5243	0%	5575	5%	5236	0%	5712	0%	4896	2%
8		+0.1	6240	-2%	5221	0%	5127	-4%	5215	0%	5685	0%	4762	-1%
9		+0.2	6209	-3%	5048	-3%	4960	-7%	5042	-4%	5509	-3%	4788	0%
10	H (0.1, 0.15, 0.2)	-50%	6584	3%	5294	1%	5190	-3%	5274	1%	5759	1%	4873	2%
11		-25%	6415	1%	5265	1%	5209	-2%	5245	0%	5731	1%	4884	2%
12		+50%	6331	-1%	5231	0%	5406	1%	5220	0%	5696	0%	4704	-2%
13		+100%	6328	-1%	5221	0%	5447	2%	5214	0%	5687	0%	4595	-4%
14	Ls (1.8, 3.1)	-50%	6507	2%	5255	1%	5444	2%	5243	0%	5721	0%	4811	0%
15		-25%	6423	1%	5249	0%	5382	1%	5240	0%	5721	0%	4875	2%
16		+50%	6272	-2%	5253	1%	5334	0%	5241	0%	5718	0%	4710	-2%
17		+100%	6132	-4%	5223	0%	5122	-4%	5221	0%	5690	0%	4624	-4%
18	Tpo (0.095, 0.8)	-50%	6053	-5%	5161	-1%	5108	-4%	5172	-1%	5622	-1%	4547	-5%
19		-25%	6280	-2%	5248	0%	5224	-2%	5241	0%	5712	0%	4670	-3%
20		+50%	6777	6%	5271	1%	5533	4%	5249	0%	5741	1%	4911	2%
21		+100%	-	N/A	5341	2%	5664	6%	5315	2%	5802	2%	4918	3%
22	Trc2 (0.1, 0.25)	-0.05	6388	0%	5236	0%	5332	0%	5225	0%	5706	0%	4729	-1%
23		+0.05	6648	4%	5237	0%	5331	0%	5225	0%	5704	0%	4832	1%
24		+0.1	6745	6%	5235	0%	5333	0%	5227	0%	5704	0%	4833	1%
25		+0.25	6715	5%	5236	0%	5332	0%	5227	0%	5703	0%	4831	1%
26	Ttr1 (0.02, 0.05, 1)	-0.05	6338	-1%	5294	1%	5276	-1%	5275	1%	5762	1%	4759	-1%
27		+0.05	6482	2%	5180	-1%	5650	6%	5228	0%	5701	0%	4801	0%
28		+0.25	6787	6%	5142	-2%	5643	6%	5229	0%	5696	0%	4934	3%
29		+0.5	8234	29%	5143	-2%	5644	6%	5227	0%	5689	0%	4950	3%
30	Ttr2 (0.02, 0.05, 1)	-0.05	6379	0%	5177	-1%	5283	-1%	5164	-1%	5647	-1%	4696	-2%
31		+0.05	6703	5%	5331	2%	5806	9%	5307	2%	5792	2%	4897	2%
32		+0.25	6520	2%	5334	2%	5804	9%	5317	2%	5801	2%	4964	4%
33		+0.5	-	N/A	5334	2%	5804	9%	5317	2%	5837	2%	4964	4%
34	Vrc1 (1)	-0.25	6687	5%	5239	0%	5331	0%	5234	0%	5704	0%	4893	2%
35		-0.15	6780	6%	5239	0%	5332	0%	5235	0%	5705	0%	4839	1%
36		-0.05	6555	3%	5237	0%	5331	0%	5231	0%	5704	0%	4831	1%
37		+0.05	6191	-3%	5237	0%	5333	0%	5235	0%	5703	0%	4733	-1%
38	Vrc2 (0.7, 1)	-0.2	7148	12%	5236	0%	5339	0%	5228	0%	5707	0%	4931	3%
39		-0.1	6514	2%	5239	0%	5373	1%	5227	0%	5706	0%	4896	2%
40		+0.1	6382	0%	5233	0%	5331	0%	5226	0%	5697	0%	4731	-1%
41		+0.2	6390	0%	5235	0%	5333	0%	5236	0%	5703	0%	4738	-1%
42	Vtr1 (0.7)	-0.15	-	N/A	5253	1%	5650	6%	5239	0%	5724	0%	4888	2%
43		-0.05	6752	6%	5241	0%	5327	0%	5232	0%	5711	0%	4795	0%
44		+0.05	6320	-1%	5242	0%	5350	0%	5231	0%	5709	0%	4800	0%
45		+0.15	6229	-2%	5261	1%	5325	0%	5255	1%	5726	0%	4685	-2%
46	Vtr2 (0.5, 0.6)	-0.15	-	N/A	5333	2%	5804	9%	5313	2%	5804	2%	4966	4%
47		-0.05	-	N/A	5279	1%	5805	9%	5272	1%	5748	1%	4896	2%
48		+0.05	6395	0%	5261	1%	5322	0%	5160	-1%	5636	-1%	4783	0%
49		+0.15	5746	-10%	5251	1%	5312	0%	5145	-2%	5619	-1%	4654	-3%

Table 4.3-8
SCE Results and Observations for the Stressed Case: Motor C Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #5		Contingency #6	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	6381	-	5224	-	5334	-	5226	-	5702	-	4792	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	6365	0%	5078	-3%	5193	-3%	5088	-3%	5610	-2%	4871	2%
3		-0.1	6294	-1%	5145	-2%	5259	-1%	5138	-2%	5698	0%	4950	3%
4		+0.1	6431	1%	5362	3%	5469	3%	5351	2%	5813	2%	4786	0%
5		+0.2	6514	2%	5424	4%	5541	4%	5415	4%	5759	1%	4780	0%
6	Ftr2 (0, 0.5, 0.7)	-0.2	6431	1%	5245	0%	5360	1%	5237	0%	5809	2%	5034	5%
7		-0.1	6462	1%	5239	0%	5356	0%	5234	0%	5785	1%	5039	5%
8		+0.1	6339	-1%	5222	0%	5331	0%	5210	0%	5701	0%	4650	-3%
9		+0.2	6260	-2%	5228	0%	5339	0%	5218	0%	5679	0%	4654	-3%
10	H (0.1, 0.15, 0.2)	-50%	6357	0%	5237	0%	5363	1%	5231	0%	5754	1%	4788	0%
11		-25%	6345	-1%	5237	0%	5351	0%	5228	0%	5748	1%	4788	0%
12		+50%	6658	4%	5232	0%	5348	0%	5226	0%	5680	0%	4754	-1%
13		+100%	6713	5%	5271	1%	5381	1%	5260	1%	5676	0%	4736	-1%
14	Ls (1.8, 3.1)	-50%	6438	1%	5192	-1%	5306	-1%	5183	-1%	5602	-2%	4746	-1%
15		-25%	6487	2%	5219	0%	5331	0%	5219	0%	5676	0%	4752	-1%
16		+50%	6375	0%	5282	1%	5393	1%	5273	1%	5796	2%	4836	1%
17		+100%	6346	-1%	5286	1%	5396	1%	5274	1%	5757	1%	4854	1%
18	Tpo (0.095, 0.8)	-50%	6293	-1%	5268	1%	5384	1%	5259	1%	5740	1%	4757	-1%
19		-25%	6367	0%	5236	0%	5345	0%	5223	0%	5741	1%	4745	-1%
20		+50%	6415	1%	5234	0%	5346	0%	5228	0%	5693	0%	4947	3%
21		+100%	6725	5%	5240	0%	5347	0%	5233	0%	5681	0%	4781	0%
22	Trc2 (0.1, 0.25)	-0.05	6557	3%	5235	0%	5349	0%	5228	0%	5741	1%	4792	0%
23		+0.05	6363	0%	5236	0%	5347	0%	5230	0%	5742	1%	4791	0%
24		+0.1	6385	0%	5236	0%	5358	0%	5226	0%	5703	0%	4792	0%
25		+0.25	6374	0%	5237	0%	5349	0%	5228	0%	5702	0%	4792	0%
26	Ttr1 (0.02, 0.05, 1)	-0.05	6313	-1%	5182	-1%	5304	-1%	5173	-1%	5737	1%	4988	4%
27		+0.05	6356	0%	5174	-1%	5295	-1%	5164	-1%	5755	1%	4974	4%
28		+0.25	6691	5%	5298	1%	5408	1%	5289	1%	5725	0%	4703	-2%
29		+0.5	6697	5%	5215	0%	5334	0%	5207	0%	5698	0%	4681	-2%
30	Ttr2 (0.02, 0.05, 1)	-0.05	6541	3%	5252	1%	5362	1%	5245	0%	5818	2%	5123	7%
31		+0.05	6380	0%	5220	0%	5299	-1%	5245	0%	5713	0%	4735	-1%
32		+0.25	6378	0%	5213	0%	5288	-1%	5245	0%	5705	0%	4728	-1%
33		+0.5	6371	0%	5185	-1%	5262	-1%	5244	0%	5707	0%	4724	-1%
34	Vrc1 (1)	-0.25	6381	0%	5237	0%	5349	0%	5226	0%	5702	0%	4809	0%
35		-0.15	6381	0%	5237	0%	5349	0%	5226	0%	5702	0%	4809	0%
36		-0.05	6381	0%	5237	0%	5349	0%	5226	0%	5702	0%	4809	0%
37		+0.05	6381	0%	5237	0%	5349	0%	5226	0%	5702	0%	4809	0%
38	Vrc2 (0.7, 1)	-0.2	6554	3%	5237	0%	5363	1%	5229	0%	5784	1%	4791	0%
39		-0.1	6435	1%	5237	0%	5345	0%	5229	0%	5743	1%	4791	0%
40		+0.1	6381	0%	5237	0%	5350	0%	5224	0%	5702	0%	4792	0%
41		+0.2	6380	0%	5233	0%	5351	0%	5227	0%	5702	0%	4876	2%
42	Vtr1 (0.7)	-0.15	6329	-1%	5208	0%	5321	0%	5200	-1%	5662	-1%	4757	-1%
43		-0.05	6351	0%	5214	0%	5323	0%	5204	0%	5726	0%	4783	0%
44		+0.05	6351	0%	5249	0%	5356	0%	5238	0%	5745	1%	4802	0%
45		+0.15	6472	1%	5298	1%	5403	1%	5292	1%	5776	1%	5263	10%
46	Vtr2 (0.5, 0.6)	-0.15	6524	2%	5251	1%	5363	1%	5245	0%	5818	2%	5122	7%
47		-0.05	6431	1%	5242	0%	5354	0%	5233	0%	5806	2%	5123	7%
48		+0.05	6386	0%	5173	-1%	5283	-1%	5162	-1%	5646	-1%	4735	-1%
49		+0.15	6279	-2%	5168	-1%	5284	-1%	5142	-2%	5600	-2%	4731	-1%

Table 4.3-9
SCE Results and Observations for the Stressed Case: Motor D Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #5		Contingency #6	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	6381	-	5224	-	5334	-	5226	-	5702	-	4792	-
2	FmD (varies)	-40%	2568	-60%	3193	-39%	3297	-38%	3191	-39%	3547	-38%	2999	-37%
3		-20%	4000	-37%	4280	-18%	4379	-18%	4270	-18%	4521	-21%	3854	-20%
4		-10%	5116	-20%	4766	-9%	4889	-8%	4761	-9%	5069	-11%	4181	-13%
5		+10%	7164	12%	5771	10%	5861	10%	5758	10%	6326	11%	5230	9%
6		+20%	7772	22%	6487	24%	6560	23%	6506	24%	6974	22%	6161	29%
7		+40%	13609	113%	7508	44%	7605	43%	7513	44%	8241	45%	7427	55%
8	Fuvr (0.1)	0	6440	1%	5244	0%	5349	0%	5234	0%	5759	1%	5168	8%
9		0.05	6393	0%	5240	0%	5343	0%	5234	0%	5804	2%	5010	5%
10		0.15	5816	-9%	5247	0%	5363	1%	5238	0%	5641	-1%	4625	-3%
11		0.2	5441	-15%	5189	-1%	5307	-1%	5180	-1%	5601	-2%	4534	-5%
12		0.25	5194	-19%	5148	-1%	5268	-1%	5141	-2%	5574	-2%	4206	-12%
13		0.5	4195	-34%	5000	-4%	5114	-4%	4984	-5%	5518	-3%	4404	-8%
14	Th1t (0.7)	0.4	6336	-1%	5216	0%	5332	0%	5208	0%	5663	-1%	4746	-1%
15		0.55	6355	0%	5219	0%	5338	0%	5210	0%	5666	-1%	4751	-1%
16		0.65	6357	0%	5241	0%	5336	0%	5213	0%	5670	-1%	4758	-1%
17		0.75	6383	0%	5226	0%	5336	0%	5220	0%	5779	1%	4862	1%
18		0.85	6400	0%	5240	0%	5349	0%	5230	0%	5792	2%	4864	2%
19		0.9	6418	1%	5247	0%	5362	1%	5236	0%	5799	2%	4864	2%
20	Th2t (1.2)	1	6392	0%	5457	4%	5426	2%	5418	4%	5911	4%	4971	4%
21		1.1	6385	0%	5336	2%	5422	2%	5396	3%	5932	4%	4903	2%
22		1.3	5924	-7%	5224	0%	5301	-1%	5201	0%	5692	0%	4792	0%
23		1.4	5907	-7%	5220	0%	5283	-1%	5194	-1%	5643	-1%	4784	0%
24		2	5845	-8%	5203	0%	5143	-4%	5146	-2%	5631	-1%	4771	0%
25		3	4107	-36%	4281	-18%	3884	-27%	4211	-19%	4576	-20%	4167	-13%
26	Tstall (0.033)	0.01667	6552	3%	5345	2%	5453	2%	5336	2%	5846	3%	5233	9%
27		0.0667	4017	-37%	4337	-17%	4293	-20%	4330	-17%	5417	-5%	2631	-45%
28		0.08335	3728	-42%	2731	-48%	2800	-48%	2731	-48%	5296	-7%	2536	-47%
29		0.1	2042	-68%	2004	-62%	2061	-61%	2003	-62%	5259	-8%	1975	-59%
30		0.1667	1902	-70%	1700	-67%	1751	-67%	1704	-67%	4711	-17%	1583	-67%
31		0.25	1902	-70%	1700	-67%	1751	-67%	1704	-67%	1930	-66%	1583	-67%
32	Tth (15)	5	6532	2%	5196	-1%	5400	1%	5345	2%	6049	6%	4946	3%
33		10	6417	1%	5246	0%	5349	0%	5347	2%	5810	2%	4874	2%
34		12	6389	0%	5236	0%	5343	0%	5282	1%	5796	2%	4862	1%
35		17	5880	-8%	5236	0%	5352	0%	5217	0%	5586	-2%	4751	-1%
36		20	5855	-8%	5245	0%	5351	0%	5136	-2%	5543	-3%	4731	-1%
37		25	5379	-16%	5256	1%	5008	-6%	5023	-4%	5525	-3%	4640	-3%
38	Vc1Vc2	Min	9503	49%	5376	3%	5494	3%	5398	3%	-	N/A	5253	10%
39		R1	5821	-9%	5260	1%	5362	1%	5241	0%	5903	4%	5087	6%
40		R2	5821	-9%	5260	1%	5362	1%	5241	0%	5903	4%	5087	6%
41		R3	4960	-22%	4997	-4%	5110	-4%	5004	-4%	5438	-5%	3938	-18%
42		R4	3026	-53%	3819	-27%	3920	-27%	3815	-27%	4130	-28%	3121	-35%
43		Max	2264	-65%	4075	-22%	4201	-21%	4102	-22%	-	N/A	2961	-38%
44	Vrst (0.95)	0.5	5154	-19%	4607	-12%	4718	-12%	4601	-12%	-	N/A	4299	-10%
45		0.7	5432	-15%	5170	-1%	4912	-8%	4786	-8%	5310	-7%	4460	-7%
46		0.8	5613	-12%	4978	-5%	5097	-4%	4971	-5%	5502	-4%	4644	-3%
47		0.85	6075	-5%	5065	-3%	5182	-3%	5058	-3%	5596	-2%	4718	-2%
48		0.9	5781	-9%	5160	-1%	5258	-1%	5139	-2%	5687	0%	4791	0%
49		1	6421	1%	5288	1%	5395	1%	5279	1%	5848	3%	4923	3%
50	Vstall (0.5)	0.3	2305	-64%	2364	-55%	2426	-55%	2362	-55%	2629	-54%	2327	-51%
51		0.4	2012	-68%	2260	-57%	2321	-56%	2260	-57%	-	N/A	1928	-60%
52		0.45	2546	-60%	2300	-56%	2362	-56%	2300	-56%	4155	-27%	2464	-49%
53		0.55	6432	1%	5290	1%	5398	1%	5281	1%	5734	1%	4835	1%
54		0.6	-	N/A	5352	2%	5459	2%	5343	2%	6069	6%	5294	10%
55		0.8	-	N/A	9304	78%	9439	77%	9235	77%	12207	114%	7958	66%

Refer to Figures 4.3-13 through 4.3-23 for representative plots of select sensitivity parameters of Motor A, Motor B, and Motor D for a three-phase fault resulting in the loss of two 500 kV transmission lines. The plots include up to eight bus voltages and four generator angles comparing the base case (Phase 2) to the multiple sensitivity parameters.

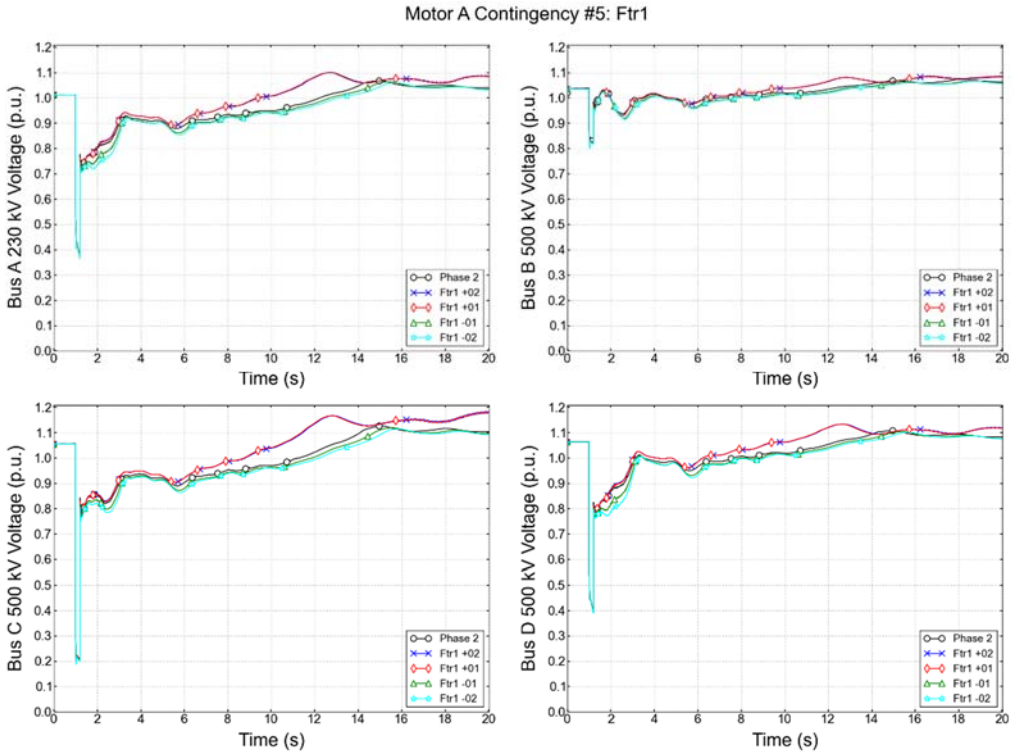

Figure 4.3-13: Bus voltages for Motor A sensitivity parameter Ftr1.

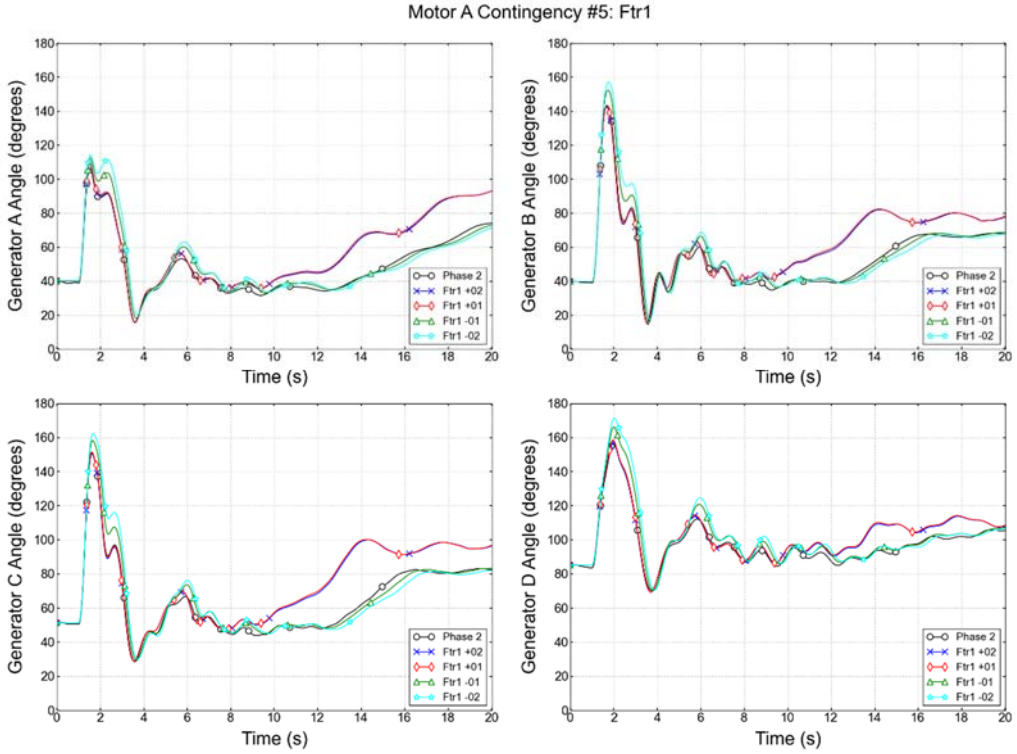

Figure 4.3-14: Generator angles for Motor A sensitivity parameter Ftr1.

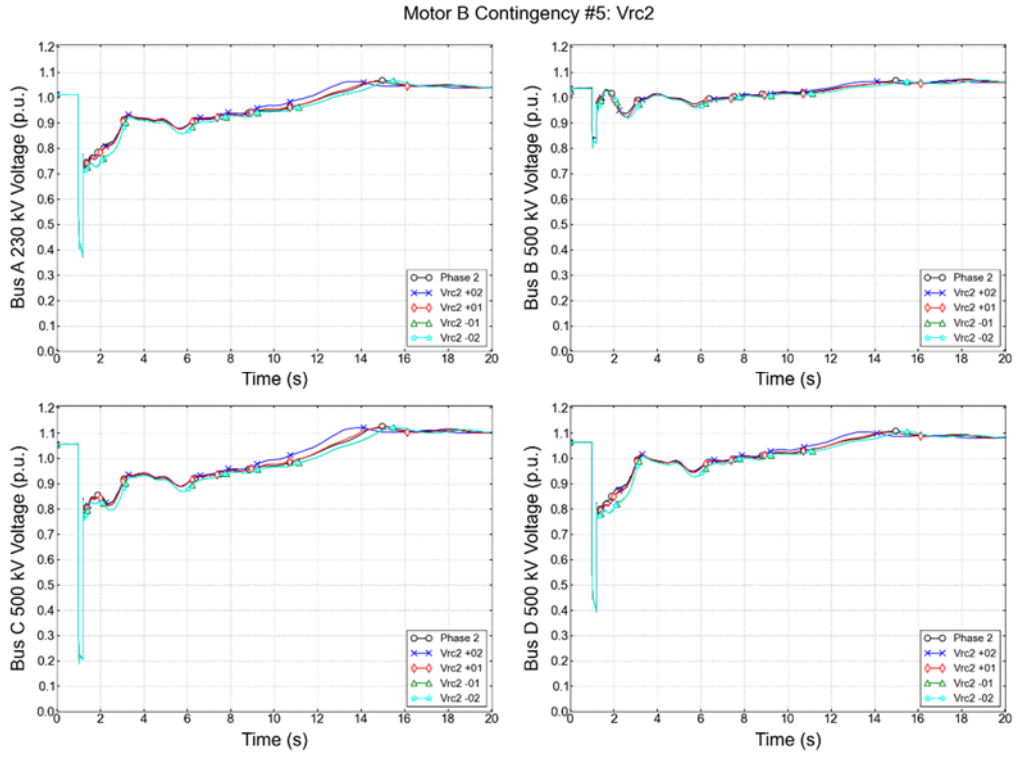

Figure 4.3-15: Bus voltages for Motor B sensitivity parameter Vrc2.

