CAITHNESS – BLYTHE II, LLC
BLYTHE II GENERATION SYSTEM IMPACT STUDY

SYSTEM PLANNING STUDY

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EXECUTIVE SUMMARY

INTRODUCTION

Caithness Blythe II (“BEPII”) applied to the California Independent System Operator (“ISO”) for interconnection pursuant to the ISO Tariff. BEPII proposes to construct the Blythe Energy Project II located in Blythe, California (“Project”) and interconnect the Project to the 500 kV switchrack at a new Southern California Edison Company (“SCE”) Substation (“Midpoint Substation”) adjacent to SCE’s Devers - Palo Verde 500 kV (DPV1) transmission line to transmit 520 MW to the ISO controlled grid.

Southern California Edison Company (“SCE”) performed a System Impact Study for the Project as requested by BEPII. The purpose of this study is to assess the Project’s impact on SCE’s transmission system, and to conduct other analysis to determine if the proposed Project requires transmission system modifications. This is needed in order to maintain system reliability in accordance with CA-ISO Planning Criteria. The study includes assessments of power flow and voltages (steady-state and post-transient), short circuit duties, and transient stability.

Results of the System Impact Study will be used as the basis to determine the Project cost allocation for facility upgrades in the Facilities Study. The study accuracy and results for the assessment of the system adequacy are contingent on the accuracy of the technical data provided by BEPII.

The study was performed with 2009 heavy autumn load forecast with maximum autumn EOR/WOR power flow and includes projects queued ahead of this Project. The autumn case was selected because historically during autumn seasonal conditions the Arizona – California system is most heavily stressed. Several regional generation patterns were modeled, including maximized generation offset in the LA Basin to fully stress DPV1.

The following report provides detailed study assumptions and conditions of the system in which the study was conducted. Furthermore, results of Power Flow (steady state and post-contingency), Post-Transient Voltage Stability, Transient Stability, and Short-Circuit Duty assessments were completed for this study. Complete details of the study scenarios are attached (Attachment 1).

Four scenarios were modeled to simulate the Project with and without the Devers – Palo Verde 500kV #2 transmission line project (DPV2) Power flow studies were conducted under 2009 heavy autumn conditions. Further description of case assumptions follows:

Case 1: 2009 Heavy Autumn Pre-Project case without the DPV2;

Case 2: 2009 Heavy Autumn Pre-Project case with DPV2;

Case3: 2009 Heavy Autumn Post-Project case without DPV2 (Case 1 plus Project interconnection to Midpoint substation, natural flow case);

Case 4: 2009 Heavy Autumn Post-Project case without DPV2 and with increased series compensation on DPV1 to deliver an additional 520MW to the Devers 500kV substation (Case 3 with approximately 64% series compensation on the DPV1 500kV line);

Case 5: 2009 Heavy Autumn Post-Project case with DPV2 (Case 2 plus Project interconnection to Midpoint substation, natural flow case);

Case 6: 2009 Heavy Autumn Post-Project case with DPV2 and with increased series compensation on both DPV1 and DPV2 to deliver an additional 520MW to the Devers 500kV substation (Case 5 with approximately 68% series compensation on the DPV1 500kV line and 70% series compensation on the DPV2 500kV line)

SUMMARY RESULTS:

Without DPV2:

The Project adversely affects SCE's transmission system. The addition of the Project results in new base case overloads on the Devers – Vista #1 and #2 230 kV and Midpoint – Devers 500 kV transmission line series capacitors for both natural flow and compensation level increase, and increases an overload triggered by TOT101 on the Devers – San Bernardino 230 kV transmission line.

Congestion management may be an alternative to mitigate these overloads if the CA-ISO deems the extent and duration of the congestion to be acceptable.

If the DPV2 transmission line project does not materialize, N-1 overloads on the West-of-Devers 230 kV transmission lines were identified on the Devers – Vista #1 & #2 230 kV and the Devers – San Bernardino #1 & #2. The Project compounds N-1 overloads that were previously identified with projects ahead of the TOT101 transmission line project, which are increased for both the natural flow and compensation increase cases.

With DPV2

For base case conditions, the Project results in base case overloads on the Devers – Valley 500kV transmission line GIS riser and wavetrap. The Project compounds an overload triggered by the TOT101 project. The overload is increased for both the natural flow and compensation increase.

