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RIVERSIDE PUBLIC UTILITIES

Riverside Energy Resource Center 3&4 *Electrical Transmission Impact Study*

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Electrical System Impact Study

Prepared by POWER Engineers, Inc. for

Riverside Public Utilities

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EXECUTIVE SUMMARY

An analysis of the impact of expanding the existing RERC generation facilities to include Units 3&4 on the Riverside Public Utilities existing 69 kV transmission system configuration was performed. This analysis entailed running multiple load flow cases at various loading and generation levels with the base system and using N-1 outages, as well as performing a short circuit analysis on the system with the additional generation. The load flow analysis did not include any aspects or features of the future Riverside Transmission Reliability Project which will significantly reinforce the RPU system. The detailed results of the analysis are shown on the tables starting on pages 5 (load flow analysis) and 7 (short circuit analysis).

In summary, the load flow analysis showed that the addition of RERC Units 3&4 significantly decreases the number of overloading problems on the RPU system. At peak anticipated loading for the summer of 2009 with the existing RERC and Springs generation on-line there are 13 N-1 outages which will lead to 16 overloaded lines. However, with the addition of the proposed RERC units there are only 6 N-1 outages contributing to 7 overloaded lines with the tie breaker between RERC Units 1&2 and RERC Units 3&4 open. If necessary to alleviate these remaining overloads should they be of significant duration, the City has in place a load shedding plan of action which will be used to ensure that system stability and reliability is not compromised.

The short circuit analysis indicates that there are six breakers on the RPU system which will require replacement. The Freeman, Hunter, and Riverside stations will all need at least one breaker replaced due to the higher fault currents resulting from the expansion of the RERC generation facility. All of the existing breakers in the Casa Blanca, Kaiser, La Colina, Harvey Lynn, Magnolia, Mt. View, Orangecrest, Plaza, RERC, Springs, and University Substations are acceptable, and do not require replacement due to Units 3&4.

INTRODUCTION

Riverside Public Utilities (RPU) proposes to expand the existing RERC (Riverside Energy Resource Center) 95-megawatt (MW) simple-cycle power plant within the City of Riverside, California. The proposed facility upgrade, referred to as the Riverside Energy Resource Center (RERC) Units 3&4 Project (Project), will result in a 191 MW power plant. RPU will develop, build, own, and operate the facility.

The RERC expansion is to supply the internal needs of the City of Riverside primarily during summer peak electrical demands and will serve the City's minimum emergency loads in the event RPU is islanded from the external transmission system. No power from RERC will be exported outside of the City.

At present Southern California Edison's (SCE) Vista Substation provides the only external connection for the RPU system through which all of the City's power imports flow. In the summer of 2007 the City had a peak load of 609 MW. The Vista Substation transformer banks for RPU have a total capacity of 557 MW, with no additional capacity for expansion. The remainder of the City's power is supplied by existing internal generation as needed; however, the projected system load for the summer of 2009 is 682 MW. With Vista's limit of 567 MW and the City's existing generation of 128 MW (summer rating of 96 MW at RERC and 32 MW at Springs) the loss of any available capacity would require that the City immediately institute rolling blackouts to reduce system loading. The expansion of RERC would mitigate that risk and allow

the City to supply all of its customers should the loading during the summer of 2009 exceed expectations, as well as for some future years.

RPU has another project underway, the Riverside Transmission Reliability Project (RTRP), which will add a second point of interconnection to the SCE system as well as reinforcing significant portions of the RPU system. This second point of interconnection will allow for additional power imports to help meet future loads. As the RTRP will follow RERC 3&4 with a present estimated completion of 2012, none of the RTRP improvements or features were included in the load flow analysis of this study.

OBJECTIVE

POWER Engineers has been contracted to analyze the impacts on the transmission system due to the proposed interconnect.

- Load flow studies have been conducted for the base case and the N-1 contingency cases for
 - Case 1: The existing system with all generation on-line
 - Case 2: The new system after adding units 3 and 4, and all generation on-line.Both these cases have been analyzed considering 50% and 100% loading.