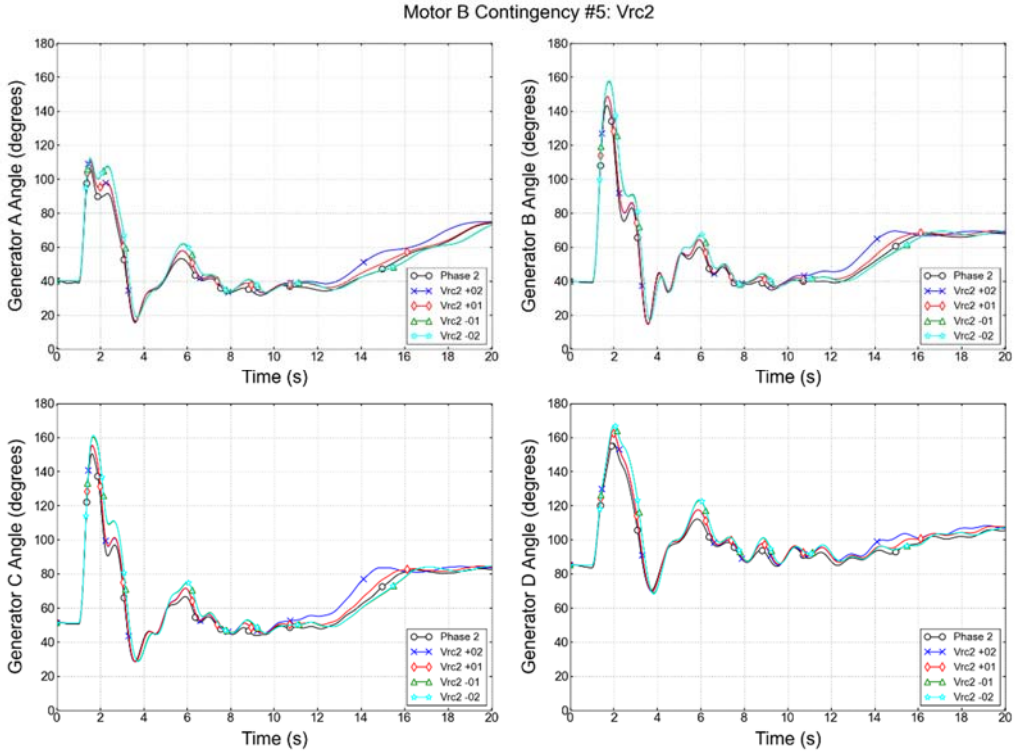

Figure 4.3-16: Generator angles for Motor B sensitivity parameter Vrc2.

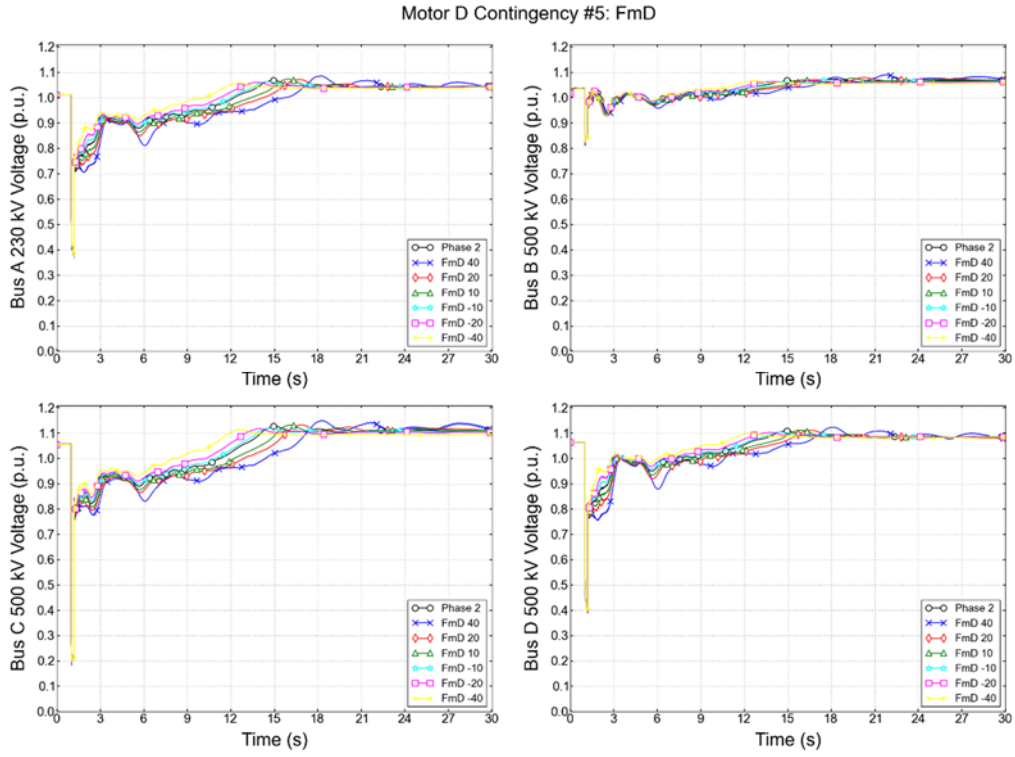

Figure 4.3-17: Bus voltages for Motor D sensitivity parameter FmD.

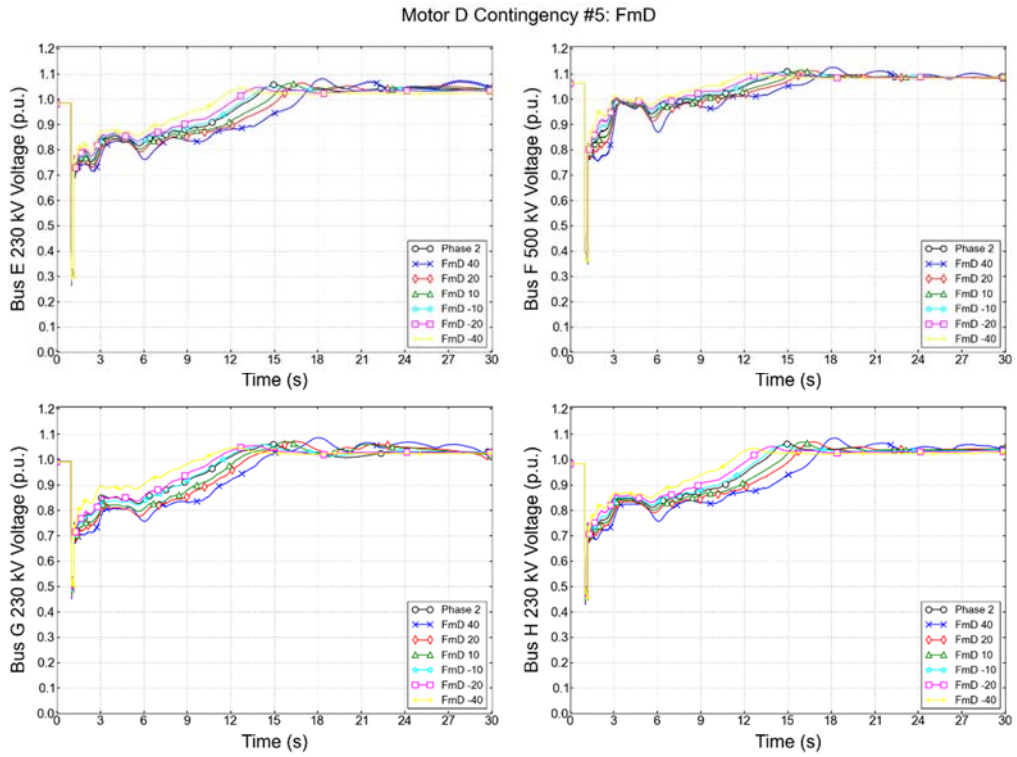

Figure 4.3-18: Bus voltages for Motor D sensitivity parameter FmD.

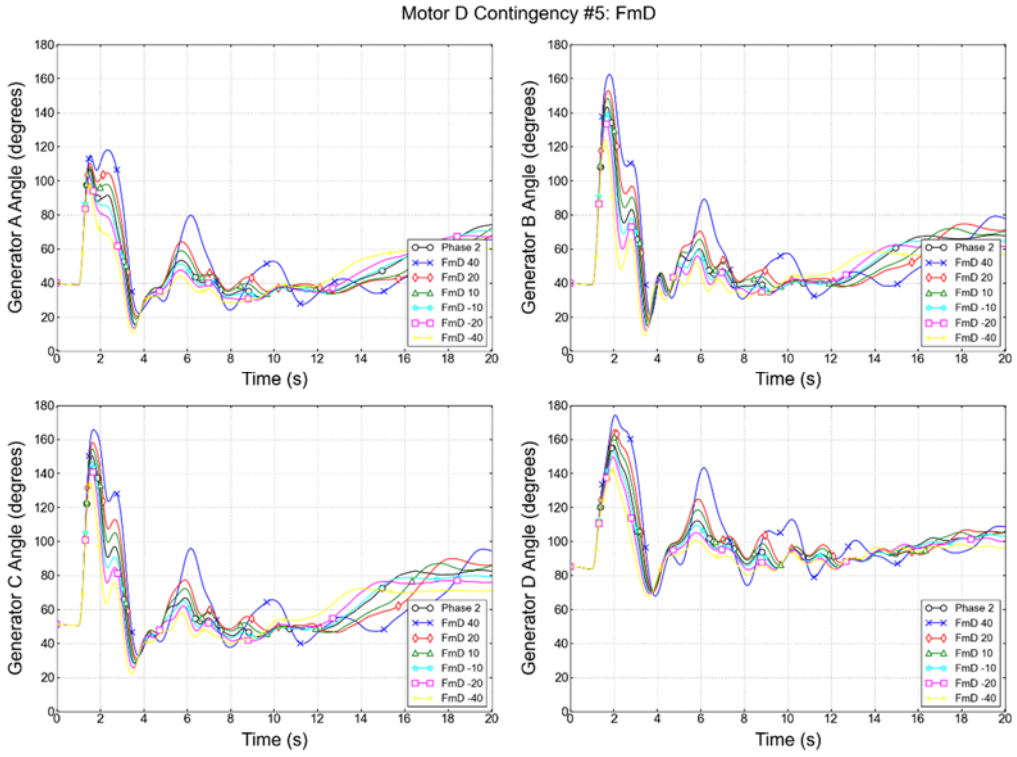

Figure 4.3-19: Generator angles for Motor D sensitivity parameter FmD.

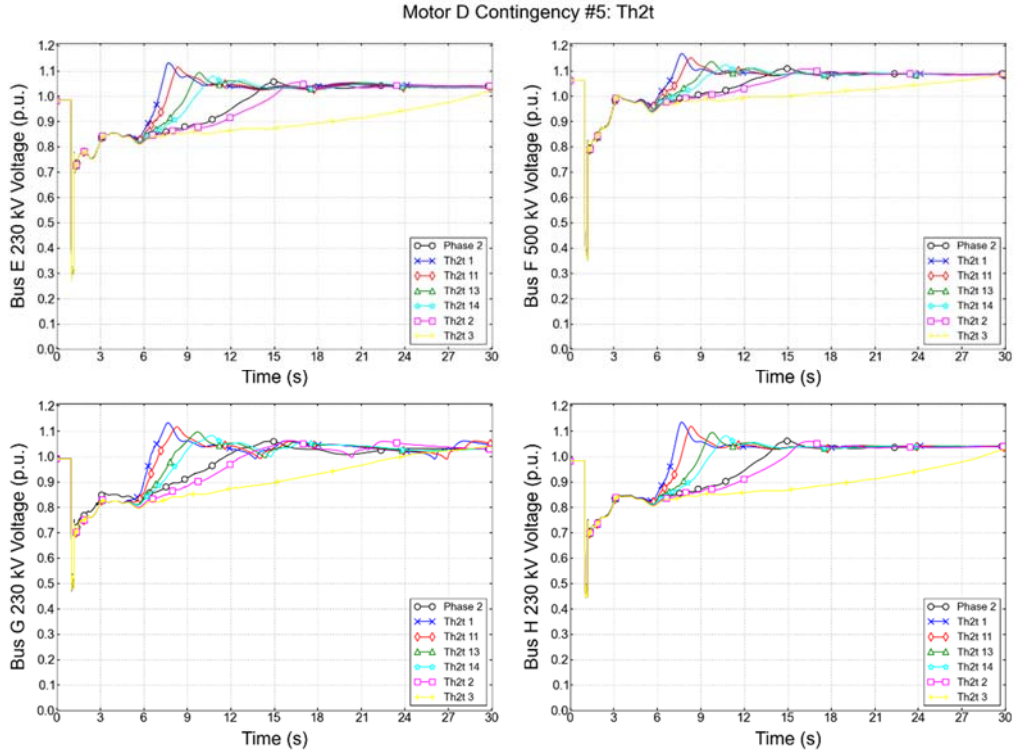

Figure 4.3-20: Bus voltages for Motor D sensitivity parameter Th2t.

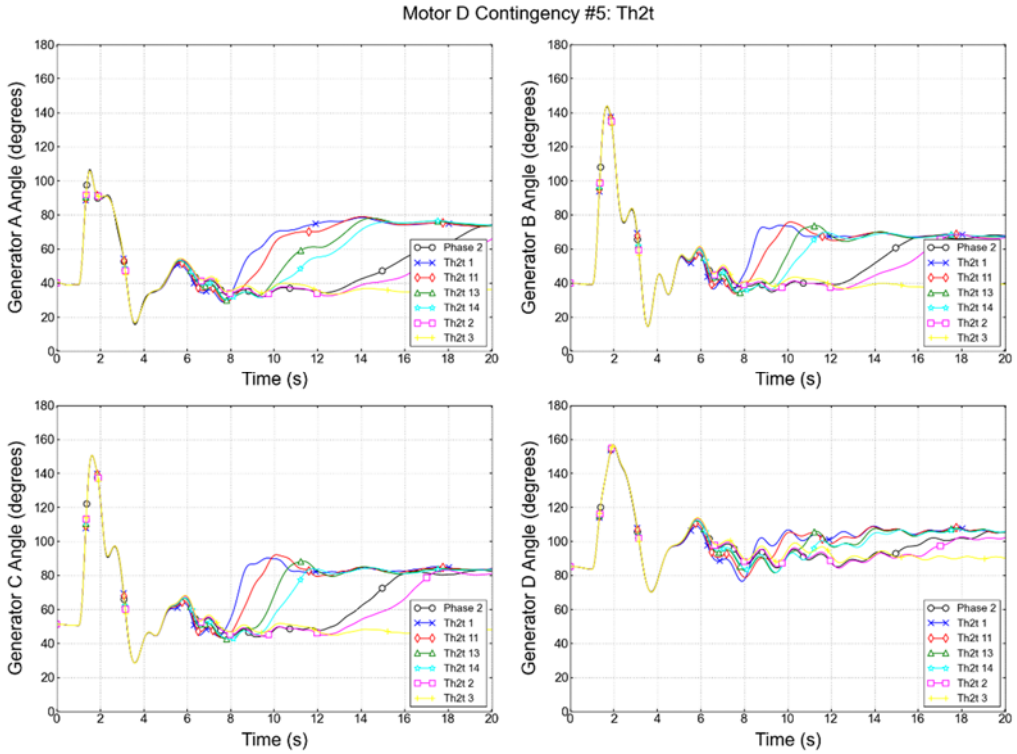

Figure 4.3-21: Generator angles for Motor D sensitivity parameter Th2t.

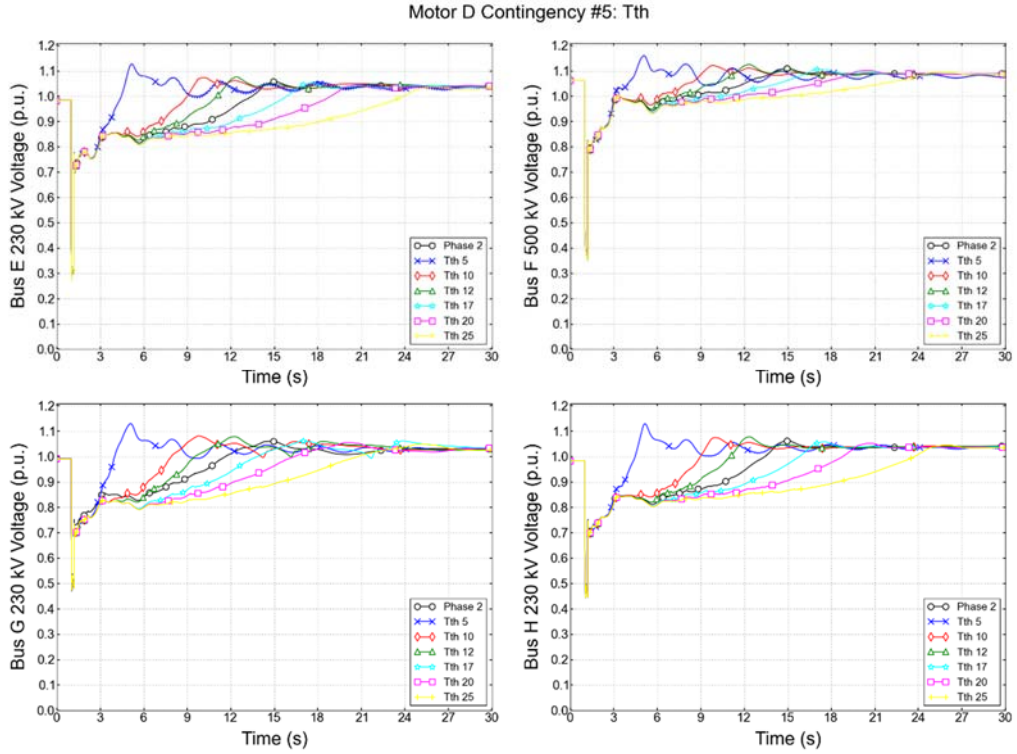

Figure 4.3-22: Bus voltages for Motor D sensitivity parameter Tth.

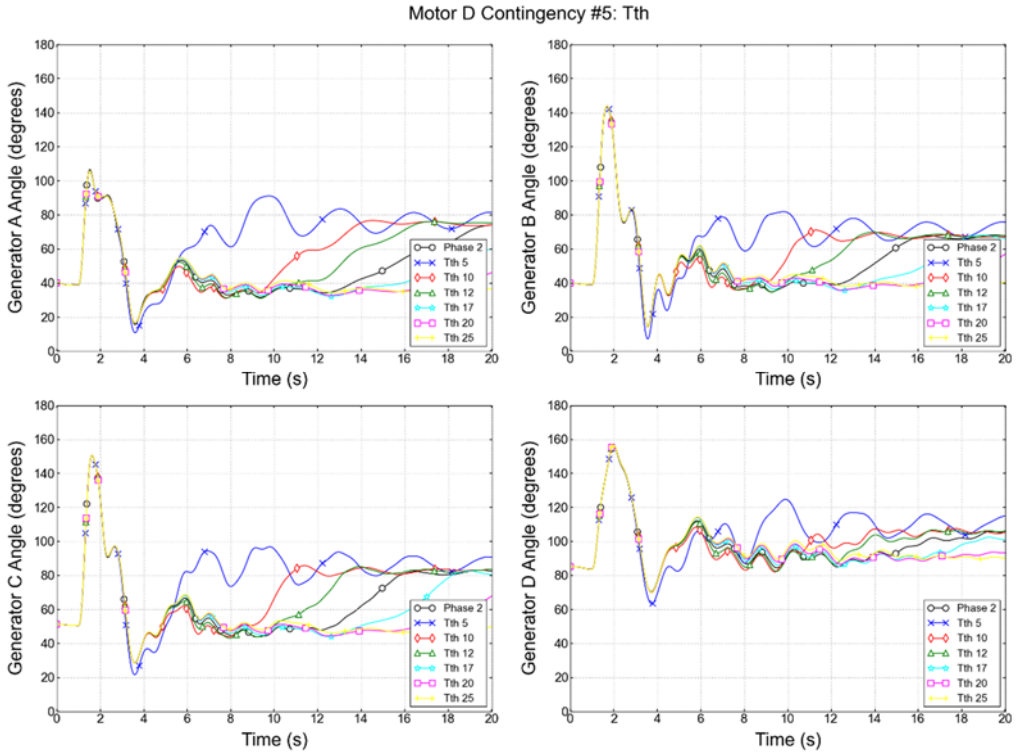

Figure 4.3-23: Generator angles for Motor D sensitivity parameter Tth.

4.4. SRP Heavy Summer and Stressed Case Results

For the Heavy Summer Case, there were 59 contingencies examined for 35 sensitivity parameters (20 parameters each with a minimum and maximum value) for Motor D for a total of 2,065 contingencies processed (include Phase 2 base case). For each contingency processed, 2,545 bus voltages and 813 generators were monitored. The results for a given sensitivity parameter (ex. fraction of Motor D increased by 20%) are an aggregate of all contingencies processed for that given sensitivity parameter. Table 4.4-1 lists the observations and results for SRP's Heavy Summer Case. The table lists the number of buses flagged by the criteria for the base case (Phase 2 composite load model) as well as a given sensitivity parameter. The "Delta (% Change)" column lists the percentage difference between the number of observations in the base case and the respective sensitivity parameter. For the observation of a bus voltage recovering to 70% of the pre-fault voltage within 1 second, the base case flagged 10,770 buses that did not meet this criterion. For the same voltage criteria, when increasing stalling voltage to 0.8 p.u. from 0.5 p.u., 19,832 buses were flagged to not meet this criterion, which is an increase of 84% from the base case. When decreasing the stalling voltage to 0.3 p.u. from 0.5 p.u., 5,474 buses were flagged to not meet this criterion, which is a decrease of 49% from the base case.

Refer to Figures 4.4-1 through 4.4-16 for representative plots of select sensitivity parameters for a three-phase fault resulting in the loss of a 230 kV line. The plots include up to eight bus voltages and four generator angles comparing the base case (Phase 2) to the maximum and minimum sensitivity parameter, respectively. Note Figure 4.4-1 is a representative plot of bus voltages 230 kV and higher. Figure 4.4-2 is a representative plot of 69 kV bus voltages. It can be observed that the bus voltages closer to the load models (non-transmission voltages) are more severely impacted that transmission level bus voltages.