For the N-1 loss of Etiwanda – San Bernardino 230 kV transmission line, the Project results in an overload on the San Bernardino – Vista 230 kV transmission line for both natural flow and series compensation increase.

For the loss of either Midpoint – Devers 500 kV #1 or #2 transmission line, the loading on the Midpoint – Devers #1 or #2 series capacitors exceed the emergency thermal limitation of 3645A.

For the N-1 loss of Devers – Valley 500 kV transmission line, the Devers 500/230 kV transformer banks exceed the thermal limitations of 110% of the normal rating.

For the loss of the Devers – Valley 500 kV Transmission Line, the loading on the Etiwanda – Vista 230 kV transmission line exceeds the thermal capabilities of the line riser, disconnects, and wavetrap of 2000A.

For the loss of the Devers – Valley 500 kV Transmission Line, the loading on the Mira Loma – Vista 230 kV transmission line exceeds the thermal capabilities of the line risers and disconnects of 2000A.

For the loss of the Devers – Valley 500 kV transmission line, the loading on the Devers – Vista 230 kV transmission lines exceed its thermal limitation of 2850A.

Series Compensation Increase:

To inject 520MW into the Devers 500kV Substation, via Midpoint – Devers 500 kV transmission line, without DPV2, the series compensation increased to 64% on DPV1.

To inject 520MW into the Devers 500kV Substation, via Midpoint – Devers 500 kV transmission line, with DPV2, the series compensation increased to 68% on DPV1 and 70% on DPV2.

TRANSIENT STABILITY

No problems were identified for transient stability analyses.

POST TRANSIENT STABILITY

The Project does not result in large changes to the voltage stability characteristics of SCE’s system. All single contingencies were within the 7% post-transient limit for percent voltage change. All double contingencies were well within the 10% post-transient limit for percent voltage change.

SHORT CIRCUIT DUTY

Three Phase Short Circuit Duty:

Evaluate the need for circuit breaker replacement at 13 bulk power substations.

Single Line to Ground Short Circuit:

Evaluate the need for circuit breaker replacement at 11 bulk power substations.

CONCLUSIONS

The following are recommended upgrades to mitigate the identified overloads:

1. Review feasibility and develop costs associated with upgrades to mitigate base case overloads

Without DPV2

If the DPV2 transmission line project does not materialize, then develop the costs to reconductor the west-of-Devers 230 kV transmission lines; Devers – Vista #1 & #2 and Devers – San Bernardino #1 230 kV transmission lines, and Midpoint – Devers 500 kV transmission lines for both the natural flow and the compensation level increase scenarios. The Project also compounds a base case overload on the Devers – San Bernardino 230 kV transmission line that was triggered by TOT101.

Although upgrading the Midpoint – Devers 500 kV series capacitor to accommodate the additional flow on DPV1 would mitigate thermal overloads, further engineering evaluation during the facility study would need to be performed to determine if there are any clearance limitations for base case.

Develop the cost for the series compensation increase. A study has been performed for series compensation increase up to 70% and confirmed that Thyristor Controlled Series Capacitors could be used to mitigate SSR concerns. Although a SSR study was performed with 70% series compensation on DPV1 and DPV2, further studies are required with the proposed new Midpoint 500 kV Substation. The series capacitors require a 4000A rating.

With DPV2

Develop the cost to upgrade the Devers – Valley 500kV transmission line GIS riser and wavetrap to 4000A

Develop the cost for increasing the series compensation level on DPV1 and DPV2.

2. Review feasibility and develop costs associated with upgrades to mitigate N-1 contingency overloads

Without DPV2

If the DPV2 transmission line project does not materialize, then develop the costs to reconductor the west-of-Devers 230 kV transmission lines; Devers – Vista #1 & #2 230 kV and Devers – San Bernardino #1 & #2. The above base case West-of-Devers 230kV mitigation alternatives would also mitigate the N-1 overloads on the Devers – Vista #1 & #2 and Devers – San Bernardino #1 230kV transmission lines.

The base case overload mitigation plan for the Midpoint – Devers 500kV series capacitors would also mitigate the N-1 overload on this capacitor.

Although upgrading the Midpoint – Devers 500 kV series capacitor to accommodate the additional flow on DPV1 would mitigate thermal overloads, further engineering evaluation during the facility study would need to be performed to determine if there are any clearance limitations for base case.