- Short circuit studies were conducted to determine if the addition of the new units would require any breakers to interrupt fault currents above their limits.
 - If any breakers are found to require replacement, a sensitivity case would also be run based on the future system configuration after the Riverside Transmission Reliability Project (RTRP) is completed. The system configuration for this case is:
 - The Wilderness 230 – 69 kV substation on-line
 - The Vista 230 – 69 kV substation on-line
 - All Springs generation running
 - Existing RERC Units 1&2, planned RERC Units 3&4, and two potential future RERC 25 MW heat recovery steam generator units all on-line.
 - Riverside's east and west 69 kV transmission systems tied together via the Riverside, Mt. View, and Freeman Substations.
 - All planned RTRP 69 kV transmission lines upgrades in service.

PROJECT DESCRIPTION

The existing RERC site is owned by the City of Riverside and is located adjacent to the City of Riverside's Riverside Regional Water Quality Control Plant (RRWQCP) in a light industrial/manufacturing area. At present RERC consists of two aero-derivative combustion turbine generators with Emission Control Modules (ECM), an on-site substation, natural gas and water supply interconnection, and on-site administration building and warehouse. The combined RERC Units 1&2 and RERC Units 3&4 expansion would occupy approximately 14 of 16 acres with the remaining 2 acres reserved for construction laydown. The entire plant perimeter is fenced with a combination of chain-link fencing and architectural block walls.

RERC Substation: Existing Equipment scenario

- Presently, there are two 69 kV transmission lines connected into RERC. One connects from RERC to the Mt. View Substation, with the other from RERC to the Riverside Substation. Both Mt. View and Riverside Substations are owned and operated by the City.
- The RERC high voltage switchyard is comprised of the 69 kV bus work, switches, arresters, insulators, interrupting devices, instrument transformers and associated galvanized steel structures.
- The initial 69 kV substation is comprised of two full bays of breaker-and-a-half scheme consisting of six breakers, two 69 kV line positions, and two GSU positions.

The ultimate layout after the addition of Units 3&4 will consist of four bays of breaker-and-a-half with a main north bus and main south bus. There will also be a tie breaker to allow segregation of the north and south main buses to align two units onto each of the of the two transmission lines that leave the RERC switchyard. This feature is included to preclude all four units being able to feed power into one transmission line during an N-1 contingency and overloading it.

IMPACT STUDY ANALYSIS

Introduction

The analysis for this project was performed using ASPEN's Power Flow and Oneliner software. Models of the existing Riverside system were obtained from the City.

The Power Flow model included the existing RERC generation, the entire 69 kV transmission system, and system loads lumped on the appropriate substation 69 kV bus. RPU indicated that the impedances used in this model were developed (with the use of temperature, wind speed, etc) to maximize load flow voltage drop for worst case load flow analysis. The proposed RERC Units 3&4 were added to the model.

The Oneliner model also included the existing RERC generation, the entire 69 kV transmission system, but no loads were modeled. The impedances used in this model were developed to maximize fault currents for relaying and worst case short circuit analysis. The proposed RERC Units 3&4 were added to the model.

A second Oneliner model was also created which contained the future 69 kV transmission system configuration, the new Wilderness 230-69 kV substation, the existing RERC Units 1&2, planned RERC Units 3&4, and the two potential RERC 25 MW heat recovery steam generator units (modeled as a single 50 MW unit for simplicity) all on-line. This model is used for the sensitivity case.

Load Flow

Methodology

The load flow analysis was performed for the base case system, as well as for N-1 conditions. No N-2 conditions were analyzed. The N-1 cases systematically took each 69 kV and 33 kV transmission line out of service individually. All of these existing system N-1 cases were run at maximum loading levels, with RERC at present generation levels (Units 1&2 only) and with

RERC at maximum generation levels (all four units on-line. Results of these cases are shown in the accompanying table on page 5.

The established criterion used by Riverside for N-1 outages is for a maximum allowable line loading of 110%, with a maximum allowable line loading of 100% for normal system operations.

Existing System Configuration Analysis

The RERC facility is connected to the RPU system via two 69 kV transmission lines. One line is connected to the Mountain View Substation and has a normal rating of 114 MW. The other line is connected to the Riverside Substation and has a normal rating of 97 MW. The RPU system was studied under peak load conditions of 682 MW with RERC and Springs both generating at their maximum outputs and it was found that no lines are overloaded with all lines in service.

Under peak loading conditions without any generation at RERC there are sixteen single contingency (N-1) outages that lead to 33 violations of the City's 110% line loading criteria. Under peak system loading with the existing RERC and Springs generation on line there are 13 N-1 outages leading to 16 violations of the City's criteria. The addition of RERC Units 3&4 with the RERC switchyard tie breaker open drops the number of N-1 outages leading to violations from 13 to 6, and the number of violations from 16 to 7. Thus while overloads remain, the addition of RERC 3&4 significantly improves the system condition.