Table 4.4-1
SRP Results and Observations for the Heavy Summer Case: Voltage Criteria

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Angle Swings Offline (+/- 180)		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u.	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	33033	-	28050	-	9	-	10770	-	17866	-	23250	-	14851	-	6717	-
2	Fel	-20%	32117	-3%	27240	-3%	8	-11%	10327	-4%	16271	-9%	21092	-9%	14148	-5%	6160	-8%
3		20%	33631	2%	28358	1%	10	11%	10938	2%	19003	6%	24204	4%	16430	11%	7974	19%
4	FmA	-20%	31943	-3%	27147	-3%	10	11%	11351	5%	16923	-5%	21160	-9%	11457	-23%	4150	-38%
5		20%	33739	2%	28507	2%	9	0%	9818	-9%	18353	3%	24147	4%	17722	19%	9589	43%
6	FmB	-20%	32292	-2%	27276	-3%	9	0%	9493	-12%	14016	-22%	17921	-23%	11873	-20%	5018	-25%
7		20%	33851	2%	28563	2%	9	0%	11067	3%	19909	11%	25915	11%	16889	14%	8243	23%
8	FmC	-20%	32249	-2%	27372	-2%	8	-11%	10485	-3%	16572	-7%	21099	-9%	13550	-9%	5838	-13%
9		20%	33490	1%	28381	1%	9	0%	10845	1%	18707	5%	23906	3%	16184	9%	7813	16%
10	FmD	-20%	30131	-9%	25258	-10%	8	-11%	8219	-24%	12982	-27%	17528	-25%	18746	26%	14550	117%
11		20%	34638	5%	29824	6%	10	11%	11259	5%	17608	-1%	23858	3%	13153	-11%	1741	-74%
12	Frst (0.2)	0	33036	0%	28049	0%	9	0%	10770	0%	17910	0%	23220	0%	14661	-1%	6478	-4%
13		1	33031	0%	28049	0%	8	-11%	10770	0%	17870	0%	23182	0%	15543	5%	7928	18%
14	Fuvr (0.1)	0	33949	3%	28617	2%	10	11%	12235	14%	22019	23%	26668	15%	13644	-8%	2533	-62%
15		0.5	30678	-7%	26334	-6%	8	-11%	2899	-73%	3916	-78%	7354	-68%	19577	32%	15373	129%
16	Th1t (0.7)	0.4	33036	0%	28051	0%	9	0%	10770	0%	17884	0%	23243	0%	25044	69%	21466	220%
17		0.9	33028	0%	28050	0%	8	-11%	10770	0%	17851	0%	23183	0%	14568	-2%	1062	-84%
18	Th2t (1.2)	1	33033	0%	28049	0%	31	244%	10770	0%	17880	0%	23254	0%	24166	63%	31083	363%
19		3	33033	0%	28048	0%	8	-11%	10770	0%	17862	0%	23252	0%	27354	84%	185	-97%
20	Trst	1	33033	0%	28050	0%	9	0%	10770	0%	17851	0%	23234	0%	15018	1%	6961	4%
21		0.1	33033	0%	28050	0%	9	0%	10550	-2%	17634	-1%	23148	0%	14984	1%	6818	2%
22	Tstall (0.033)	0.25	31312	-5%	26834	-4%	8	-11%	3439	-68%	24	-100%	30	-100%	384	-97%	9206	37%
23		0.01667	34046	3%	28812	3%	23	156%	14448	34%	25039	40%	30774	32%	21556	45%	12215	82%
24	Tth (15)	5	33032	0%	28049	0%	39	333%	10769	0%	17852	0%	23181	0%	24519	65%	29807	344%
25		25	33032	0%	28049	0%	8	-11%	10770	0%	17829	0%	23246	0%	27249	83%	185	-97%
26	Ttr1 (0.02)	0.25	33935	3%	28604	2%	11	22%	12235	14%	21227	19%	26173	13%	18420	24%	9984	49%
27		0.01667	33096	0%	28085	0%	8	-11%	10896	1%	18238	2%	23555	1%	15231	3%	7056	5%
28	Vc1off (0.5)	Max	27297	-17%	21800	-22%	8	-11%	2791	-74%	3248	-82%	9387	-60%	12372	-17%	13917	107%
29		Min	36188	10%	31526	12%	9	0%	17262	60%	29810	67%	33771	45%	20040	35%	1764	-74%
30	Vrst (0.95)	1	33032	0%	28049	0%	9	0%	10770	0%	17870	0%	23253	0%	14757	-1%	6565	-2%
31		0.5	33019	0%	28037	0%	8	-11%	10770	0%	17939	0%	23667	2%	23924	61%	14915	122%
32	Vstall (0.5)	0.3	32495	-2%	28327	1%	8	-11%	5474	-49%	2532	-86%	3466	-85%	3580	-76%	2915	-57%
33		0.8	37680	14%	32802	17%	100	1011%	19832	84%	33328	87%	39705	71%	38295	158%	38333	471%
34	Vtr1 (0.6)	0.4	33919	3%	28602	2%	10	11%	12042	12%	21813	22%	26404	14%	13096	-12%	3602	-46%
35		0.8	30903	-6%	26189	-7%	9	0%	10636	-1%	14462	-19%	19165	-18%	12471	-16%	4893	-27%

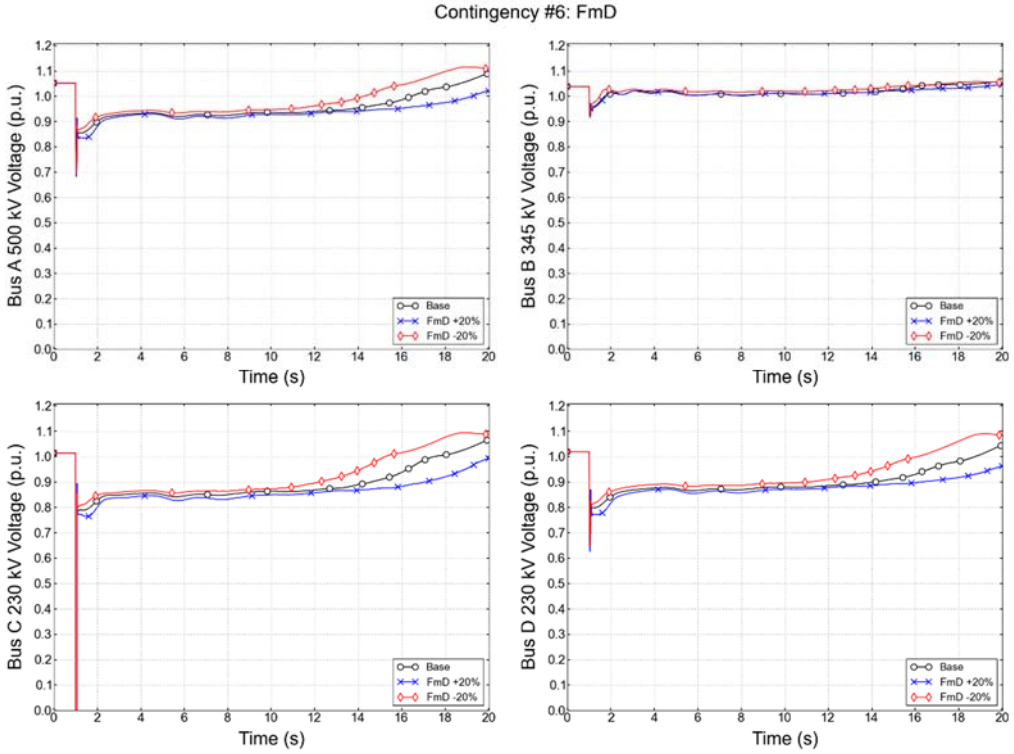

Figure 4.4-1: Bus voltages for sensitivity parameter FmD.

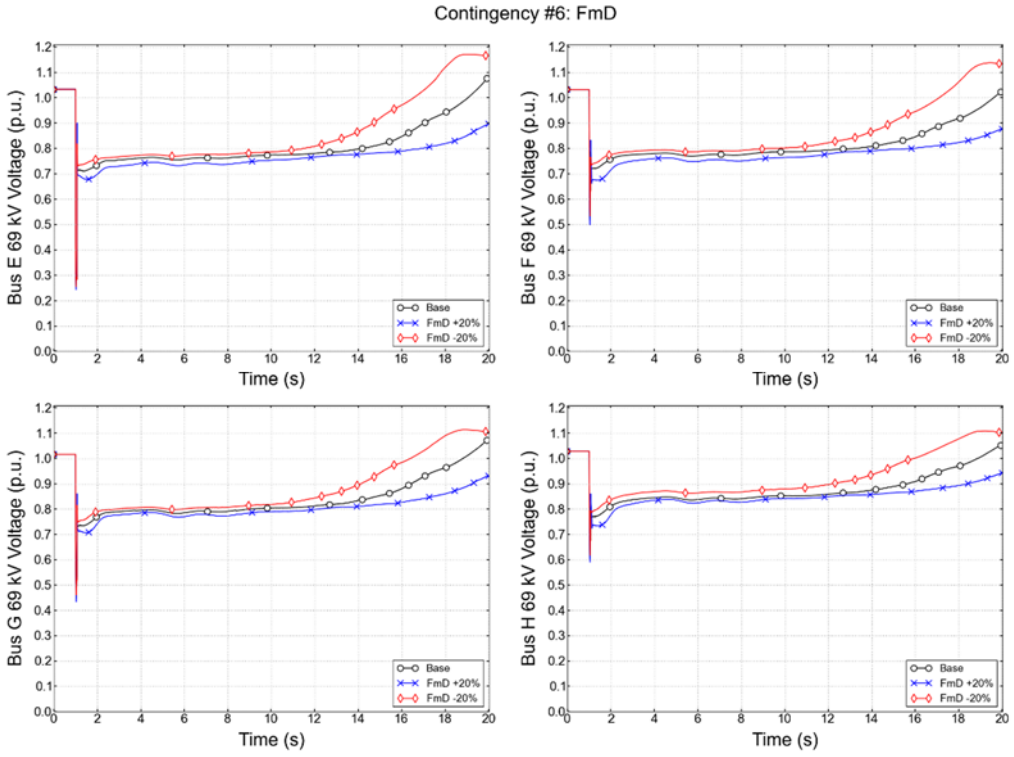

Figure 4.4-2: Bus voltages for sensitivity parameter FmD.

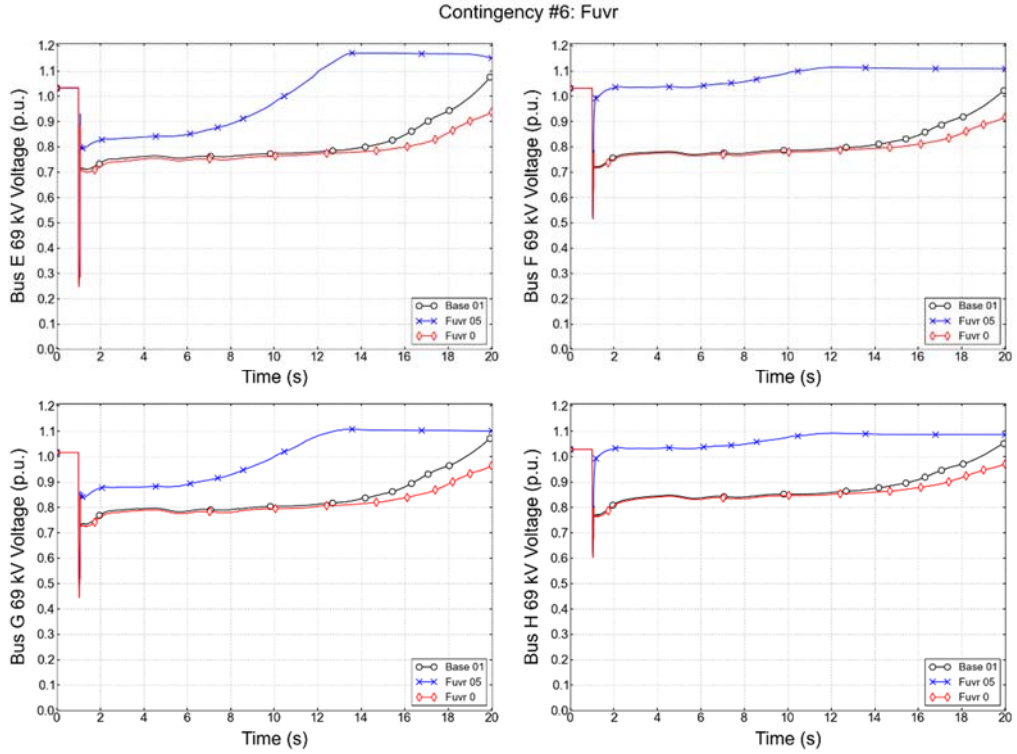

Figure 4.4-3: Bus voltages for sensitivity parameter Fuvr.

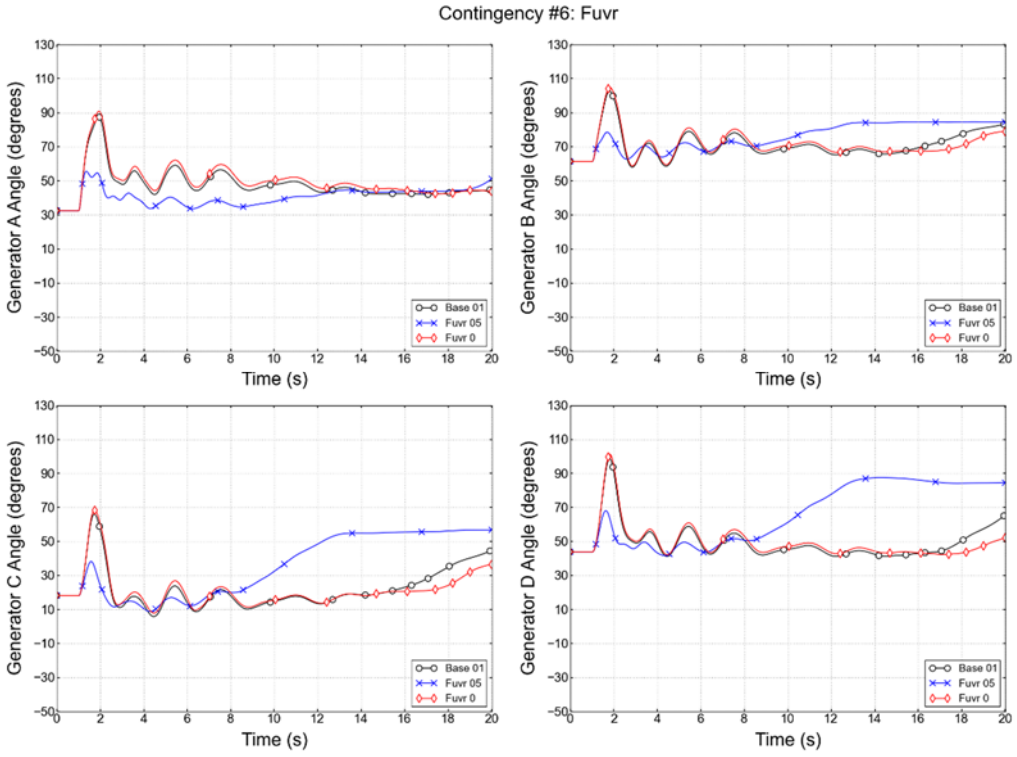

Figure 4.4-4: Generator angles for sensitivity parameter Fuvr.

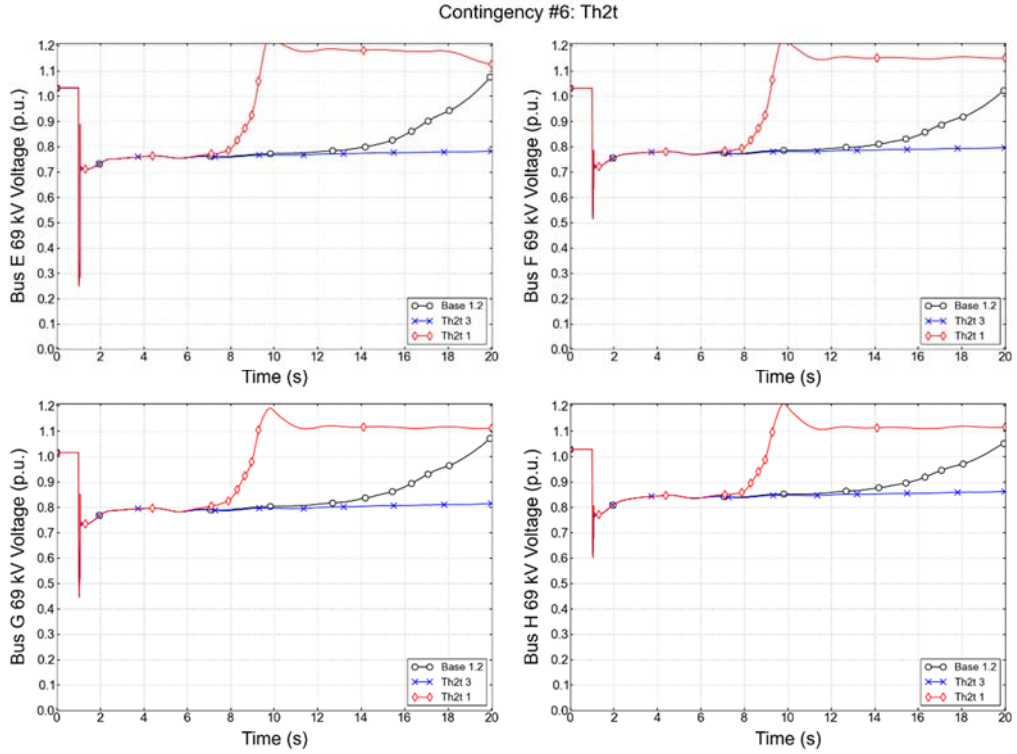

Figure 4.4-5: Bus voltages for sensitivity parameter Th2t.

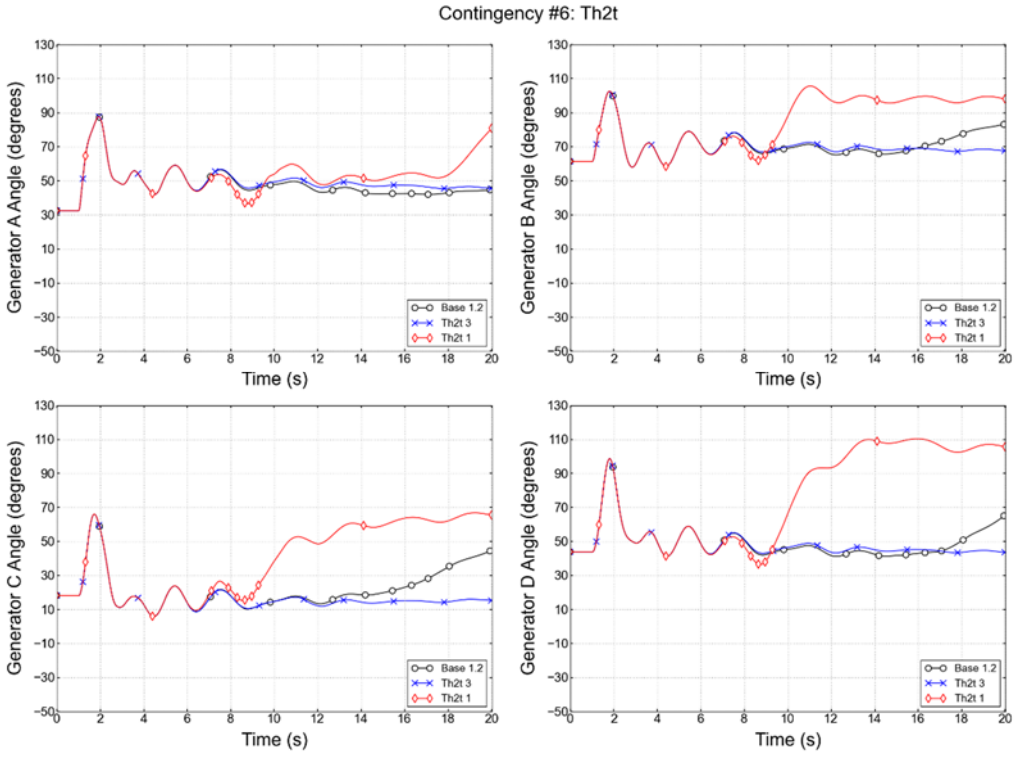

Figure 4.4-6: Generator angles for sensitivity parameter Th2t.

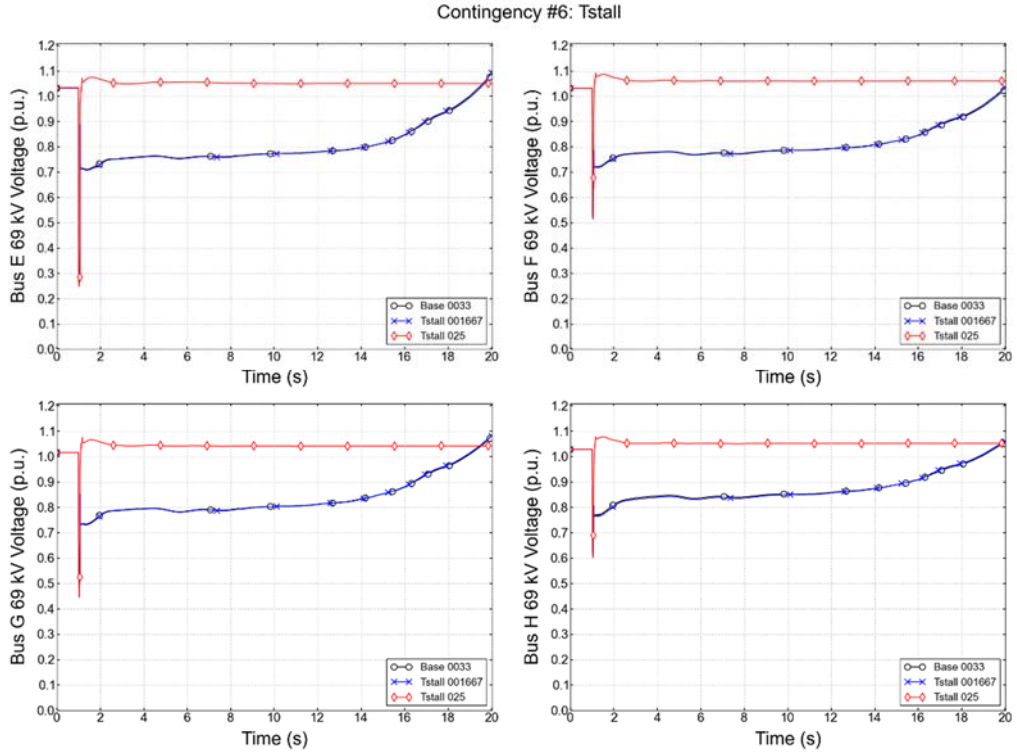

Figure 4.4-7: Bus voltages for sensitivity parameter Tstall.

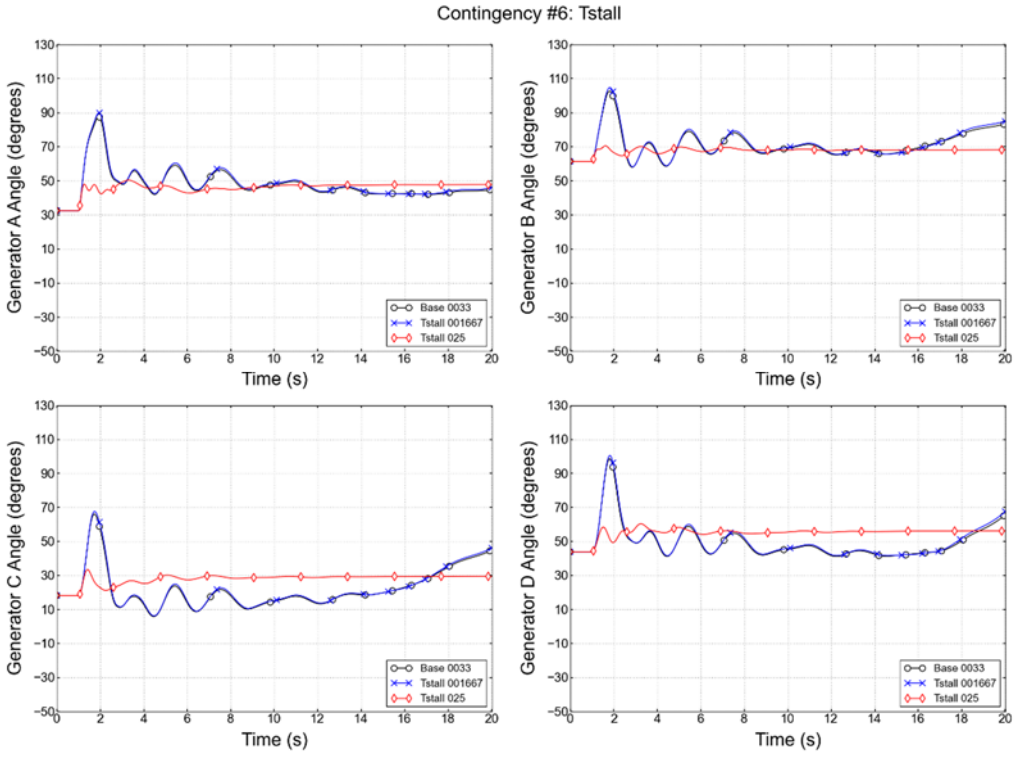

Figure 4.4-8: Generator angles for sensitivity parameter Tstall.

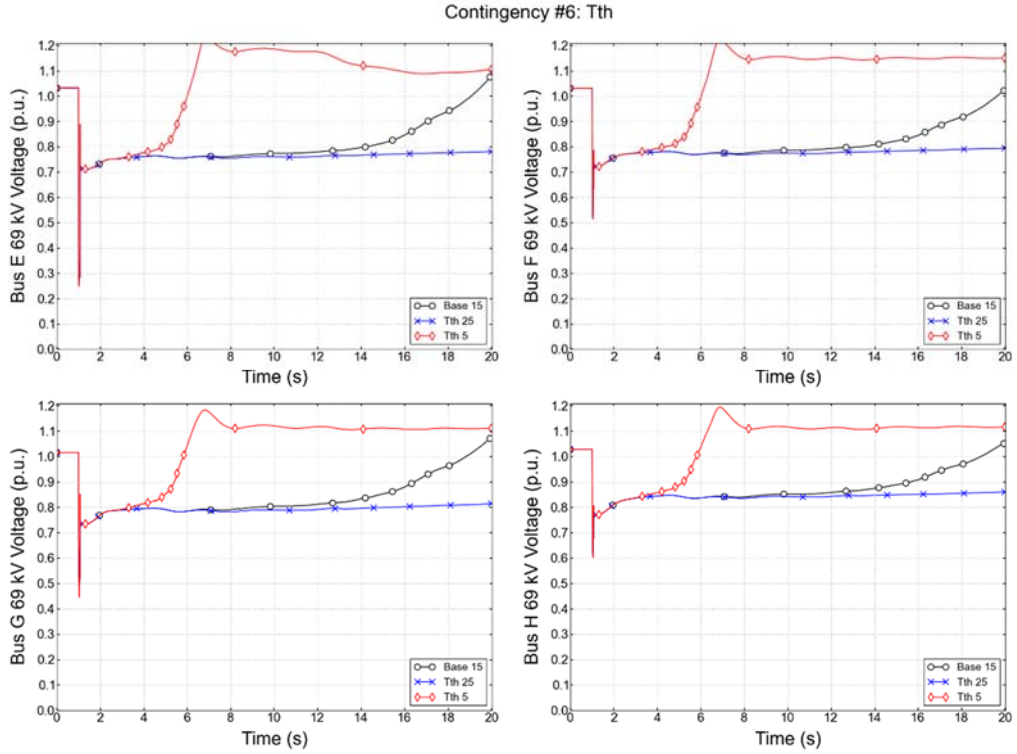

Figure 4.4-9: Bus voltages for sensitivity parameter Tth.