Upgrade the Devers – Valley GIS riser and wavetrap.

With DPV2

Develop the costs to construct a second San Bernardino – Vista 230 kV transmission line, or

Develop the costs to accelerate the second Devers – Valley 500 kV transmission line project as an alternative to mitigate N-1 overloads on the San Bernardino – Vista #2 230 kV transmission line, or evaluate potential future SCE facility upgrades.

Develop the cost to upgrade the series capacitors to accommodate 4 N-1 500 Amps.

Develop the cost to install a third Devers 500/230 kV transformer bank.

Develop the cost to reconductor the Devers – Vista #1 & #2 230 kV lines to 2B-1590

Develop the cost to upgrade the Etiwanda – Vista 230 kV transmission line disconnects, line risers, and wavetrap at the Etiwanda Substation to 3000A.

Develop the cost to upgrade the Mira Loma – Vista 230 kV transmission line disconnects and risers to 3000A.

3. Review feasibility and develop costs associated with upgrades to mitigate N-2 contingency overloads

The base case or N-1 mitigation plans will mitigate the N-2 overloads.

4. Short Circuit Duty

Three Phase Short Circuit Duty

Evaluate the need for circuit breaker replacement at 13 bulk power substations.

		Min	PRE CASE		POST CASE		
Bus Name	Bus KV	Rating	X/R	KA	X/R	KA	DELTA KA
LUGO	500	37.8	21.2	42.1	21.1	42.2	0.1
MIRALOMA	500	38.4	24.2	32.6	24.1	32.7	0.1
SERRANO	500	40	23.5	27.8	23.4	27.9	0.1
BARRE	230	45.6	18.5	48.9	18.5	49	0.1
CHINO	230	50	17.3	46.7	17.2	46.8	0.1

DEVERS	230	33	20.8	42.4	20.8	43.3	0.9
ETIWANDA	230	34	20.3	40	20.2	40.1	0.1
MIRAGE	230	25	9.5	15.1	9.5	15.2	0.1
MRLOMA E	230	63	22.8	53.5	22.7	53.6	0.1
MRLOMA W	230	63	20.6	49.3	20.5	49.4	0.1
OLINDA	230	37.7	14	26.9	13.9	27	0.1
SANBRDNO	230	50	21.9	38	21.8	38.1	0.1
SERRANO	230	63	23.5	51.6	23.5	51.7	0.1
VISTA	230	40	19.8	45.4	19.8	45.6	0.2
BLYTHESC	161	31.5	12.4	19.6	12.6	19.8	0.2
DEVERS	115	23	46	24.1	46.3	24.2	0.1
VALLEY A	115	0	53.4	17.6	53.3	17.7	0.1
VALLEY C	115	0	50.6	17.6	50.5	17.7	0.1

Single Line to Ground Short Circuit

Evaluate the need for circuit breaker replacement at 11 bulk power substations.

		Min	PRE CASE		POST CASE		
Bus Name	Bus KV	Rating	X/R	KA	X/R	KA	DELTA KA
Barre	230	45.6	13.1	42.4	13.1	42.5	0.1
Blythe	161	31.5	12.3	19.7	12.3	20	0.3
Chino	230	50	12.8	38.9	12.7	39	0.1
Devers	230	33	16.2	46	16.3	46.8	0.8
Lewis	230	45.6	15.4	39.1	15.4	39.2	0.1
Mira Loma	525	38.4	14.8	30.1	14.8	30.2	0.1
Mira Loma B	230	63	12.7	55	12.7	55.1	0.1
San Ber'dino	230	50	19.2	40.3	19.2	40.4	0.1
Serrano	525	40	13.9	25.2	13.9	25.3	0.1
Vincent A	230	63	15.8	49.2	15.8	49.3	0.1
Vista	230	40	13.6	39.7	13.6	39.8	0.1

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Results of the System Impact Study will be used as the basis to determine the Project cost allocation for facility upgrades in the Facilities Study. The study accuracy and results for the assessment of the system adequacy are contingent on the accuracy of the technical data provided by BEPII.

The study was performed with 2009 heavy autumn load forecast with maximum autumn EOR/WOR power flow and includes projects queued ahead of this Project. The autumn case was selected because historically during autumn seasonal conditions the Arizona – California system is most heavily stressed. Several regional generation patterns were modeled, including maximized generation offset in the LA Basin to fully stress DPV1.