The RPU 69 kV electrical system was also studied under minimum loading conditions of 341 MW. Line loading for base case and contingency cases was less than 100% of the nominal conductor rating for this system load condition.

Mitigated System Analysis

Any line loadings above 125% of nominal will require load shedding. The City has in place a load shedding plan of action which will be used to mitigate line overloads. RPU will take operator action to shed load as needed to preclude sustained operation in an overloaded condition. The area(s) which will be affected by the load shedding will be determined on an as needed basis and determined by the N-1 outage which is occurring, system configuration at the time of the outage, and substation loading. Ultimately the combination of new generation and the RTRP project are needed to eliminate all overloads.

Table 1: Overloaded Line Summary - Existing System

Outage Case	Overloaded Line Summary (%) - All Four RERC Units On-line		Overloaded Line Summary (%) - Existing RERC Units On-line	
	50% System Loading	100% System Loading	50% System Loading	100% System Loading
Base Case	--	--	--	--
Alumax - Hunter	--	--	--	Vista - Hunter : 131.19
Alumax - Vista	--	--	--	Vista - Hunter : 131.19
Casa Blanca - Freeman	--	--	--	--
Casa Blanca - Magnolia	--	--	--	--
Freeman - Vista	--	Plaza - Riverside : 117.54	--	Mt. View - RERC : 111.57
Freeman - Orangecrest	--	--	--	--
Freeman - Kaiser	--	Mt. View - Harvey Lynn : 111.62	--	Mt. View - Harvey Lynn : 114.95
Freeman - Mt. View	--	--	--	--
Hunter - University	--	La Colina - Vista : 133.69	--	La Colina - Vista : 138.11
Hunter - Riverside	--	--	--	--
Hunter - Vista	--	--	--	Vista - Alumax : 119.97 Alumax - Hunter : 119.97
Kaiser - Harvey Lynn	--	--	--	--
La Colina - Orangecrest	--	--	--	--
La Colina - University	--	--	--	La Colina - Vista : 113.48
La Colina - Springs	--	--	--	--
La Colina - Vista	--	Hunter - University : 142.07	--	Hunter - University : 144.04
Harvey Lynn - Mt. View	--	Mt. View - Freeman : 116.05 Freeman - Kaiser: 113.48	--	Mt. View - Freeman : 114.75 Harvey Lynn - Kaiser: 111.43 Freeman - Kaiser: 116.20
Magnolia - Riverside	--	--	--	--
Mt. View - RERC	--	--	--	Plaza - Riverside : 134.92
Mt. View - Plaza	--	--	--	Mt. View - RERC : 110.72
Mt. View - Vista	--	Plaza - Riverside : 127.78	--	Mt. View - RERC : 114.77
Orangecrest - Springs	--	--	--	--
Plaza - Riverside	--	--	--	Mt. View - RERC : 125.03
RERC - Riverside	--	--	--	--
Riverside - Vista #1	--	--	--	--
Riverside - Vista #2	--	--	--	--

Line Operating Ratings for the RPU system

1000 A	850 A		Springs - Orangecrest	750 A
Alumax - Hunter	Casa Blanca - Freeman	Plaza - Mt. View		
Hunter - Riverside	Hunter - University	Riverside - RERC	Riverside - Magnolia	580 A
La Colina - Springs	Kaiser - Freeman	Riverside - Plaza		
RERC - Mt. View	Harvey Lynn - Kaiser	University - La Colina	Magnolia - Casa Blanca	360 A
Vista - Riverside	Mt. View - Freeman	Vista - La Colina		
Vista - Freeman	Mt. View - Harvey Lynn	Vista - Mt. View		
Vista - Alumax	Orangecrest - La Colina	Vista - Riverside		
	Orangecrest - Freeman	Vista - Hunter		

Breaker Rating Study

Methodology

Short-circuit analysis was performed by POWER to determine if the addition of RERC Units 3&4 would increase the system fault currents enough to cause any breakers to be operated beyond their interrupting limits. If any breakers were found to require a replacement, a sensitivity case would also be run based on the future system configuration after the Riverside Transmission Reliability Project (RTRP) is completed.