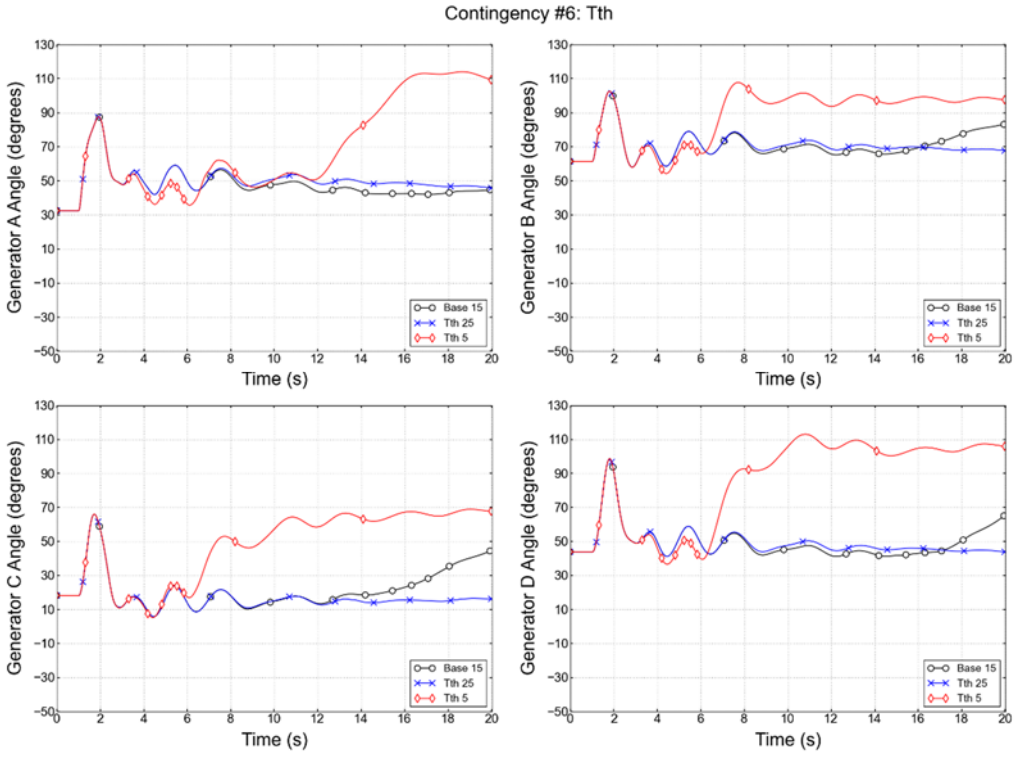

Figure 4.4-10: Generator angles for sensitivity parameter Tth.

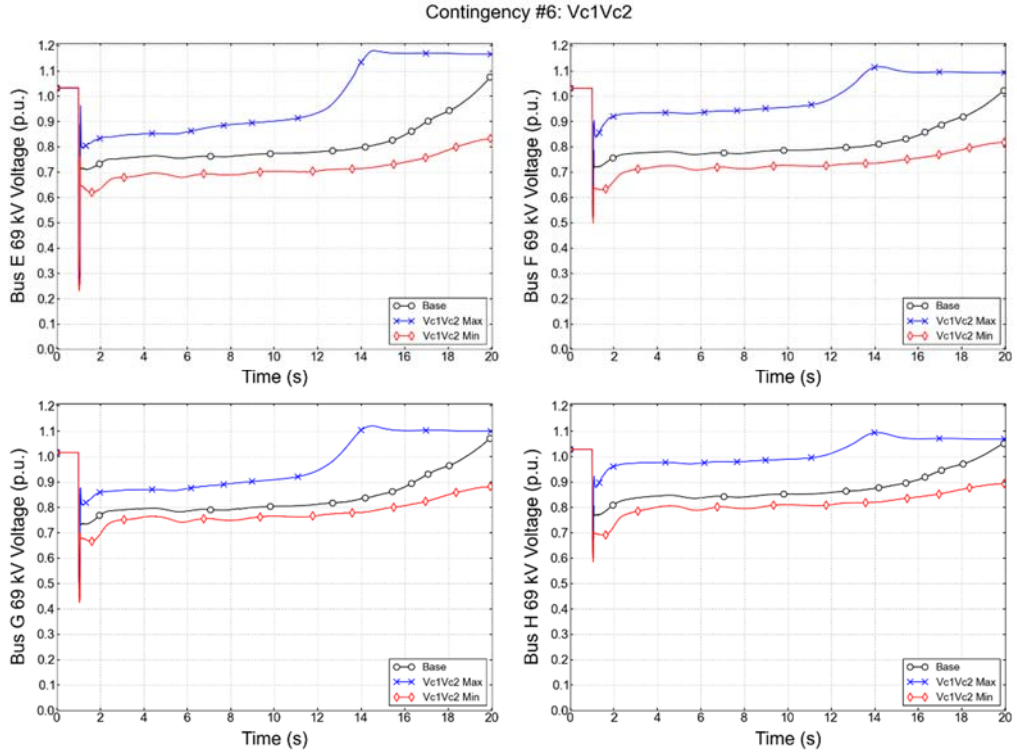

Figure 4.4-11: Bus voltages for sensitivity parameter Vc1Vc2.

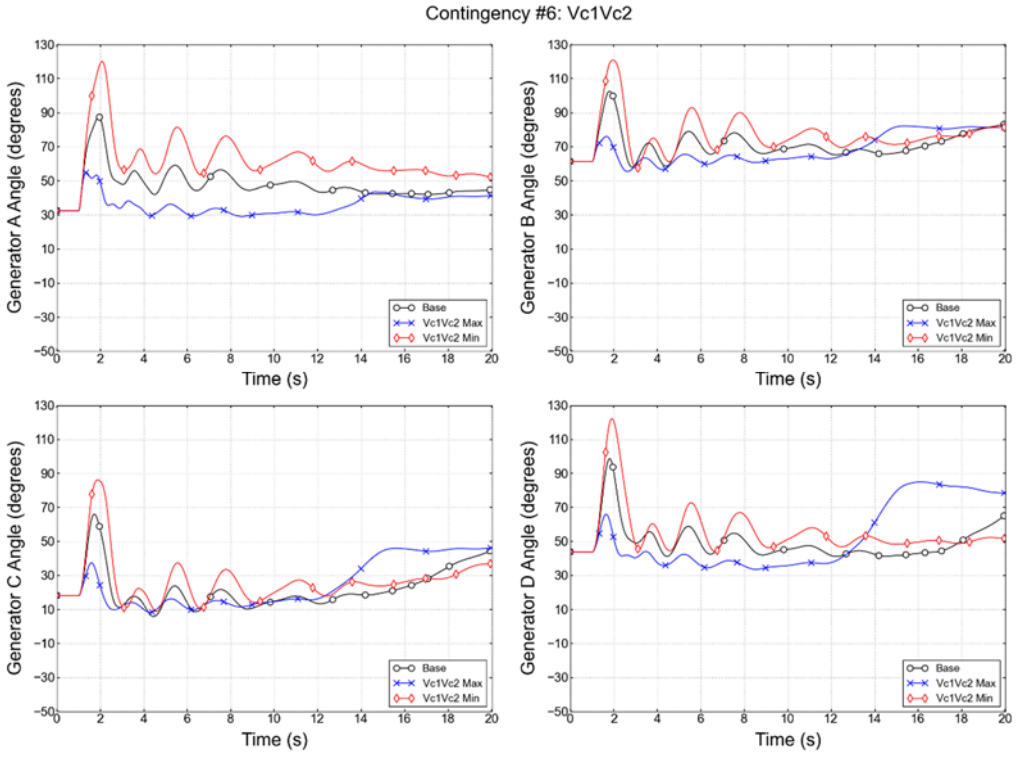

Figure 4.4-12: Generator angles for sensitivity parameter Vc1Vc2.

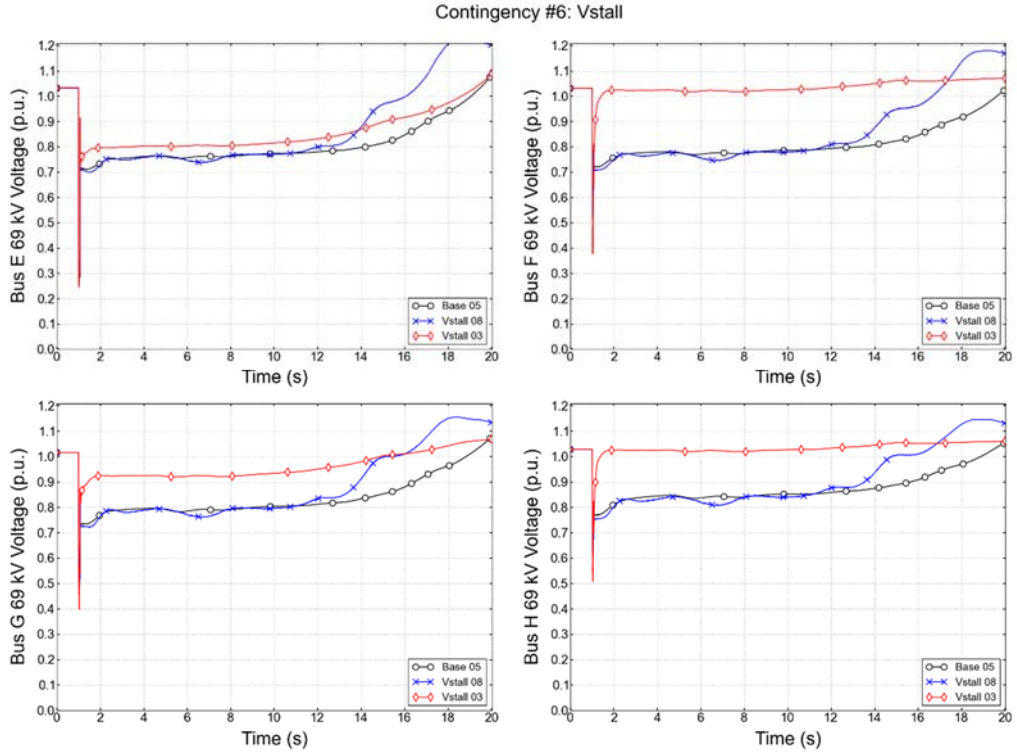

Figure 4.4-13: Bus voltages for sensitivity parameter Vstall.

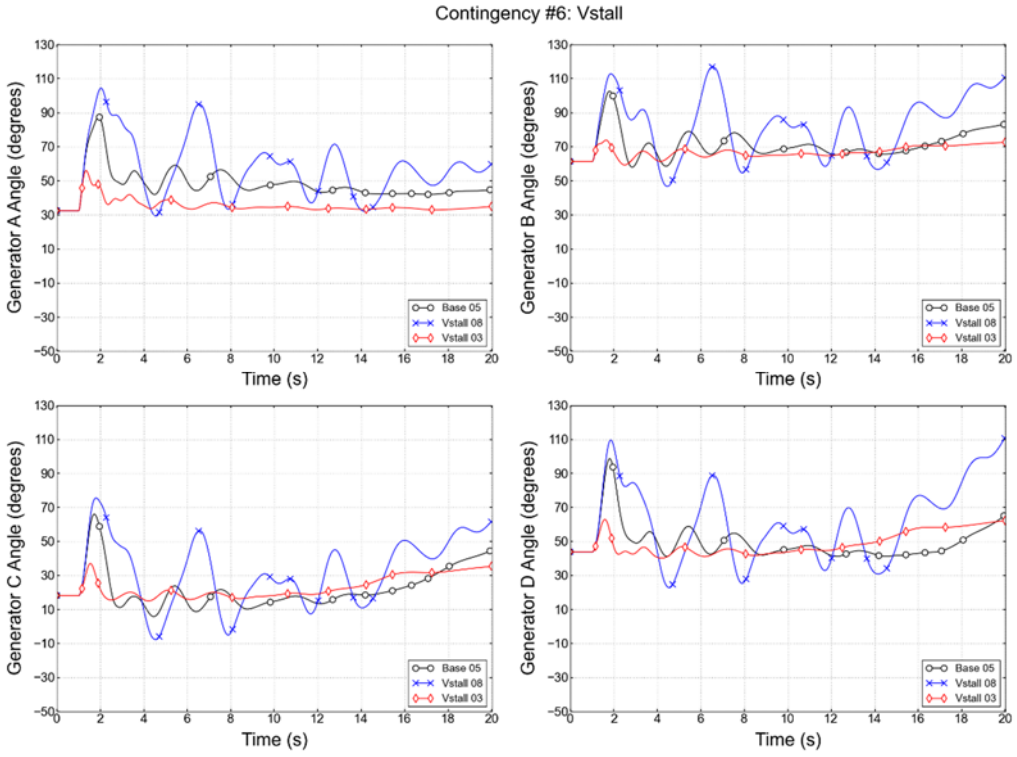

Figure 4.4-14: Generator angles for sensitivity parameter Vstall.

From the observations in Table 4.4-1 and the voltages and generator angles in Figures 4.4-1 through 4.4-14, it can be observed that the following parameters have a significant impact on the outcome of results:

- **Vstall**: Stall voltage, p.u.
- **Tstall**: Stall time delay, sec.
- **FmD**: Motor D fraction of load P
- **Fuvr**: Fraction of load with under voltage relay protection
- **Tth**: Motor D thermal time constant, sec.
- **Th1t**: Motor D thermal protection trip start level, p.u. temperature
- **Th2t**: Motor D thermal protection trip completion level, p.u. temperature
- **Vc1off**: Contactor voltage at which tripping starts, p.u.
- **Vc2off**: Contactor voltage at which tripping is complete, p.u.
- **Vc1on**: Contactor voltage at which reconnection starts, p.u.
- **Vc2on**: Contactor voltage at which reconnection is complete, p.u.

For the Stressed Case, there were 6 contingencies examined for 198 sensitivity parameters:

- Motor A: 12 parameters (see Table 2.2-2) x 4 values = 48 sensitivity parameters
- Motor B: 12 parameters (see Table 2.2-3) x 4 values = 48 sensitivity parameters
- Motor C: 12 parameters (see Table 2.2-4) x 4 values = 48 sensitivity parameters
- Motor D: 9 parameters (see Table 2.2-1) x 6 values = 54 sensitivity parameters

For each contingency processed, 3,256 bus voltages and 1,012 generators were monitored. The results for a given sensitivity parameter (ex. fraction of Motor D increased by 20%) are an aggregate of all contingencies processed for that given sensitivity parameter. Tables 4.4-2 through 4.4-5 list the observations and results for SRP's Stressed Case for Motor A, Motor B, Motor C, and Motor D, respectively. The tables list the number of buses flagged by the criteria for the base case (Phase II composite load model) as well as a given sensitivity parameter. The "Delta (% Change)" column lists the percentage difference between the number of observations in the base case and the respective sensitivity parameter.

In Table 4.4-2, Motor A, the observation of a bus voltage recovering to 70% of the pre-fault voltage within 1 second, the base case flagged 823 buses that did not meet this criteria. For the same voltage criteria, when increasing the fraction of motors that trip on the first low voltage trip setting by 0.2, 367 buses were flagged to not meet this criteria, which is a decrease of 55% from the base case. When decreasing the fraction of motors that trip on the first low voltage trip setting by a factor of 0.2, 938 buses were flagged to not meet this criterion, which is an increase of 14% from the base case. For this sensitivity, decreasing the fraction of motors that trip after the first voltage setting has a negative impact on the system. Since more motors are remaining online during low voltages, more motors are stalling that will draw more reactive power, resulting in low voltages.

Table 4.4-2
SRP Results and Observations for the Stressed Case: Motor A

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	2725	-	2316	-	34	-	823	-	1157	-	2521	-	2713	-	1283	-	17	-	2159	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	0	2969	9%	2505	8%	49	44%	938	14%	1302	13%	3115	24%	2652	-2%	1937	51%	14	-18%	1947	-10%
3		-0.1	0	2819	3%	2388	3%	41	21%	853	4%	1207	4%	2889	15%	2766	2%	1649	29%	15	-12%	2025	-6%
4		+0.1	0	2596	-5%	2223	-4%	36	6%	501	-39%	971	-16%	2117	-16%	2800	3%	754	-41%	217	1176%	2559	19%
5		+0.2	0	2402	-12%	2054	-11%	32	-6%	367	-55%	913	-21%	1834	-27%	2624	-3%	714	-44%	337	1882%	2726	26%
6	Ftr2 (0, 0.5, 0.7)	-0.2	0	2845	4%	2422	5%	45	32%	892	8%	1239	7%	2964	18%	2832	4%	1675	31%	53	212%	2409	12%
7		-0.1	0	2766	2%	2359	2%	36	6%	860	4%	1194	3%	2551	1%	2720	0%	1422	11%	20	18%	2254	4%
8		+0.1	0	2696	-1%	2272	-2%	33	-3%	786	-4%	1132	-2%	2496	-1%	2643	-3%	1157	-10%	15	-12%	2019	-6%
9		+0.2	0	2690	-1%	2274	-2%	34	0%	744	-10%	1130	-2%	2423	-4%	2623	-3%	1023	-20%	15	-12%	1956	-9%
10	H (0.1, 0.15, 0.2)	-50%	0	2748	1%	2345	1%	35	3%	873	6%	1177	2%	2577	2%	2713	0%	1504	17%	19	12%	2275	5%
11		-25%	0	2738	0%	2336	1%	36	6%	849	3%	1172	1%	2541	1%	2714	0%	1390	8%	18	6%	2201	2%
12		+50%	0	2722	0%	2282	-1%	35	3%	807	-2%	1147	-1%	2486	-1%	2711	0%	1212	-6%	17	0%	2138	-1%
13		+100%	0	2712	0%	2260	-2%	36	6%	793	-4%	1137	-2%	2482	-2%	2709	0%	1116	-13%	17	0%	2103	-3%
14	Ls (1.8, 3.1)	-50%	0	2566	-6%	2188	-6%	32	-6%	576	-30%	1028	-11%	2190	-13%	2522	-7%	633	-51%	9	-47%	1959	-9%
15		-25%	0	2679	-2%	2280	-2%	34	0%	779	-5%	1129	-2%	2470	-2%	2692	-1%	981	-24%	13	-24%	2084	-3%
16		+50%	0	2758	1%	2344	1%	35	3%	842	2%	1176	2%	2614	4%	2709	0%	1626	27%	23	35%	2206	2%
17		+100%	4	2752	1%	2341	1%	34	0%	839	2%	1165	1%	2592	3%	2712	0%	1323	3%	124	629%	2210	2%
18	Tpo (0.095, 0.8)	-50%	0	2743	1%	2351	2%	36	6%	866	5%	1170	1%	2582	2%	2726	0%	1427	11%	21	24%	2237	4%
19		-25%	0	2730	0%	2342	1%	36	6%	837	2%	1162	0%	2534	1%	2716	0%	1386	8%	19	12%	2192	2%
20		+50%	0	2690	-1%	2296	-1%	33	-3%	801	-3%	1142	-1%	2507	-1%	2671	-2%	1269	-1%	17	0%	2126	-2%
21		+100%	0	2684	-2%	2282	-1%	34	0%	792	-4%	1148	-1%	2502	-1%	2680	-1%	1182	-8%	15	-12%	2018	-7%
22	Trc2 (0.1, 0.25)	-0.05	0	2733	0%	2323	0%	33	-3%	830	1%	1168	1%	2526	0%	2716	0%	1404	9%	18	6%	2193	2%
23		+0.05	0	2719	0%	2312	0%	31	-9%	825	0%	1155	0%	2513	0%	2674	-1%	1210	-6%	16	-6%	2102	-3%
24		+0.1	0	2700	-1%	2304	-1%	32	-6%	810	-2%	1144	-1%	2503	-1%	2664	-2%	1116	-13%	16	-6%	2066	-4%
25		+0.25	0	2689	-1%	2300	-1%	31	-9%	778	-5%	1132	-2%	2463	-2%	2631	-3%	942	-27%	14	-18%	2011	-7%
26	Ttr1 (0.02, 0.05, 1)	-0.05	0	2659	-2%	2163	-7%	28	-18%	575	-30%	820	-29%	1782	-29%	2087	-23%	598	-53%	9	-47%	1435	-34%
27		+0.05	0	2760	1%	2368	2%	36	6%	849	3%	1195	3%	2671	6%	2712	0%	1543	20%	18	6%	2312	7%
28		+0.25	0	2884	6%	2410	4%	53	56%	864	5%	1207	4%	2805	11%	2835	4%	1649	29%	113	565%	2364	9%
29		+0.5	0	2945	8%	2481	7%	57	68%	890	8%	1256	9%	3056	21%	2966	9%	1983	55%	693	3976%	2575	19%
30	Ttr2 (0.02, 0.05, 1)	-0.05	0	2690	-1%	2269	-2%	29	-15%	682	-17%	1102	-5%	1894	-25%	2645	-3%	1071	-17%	15	-12%	2026	-6%
31		+0.05	0	2855	5%	2438	5%	51	50%	880	7%	1261	9%	2703	7%	2786	3%	1870	46%	22	29%	2511	16%
32		+0.25	1	2930	8%	2467	7%	53	56%	877	7%	1280	11%	2774	10%	2875	6%	1830	43%	23	35%	2562	19%
33		+0.5	2	2844	4%	2415	4%	49	44%	888	8%	1260	9%	2725	8%	2818	4%	1672	30%	19	12%	2478	15%

*Contingencies diverged and are taken into account in the results

Table 4.4-2 (continued)
SRP Results and Observations for the Stressed Case: Motor A

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	2725	-	2316	-	34	-	823	-	1157	-	2521	-	2713	-	1283	-	17	-	2159	-
34	Vrc1 (1)	-0.25	0	2724	0%	2316	0%	34	0%	823	0%	1158	0%	2520	0%	2714	0%	1287	0%	17	0%	2160	0%
35		-0.15	0	2724	0%	2316	0%	34	0%	823	0%	1158	0%	2520	0%	2714	0%	1287	0%	17	0%	2160	0%
36		-0.05	0	2724	0%	2316	0%	34	0%	823	0%	1158	0%	2520	0%	2714	0%	1287	0%	17	0%	2160	0%
37		+0.05	0	2724	0%	2316	0%	34	0%	823	0%	1158	0%	2520	0%	2714	0%	1287	0%	17	0%	2160	0%
38	Vrc2 (0.7, 1)	-0.2	1	2757	1%	2364	2%	43	26%	1019	24%	1327	15%	2652	5%	2755	2%	1460	14%	24	41%	2411	12%
39		-0.1	0	2731	0%	2323	0%	37	9%	893	9%	1294	12%	2659	5%	2746	1%	1454	13%	21	24%	2446	13%
40		+0.1	0	2722	0%	2313	0%	33	-3%	747	-9%	1115	-4%	2482	-2%	2669	-2%	1158	-10%	16	-6%	2024	-6%
41		+0.2	0	2714	0%	2309	0%	32	-6%	667	-19%	1098	-5%	2460	-2%	2580	-5%	1061	-17%	13	-24%	1925	-11%
42	Vtr1 (0.7)	-0.15	0	2854	5%	2395	3%	48	41%	962	17%	1230	6%	2673	6%	2813	4%	1577	23%	638	3653%	2441	13%
43		-0.05	0	2823	4%	2368	2%	40	18%	878	7%	1174	1%	2568	2%	2743	1%	1593	24%	18	6%	2268	5%
44		+0.05	0	2701	-1%	2302	-1%	33	-3%	787	-4%	1133	-2%	2506	-1%	2660	-2%	1191	-7%	16	-6%	2064	-4%
45		+0.15	0	2586	-5%	2245	-3%	31	-9%	723	-12%	1102	-5%	2298	-9%	2533	-7%	996	-22%	15	-12%	2027	-6%
46	Vtr2 (0.5, 0.6)	-0.15	4	2752	1%	2353	2%	36	6%	889	8%	1214	5%	2569	2%	2732	1%	1323	3%	18	6%	2273	5%
47		-0.05	2	3142	15%	2560	11%	57	68%	970	18%	1314	14%	2668	6%	2962	9%	2343	83%	80	371%	2536	17%
48		+0.05	1	2598	-5%	2297	-1%	34	0%	669	-19%	1003	-13%	2168	-14%	2497	-8%	1139	-11%	16	-6%	2113	-2%
49		+0.15	1	2530	-7%	2143	-7%	26	-24%	497	-40%	920	-20%	1867	-26%	2179	-20%	830	-35%	11	-35%	1729	-20%