The following report provides detailed study assumptions and conditions of the system in which the study was conducted. Furthermore, results of Power Flow (steady state and post-contingency), Post-Transient Voltage Stability, Transient Stability, and Short-Circuit Duty assessments were completed for this study. Complete details of the study scenarios are attached (Attachment 1).

STUDY CONDITIONS AND ASSUMPTIONS

Planning Criteria

The study was conducted by applying the SCE Transmission Planning Criteria and Guidelines, as well as the CAISO Reliability Criteria. More specifically, the main criteria applicable to this study are shown in the table below:

	Normal Condition Base Case Rating	**N-1 Contingency Rating**	**N-2 Contingency Rating**
Transmission Lines	100% normal continuous	115% normal continuous*	135% normal continuous*
Banks (AA-Banks)	100% of Nameplate (NPL)	110% of Nameplate (24-hours)#	110% of Nameplate (24-hours)#

Banks (AA-Banks) Purchased after 1970		150% of Nameplate (1-hour)#	150% of Nameplate (1-hour)#

* Except when specific lower limitations have been identified

\# If no factory heat run studies (FHR) or load capability studies (LCS) are available. Higher limits can be used if FHR or LCS is available, as long as they do not exceed 120% and 160% of NPL for long-term and short-term respectively.

For AA-Banks purchased before 1970, the above limits are the same, except for the long-term limit, which is only 100% of Nameplate. The main criteria applicable to this study are as follows:

Power Flow Analysis

The following study criteria were used to evaluate power flow performance for both pre- and post-contingency analysis:

Normal Conditions

i. Under normal conditions, bus voltages must be maintained between 0.95 per unit and 1.05 per unit, except for the Palo Verde 500-kV bus voltages which must be maintained between 1.0 per unit and 1.02 per unit (525-kV base).

ii. All line and transformer loadings must be below normal continuous ratings.

Single Contingency Outage Conditions

i. For a single contingency, no transmission element will be loaded above its emergency rating.

ii. Established loading limits for other utilities will be monitored.

iii. Equipment emergency voltage limits (high or low) will not be exceeded for single contingency outages.

iv. Bus voltage deviations from the base case voltage shall not exceed established planning limits (These limits may vary throughout the system).

v. Single contingency outages on the 230-kV and EHV systems will not result in loss of load.

Planning Criteria

The study was conducted by applying the CAISO Reliability Criteria. More specifically, the main criteria applicable to this study are as follows:

Power Flow Assessment

The following contingencies are considered for transmission and sub-transmission lines and 500/230 kV transformer banks (“AA-Banks”):

- Single Contingencies (loss of one line or one AA-Bank)
- Credible Double Contingencies (loss of two lines or one line and one AA-Bank)
    - Outages of two AA-Banks are beyond the Planning Criteria

The following reliability criteria are used:

Transmission Lines	Base Case	Limiting Component Normal Rating
	N-1	Limiting Component Emergency-Rating
	N-2	Limiting Component Emergency-Rating
AA-Banks	Base Case	Normal Loading Rating
	Long Term & Short Term	Bank Emergency-Rating

System upgrades for transmission lines are generally recommended for all reliability criteria violations. Special Protection Schemes (SPS) may be allowed for single contingency and credible double contingencies reliability criteria violation in place of system upgrade.

Congestion Assessment

The following principles were used in determining whether congestion management, special protection schemes, or facility upgrades are required to mitigate base case, single contingency, or double contingency overloads:

Congestion management, as a means to mitigate base case overloads, can be used if it is determined to be manageable and the CAISO concurs with the implementation.

Facility upgrades will be required if it is determined that the use of congestion management is unmanageable as defined in the congestion management section that follows.

SPS, in lieu of facility upgrades, will be recommended if the scheme is effective, does not jeopardize system integrity, does not exceed the current CAISO single and double contingency tripping limitations, does not adversely effect existing or proposed special protection schemes in the area, and can be readily implemented.

Facility upgrades will be required if use of protection schemes is determined to be ineffective, the amount of tripping exceeds the current CAISO single and double contingency tripping limitations, adverse impacts are identified on existing or currently proposed special protection schemes, or the scheme cannot be readily implemented.

Congestion management in preparation for the next contingency will be required, with CAISO concurrence, if no facility upgrades or special protection schemes are implemented.