This sensitivity case has two purposes. The first is to ensure that any existing breakers replaced due to RERC Units 3&4 were rated high enough that they would not again need to be replaced once the RTRP project was completed. The second was to allow the new breakers at RERC for Units 3&4 to be sized such that they would not need to be replaced upon completion of RTRP.

The system configuration for the sensitivity case after RTRP completion is:

- The Wilderness 230 – 69 kV substation on-line
- The Vista 230 – 69 kV substation on-line
- All Springs generation running
- Existing RERC Units 1&2, planned RERC Units 3&4, and two potential future RERC 25 MW heat recovery steam generator units all on-line.
- The east and west 69 kV transmission systems tied together via the Riverside, Mt. View, and Freeman Substations.
- All planned RTRP 69 kV transmission lines upgrades in service.

RPU also asked that a sensitivity case also be run for the 33 kV Riverside breakers. This sensitivity case was for the Riverside 33 kV breakers (A1-1 and A1-2) which are shown to be underrated. RPU has stated that the 33 kV system loading is low enough to allow all of the 33 kV system to be served with only one of the existing 69/33 kV Riverside transformers. The sensitivity case uses the existing 69 kV system configuration and the presently planned RERC expansion (Units 1-4) but only one of the Riverside transformers in service, in an attempt to lower the 33 kV fault currents below the existing breaker interrupt ratings. The results indicate that with only Riverside transformer AT2 in service the fault current will be 98.1 % of the breaker interrupt rating for A1-2, while with only AT1 in service the fault current will be 100.8 % of the breaker interrupt rating for A1-1. The difference between the two results is the fact that transformer AT2 has a slightly higher impedance, and hence decreases the fault currents just enough to fall under the breaker rating.

Using substation configuration drawings and specific breaker rating information (obtained from the City and shown in Appendix A), the Oneliner model was modified to allow a breaker rating analysis to be performed. This analysis is an automated process within the computer program. Once the individual breaker configuration and interrupting information is added to the model the software performs a series of faults. These faults include the normal system configuration, but it also simulates faults with appropriate branch outages to find maximum short-circuit currents that flow through each breaker. It then computes the ANSI X/R ratio and adjusts the short-circuit current accordingly. Finally, it compares the currents to the rated capabilities of the breakers and reports the findings. Any breakers which have ratings below the short circuit currents seen are flagged. The program logic adheres to ANSI/IEEE standards for total-current related and symmetric-current rated breakers.

The analysis of the existing system configuration with RERC Units 1 – 4 on-line determined that there are six breakers which will require replacement. The tables on the following pages show the results of the analysis: the breakers which will require replacement and the currents which the breakers will be required to interrupt. Table 3 shows the complete results for the existing system configuration, while Table 4 shows the complete results for the sensitivity case. On the following page is a summary of those breakers which require replacement for the addition of RERC Units 3&4.

Table 2: Breakers Requiring Replacement

Breaker ID	Rating	Predicted Fault Duty
Alumax Substation		
Fuse	20,000 A	20,408 A
Freeman Substation		
#1 - Xfmr AT-1 & Mt. View line	12,600 A	20,383 A
#9 - Xfmr AT-1 & Vista line	12,600 A	20,383 A
#13 - Xfmr T-3 & Orangecrest line	12,600 A	20,383 A
Hunter Substation		
#4 - University line	19,000 A	20,576 A
Riverside Substation		
#1 - Xfmr AT-1 33 kV	8,400 A	8,890A
#2 - Xfmr AT-2 33 kV	8,400 A	8,911 A