*Contingencies diverged and are taken into account in the results

Table 4.4-3
SRP Results and Observations for the Stressed Case: Motor B

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	2725	-	2316	-	34	-	823	-	1157	-	2521	-	2713	-	1283	-	17	-	2159	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	0	2802	3%	2411	4%	51	50%	862	5%	1243	7%	3003	19%	2861	5%	1872	46%	44	159%	2450	13%
3		-0.1	0	2748	1%	2360	2%	39	15%	834	1%	1214	5%	2661	6%	2802	3%	1588	24%	38	124%	2258	5%
4		+0.1	0	2680	-2%	2298	-1%	31	-9%	766	-7%	1142	-1%	2436	-3%	2635	-3%	1045	-19%	15	-12%	2004	-7%
5		+0.2	0	2651	-3%	2278	-2%	30	-12%	672	-18%	1093	-6%	2367	-6%	2606	-4%	951	-26%	13	-24%	1929	-11%
6	Ftr2 (0, 0.5, 0.7)	-0.2	0	2776	2%	2404	4%	41	21%	891	8%	1221	6%	2896	15%	2783	3%	1630	27%	44	159%	2277	5%
7		-0.1	0	2742	1%	2360	2%	37	9%	858	4%	1195	3%	2581	2%	2739	1%	1431	12%	22	29%	2211	2%
8		+0.1	0	2690	-1%	2307	0%	32	-6%	779	-5%	1142	-1%	2496	-1%	2659	-2%	1094	-15%	17	0%	2043	-5%
9		+0.2	0	2667	-2%	2268	-2%	30	-12%	740	-10%	1133	-2%	2459	-2%	2649	-2%	1067	-17%	16	-6%	2011	-7%
10	H (0.1, 0.15, 0.2)	-50%	0	2764	1%	2364	2%	39	15%	891	8%	1202	4%	2558	1%	2757	2%	1635	27%	22	29%	2283	6%
11		-25%	0	2749	1%	2354	2%	36	6%	869	6%	1189	3%	2559	2%	2720	0%	1575	23%	17	0%	2174	1%
12		+50%	0	2690	-1%	2294	-1%	35	3%	761	-8%	1146	-1%	2436	-3%	2702	0%	1185	-8%	17	0%	2067	-4%
13		+100%	0	2669	-2%	2277	-2%	33	-3%	752	-9%	1140	-1%	2424	-4%	2691	-1%	1084	-16%	17	0%	2057	-5%
14	Ls (1.8, 3.1)	-50%	0	2751	1%	2366	2%	38	12%	853	4%	1197	3%	2558	1%	2783	3%	950	-26%	504	2865%	2046	-5%
15		-25%	0	2740	1%	2342	1%	38	12%	852	4%	1170	1%	2529	0%	2735	1%	1139	-11%	119	600%	2054	-5%
16		+50%	0	2695	-1%	2307	0%	32	-6%	779	-5%	1147	-1%	2500	-1%	2690	-1%	1448	13%	17	0%	2191	1%
17		+100%	0	2677	-2%	2283	-1%	32	-6%	767	-7%	1121	-3%	2474	-2%	2615	-4%	1491	16%	16	-6%	2270	5%
18	Tpo (0.095, 0.8)	-50%	0	2661	-2%	2273	-2%	33	-3%	747	-9%	1111	-4%	2393	-5%	2553	-6%	759	-41%	12	-29%	1919	-11%
19		-25%	0	2693	-1%	2296	-1%	32	-6%	800	-3%	1149	-1%	2424	-4%	2697	-1%	1034	-19%	17	0%	2085	-3%
20		+50%	0	2798	3%	2391	3%	46	35%	821	0%	1176	2%	2766	10%	2818	4%	1679	31%	83	388%	2271	5%
21		+100%	1	2765	1%	2380	3%	48	41%	837	2%	1170	1%	2638	5%	2820	4%	1500	17%	95	459%	2288	6%
22	Trc2 (0.1, 0.25)	-0.05	0	2758	1%	2337	1%	36	6%	861	5%	1191	3%	2584	2%	2726	0%	1539	20%	19	12%	2207	2%
23		+0.05	0	2694	-1%	2313	0%	35	3%	808	-2%	1151	-1%	2512	0%	2716	0%	1244	-3%	17	0%	2134	-1%
24		+0.1	0	2692	-1%	2312	0%	33	-3%	796	-3%	1142	-1%	2494	-1%	2687	-1%	1200	-6%	17	0%	2087	-3%
25		+0.25	0	2687	-1%	2306	0%	33	-3%	790	-4%	1135	-2%	2497	-1%	2674	-1%	1151	-10%	16	-6%	2068	-4%
26	Ttr1 (0.02, 0.05, 1)	-0.05	0	2682	-2%	2303	-1%	54	59%	889	8%	1255	8%	3056	21%	2942	8%	1673	30%	40	135%	2368	10%
27		+0.05	0	2763	1%	2370	2%	37	9%	765	-7%	1149	-1%	2496	-1%	2727	1%	1081	-16%	17	0%	2138	-1%
28		+0.25	0	2761	1%	2365	2%	38	12%	716	-13%	1135	-2%	2473	-2%	2764	2%	1081	-16%	17	0%	2107	-2%
29		+0.5	0	2777	2%	2365	2%	48	41%	716	-13%	1125	-3%	2440	-3%	2795	3%	970	-24%	17	0%	2071	-4%
30	Ttr2 (0.02, 0.05, 1)	-0.05	0	2688	-1%	2239	-3%	35	3%	750	-9%	1119	-3%	2504	-1%	2658	-2%	1792	40%	14	-18%	2003	-7%
31		+0.05	0	2814	3%	2409	4%	44	29%	871	6%	1219	5%	2937	17%	2793	3%	1104	-14%	22	29%	2347	9%
32		+0.25	1	2796	3%	2384	3%	41	21%	860	4%	1214	5%	2616	4%	2760	2%	1073	-16%	20	18%	2316	7%
33		+0.5	1	2807	3%	2388	3%	42	24%	861	5%	1214	5%	2622	4%	2762	2%	1056	-18%	21	24%	2313	7%

*Contingencies diverged and are taken into account in the results

Table 4.4-3 (continued)
SRP Results and Observations for the Stressed Case: Motor B

Ref. No.	Variable	Setting	Contingencies Diverged*	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
				# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	-	2725	-	2316	-	34	-	823	-	1157	-	2521	-	2713	-	1283	-	17	-	2159	-
34	Vrc1 (1)	-0.25	0	2705	-1%	2311	0%	43	26%	753	-9%	1132	-2%	2350	-7%	2859	5%	1104	-14%	644	3688%	2105	-3%
35		-0.15	0	2697	-1%	2319	0%	44	29%	776	-6%	1145	-1%	2422	-4%	2583	-5%	1206	-6%	164	865%	2119	-2%
36		-0.05	0	2698	-1%	2321	0%	36	6%	780	-5%	1149	-1%	2494	-1%	2719	0%	1238	-4%	17	0%	2118	-2%
37		+0.05	0	2745	1%	2333	1%	34	0%	839	2%	1172	1%	2579	2%	2698	-1%	1435	12%	17	0%	2254	4%
38	Vrc2 (0.7, 1)	-0.2	1	2812	3%	2373	2%	46	35%	877	7%	1200	4%	2636	5%	2782	3%	1824	42%	20	18%	2287	6%
39		-0.1	0	2781	2%	2376	3%	41	21%	910	11%	1222	6%	2734	8%	2757	2%	1718	34%	26	53%	2283	6%
40		+0.1	0	2689	-1%	2318	0%	33	-3%	771	-6%	1137	-2%	2498	-1%	2700	0%	1118	-13%	17	0%	2085	-3%
41		+0.2	0	2689	-1%	2314	0%	32	-6%	759	-8%	1134	-2%	2488	-1%	2712	0%	1094	-15%	17	0%	2068	-4%
42	Vtr1 (0.7)	-0.15	0	2790	2%	2390	3%	46	35%	899	9%	1230	6%	2676	6%	2850	5%	1056	-18%	42	147%	2426	12%
43		-0.05	0	2749	1%	2343	1%	41	21%	864	5%	1181	2%	2607	3%	2768	2%	1162	-9%	665	3812%	2259	5%
44		+0.05	0	2693	-1%	2314	0%	34	0%	794	-4%	1137	-2%	2493	-1%	2692	-1%	1441	12%	17	0%	2088	-3%
45		+0.15	0	2622	-4%	2286	-1%	33	-3%	732	-11%	1107	-4%	2333	-7%	2541	-6%	1524	19%	17	0%	1951	-10%
46	Vtr2 (0.5, 0.6)	-0.15	1	2822	4%	2398	4%	41	21%	879	7%	1220	5%	2629	4%	2761	2%	1135	-12%	20	18%	2303	7%
47		-0.05	1	2771	2%	2370	2%	38	12%	871	6%	1211	5%	2602	3%	2738	1%	1210	-6%	18	6%	2278	6%
48		+0.05	0	2699	-1%	2284	-1%	37	9%	786	-4%	1121	-3%	2446	-3%	2747	1%	1624	27%	17	0%	2047	-5%
49		+0.15	0	2641	-3%	2262	-2%	37	9%	712	-13%	1087	-6%	2245	-11%	2513	-7%	1982	54%	17	0%	1967	-9%

*Contingencies diverged and are taken into account in the results

Table 4.4-4
SRP Results and Observations for the Stressed Case: Motor C

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	2765	-	2395	-	33	-	784	-	1133	-	2453	-	2723	-	1223	-	16	-	2135	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	2821	2%	2425	1%	33	0%	809	3%	1159	2%	2509	2%	2737	1%	1426	17%	21	31%	2341	10%
3		-0.1	2779	1%	2402	0%	32	-3%	794	1%	1150	2%	2484	1%	2707	-1%	1317	8%	20	25%	2192	3%
4		+0.1	2755	0%	2376	-1%	32	-3%	776	-1%	1109	-2%	2400	-2%	2727	0%	1120	-8%	15	-6%	2108	-1%
5		+0.2	2731	-1%	2347	-2%	30	-9%	770	-2%	1104	-3%	2346	-4%	2724	0%	881	-28%	14	-13%	2042	-4%
6	Ftr2 (0, 0.5, 0.7)	-0.2	2786	1%	2410	1%	34	3%	816	4%	1154	2%	2498	2%	2740	1%	1329	9%	18	13%	2195	3%
7		-0.1	2774	0%	2404	0%	33	0%	800	2%	1142	1%	2480	1%	2736	0%	1318	8%	17	6%	2165	1%
8		+0.1	2761	0%	2381	-1%	31	-6%	763	-3%	1113	-2%	2428	-1%	2703	-1%	1143	-7%	15	-6%	2104	-1%
9		+0.2	2739	-1%	2358	-2%	28	-15%	747	-5%	1100	-3%	2389	-3%	2677	-2%	1077	-12%	15	-6%	2048	-4%
10	H (0.1, 0.15, 0.2)	-50%	2773	0%	2397	0%	33	0%	740	-6%	1126	-1%	2440	-1%	2733	0%	1176	-4%	16	0%	2101	-2%
11		-25%	2774	0%	2399	0%	33	0%	757	-3%	1124	-1%	2446	0%	2730	0%	1198	-2%	16	0%	2123	-1%
12		+50%	2761	0%	2390	0%	33	0%	806	3%	1140	1%	2476	1%	2728	0%	1324	8%	16	0%	2156	1%
13		+100%	2761	0%	2388	0%	34	3%	822	5%	1141	1%	2483	1%	2735	0%	1319	8%	16	0%	2173	2%
14	Ls (1.8, 3.1)	-50%	2784	1%	2393	0%	34	3%	826	5%	1140	1%	2391	-3%	2769	2%	1411	15%	24	50%	2255	6%
15		-25%	2769	0%	2399	0%	34	3%	811	3%	1135	0%	2455	0%	2739	1%	1329	9%	17	6%	2168	2%
16		+50%	2764	0%	2395	0%	33	0%	775	-1%	1134	0%	2464	0%	2717	0%	1171	-4%	15	-6%	2093	-2%
17		+100%	2764	0%	2391	0%	31	-6%	763	-3%	1134	0%	2479	1%	2707	-1%	1160	-5%	15	-6%	2056	-4%
18	Tpo (0.095, 0.8)	-50%	2767	0%	2394	0%	31	-6%	746	-5%	1118	-1%	2407	-2%	2714	0%	1065	-13%	15	-6%	2209	3%
19		-25%	2766	0%	2396	0%	30	-9%	753	-4%	1123	-1%	2433	-1%	2730	0%	1140	-7%	15	-6%	2183	2%
20		+50%	2783	1%	2405	0%	35	6%	811	3%	1142	1%	2477	1%	2744	1%	1474	21%	18	13%	2090	-2%
21		+100%	2828	2%	2418	1%	39	18%	844	8%	1145	1%	2503	2%	2775	2%	1528	25%	31	94%	2042	-4%
22	Trc2 (0.1, 0.25)	-0.05	2765	0%	2396	0%	32	-3%	803	2%	1143	1%	2466	1%	2731	0%	1255	3%	16	0%	2161	1%
23		+0.05	2763	0%	2393	0%	32	-3%	782	0%	1121	-1%	2449	0%	2735	0%	1192	-3%	16	0%	2124	-1%
24		+0.1	2764	0%	2391	0%	33	0%	780	-1%	1122	-1%	2446	0%	2719	0%	1181	-3%	16	0%	2121	-1%
25		+0.25	2758	0%	2387	0%	33	0%	777	-1%	1121	-1%	2449	0%	2726	0%	1159	-5%	16	0%	2104	-1%
26	Ttr1 (0.02, 0.05, 1)	-0.05	2738	-1%	2320	-3%	33	0%	824	5%	1164	3%	2524	3%	2655	-2%	1469	20%	11	-31%	1993	-7%
27		+0.05	2772	0%	2411	1%	32	-3%	722	-8%	1115	-2%	2421	-1%	2718	0%	1159	-5%	16	0%	2193	3%
28		+0.25	2787	1%	2422	1%	32	-3%	698	-11%	1113	-2%	2400	-2%	2729	0%	1134	-7%	16	0%	2198	3%
29		+0.5	2802	1%	2427	1%	35	6%	691	-12%	1108	-2%	2329	-5%	2711	0%	999	-18%	16	0%	2331	9%
30	Ttr2 (0.02, 0.05, 1)	-0.05	2721	-2%	2294	-4%	31	-6%	652	-17%	1039	-8%	2222	-9%	2539	-7%	955	-22%	10	-38%	1573	-26%
31		+0.05	2783	1%	2426	1%	34	3%	821	5%	1163	3%	2464	0%	2743	1%	1355	11%	18	13%	2230	4%
32		+0.25	2797	1%	2434	2%	34	3%	832	6%	1169	3%	2503	2%	2763	1%	1377	13%	18	13%	2276	7%
33		+0.5	2799	1%	2436	2%	33	0%	844	8%	1177	4%	2499	2%	2765	2%	1377	13%	18	13%	2255	6%

Table 4.4-4 (continued)
SRP Results and Observations for the Stressed Case: Motor C

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	2765	-	2395	-	33	-	784	-	1133	-	2453	-	2723	-	1223	-	16	-	2135	-
34	Vrc1 (1)	-0.25	2767	0%	2396	0%	33	0%	784	0%	1134	0%	2453	0%	2725	0%	1223	0%	16	0%	2135	0%
35		-0.15	2767	0%	2396	0%	33	0%	784	0%	1134	0%	2453	0%	2725	0%	1223	0%	16	0%	2135	0%
36		-0.05	2767	0%	2396	0%	33	0%	784	0%	1134	0%	2453	0%	2725	0%	1223	0%	16	0%	2135	0%
37		+0.05	2767	0%	2396	0%	33	0%	784	0%	1134	0%	2453	0%	2725	0%	1223	0%	16	0%	2135	0%
38	Vrc2 (0.7, 1)	-0.2	2798	1%	2407	1%	38	15%	831	6%	1153	2%	2469	1%	2739	1%	1411	15%	17	6%	2200	3%
39		-0.1	2786	1%	2406	0%	35	6%	814	4%	1157	2%	2481	1%	2746	1%	1352	11%	16	0%	2184	2%
40		+0.1	2758	0%	2390	0%	30	-9%	772	-2%	1116	-2%	2374	-3%	2716	0%	1141	-7%	15	-6%	2090	-2%
41		+0.2	2758	0%	2390	0%	31	-6%	769	-2%	1115	-2%	2368	-3%	2732	0%	1091	-11%	15	-6%	2049	-4%
42	Vtr1 (0.7)	-0.15	2791	1%	2408	1%	34	3%	825	5%	1154	2%	2504	2%	2729	0%	1381	13%	16	0%	2211	4%
43		-0.05	2788	1%	2407	1%	32	-3%	792	1%	1144	1%	2474	1%	2729	0%	1254	3%	16	0%	2172	2%
44		+0.05	2752	0%	2385	0%	33	0%	781	0%	1120	-1%	2424	-1%	2738	1%	1152	-6%	16	0%	2125	0%
45		+0.15	2737	-1%	2370	-1%	34	3%	746	-5%	1114	-2%	2372	-3%	2725	0%	1011	-17%	16	0%	2108	-1%
46	Vtr2 (0.5, 0.6)	-0.15	2809	2%	2450	2%	31	-6%	752	-4%	1114	-2%	2364	-4%	2758	1%	1000	-18%	16	0%	2279	7%
47		-0.05	2800	1%	2424	1%	34	3%	762	-3%	1115	-2%	2417	-1%	2757	1%	1062	-13%	16	0%	2256	6%
48		+0.05	2752	0%	2384	0%	34	3%	811	3%	1141	1%	2477	1%	2747	1%	1323	8%	16	0%	2111	-1%
49		+0.15	2745	-1%	2364	-1%	33	0%	815	4%	1146	1%	2478	1%	2698	-1%	1411	15%	16	0%	2061	-3%

Table 4.4-5
SRP Results and Observations for the Stressed Case: Motor D

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	2725	-	2316	-	34	-	823	-	1157	-	2521	-	2713	-	1283	-	17	-	2159	-
2	FmD (varies)	-40%	2403	-12%	1986	-14%	14	-59%	340	-59%	801	-31%	1614	-36%	1683	-38%	324	-75%	4	-76%	1066	-51%
3		-20%	2594	-5%	2225	-4%	26	-24%	528	-36%	1062	-8%	2197	-13%	2405	-11%	720	-44%	9	-44%	1658	-23%
4		-10%	2670	-2%	2273	-2%	33	-3%	647	-21%	1097	-5%	2418	-4%	2592	-4%	921	-28%	13	-25%	1855	-14%
5		+10%	2780	2%	2358	2%	46	35%	992	21%	1179	2%	2644	5%	2878	6%	1573	23%	22	31%	2382	10%
6		+20%	3884	43%	3221	39%	47	38%	1056	28%	1233	7%	2845	13%	3297	22%	1944	52%	47	176%	3065	42%
7		+40%	3598	32%	2877	24%	71	109%	1512	84%	1335	15%	3180	26%	3296	21%	2271	77%	298	1655%	3288	52%
8	Fuvr (0.1)	0	2786	2%	2351	2%	36	6%	1895	130%	1180	2%	2611	4%	2816	4%	1416	10%	22	32%	2094	-3%
9		0.05	2747	1%	2327	0%	34	0%	1854	125%	1160	0%	2589	3%	2753	1%	1443	12%	19	11%	2090	-3%
10		0.15	2652	-3%	2257	-3%	28	-18%	475	-42%	853	-26%	1877	-26%	2300	-15%	932	-27%	10	-42%	1735	-20%
11		0.2	2616	-4%	2236	-3%	29	-15%	319	-61%	661	-43%	1518	-40%	2050	-24%	746	-42%	9	-49%	1476	-32%
12		0.25	2568	-6%	2213	-4%	25	-26%	283	-66%	603	-48%	1333	-47%	2139	-21%	1106	-14%	9	-48%	1440	-33%
13		0.5	2537	-7%	2182	-6%	25	-26%	91	-89%	303	-74%	768	-70%	2109	-22%	1464	14%	9	-45%	1593	-26%
14	Th1t (0.7)	0.4	2725	0%	2317	0%	34	0%	823	0%	1157	0%	2521	0%	2693	-1%	1283	0%	23	34%	2184	1%
15		0.55	2725	0%	2317	0%	35	3%	823	0%	1157	0%	2521	0%	2706	0%	1283	0%	18	6%	2165	0%
16		0.65	2725	0%	2317	0%	34	0%	823	0%	1157	0%	2521	0%	2711	0%	1283	0%	17	0%	2163	0%
17		0.75	2725	0%	2317	0%	33	-3%	823	0%	1157	0%	2521	0%	2715	0%	1283	0%	17	0%	2152	0%
18		0.85	2725	0%	2317	0%	33	-3%	823	0%	1157	0%	2521	0%	2744	1%	1283	0%	17	0%	2149	0%
19		0.9	2725	0%	2317	0%	32	-6%	823	0%	1157	0%	2521	0%	2711	0%	1283	0%	17	0%	2142	-1%
20	Th2t (1.9)	1	2725	0%	2317	0%	37	9%	823	0%	1157	0%	2524	0%	2694	-1%	1283	0%	17	0%	2611	21%
21		1.1	2725	0%	2317	0%	37	9%	823	0%	1157	0%	2524	0%	2702	0%	1283	0%	17	0%	2546	18%
22		1.3	2725	0%	2317	0%	36	6%	823	0%	1157	0%	2524	0%	2675	-1%	1283	0%	17	0%	2417	12%
23		1.4	2725	0%	2317	0%	35	3%	823	0%	1157	0%	2524	0%	2700	0%	1283	0%	17	0%	2360	9%
24		2	2725	0%	2317	0%	33	-3%	823	0%	1157	0%	2524	0%	2731	1%	1283	0%	17	0%	2129	-1%
25		3	2725	0%	2317	0%	24	-29%	823	0%	1157	0%	2524	0%	2575	-5%	1283	0%	17	0%	156	-93%
26	Tstall (0.033)	0.01667	2796	3%	2364	2%	45	32%	2076	152%	1272	10%	2869	14%	2856	5%	2082	62%	76	349%	2514	16%
27		0.0667	2609	-4%	2236	-3%	14	-59%	98	-88%	269	-77%	567	-78%	606	-78%	160	-88%	6	-66%	529	-75%
28		0.08335	2578	-5%	2224	-4%	14	-59%	83	-90%	257	-78%	499	-80%	534	-80%	434	-66%	6	-67%	352	-84%
29		0.1	2563	-6%	2219	-4%	12	-65%	83	-90%	252	-78%	454	-82%	524	-81%	584	-55%	4	-77%	325	-85%
30		0.1667	2554	-6%	2199	-5%	6	-82%	83	-90%	44	-96%	42	-98%	69	-97%	675	-47%	0	-99%	17	-99%
31		0.25	2554	-6%	2199	-5%	6	-82%	83	-90%	43	-96%	42	-98%	69	-97%	679	-47%	0	-99%	13	-99%

Table 4.4-5 (continued)
SRP Results and Observations for the Stressed Case: Motor D

Ref. No.	Variable	Setting	> 25% Voltage Dip		> 30% Voltage Dip		Generator Swings Offline		Voltage < 70% in 1 second		Voltage < 80% in 3 seconds		Voltage < 90% in 5 seconds		Voltage Deviation > 5%		Voltage overshoot over 1.1 p.u. within 8 seconds		Voltage overshoot over 1.1 p.u. b/w 8 and 15 seconds		Voltage overshoot over 1.1 p.u. b/w 15 and 30 seconds	
			# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta	# of Buses	Delta (% change)	# of Buses	Delta (% change)	# of Buses	Delta (% change)
1	Phase 2	-	2725	-	2316	-	34	-	823	-	1157	-	2521	-	2713	-	1283	-	17	-	2159	-
32	Tth (15)	5	2725	0%	2317	0%	39	15%	823	0%	1157	0%	2523	0%	2732	1%	1283	0%	23	36%	2591	20%
33		10	2725	0%	2317	0%	34	0%	823	0%	1157	0%	2523	0%	2709	0%	1283	0%	20	15%	2306	7%
34		12	2726	0%	2317	0%	42	24%	823	0%	1157	0%	2523	0%	2716	0%	1283	0%	17	0%	2274	5%
35		17	2725	0%	2317	0%	32	-6%	823	0%	1157	0%	2523	0%	2720	0%	1283	0%	17	0%	2120	-2%
36		20	2725	0%	2317	0%	30	-12%	823	0%	1157	0%	2523	0%	2120	-22%	1283	0%	17	0%	1213	-44%
37		25	2725	0%	2317	0%	28	-18%	823	0%	1157	0%	2523	0%	1737	-36%	1283	0%	17	0%	181	-92%
38	Vc1Vc2	Min	4840	78%	4015	73%	880	2488%	2203	168%	1562	35%	3845	53%	4498	66%	1438	12%	651	3728%	1056	-51%
39		R1	3597	32%	2946	27%	51	50%	1423	73%	1069	-8%	2564	2%	3119	15%	919	-28%	22	28%	2924	35%
40		R2	3597	32%	2946	27%	51	50%	1423	73%	1069	-8%	2564	2%	3119	15%	919	-28%	22	28%	2924	35%
41		R3	2566	-6%	2184	-6%	26	-24%	204	-75%	607	-48%	1442	-43%	1803	-34%	1059	-17%	11	-38%	1197	-45%
42		R4	2501	-8%	2087	-10%	17	-50%	35	-96%	547	-53%	1024	-59%	1392	-49%	735	-43%	1	-93%	1113	-48%
43		Max	2381	-13%	1802	-22%	17	-50%	28	-97%	480	-58%	1095	-57%	1342	-51%	570	-56%	1	-93%	1333	-38%
44	Vrst (0.95)	0.5	2725	0%	2314	0%	32	-6%	823	0%	1144	-1%	2531	0%	2581	-5%	1213	-5%	23	33%	1904	-12%
45		0.7	2725	0%	2317	0%	34	0%	823	0%	1157	0%	2523	0%	2662	-2%	1283	0%	18	6%	2055	-5%
46		0.8	2725	0%	2317	0%	34	0%	823	0%	1157	0%	2523	0%	2687	-1%	1283	0%	17	0%	2094	-3%
47		0.85	2725	0%	2317	0%	34	0%	823	0%	1157	0%	2523	0%	2697	-1%	1283	0%	17	0%	2110	-2%
48		0.9	2725	0%	2317	0%	34	0%	823	0%	1157	0%	2523	0%	2706	0%	1283	0%	17	0%	2135	-1%
49		1	2725	0%	2317	0%	34	0%	823	0%	1157	0%	2523	0%	2715	0%	1283	0%	17	0%	2176	1%
50	Vstall (0.5)	0.3	2593	-5%	2219	-4%	8	-76%	94	-89%	164	-86%	362	-86%	615	-77%	142	-89%	1	-91%	206	-90%
51		0.4	2557	-6%	2202	-5%	6	-82%	173	-79%	74	-94%	215	-91%	437	-84%	448	-65%	2	-88%	72	-97%
52		0.45	2549	-6%	2246	-3%	8	-76%	177	-78%	394	-66%	463	-82%	652	-76%	834	-35%	5	-70%	239	-89%
53		0.55	2724	0%	2314	0%	33	-3%	824	0%	1189	3%	2616	4%	2631	-3%	2025	58%	23	38%	2287	6%
54		0.6	2798	3%	2326	0%	37	9%	872	6%	1225	6%	2771	10%	2929	8%	2640	106%	32	90%	2944	36%
55		0.8	4768	75%	3687	59%	234	588%	2308	180%	1637	42%	3800	51%	5716	111%	3506	173%	484	2745%	4383	103%

The amount of total load loss at each load bus in SRP for each contingency and sensitivity parameter analyzed for the Stressed Case was recorded. Tables 4.4-6 through 4.4-9 list the total load loss for each of the five contingencies and sensitivities examined for Motor A, Motor B, Motor C, and Motor D, respectively. The tables list the contingency, the amount of load loss, the percent change from the Phase 2 base case and the respective sensitivity parameter. For Motor A Contingency #3 in Table 4.4-6, the Phase 2 base case loss total was 4,988 MW. For sensitivity parameter Ftr1, 3,731 MW of load was loss after increasing each motor trip fraction by a factor of 0.2, which is a decrease of 25% from the Phase 2 base case. For the same contingency and parameter, 18,894 MW of load was loss after decreasing each motor trip fraction by a factor of 0.2, which is an increase of 279% from the Phase 2 base case.