The following study method was implemented to assess the extent of possible congestion:

Under Base Case with all transmission facilities in service, the system was evaluated with all existing interconnected generation and all generation requests in the area that have a queue position ahead of this request (pre-project).

Under Base Case with all transmission facilities in service, the system was reevaluated with the inclusion of the Project (post-project).

If the normal loading limits of facilities are exceeded in (a), the overload is identified as an existing overload that was triggered by a project in queue ahead of the Project. If the normal loading limits of facilities are exceeded in (b) and were not exceeded in (a), the overload is identified as triggered by the addition of the Project. The Project, assuming it is a market participant, and other market participants in the area may be subjected to congestion management, potential upgrade cost and/or participation of any proposed special protection scheme if the project addition aggravates or triggers the overload. Additionally, the Project may have to participate in mitigation of overloads triggered by subsequent projects in queue, subject to FERC protocols and policies.

In order for congestion management to be a feasible alternative to system facilities, all of the following factors need to be satisfied:

Time requirements for necessary coordination and communication between the CAISO operators, scheduling operators and SCE operators.

Distinct Path/Corridor rating should be well defined so monitoring and detecting congestion and implementing congestion of the contributing generation resources can be performed when limits are exceeded.

Sufficient amount of market generation in either side of the congested path/corridor should be available to eliminate market power.

Manageable generation in the affected area is necessary so that operators can implement congestion management if required (i.e. the dispatch schedule is known and controllable).

The results of these studies should identify:

If capacity is available to accommodate the proposed Project and all projects ahead in queue without the need for congestion management, special protection schemes, or facility upgrades

If overloads exist in the area after the addition of all projects in queue ahead of the Project and all facilities in service

If congestion exists in the area with the addition of the Project and all projects ahead in queue under single and double element outage conditions assuming no new special protection schemes are in place

If sufficient capacity is maintained to accommodate all Must-Run and Regulatory Must-Take generation resources with all facilities in service

If sufficient capacity is maintained to accommodate the total output of any one generation resource which is not classified as Must-Run.

Post-Transient Voltage Stability Analysis

The following assumptions were modeled in the studies:

a) All loads will be modeled as constant power during the first few minutes following an outage or disturbance.

b) All voltages at distribution substations will be restored to normal values by the transformer tap changers and other voltage control devices.

c) Generator VAR limits will be modeled as a single value for each generator since the reactive power capability curve will not be modeled in the power flow program.

d) There will be no manual operator intervention to increase the generator VAR output.

e) Remedial actions such as generator dropping, load shedding and blocking of automatic generation control (AGC) will not be considered.

h) Other Assumptions

· Area Interchange: Disabled;

· Governor Blocking: Per WECC Modeling & Validation Work Group recommendations - Diablo, Palo Verde, and San Onofre;

· DC Line Transformer Tap Automatic Adjustment: Enabled;

· Generator Voltage Control set to local except for San Onofre, Palo Verde, and selected Northwest generation;

· Phase Shifter Control: Disabled;

· Switched Shunt Devices: Disabled - except in Sierra Pacific Power's system.

The transient voltage dips should meet the following combined SCE and WECC Reliability Criteria:

a)

Performance Level	Disturbance	Post Transient Voltage Deviations
B	N-1	Not to exceed 7% at any bus.
C	N-2	NOT TO EXCEED 10% AT ANY BUS.
D	N-3	Cascading Not Permitted

Transient Stability Analysis

The following criterion was applied for the transient stability analysis:

a.) All machines in the system shall remain in synchronism as demonstrated by their relative rotor angles.

b.) All stability simulation cases will be run for a minimum of 10 seconds.

c.) Governors will be set out-of-service on steam generators with governor P-Max over 150 MW and loading over 90% of governor P-Max.

d.) System stability is evaluated based on the damping of the relative rotor angles and the damping of the voltage magnitude swings.

e.) The transient voltage dip should be maintained above 0.80 per unit at Adelanto and Sylmar.

f.) Other transient voltage dips must meet the following WECC Reliability Criteria:

Performance Level	Disturbance	Transient Voltage Dip Criteria
B	N-1	Transient Voltage Dip: Not to exceed 25% at load buses or 30% at non-load buses. Also, not to exceed 20% for more than 20 cycles at load buses. Minimum Transient Frequency: Not below 59.6 Hz for 6 cycles or more at a load bus.
C	N-2	Transient Voltage Dip: Not to exceed 30% at any bus. Also, not to exceed 20% for more than 40 cycles at load buses. Minimum Transient Frequency: Not below 59.0 Hz for 6 cycles or more at a load bus.
D	N-3	Not Specified

Short-Circuit Analysis

The following study assumptions were used for conducting the short-circuit analysis:

a) Shunt capacitor banks will be omitted at all stations. Normally, shunt capacitors produce a minimal effect on fault currents. When they are large enough to be significant, their effect is to reduce total fault current. Results are more conservative to neglect them altogether.

b) Shunt reactors will also be neglected since their contribution is minimal.

c) Reactors connected to autotransformer delta tertiary windings will be neglected since they cannot contribute fault current to the system.

d) Phase shifting transformers will be by-passed as this would be the worst case from the fault current standpoint.

e) If zero sequence data is not available, the assumption will be made that Xo=3X1 and Ro=0 or R1.

Circuit breakers exposed to fault currents in excess of 100 percent of their interrupting capacities will be replaced or upgraded, whichever is appropriate.

Subsynchronous Resonance Analysis (SSR)

Based on previous studies where series compensation exceeded 50%, SSR analysis has shown that problems may occur in the SCE or nearby systems. Therefore with the new Midpoint 500 kV Substation, if the series compensation alternative is selected, a SSR analysis will be required for 68% on DPV1 and 70% on DPV2.

BEPII GENERATION PROJECT

The project studied the 2009 Heavy Autumn case with high EOR/WOR flow. The light load condition is the worst case scenario with high flows on the Paths 49 & 46. Therefore, a heavy summer case was not evaluated for this study.

BEPII Proposes to interconnect to the new Midpoint 500 kV Substation.

A. System Conditions

To simulate the SCE transmission system for analysis, the study used a Western Arizona Transmission Studies ("WATS") approved planning case that modeled 2008, heavy autumn, heavy EOR flow. This starting WATS case was updated to represent system conditions in 2009. Most significantly, SCE's load was escalated to a 2009 forecast value, and associated resource adjustments were made to maintain an emphasis on heavy imports to Southern California from the desert southwest. These conditions were evaluated to identify worst case scenarios that would stress the SCE 500-kV and 230-kV Eastern transmission system networks.

B. Load Flow Study

Load flow studies were conducted under 2009 heavy autumn conditions. Further description of case assumptions follows:

Four scenarios were modeled to simulate the Project with and without the DPV2 project. Power flow studies were conducted under 2009 heavy autumn conditions. Further description of case assumptions follows:

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Table 1: Power Flows and Loads

2009 EAST-OF-RIVER AND WEST-OF-RIVER FLOWS Total Imports LOAD AND LOSSES (MW)						
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
EOR	7897	9,257	7,863	7,910	9,242	9,275
WOR	8884	11,074	9,389	9,412	11,567	11,552
Flow Into Devers	2329	3,538	2,635	2,842	3,852	4,038
Total Import	6302	7,691	6,822	6,822	8,211	8,211
Load	15,000	15,000	15,000	15,000	15,000	15,000
Losses	486.86	555.43	526.44	552.07	596.11	616.39

C. <u>Transient Stability</u>

Transient stability studies were performed to assess the impact on the dynamic performance of the system for a heavily stressed East-of-River scenario.

D. <u>Post-Transient Voltage Stability Study</u>

The power flow study voltage results were used as a screen to identify contingencies that may require additional post transient voltage studies. Contingencies used for this analysis were outlined in the study scope and are identified in the Planning Criteria section of this report.

The following Post Transient Voltage analyses were performed on the following contingencies:

- Devers-Mirage& Devers-Coachella 230kV Transmission Lines
- Devers-Valley 500kV Transmission Line
- Devers-Mirage & Ramon-Coachella 230kV Transmission Line
- Devers – Palo Verde-Julian Hinds-Mirage- Transmission Line
- Valley-Serrano 500kV Transmission Line
- Palo Verde-Devers 500kV Transmission Line

- Palo Verde-Midpoint 500kV Transmission Line
  Hassayampa-N. Gila 500kV Transmission Line

E. Short Circuit Duty Study

To determine the impact of the proposed transmission project on short circuit duties at buses in the SCE bulk transmission system, the study calculated the maximum symmetrical three-phase-to-ground short circuit duties at the most critical 230-kV and 500-kV buses.