Table 3: Results of Breaker Rating Analysis - All RERC Generation On-line

Station	Breaker	Device Rating (A)	Fault Current (A)	Duty (%)
Alumax	Fuse	20,000	19,240	96.2
Casa Blanca	#1 - Freeman line	8,400	4,543	54.1
	#2 - Xfmr T-3	25,000	4,543	18.2
	#4 - Xfmr T-3 & T-4	8,400	4,543	54.1
	#5 - Magnolia line	8,400	4,543	54.1
Freeman	#1 - Xfmr AT-1 & Mt. View line	12,600	13,156	104.4
	#10 - Xfmr T-4 & T-6	31,500	13,525	42.9
	#12 - Xfmr T-1 & Mt. View line	24,000	13,525	56.4
	#13 - Xfmr T-3 & Orangecrest line	12,600	13,525	107.3
	#14 - Xfmr T-5 & Orangecrest line	24,000	13,525	56.4
	#15 - Xfmr T-5 & Kaiser line	24,000	13,525	56.4
	#8 - Xfmr T-6 & Kaiser line	21,000	13,525	64.4
	#9 - Xfmr AT-1 & Vista line	12,600	13,156	104.4
	#9A - Xfmr T-4 & Vista line	31,500	13,525	42.9
Hunter	#7 - Casa Blanca line	8,400	8,072	96.1
	#1 - Vista line	31,500	18,014	57.2
	#2 - Xfmr T-1, T-2, T3, & T-4	31,500	18,014	57.2
	#3 - Riverside line	31,500	16,936	53.8
	#4 - University line	19,000	18,983	99.9
	#5 - Alumax line	31,500	17,616	55.9
	#6 - Xfmr T-2 & T-5	24,000	16,125	67.2
	#7 - Xfmr T-5 & T-6	31,500	16,125	51.2
Kaiser	#8 - Xfmr T-6	31,500	16,125	51.2
	Fuse	17,500	10,203	58.3
La Colina	#1 - Xfmr T-1 & Vista line	21,000	14,275	68.0
	#2 - University & Springs lines	31,500	13,764	43.7
	#3 - Xfmr T-1 & T-2	21,000	14,275	68.0
	#4 - Xfmr T-4 & Springs line	27,000	14,275	52.9
	#5 - Xfmr T-2 & University line	21,000	14,275	68.0
	#6 - Xfmr T-3 & T-4	19,000	14,275	75.1
	#7 - Xfmr T-3 & Orangecrest line	21,000	14,275	68.0
	#8 - Orangecrest & Vista lines	31,500	13,859	44.0
Harvey Lynn	#1 - Xfmr T-5 & Mt. View line	21,000	9,792	46.6
	#3 - Xfmr T-2 & Mt. View line	21,000	9,792	46.6
	#4 - Xfmr T-3 & Kaiser line	21,000	9,792	46.6
	#6 - Xfmr T-1, T-4, & Kaiser line	27,000	9,792	36.3
	#7 - Xfmr T-1, T-4, & T-5	12,600	9,792	77.7
Magnolia	#3 - Casa Blanca line	8,400	6,663	79.3
	#4 - Bus tie	8,400	6,663	79.3
	#5 - Riverside line	8,400	6,663	79.3
Mt. View	#1 - RERC line	31,500	12,707	40.3
	#2 - Bus tie	31,500	15,207	48.3
	#3 - Vista line	31,500	16,669	52.9
	#4 - Freeman line	31,500	17,700	56.2
	#5 - Plaza line	31,500	16,359	51.9
	#6 - Harvey Lynn line	31,500	18,307	58.1
	#7 - Xfmr T-2, T-4, T-6, & Bus tie	31,500	16,359	51.9
Orangecrest	#1 - Xfmr T-5 & Freeman line	31,500	11,164	35.4
	#2 - Xfmr T-1 & Freeman line	31,500	11,164	35.4
	#5 - Xfmr T-1 & Springs line	31,500	11,164	35.4
	#6 - Xfmr T-2 & Springs line	31,500	11,164	35.4
	#8 - Xfmr T-2 & La Colina line	31,500	11,164	35.4
Plaza	#9 - Xfmr T-5 & La Colina line	31,500	11,164	35.4
	#1 - Mt. View line	21,000	10,335	49.2
	#2 - Bus tie	21,000	10,335	49.2
RERC	#3 - Riverside line	21,000	10,335	49.2
	#1 - North Bus & GSU 1	31,500	19,718	62.6
	#2 - GSU 1 & Mt. View line	31,500	13,095	41.6
	#3 - South Bus & Mt. View line	31,500	19,718	62.6
	#4 - North Bus & GSU 2	31,500	19,718	62.6
	#5 - GSU 2 & Riverside line	31,500	18,115	57.5
	#6 - South Bus & Riverside line	31,500	19,718	62.6
	Unit 3 - GSU 3	31,500	19,718	62.6
Unit 4 - GSU4	31,500	19,718	62.6	