Table 4.4-6
SRP Results and Observations for the Stressed Case: Motor A Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #6	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	4676	-	4466	-	4988	-	5205	-	7813	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	5491	17%	4824	8%	18894	279%	5951	14%	10312	32%
3		-0.1	5110	9%	4976	11%	4964	0%	5453	5%	14378	84%
4		+0.1	4553	-3%	4293	-4%	4146	-17%	5046	-3%	7829	0%
5		+0.2	4453	-5%	4194	-6%	3731	-25%	4998	-4%	7444	-5%
6	Ftr2 (0, 0.5, 0.7)	-0.2	4816	3%	5195	16%	5980	20%	5370	3%	9410	20%
7		-0.1	4740	1%	5060	13%	5048	1%	5274	1%	8496	9%
8		+0.1	4617	-1%	4410	-1%	4363	-13%	4394	-16%	7733	-1%
9		+0.2	4467	-4%	4317	-3%	4850	-3%	4179	-20%	7494	-4%
10	H (0.1, 0.15, 0.2)	-50%	4682	0%	5203	16%	5160	3%	5297	2%	8997	15%
11		-25%	4676	0%	4472	0%	4985	0%	5192	0%	7836	0%
12		+50%	4664	0%	4347	-3%	4965	0%	5193	0%	7838	0%
13		+100%	4660	0%	4312	-3%	4940	-1%	5214	0%	7765	-1%
14	Ls (1.8, 3.1)	-50%	4088	-13%	3658	-18%	3921	-21%	4028	-23%	7247	-7%
15		-25%	4634	-1%	4300	-4%	4214	-16%	4345	-17%	7646	-2%
16		+50%	4714	1%	5216	17%	5153	3%	5397	4%	8731	12%
17		+100%	-	N/A	-	N/A	-	N/A	-	N/A	9108	17%
18	Tpo (0.095, 0.8)	-50%	4664	0%	5087	14%	5014	1%	5332	2%	8667	11%
19		-25%	4671	0%	4445	0%	5028	1%	5235	1%	8285	6%
20		+50%	4666	0%	4440	-1%	4377	-12%	5123	-2%	7744	-1%
21		+100%	4654	0%	4207	-6%	4995	0%	4343	-17%	7070	-10%
22	Trc2 (0.1, 0.25)	-0.05	4678	0%	5060	13%	5084	2%	5203	0%	7832	0%
23		+0.05	4677	0%	4453	0%	4445	-11%	4662	-10%	7697	-1%
24		+0.1	4677	0%	4434	-1%	4365	-12%	4549	-13%	7737	-1%
25		+0.25	4679	0%	4432	-1%	3981	-20%	4524	-13%	7578	-3%
26	Ttr1 (0.02, 0.05, 1)	-0.05	4605	-2%	3932	-12%	1736	-65%	3507	-33%	7582	-3%
27		+0.05	4706	1%	5144	15%	5131	3%	5275	1%	8029	3%
28		+0.25	4786	2%	5102	14%	7120	43%	6164	18%	9476	21%
29		+0.5	5400	15%	5192	16%	9818	97%	6574	26%	14536	86%
30	Ttr2 (0.02, 0.05, 1)	-0.05	4549	-3%	4407	-1%	1067	-79%	4221	-19%	7650	-2%
31		+0.05	4730	1%	6498	45%	6490	30%	5646	8%	9901	27%
32		+0.25	4810	3%	6980	56%	7656	53%	6605	27%	-	N/A
33		+0.5	5232	12%	7259	63%	-	N/A	6728	29%	-	N/A
34	Vrc1 (1)	-0.25	4677	0%	4466	0%	4988	0%	5205	0%	7813	0%
35		-0.15	4677	0%	4466	0%	4988	0%	5205	0%	7813	0%
36		-0.05	4677	0%	4466	0%	4988	0%	5205	0%	7813	0%
37		+0.05	4677	0%	4466	0%	4988	0%	5205	0%	7813	0%
38	Vrc2 (0.7, 1)	-0.2	5106	9%	5329	19%	5058	1%	5513	6%	9420	21%
39		-0.1	4666	0%	5108	14%	5042	1%	5190	0%	7854	1%
40		+0.1	4678	0%	4374	-2%	5008	0%	4422	-15%	7242	-7%
41		+0.2	4680	0%	4207	-6%	4380	-12%	4284	-18%	7238	-7%
42	Vtr1 (0.7)	-0.15	4680	0%	5072	14%	6501	30%	5232	1%	12816	64%
43		-0.05	4672	0%	4541	2%	6432	29%	5180	0%	8069	3%
44		+0.05	4639	-1%	3777	-15%	4377	-12%	5171	-1%	6121	-22%
45		+0.15	4334	-7%	3513	-21%	4432	-11%	4700	-10%	5557	-29%
46	Vtr2 (0.5, 0.6)	-0.15	5387	15%	-	N/A	-	N/A	-	N/A	-	N/A
47		-0.05	4804	3%	5635	26%	13073	162%	-	N/A	-	N/A
48		+0.05	4674	0%	4270	-4%	4026	-19%	-	N/A	7101	-9%
49		+0.15	4251	-9%	4272	-4%	2645	-47%	-	N/A	5145	-34%

Table 4.4-7
SRP Results and Observations for the Stressed Case: Motor B Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #6	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	4676	-	4466	-	4988	-	5205	-	7813	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	4747	2%	4531	1%	5532	11%	5496	6%	12437	59%
3		-0.1	4740	1%	4484	0%	5099	2%	5372	3%	10754	38%
4		+0.1	4671	0%	4448	0%	4140	-17%	4570	-12%	7641	-2%
5		+0.2	4590	-2%	4369	-2%	3968	-20%	4548	-13%	7499	-4%
6	Ftr2 (0, 0.5, 0.7)	-0.2	4742	1%	4473	0%	5141	3%	5462	5%	9396	20%
7		-0.1	4724	1%	4473	0%	5105	2%	5379	3%	8910	14%
8		+0.1	4675	0%	4446	0%	4398	-12%	4582	-12%	7743	-1%
9		+0.2	4648	-1%	4412	-1%	4383	-12%	4538	-13%	7691	-2%
10	H (0.1, 0.15, 0.2)	-50%	4791	2%	4548	2%	6769	36%	5388	4%	8779	12%
11		-25%	4700	1%	4500	1%	5167	4%	5356	3%	8551	9%
12		+50%	4669	0%	4407	-1%	4973	0%	5159	-1%	7809	0%
13		+100%	4618	-1%	4388	-2%	4834	-3%	5159	-1%	7519	-4%
14	Ls (1.8, 3.1)	-50%	4679	0%	4484	0%	5104	2%	5329	2%	15377	97%
15		-25%	4698	0%	4466	0%	5139	3%	5298	2%	10751	38%
16		+50%	4543	-3%	4438	-1%	4989	0%	5103	-2%	7601	-3%
17		+100%	4523	-3%	3665	-18%	4351	-13%	4470	-14%	7354	-6%
18	Tpo (0.095, 0.8)	-50%	4454	-5%	3540	-21%	4219	-15%	4543	-13%	7463	-4%
19		-25%	4670	0%	4444	-1%	4928	-1%	5179	0%	7555	-3%
20		+50%	4713	1%	4524	1%	6534	31%	5383	3%	13602	74%
21		+100%	4718	1%	4614	3%	-	N/A	5410	4%	11086	42%
22	Trc2 (0.1, 0.25)	-0.05	4641	-1%	4330	-3%	4383	-12%	5164	-1%	7735	-1%
23		+0.05	4692	0%	4463	0%	4988	0%	5350	3%	7869	1%
24		+0.1	4701	1%	4498	1%	5002	0%	5363	3%	7842	0%
25		+0.25	4700	1%	4499	1%	5313	7%	5362	3%	7848	0%
26	Ttr1 (0.02, 0.05, 1)	-0.05	4747	2%	4617	3%	8132	63%	5533	6%	10284	32%
27		+0.05	4650	-1%	4470	0%	4811	-4%	4913	-6%	7461	-5%
28		+0.25	4572	-2%	4421	-1%	4765	-4%	4878	-6%	7231	-7%
29		+0.5	4490	-4%	4213	-6%	4713	-6%	4865	-7%	7119	-9%
30	Ttr2 (0.02, 0.05, 1)	-0.05	4504	-4%	3726	-17%	4420	-11%	4170	-20%	7724	-1%
31		+0.05	4732	1%	4500	1%	6346	27%	5610	8%	7913	1%
32		+0.25	4763	2%	4507	1%	6474	30%	5713	10%	-	N/A
33		+0.5	4846	4%	4729	6%	6543	31%	5913	14%	8136	4%
34	Vrc1 (1)	-0.25	4750	2%	4477	0%	5092	2%	5396	4%	12657	62%
35		-0.15	4711	1%	4467	0%	5066	2%	5363	3%	17546	125%
36		-0.05	4700	1%	4450	0%	5044	1%	5339	3%	7825	0%
37		+0.05	4602	-2%	4231	-5%	4907	-2%	5212	0%	7682	-2%
38	Vrc2 (0.7, 1)	-0.2	4782	2%	5744	29%	5337	7%	6493	25%	-	N/A
39		-0.1	4763	2%	4979	11%	5122	3%	5717	10%	9629	23%
40		+0.1	4690	0%	4395	-2%	4965	0%	5134	-1%	7799	0%
41		+0.2	4695	0%	4204	-6%	4901	-2%	5127	-1%	7603	-3%
42	Vtr1 (0.7)	-0.15	4717	1%	4529	1%	5435	9%	5347	3%	11242	44%
43		-0.05	4710	1%	4488	0%	5062	1%	5336	3%	18436	136%
44		+0.05	4695	0%	4454	0%	4396	-12%	5098	-2%	7733	-1%
45		+0.15	4271	-9%	3866	-13%	4363	-13%	4683	-10%	7473	-4%
46	Vtr2 (0.5, 0.6)	-0.15	4717	1%	4500	1%	6536	31%	5664	9%	-	N/A
47		-0.05	4730	1%	4477	0%	5491	10%	5395	4%	-	N/A
48		+0.05	4600	-2%	4433	-1%	5004	0%	5103	-2%	7461	-5%
49		+0.15	4354	-7%	4433	-1%	3959	-21%	**5071**	-3%	7319	-6%

Table 4.4-8
SRP Results and Observations for the Stressed Case: Motor C Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #6	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	4676	-	4466	-	4988	-	5205	-	7813	-
2	Ftr1 (0.2, 0.3, 1)	-0.2	4555	-3%	4271	-4%	4924	-1%	5060	-3%	7213	-8%
3		-0.1	4616	-1%	4362	-2%	4921	-1%	5135	-1%	7578	-3%
4		+0.1	4735	1%	4554	2%	5000	0%	5234	1%	7974	2%
5		+0.2	4786	2%	4607	3%	5298	6%	5590	7%	8143	4%
6	Ftr2 (0, 0.5, 0.7)	-0.2	4680	0%	4519	1%	5011	0%	5220	0%	9149	17%
7		-0.1	4680	0%	4501	1%	5011	0%	5229	0%	8145	4%
8		+0.1	4662	0%	4460	0%	4935	-1%	5092	-2%	7637	-2%
9		+0.2	4653	0%	4436	-1%	4317	-13%	4429	-15%	7513	-4%
10	H (0.1, 0.15, 0.2)	-50%	4658	0%	4396	-2%	4927	-1%	5141	-1%	7413	-5%
11		-25%	4660	0%	4424	-1%	4931	-1%	5191	0%	7628	-2%
12		+50%	4667	0%	4467	0%	5027	1%	5203	0%	8073	3%
13		+100%	4675	0%	4485	0%	5048	1%	5660	9%	8173	5%
14	Ls (1.8, 3.1)	-50%	4706	1%	4561	2%	5045	1%	5280	1%	8830	13%
15		-25%	4680	0%	4510	1%	5032	1%	5261	1%	7835	0%
16		+50%	4658	0%	4483	0%	4936	-1%	5137	-1%	7368	-6%
17		+100%	4652	-1%	4377	-2%	4905	-2%	5117	-2%	7307	-6%
18	Tpo (0.095, 0.8)	-50%	4649	-1%	4413	-1%	4951	-1%	5090	-2%	7503	-4%
19		-25%	4661	0%	4441	-1%	5003	0%	5189	0%	7743	-1%
20		+50%	4662	0%	4468	0%	5087	2%	5257	1%	8619	10%
21		+100%	4713	1%	4464	0%	5865	18%	5267	1%	10137	30%
22	Trc2 (0.1, 0.25)	-0.05	4668	0%	4438	-1%	4959	-1%	5192	0%	7455	-5%
23		+0.05	4675	0%	4467	0%	5060	1%	5205	0%	8442	8%
24		+0.1	4676	0%	4467	0%	5135	3%	5204	0%	8463	8%
25		+0.25	4675	0%	4468	0%	5221	5%	5183	0%	9181	18%
26	Ttr1 (0.02, 0.05, 1)	-0.05	4618	-1%	3678	-18%	4042	-19%	4029	-23%	7390	-5%
27		+0.05	4665	0%	4533	1%	5004	0%	5251	1%	8346	7%
28		+0.25	4679	0%	4610	3%	5041	1%	5293	2%	9463	21%
29		+0.5	4678	0%	4621	3%	5070	2%	5297	2%	13134	68%
30	Ttr2 (0.02, 0.05, 1)	-0.05	4476	-4%	3226	-28%	2292	-54%	3896	-25%	7307	-6%
31		+0.05	4682	0%	4531	1%	5013	1%	5226	0%	9172	17%
32		+0.25	4682	0%	4607	3%	5014	1%	5246	1%	9570	22%
33		+0.5	4690	0%	4608	3%	5019	1%	5248	1%	8885	14%
34	Vrc1 (1)	-0.25	4676	0%	4466	0%	4988	0%	5205	0%	7813	0%
35		-0.15	4676	0%	4466	0%	4988	0%	5205	0%	7813	0%
36		-0.05	4676	0%	4466	0%	4988	0%	5205	0%	7813	0%
37		+0.05	4676	0%	4466	0%	4988	0%	5205	0%	7813	0%
38	Vrc2 (0.7, 1)	-0.2	4691	0%	4789	7%	4978	0%	5481	5%	8911	14%
39		-0.1	4678	0%	4548	2%	4971	0%	5234	1%	8427	8%
40		+0.1	4674	0%	4391	-2%	4987	0%	5208	0%	7417	-5%
41		+0.2	4676	0%	4395	-2%	4970	0%	5203	0%	7395	-5%
42	Vtr1 (0.7)	-0.15	4751	2%	4453	0%	4998	0%	5283	2%	9104	17%
43		-0.05	4752	2%	4458	0%	4991	0%	5276	1%	9355	20%
44		+0.05	4692	0%	4485	0%	4935	-1%	5172	-1%	7626	-2%
45		+0.15	4680	0%	4430	-1%	4857	-3%	5168	-1%	7373	-6%
46	Vtr2 (0.5, 0.6)	-0.15	4665	0%	4539	2%	5016	1%	5242	1%	9766	25%
47		-0.05	4667	0%	4531	1%	5017	1%	5196	0%	8489	9%
48		+0.05	4666	0%	4461	0%	4580	-8%	5120	-2%	7730	-1%
49		+0.15	4652	-1%	4470	0%	4105	-18%	**5157**	-1%	7680	-2%

Table 4.4-9
SRP Results and Observations for the Stressed Case: Motor D Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #6	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	4450	-	4129	-	4410	-	4485	-	8536	-
2	FmD (varies)	-40%	2277	-49%	2355	-43%	690	-84%	2276	-49%	2778	-67%
3		-20%	3081	-31%	3357	-19%	3124	-29%	3428	-24%	4424	-48%
4		-10%	3814	-14%	3976	-4%	3640	-17%	3924	-13%	7471	-12%
5		+10%	5728	29%	4580	11%	5666	28%	4715	5%	10878	27%
6		+20%	7545	70%	5294	28%	7439	69%	6011	34%	32195	277%
7		+40%	12438	179%	5849	42%	9289	111%	10436	133%	30732	260%
8	Fuvr (0.1)	0	4492	1%	4223	2%	5031	14%	5330	19%	11921	40%
9		0.05	4467	0%	4262	3%	5068	15%	4632	3%	9089	6%
10		0.15	4392	-1%	3878	-6%	1885	-57%	4037	-10%	7511	-12%
11		0.2	3116	-30%	3781	-8%	1386	-69%	3702	-17%	7401	-13%
12		0.25	2916	-34%	3685	-11%	1667	-62%	3627	-19%	5624	-34%
13		0.5	3214	-28%	3567	-14%	1903	-57%	3786	-16%	3457	-60%
14	Th1t (0.7)	0.4	4447	0%	4124	0%	4406	0%	4482	0%	7853	-8%
15		0.55	4448	0%	4125	0%	4403	0%	4482	0%	8193	-4%
16		0.65	4453	0%	4131	0%	4412	0%	4487	0%	7884	-8%
17		0.75	4450	0%	4129	0%	4406	0%	4483	0%	8748	2%
18		0.85	4450	0%	4134	0%	4398	0%	4481	0%	9004	5%
19		0.9	4464	0%	4145	0%	4413	0%	4488	0%	9474	11%
20	Th2t (1.2)	1	4450	0%	4129	0%	4410	0%	4485	0%	8820	3%
21		1.1	4450	0%	4129	0%	4410	0%	4485	0%	8725	2%
22		1.3	4450	0%	4129	0%	4410	0%	4485	0%	8649	1%
23		1.4	4450	0%	4129	0%	4410	0%	4485	0%	8632	1%
24		2	4437	0%	4118	0%	4391	0%	4473	0%	7995	-6%
25		3	2379	-47%	2418	-41%	2754	-38%	2613	-42%	5272	-38%
26	Tstall (0.033)	0.01667	4566	3%	5414	31%	6756	53%	5528	23%	9154	7%
27		0.0667	1182	-73%	1155	-72%	806	-82%	1076	-76%	6830	-20%
28		0.08335	879	-80%	1142	-72%	806	-82%	1076	-76%	5846	-32%
29		0.1	879	-80%	1142	-72%	806	-82%	1076	-76%	5012	-41%
30		0.1667	879	-80%	1142	-72%	806	-82%	1076	-76%	1860	-78%
31		0.25	879	-80%	1142	-72%	806	-82%	1076	-76%	1828	-79%
32	Tth (15)	5	4526	2%	4214	2%	4513	2%	4554	2%	9137	7%
33		10	4523	2%	4192	2%	4475	1%	4557	2%	9000	5%
34		12	4471	0%	4145	0%	4431	0%	4503	0%	8830	3%
35		17	4441	0%	4127	0%	4392	0%	4469	0%	8114	-5%
36		20	3776	-15%	3435	-17%	3551	-19%	3781	-16%	7672	-10%
37		25	2714	-39%	2592	-37%	2380	-46%	2918	-35%	7858	-8%

Table 4.4-9 (continued)
SRP Results and Observations for the Stressed Case: Motor D Load Loss

Ref. No.	Variable	Setting	Contingency #1		Contingency #2		Contingency #3		Contingency #4		Contingency #6	
			Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)	Load Loss (MW)	Delta (% change)
1	Phase 2	-	4450	-	4129	-	4410	-	4485	-	8536	-
38	Vc1Vc2	Min	6798	53%	8107	96%	22905	419%	8886	98%	38033	346%
39		R1	4371	-2%	4348	5%	5198	18%	4479	0%	22353	162%
40		R2	4371	-2%	4348	5%	5198	18%	4479	0%	22353	162%
41		R3	2765	-38%	3471	-16%	1210	-73%	3179	-29%	5933	-30%
42		R4	2595	-42%	3839	-7%	1037	-76%	3741	-17%	2005	-77%
43		Max	3358	-25%	3556	-14%	969	-78%	3868	-14%	1550	-82%
44	Vrst (0.95)	0.5	3875	-13%	3621	-12%	3863	-12%	3898	-13%	8160	-4%
45		0.7	4185	-6%	3886	-6%	4180	-5%	4223	-6%	7458	-13%
46		0.8	4306	-3%	3999	-3%	4286	-3%	4344	-3%	7884	-8%
47		0.85	4357	-2%	4046	-2%	4329	-2%	4395	-2%	8109	-5%
48		0.9	4405	-1%	4091	-1%	4371	-1%	4443	-1%	8424	-1%
49		1	4484	1%	4155	1%	4438	1%	4515	1%	8534	0%
50	Vstall (0.5)	0.3	1727	-61%	2277	-45%	1244	-72%	1244	-72%	1525	-82%
51		0.4	1582	-64%	1636	-60%	806	-82%	1213	-73%	1389	-84%
52		0.45	1783	-60%	2535	-39%	784	-82%	1158	-74%	1423	-83%
53		0.55	4452	0%	4129	0%	4410	0%	4605	3%	10231	20%
54		0.6	4452	0%	4129	0%	4410	0%	4679	4%	15014	76%
55		0.8	15334	245%	18045	337%	23169	425%	17768	296%	24299	185%

Refer to Figures 4.4-17 through 4.4-28 for representative plots of select sensitivity parameters of Motor A, Motor B, and Motor D for a three-phase fault resulting in the loss of a 500 kV line. The plots include up to eight bus voltages and four generator angles comparing the base case (Phase 2) to the multiple sensitivity parameters.

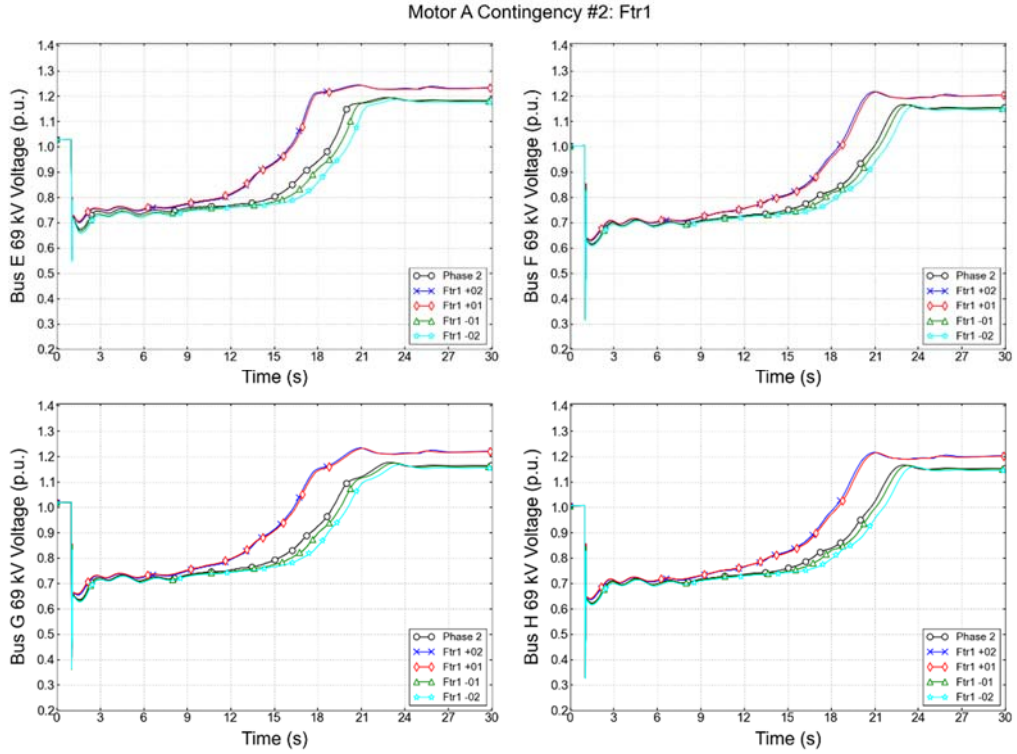

Figure 4.4-15: Bus voltages for Motor A sensitivity parameter Ftr1.

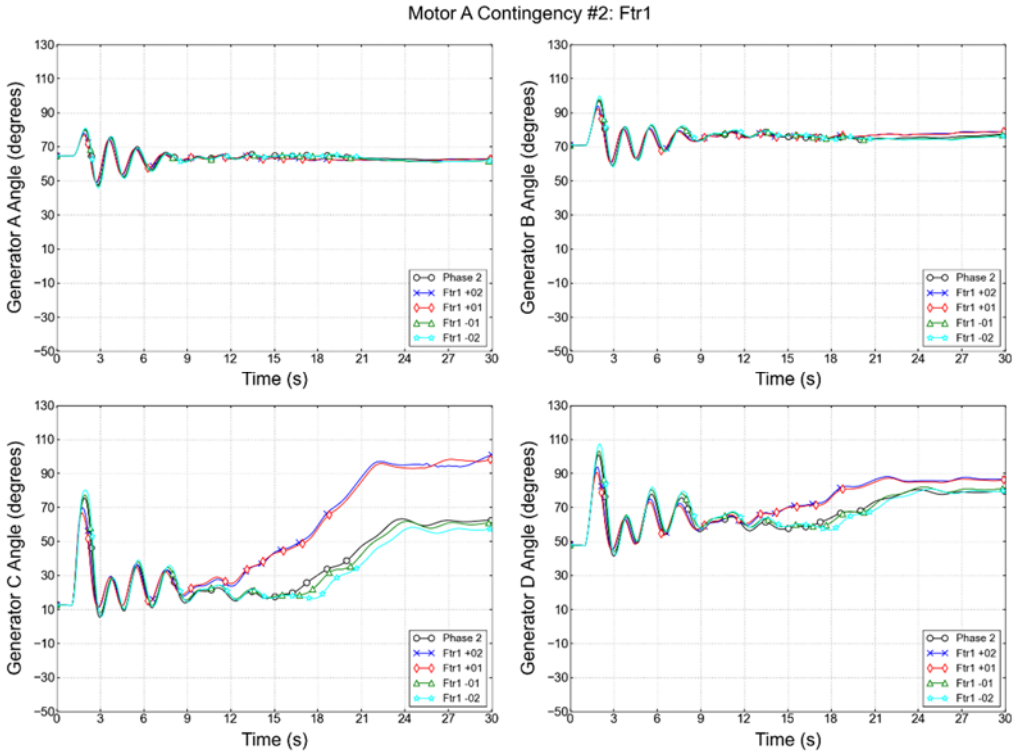

Figure 4.4-16: Generator angles for Motor A sensitivity parameter Ftr1.

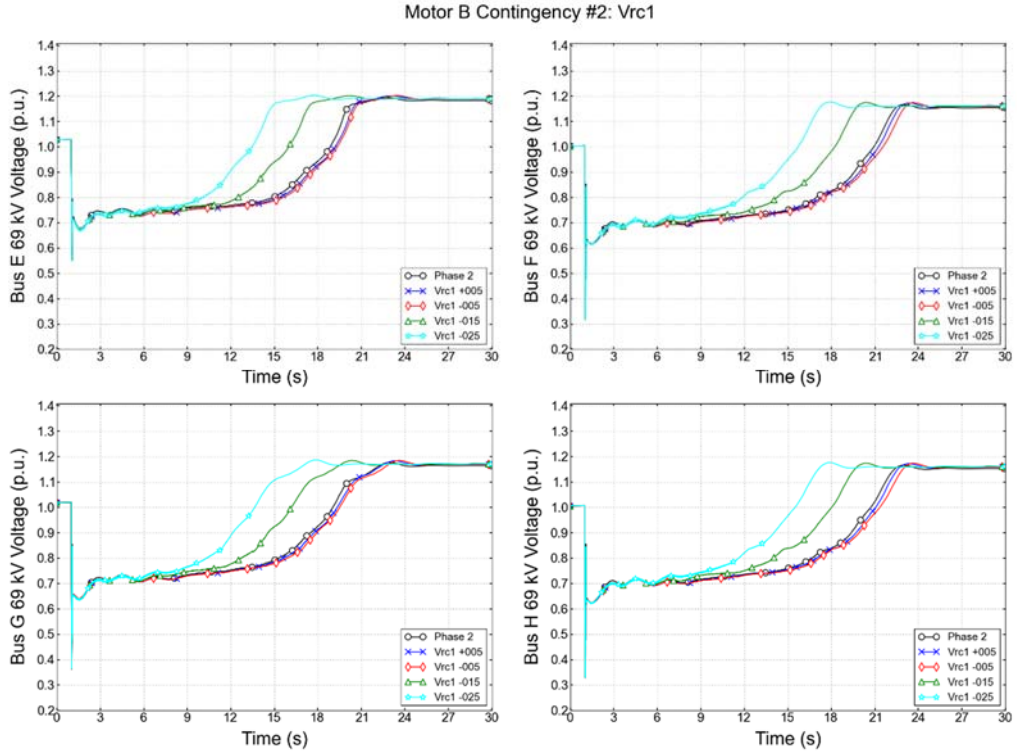

Figure 4.4-17: Bus voltages for Motor B sensitivity parameter Vrc1.

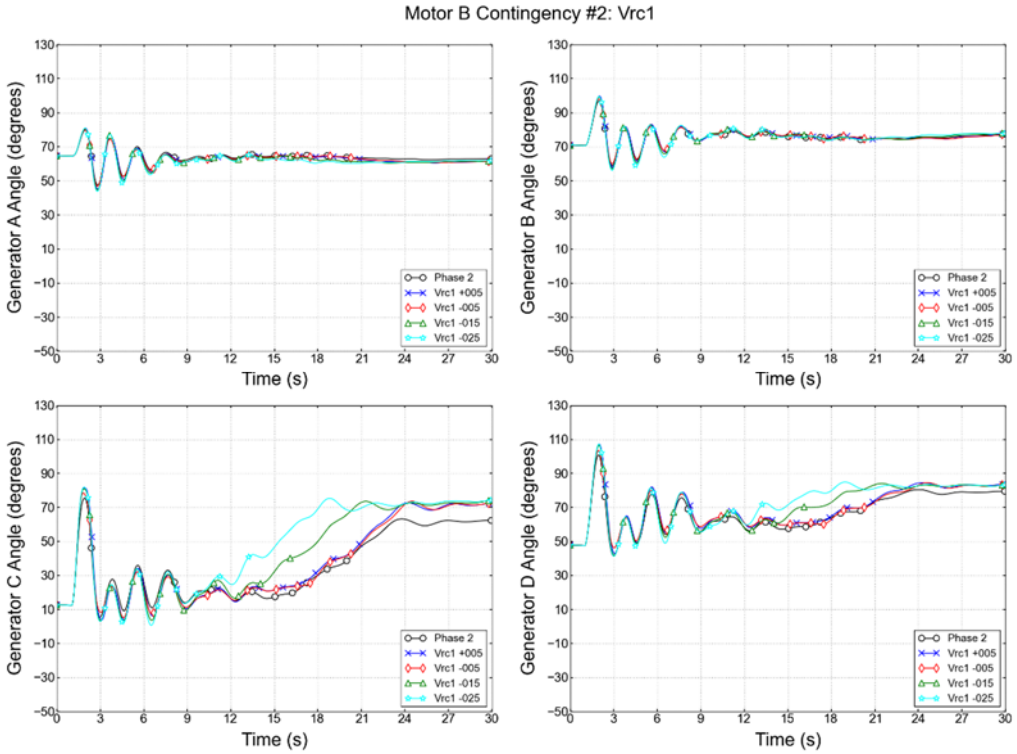

Figure 4.4-18: Generator angles for Motor B sensitivity parameter Vrc1.

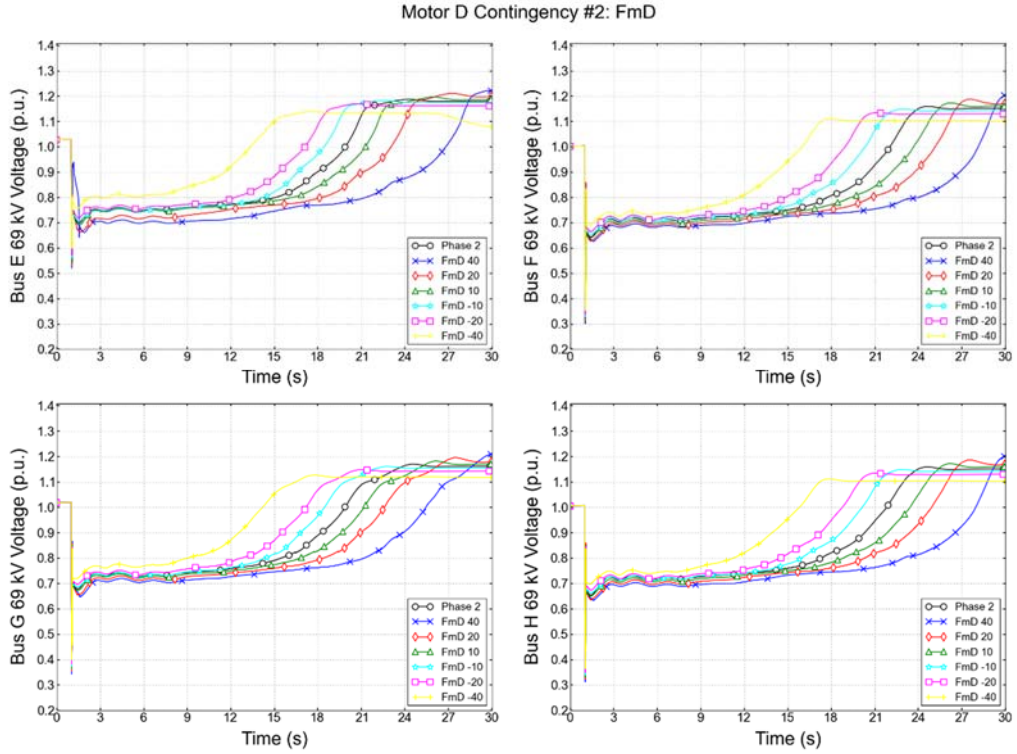

Figure 4.4-19: Bus voltages for Motor D sensitivity parameter FmD.

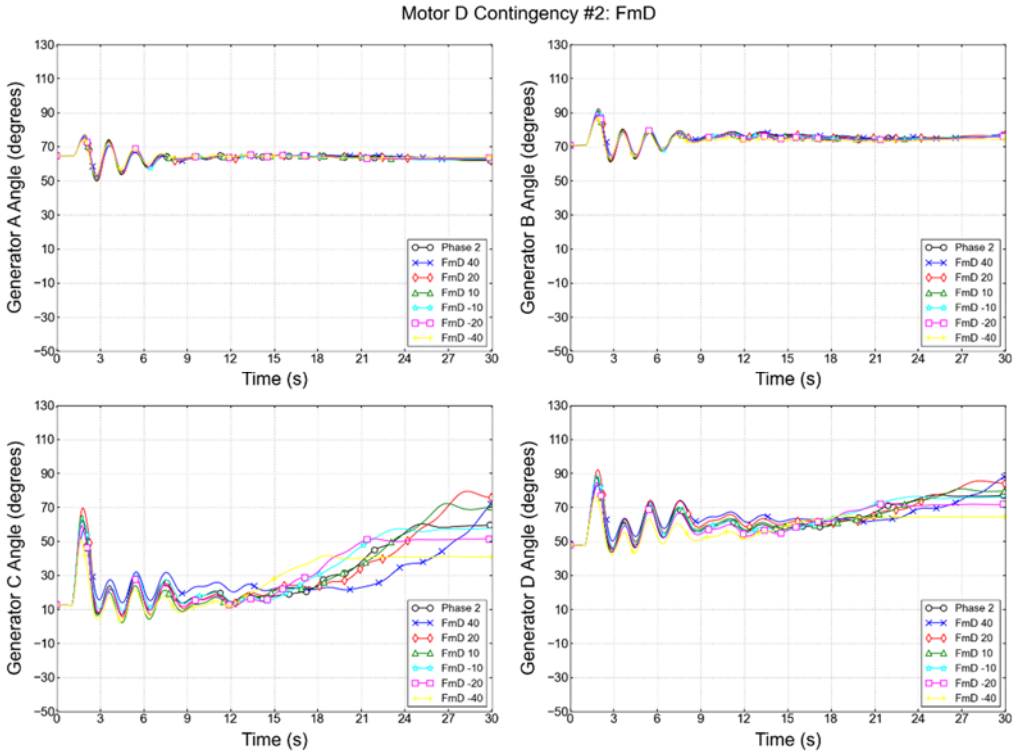

Figure 4.4-20: Generator angles for Motor D sensitivity parameter FmD.

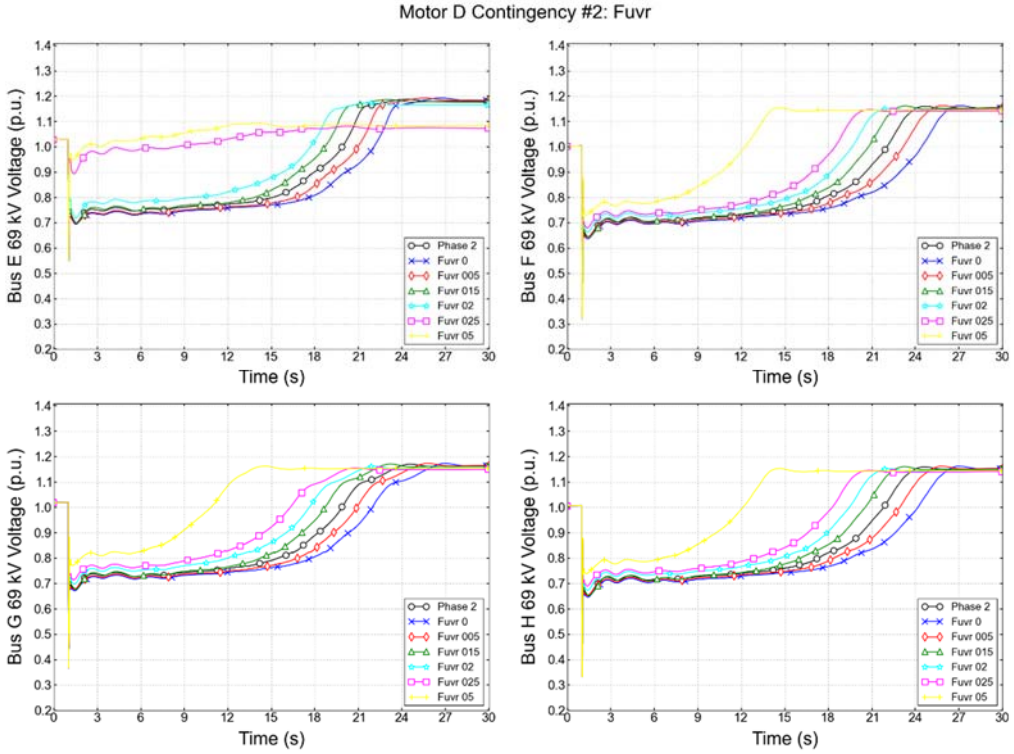

Figure 4.4-21: Bus voltages for Motor D sensitivity parameter Fuvr.

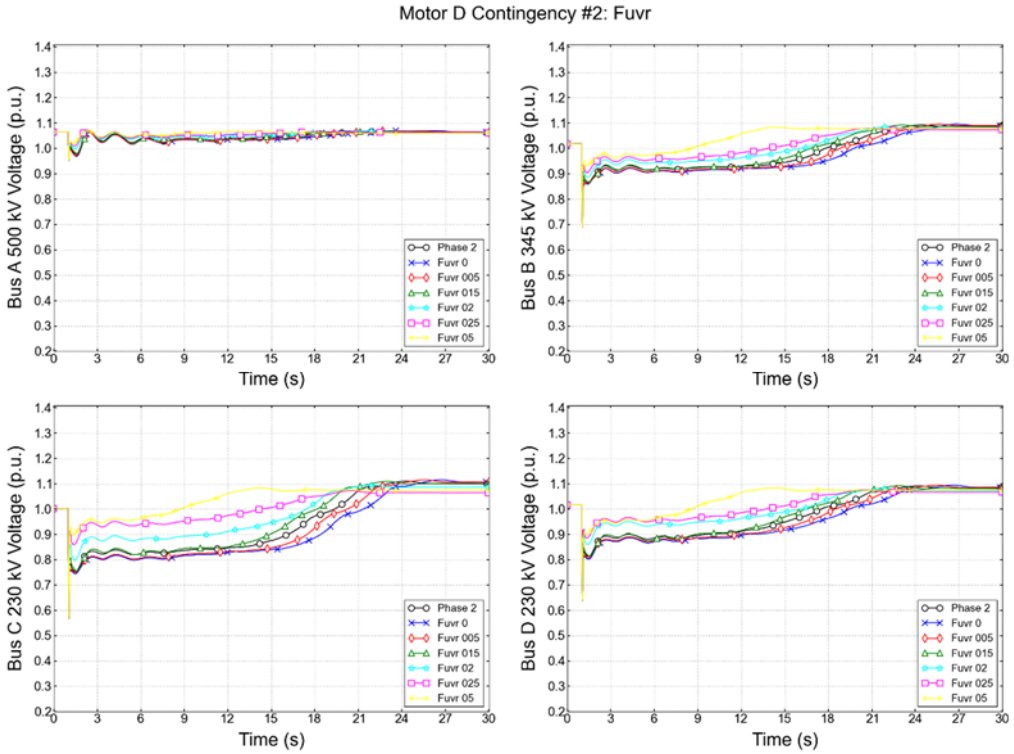

Figure 4.4-22: Generator angles for Motor D sensitivity parameter Fuvr.

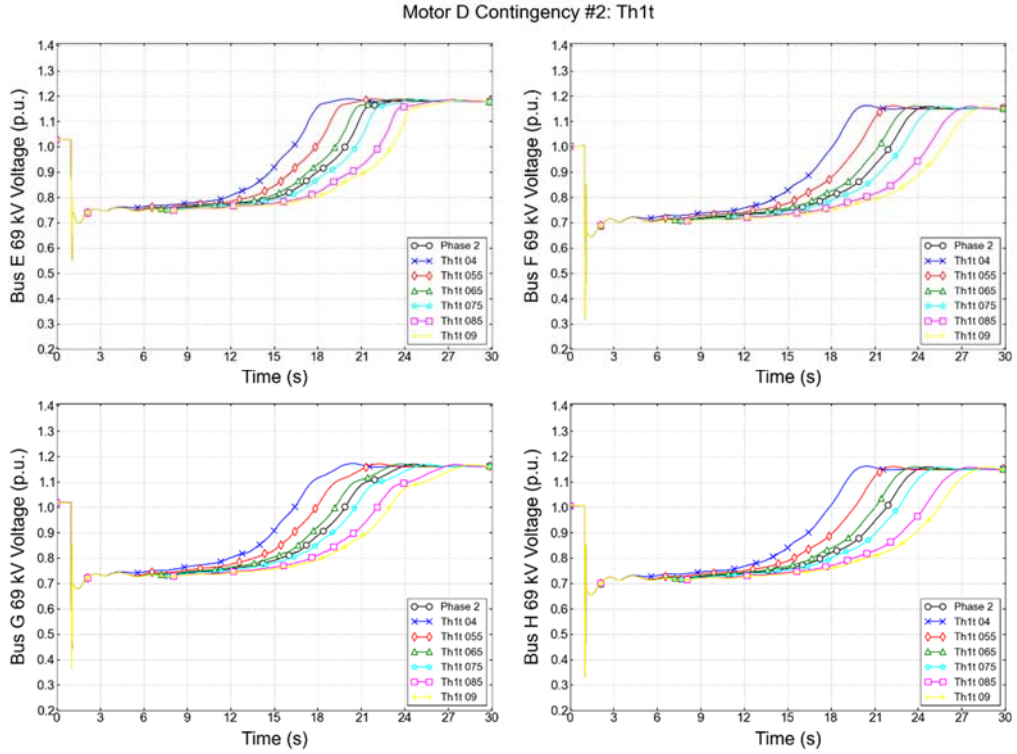

Figure 4.4-23: Bus voltages for Motor D sensitivity parameter Th1t.

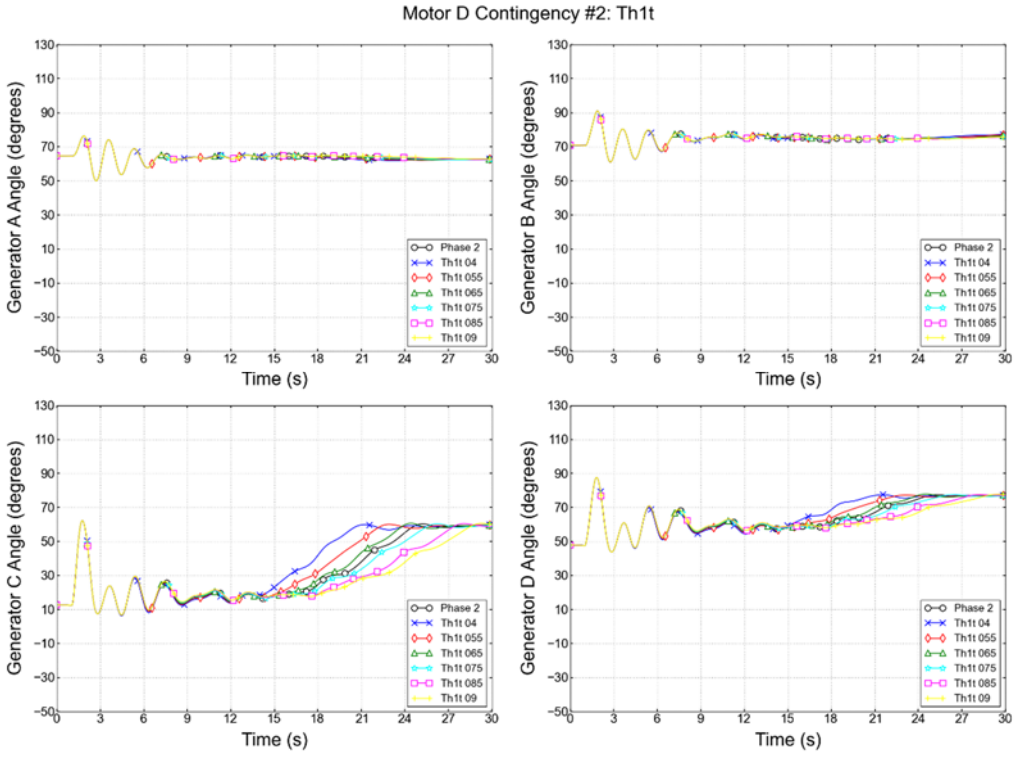

Figure 4.4-24: Generator angles for Motor D sensitivity parameter Th1t.