Table 3: Results of Breaker Rating Analysis - All RERC Generation On-line

Station	Breaker	Device Rating (A)	Fault Current (A)	Duty (%)
Riverside	#1 - Xfmr AT-1 33 kV*	8,400	8,465	
	#2 - Xfmr AT-2 33 kV*	8,400	8,465	
	#4 - Bus tie 33 kV	25,000	13,964	55.9
	#5 - Xfmr T-2 & Bus tie	25,000	13,964	55.9
	#6 - Magnolia line	25,000	13,964	55.9
	#1N - Xfmr AT-1	31,500	20,352	64.6
	#1S - Vista #1 line	31,500	20,352	64.6
	#1T - Xfmr AT-1 & Vista #1 line tie	27,000	20,338	75.3
	#2N - Xfmr AT-2	27,000	20,352	75.4
	#2S - Vista #2 line	31,500	20,352	64.6
	#2T - Xfmr AT-2 & Vista #2 line tie	31,500	20,340	64.6
	#3N - RERC line	31,500	20,352	64.6
	#3S - Hunter line	31,500	20,352	64.6
	#3T - RERC & Hunter lines tie	31,500	18,641	59.2
	#4N - North Bus & Plaza line	31,500	20,352	64.6
	#4S - South Bus & Xfmr T-5	31,500	20,352	64.6
#4T - Xfmr T-5 & Plaza line tie	31,500	20,352	64.6	
Springs	#1 - GSU 1 & La Colina line	31,500	10,353	32.9
	#2 - Xfmr T-1 & La Colina line	31,500	11,080	35.2
	#3 - Xfmr T-1 & GSU 2	31,500	11,080	35.2
	#5 - GSU 2 & Orangecrest line	31,500	8,548	27.1
	#6 - Xfmr T-2 & Orangecrest line	40,000	11,080	27.7
	#8 - Xfmr T-2 & GSU 1	40,000	11,080	27.7
University	#1 - Hunter line	31,500	9,496	30.1
	#3 - Bus tie	31,500	9,496	30.1
	#5 - La Colina line	31,500	9,496	30.1

* The 33 kV system is fed from Riverside.

Table 4: Results of Breaker Rating Analysis - Sensitivity Case

Station	Breaker	Device Rating (A)	Fault Current (A)	Duty (%)
Alumax	Fuse	20,000	20,408	
Casa Blanca	#1 - Freeman line	8,400	4,813	57.3
	#2 - Xfmr T-3	25,000	4,813	19.3
	#4 - Xfmr T-3 & T-4	8,400	4,813	57.3
	#5 - Magnolia line	8,400	4,813	57.3
Freeman	#1 - Xfmr AT-1 & Mt. View line	12,600	20,383	
	#10 - Xfmr T-4 & T-6	31,500	20,383	64.7
	#12 - Xfmr T-1 & Mt. View line	24,000	20,383	84.9
	#13 - Xfmr T-3 & Orangecrest line	12,600	20,383	
	#14 - Xfmr T-5 & Orangecrest line	24,000	20,383	84.9
	#15 - Xfmr T-5 & Kaiser line	24,000	20,383	84.9
	#8 - Xfmr T-6 & Kaiser line	21,000	20,383	
	#9 - Xfmr AT-1 & Vista line	12,600	20,383	
	#9A - Xfmr T-4 & Vista line	31,500	20,383	64.7
	#7 - Casa Blanca line	8,400	9,023	
Hunter	#1 - Vista line	31,500	19,766	62.7
	#2 - Xfmr T-1, T-2, T3, & T-4	31,500	19,766	62.7
	#3 - Riverside line	31,500	16,661	52.9
	#4 - University line	19,000	20,576	
	#5 - Alumax line	31,500	20,000	63.5
	#6 - Xfmr T-2 & T-5	24,000	17,965	74.9
	#7 - Xfmr T-5 & T-6	31,500	17,965	57.0
	#8 - Xfmr T-6	31,500	17,965	57.0
Kaiser	Fuse	17,500	15,667	89.5
La Colina	#1 - Xfmr T-1 & Vista line	21,000	17,246	82.1
	#2 - University & Springs lines	31,500	15,580	49.5
	#3 - Xfmr T-1 & T-2	21,000	17,246	82.1
	#4 - Xfmr T-4 & Springs line	27,000	17,246	63.9
	#5 - Xfmr T-2 & University line	21,000	17,246	82.1
	#6 - Xfmr T-3 & T-4	19,000	17,246	90.8
	#7 - Xfmr T-3 & Orangecrest line	21,000	17,246	82.1
	#8 - Orangecrest & Vista lines	31,500	14,427	45.8
Harvey Lynn	#1 - Xfmr T-5 & Mt. View line	21,000	16,598	79.0
	#3 - Xfmr T-2 & Mt. View line	21,000	16,598	79.0
	#4 - Xfmr T-3 & Kaiser line	21,000	16,598	79.0
	#6 - Xfmr T-1, T-4, & Kaiser line	27,000	16,598	61.5
	#7 - Xfmr T-1, T-4, & T-5	12,600	16,598	
Magnolia	#3 - Casa Blanca line	8,400	6,981	83.1
	#4 - Bus tie	8,400	6,981	83.1
	#5 - Riverside line	8,400	6,972	83.0
Mt. View	#1 - RERC line	31,500	25,284	80.3
	#2 - Bus tie	31,500	22,506	71.4
	#3 - Vista line	31,500	27,667	87.8
	#4 - Freeman line	31,500	25,235	80.1
	#5 - Plaza line	31,500	27,123	86.1
	#6 - Harvey Lynn line	31,500	28,569	90.7
	#7 - Xfmr T-2, T-4, T-6, & Bus tie	31,500	27,123	86.1
Orangecrest	#1 - Xfmr T-5 & Freeman line	31,500	14,455	45.9
	#2 - Xfmr T-1 & Freeman line	31,500	14,455	45.9
	#5 - Xfmr T-1 & Springs line	31,500	14,455	45.9
	#6 - Xfmr T-2 & Springs line	31,500	14,455	45.9
	#8 - Xfmr T-2 & La Colina line	31,500	14,455	45.9
	#9 - Xfmr T-5 & La Colina line	31,500	14,455	45.9
Plaza	#1 - Mt. View line	21,000	12,792	60.9
	#2 - Bus tie	21,000	12,792	60.9
	#3 - Riverside line	21,000	12,792	60.9
RERC	#1 - North Bus & GSU 1	31,500	34,592	
	#2 - GSU 1 & Mt. View line	31,500	32,433	
	#3 - South Bus & Mt. View line	31,500	34,592	
	#4 - North Bus & GSU 2	31,500	34,592	
	#5 - GSU 2 & Riverside line	31,500	32,433	
	#6 - South Bus & Riverside line	31,500	34,592	
	Unit 3 - GSU 3	NEW	34,592	-
Unit 4 - GSU4	NEW	34,315	-	