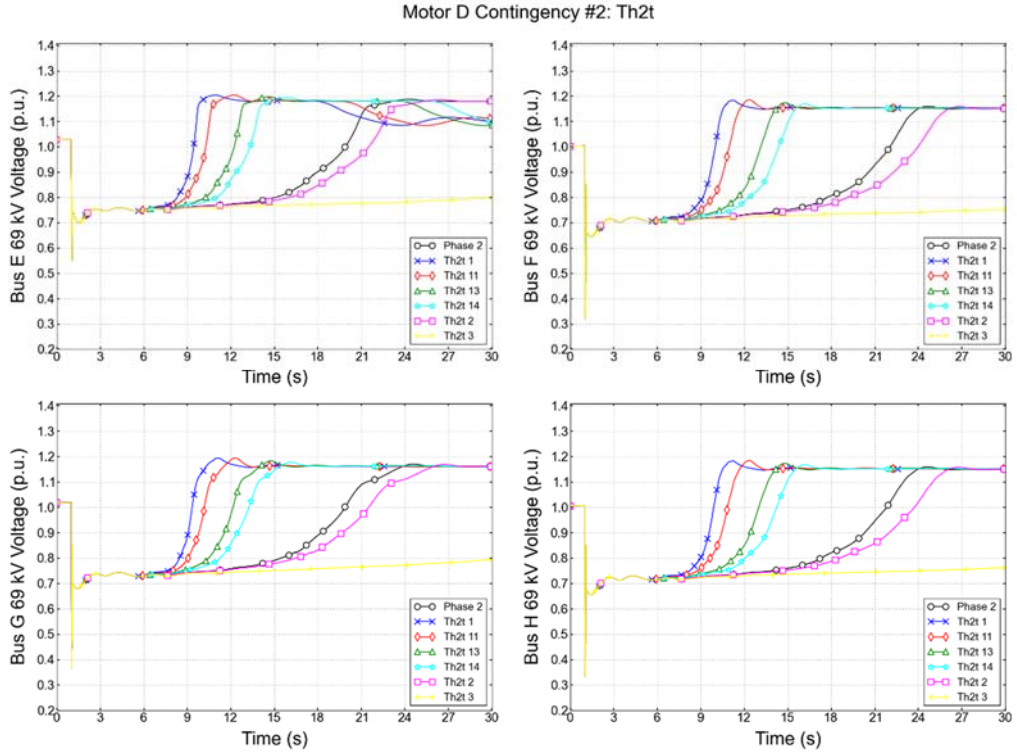

Figure 4.4-25: Bus voltages for Motor D sensitivity parameter Th2t.

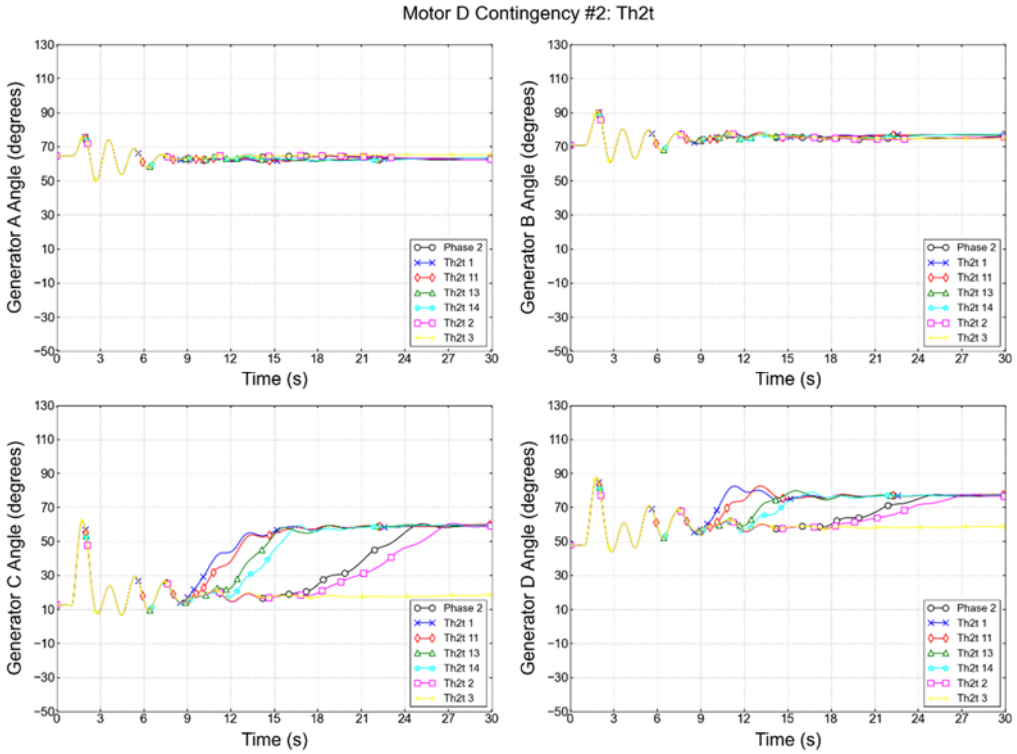

Figure 4.4-26: Generator angles for Motor D sensitivity parameter Th2t.

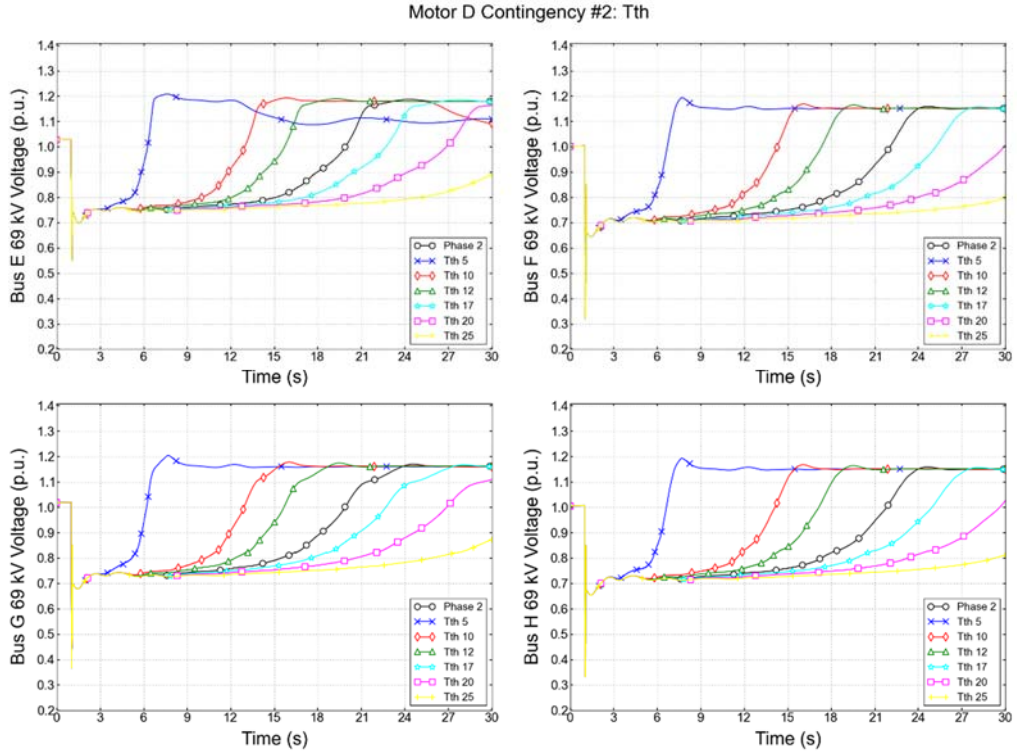

Figure 4.4-27: Bus voltages for Motor D sensitivity parameter Tth.

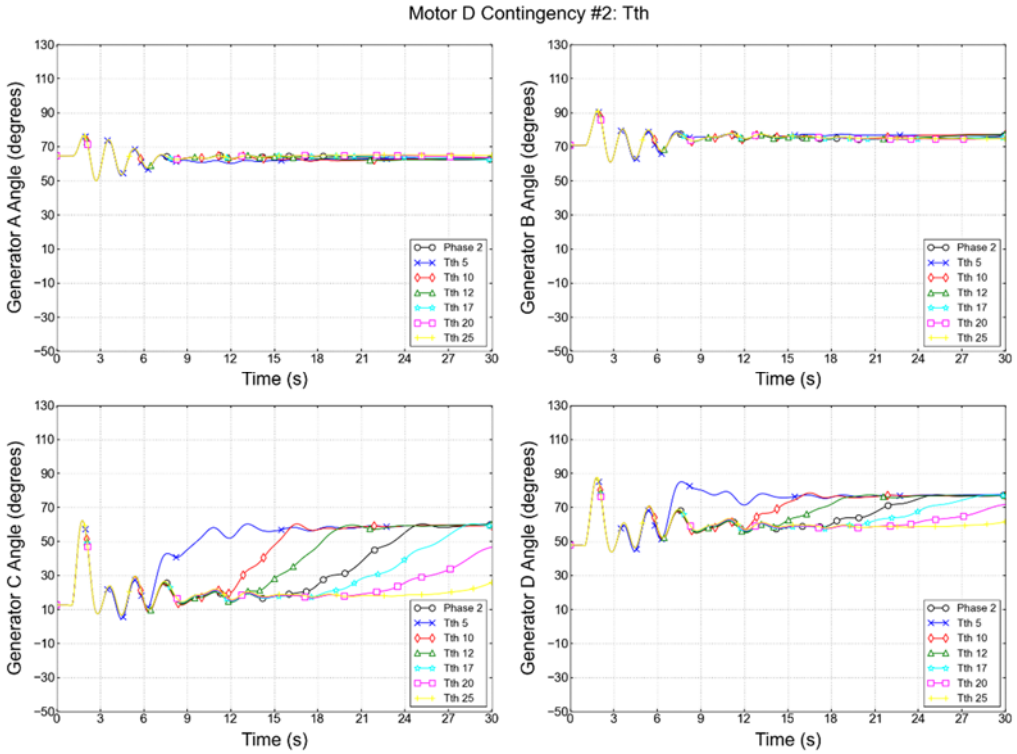

Figure 4.4-28: Generator angles for Motor D sensitivity parameter Tth.

SECTION 5. OVERALL CONCLUSIONS

MEPPI performed the "An Analysis of the Sensitivity of WECC Grid Planning Models to Assumptions Regarding the Composition of Loads" project in collaboration with the University of California Lawrence Berkeley National Laboratory (LBNL), the Western Electricity Coordination Council (WECC), and associated WECC members. The objective of this project was to conduct a parametric set of simulations that explore the sensitivity of WECC's planning models to uncertainties in the composition and behavior of loads.

The results of the simulations performed in this study have provided insight to the behavior of the CMPLDW model. Several types of faults, including three-phase normal clearing faults, single-phase stuck breaker faults, and three-phase double outage faults, were analyzed to determine the sensitivity of the parameters to different fault types. It was observed that all fault types were similar in system response because the varying of parameters had the most impact on the response of the system.

5.1. Motor D Conclusions

As a result of this study, the Motor D parameters that had the most impact on study results are listed in Table 5.0-1.

Table 5.0-1
Motor D Sensitivity to Parameters

Impact of Parameter Sensitivities Compared to Default NERC Data Set for Motor D										
Parameter Name	Parameter Description	Voltage Recovery (Impact on FIDVR)		Over Voltage Above 1.1 p.u. within 8 sec.		Over Voltage Above 1.1 p.u. b/w 8 and 30 sec.		Generation Trip		System Impact Significance Compared to NERC Default Data Set
		NDDS (+)	NDDS (-)	NDDS (+)	NDDS (-)	NDDS (+)	NDDS (-)	NDDS (+)	NDDS (-)	
Vstall	Stall voltage (p.u.)	Large ↑ in observations	Large ↓ in observations	Large ↓ in observations	Large ↑ in observations	↑ in observations	↓ in observations	↑ in observations	No Change	- Increased stalling voltage: increased voltage recovery issues (FIDVR) - Decreased stalling voltage: improved system recovery
Tstall	Stall delay time (sec)	Large ↓ in observations	Large ↑ in observations	Large ↑ in observations	No Change	Large ↓ in observations	Large ↑ in observations	No Change	Small ↑ in observations	- Increased stall delay time: improved system recovery - Decreased stall delay time: increase FIDVR
FmD	Motor D fraction of load	↑ in observations	↓ in observations	↑ in observations	↓ in observations	Large ↑ in observations	Large ↓ in observations	Small ↑ in observations	No Change	- Increase percentage of Motor D load: increase FIDVR - Decrease percentage of Motor D load: improved system recovery
Fuvr	Fraction of load with under voltage relay protection	↓ in observations	↑ in observations	↑ in observations	No Change	↓ in observations	↑ in observations	No Change	No Change	- Increase motors with under voltage protection: improved system recovery - Decrease motors with under voltage protection: increase FIDVR
Tth	Motor D thermal time constant (sec)	↑ in observations	↓ in observations	Large ↑ in observations	No Change	↓ in observations	↑ in observations	No Change	No Change	- Increase thermal time constant: increase FIDVR - Decrease thermal time constant: improved system recovery
Th1t	Motor D thermal protection trip start level (p.u. temp)	↑ in observations	↓ in observations	No Change	No Change	↑ in observations	↓ in observations	No Change	No Change	- Increase thermal trip protection start: increase FIDVR - Decrease thermal trip protection start: improved system recovery
Th2t	Motor D thermal protection trip completion level (p.u. temp)	↑ in observations	↓ in observations	No Change	Large ↑ in observations	↑ in observations	↓ in observations	No Change	No Change	- Increase thermal trip protection completion: increase FIDVR - Decrease thermal trip protection completion: improved system recovery

* NDDS - NERC Default Data Set
** NDDS (+) - Parameter increase from NERC Default Data Set
*** NDDS (-) - Parameter decrease from NERC Default Data Set
**** ↑ - Increase, ↓ - Decrease

Refer to the following for a brief description of each parameter listed in Table 5.0-1 and the impact it had on system recovery.

Parameter: Tstall

Tstall is the time it takes for a residential air-conditioner to stall once the voltage threshold, Vstall, is reached. This parameter has a significant impact on the voltage recovery of a system. Based on laboratory testing, once the voltage threshold is met, a residential air-conditioner will stall in 2 cycles, or 0.03 seconds. It was observed that decreasing the stall time to 1 cycle or 0.01667 seconds will have a significant impact on the results, increasing the amount of motors that stall and severely reducing the stability of the system. However, increasing the stall time of an A/C motor will benefit the system as the motors will not stall and will allow the system to recover. Although the A/C motors will not stall as quick and will not inhibit Fault Induced Delayed Voltage Recovery (FIDVR), an increase in voltage overshoot above 1.1 p.u. is observed following the clearing of the fault which is a cause for concern.

Parameter: Vstall

Vstall is the stalling voltage of a residential air-conditioner. Once this limit is reached, the A/C motor will stall according to Tstall. This parameter has a significant impact on the voltage recovery of a system. It was observed that increasing the stalling voltage from 0.5 p.u. to 0.8 p.u. will increase the observations associated with Fault Induced Delayed Voltage Recovery (FIDVR) such as recovery voltage and voltage sags. Reducing the voltage stalling threshold has an equally opposite impact on the recovery of the system. Reducing the voltage stalling to 0.3 p.u. reduces the number of observations of delayed voltage recovery by 50% but increases the observations of an initial voltage overshoot (voltage above 1.1 p.u. within eight seconds after clearing the fault).

Parameter: FmD

FmD is the fraction of Motor D at a given load location. Increasing the amount of load that is a single-phase residential air-conditioner at a specific feeder will cause significant delayed voltage recovery of the system. An increase in A/C motors will cause additional reactive power to be drawn into the motors and will pull the voltage down. With less A/C motor load on the system, there is a reduced number of motors that will stall.

Parameter: Tth

Tth is the thermal time constant of an A/C motor load and will protect the motor from damage as the motor begins to stall. Once an A/C motor stalls and begins to draw reactive power, the inrush of current will heat the stator winding of the motor and possibly damage the motor. Decreasing the thermal time constant will allow A/C motor load to trip off quicker, reducing the amount of motors stalling that the system has to support. This will lead to quicker voltage

recover but increased voltage overshoots above 1.1 p.u. Increasing the thermal time constant will force the A/C motor loads to remain on the system in a stalled state and drag the system voltages down until the thermal constant is reached which was observed for all cases examined.

Parameter: Th1t

Th1t is the thermal protection tripping start level in p.u. temperature. Once the thermal temperature starting temperature is reached, Motor D load will begin to be tripped until Th2t is reached, thermal protection tripping complete level. The motors will be tripped following a linear relationship from Th1t to Th2t. The main impact the thermal protection tripping start level has on the recovery of the system is the voltage recovery within 5 cycles after a fault is cleared and the voltage overshoot after a fault is cleared. As Th1t is decreased, motors will trip offline sooner and over a longer time period (motor loads will trip offline following a linear relationship between Th1t and Th2t), allowing the system to recover in an acceptable amount of time.

Parameter: Th2t

Th2t is the thermal protection tripping completion level in p.u. temperature. Once the thermal temperature starting temperature is reached, Th1t, Motor D load will begin to be tripped until Th2t is reached. The motors will be tripped following a linear relationship from Th1t to Th2t. The main impact the thermal protection tripping start level has on the recovery of the system is the voltage recovery within 5 cycles after a fault is cleared and the voltage overshoot after a fault is cleared. As Th2t is decreased, motors will trip offline sooner and in a shorter amount of time, allowing the system to recover in an acceptable amount of time. However, as the motors trip off quicker, this will induce voltage overshoots after the fault is cleared and until the motor tripping is completed.

Parameter: Fuvr

Fuvr is the percentage of Motor D loads that are modeled with under voltage relay protection. From the analysis, it can be observed that an increase in this percentage will greatly reduce the FIDVR impact on the system. An increase in motors modeled with under voltage relay protection will result in more motors tripping offline as the voltage of the system is reduced following a fault. As more motors are tripped offline, this will reduce the number of motors that draw excessive reactive power and will lead to increased system recovery. A decrease in motors modeled with under voltage relay protection will result in an increase of motors drawing reactive power as they are not able to trip offline. This will result in delayed voltage recovery and may be harmful to the system.

5.2. Motor A, Motor B, and Motor C Conclusions

After performing the initial analysis, an additional sensitivity analysis was performed on a heavily stressed case that examined sensitivity to Motor A parameters, Motor B parameters,

Motor C parameters, and a detailed set of Motor D parameters, independently. For the additional Motor D parameters that were varied on the Stressed Case, the same system response was observed as was observed on the Heavy Summer case for each utility. Refer to Table 5.0-2 for the most influential parameters observed for Motor A, Motor B, and Motor C.

Table 5.0-2
Motors A, B, and C Sensitivity to Parameters

Impact of Parameter Sensitivities Compared to Default NERC Data Set for Motor A, Motor B, and Motor C										
Parameter Name	**Parameter Description**	**Voltage Recovery (Impact on FIDVR)**		**Over Voltage Above 1.1 p.u. within 8 sec.**		**Over Voltage Above 1.1 p.u. b/w 8 and 30 sec.**		**Generation Trip**		**System Impact Significance Compared to NERC Default Data Set**
		NDDS (+)	**NDDS (-)**	**NDDS (+)**	**NDDS (-)**	**NDDS (+)**	**NDDS (-)**	**NDDS (+)**	**NDDS (-)**	
Ftr1	Percentage of motor loads that will trip on the first voltage trip setting (%)	↓ in observations	↑ in observations	Large ↑ in observations	Large ↓ in observations	Large ↑ in observations	Large ↓ in observations	Large ↑ in observations	No Change	- Increased percentage of motor loads that trip: improved system recovery - Decreased percentage of motor loads that trip: increased voltage recovery issues (FIDVR)
Ttr1	First low voltage trip delay time for three phase motors (secs)	Small ↑ in observations	Small ↓ in observations	Small ↓ in observations	No Change	Small ↓ in observations	No Change	No Change	Small ↑ in observations	- Increased trip delay time: increase FIDVR - Decreased trip delay time: improve system recovery
Vtr1	First low voltage trip setting for three phase motors (p.u.)	No Change	Large ↑ in observations	↑ in observations	↓ in observations	Small ↓ in observations	↑ in observations	Small ↑ in observations	Small ↓ in observations	- Increase voltage trip setting: improved system recovery - Decrease voltage trip setting: increase FIDVR (motors remain connected to system, stalling for longer duration)

* NDDS - NERC Default Data Set
** NDDS (+) - Parameter increase from NERC Default Data Set
*** NDDS (-) - Parameter decrease from NERC Default Data Set
**** ↑ - Increase, ↓ - Decrease

Parameter: Ftr1, Ttr1, Vtr1

It was observed that all three parameters listed above have similar impacts on system response. As more motor loads remain on the system during and after a system disturbance, the motors will draw excessive current which will drag system voltages down and will induced delayed voltage recovery. System voltages will respond back to steady state voltages quicker and have a greater chance of avoiding system instability as the percentage of motors modeled with voltage protection settings is increased and more strict settings are used.

5.3. Composite Load Model: Software Modeling

It was discovered that unexpected results were obtained in the GE PSLF software, V19.0_01, for the Ttr1 and Ttr2 parameters. When setting the first or second voltage trip delay time to instantaneous, i.e. zero (0), the models will remain online, simulating an extended trip time, and will effectively cause delayed voltage recovery. Therefore, these values must be set greater than zero (0). Refer to Figure 5.0-1 for a representative voltage plot of this modeling difference. For this analysis, MEPPI set Ttr1 and Ttr2 to 0.001 seconds when simulating the Ttr1 and Ttr2 values to trip instantaneously.

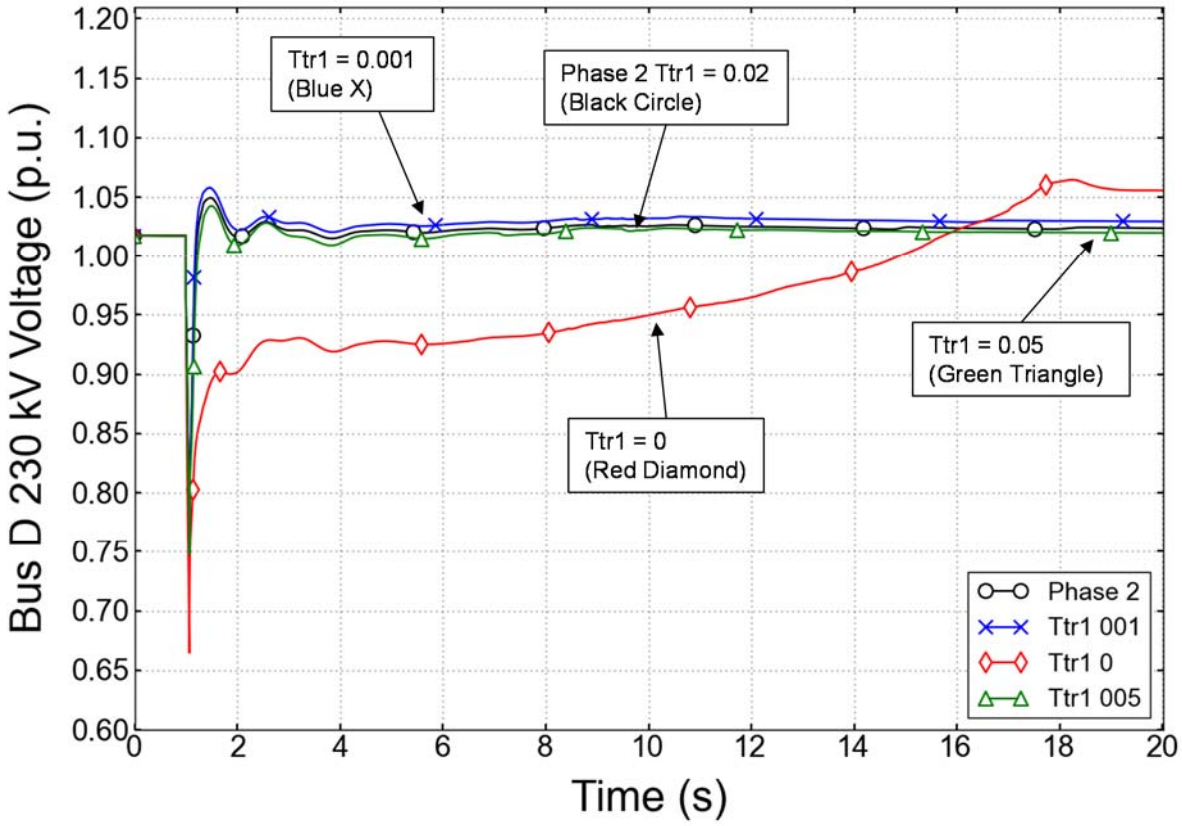

Figure 5.0-1: Representative voltage plot showing modeling discrepancy.

SECTION 6. RECOMMENDATIONS

This analysis focused on the sensitivity of the composite load model to a variation of parameters. It was observed that variations to certain parameters will impact the recovery of the system such as Vstall, Tstall, FmD, Fuvr, Tth, Th1t, and Th2t (specific examples can be found in the Conclusion section). MEPPI recommends Transmission Owners and Transmission Planners focus data collection on the following parameters:

- **Vstall**: Stall voltage, p.u.
- **Tstall**: Stall time delay, sec.
- **FmD**: Motor D fraction of load P
- **Fuvr**: Fraction of load with under voltage relay protection
- **Tth**: Motor D thermal time constant, sec.
- **Th1t**: Motor D thermal protection trip start level, p.u. temperature
- **Th2t**: Motor D thermal protection trip completion level, p.u. temperature

For all four utilities in the West that participated in this study, a total of 8,544 simulations were performed using PSLF software and a total of 12,886 simulations were performed using PSSE software. The Phase 2 composite load model showed numerical stability and credible behavior for all of these contingencies using default NERC data sets for normal loading conditions and heavy stressed loading conditions. If detailed load model data is not available for a given entity, MEPPI recommends the default NERC load model parameters (as used in this study) when performing transmission planning studies.

This analysis examined the inner workings of the composite load model in the GE PSLF and Siemens PTI software. MEPPI recommends additional studies and testing be performed to understand the engineering and physics of three phase and single phase induction motors to benchmark software simulations to system disturbances.

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