Table 4: Results of Breaker Rating Analysis - Sensitivity Case

Station	Breaker	Device Rating (A)	Fault Current (A)	Duty (%)
Riverside	#1 - Xfmr AT-1 33 kV	8,400	8,890	
	#2 - Xfmr AT-2 33 kV	8,400	8,911	
	#4 - Bus tie 33 kV	25,000	14,938	59.8
	#5 - Xfmr T-2 & Bus tie	25,000	14,938	59.8
	#6 - Magnolia line	25,000	14,938	59.8
	#1N - Xfmr AT-1	31,500	25,824	82.0
	#1S - Vista #1 line	31,500	25,824	82.0
	#1T - Xfmr AT-1 & Vista #1 line tie	27,000	25,824	95.6
	#2N - Xfmr AT-2	27,000	25,824	95.6
	#2S - Vista #2 line	31,500	25,824	82.0
	#2T - Xfmr AT-2 & Vista #2 line tie	31,500	25,824	82.0
	#3N - RERC line	31,500	25,824	82.0
	#3S - Hunter line	31,500	25,824	82.0
	#3T - RERC & Hunter lines tie	31,500	23,295	74.0
	#4N - North Bus & Plaza line	31,500	25,824	82.0
	#4S - South Bus & Xfmr T-5	31,500	25,824	82.0
#4T - Xfmr T-5 & Plaza line tie	31,500	24,260	77.0	
Springs	#1 - GSU 1 & La Colina line	31,500	12,066	38.3
	#2 - Xfmr T-1 & La Colina line	31,500	13,585	43.1
	#3 - Xfmr T-1 & GSU 2	31,500	13,585	43.1
	#5 - GSU 2 & Orangecrest line	31,500	12,066	38.3
	#6 - Xfmr T-2 & Orangecrest line	40,000	13,585	34.0
	#8 - Xfmr T-2 & GSU 1	40,000	13,585	34.0
University	#1 - Hunter line	31,500	10,892	34.6
	#3 - Bus tie	31,500	10,892	34.6
	#5 - La Colina line	31,500	10,892	34.6