RESULTS

1. POWER FLOW ANALYSES

A: Transmission Line Loadings:

Base Case Results

TABLE 2
BYTHE II GENERATION SYSTEM IMPACT STUDIES
WITHOUT DPV2
BASE CASE

From Bus Name	To Bus Name	TkV	ID	Amp/MVA Rating	Pre-Project (Case 1) Loading %	Natural Flow (Case 3) Loading%	Compensation Increase (Case 4) Loading%	Contingency Description
DEVERS	VSTA	230	2	1240	93.40%	99.70%	103.70%	Base Case
MIDPINTS	DEVERS	500	1	2700	99.90%	113.00%	122.20%	Base Case
SANBRDNO	DEVERS	230	1	795	110.20%	118.80%	124.10%	Base Case
VSTA	DEVERS	230	1	1150	99.60%	106.40%	110.60%	Base Case

The percent loadings are on the Normal ratings.

Devers – Vista #1 & #2 and San Bernardino - Devers 230 kV Transmission Lines

Finding:

The study resulted in base case overloads on the above west of Devers 230 kV transmission lines.

Conclusion:

The following would mitigate the west-of-Devers overload if the proposed DPV2 line and its associated West-of-Devers 230kV facility upgrades, or projects queued ahead of this Project that would otherwise mitigate the overload do not materialize:

- Reconductor the transmission lines with 2B-1033 ACSR

- Congestion management may be an alternative to mitigate these overloads if the CA-ISO deems that the extent and duration of the congestion is acceptable.

Midpoint – Devers 500 kV Transmission Line Series Capacitor

Finding:

For base case conditions, the loading on the Midpoint – Devers 500 kV transmission line series capacitor exceeded its thermal limit for both the BEPII natural power flow and increased series compensation cases.

Conclusion:

Upgrade the series capacitor to a higher rating of 4000A for the compensation increase scenario,

TABLE 3
BYTHE II GENERATION SYSTEM IMPACT STUDIES
WITH DPV2
BASE CASE

From Bus Name	*To Bus Name*	*TkV*	*ID*	*Normal Amp Rating*	*(Pre-Project) (Case 2) Loading %*	*(Natural Flow) (Case 5) Loading %*	*(Compensation Increase) (Case 6) Loading %*	*Contingency Description*
DEVERS	VALLEYSC	500	1	3000	105.7%	111.3%	115.3%	Base Case
MIDPOINT	DEVERS	500	1	2700	83%	91.9%	105.5%	Base Case

The percent loadings are on the Normal ratings.

<u>Devers - Valley 500 kV Transmission Line Line Riser and Wavetrap</u>

Finding:

For base case conditions, the loading on the Devers – Valley 500 kV transmission line riser and wavetrap exceeded its thermal limit for both the BEPII natural power flow and increased series compensation cases.

Conclusion:

Project TOT101 resulted in overloads on this GIS riser and wavetrap and is expected to mitigate the overload. If that project does not materialize, then these components would require an upgrade to 4000A.

N-1 Contingency Results

TABLE 4 BYTHE II GENERATION SYSTEM IMPACT STUDIES WITHOUT DPV2 N-1								
From Bus Name	*To Bus Name*	*TkV*	*ID*	*Normal/ N-1 Emergency Amp Ratings*	*(Pre-Project) (Case 1) Loading %*	*(Natural Flow) (Case 3) Loading %*	*(Compensation Increase) (Case 4) Loading %*	*Contingency Description*
DEVERS	SANBRDNO	230	2	1150/1150	140.5%	152.1%	161.6%	line DEVERS to VALLEYSC 500 ck 1
DEVERS	VALLEYSC	500	1	3000/3000	90.50%	97.80%	102.40%	line DEVERS to VSTA 230 ck 2
DEVERS	VSTA	230	2	1240/1240	157.3%	170.1%	179.5%	line DEVERS to VALLEYSC 500 ck 1
MIDPINTS	DEVERS	500	1	2700/3645	107.40%	120.80%	130.20%	line MOENKOPI to ELDORDO 500 ck 1
SANBRDNO	DEVERS	230	1	795/795	196.5.90%	212.7%	225.8%	line DEVERS to VALLEYSC 500 ck 1
SANBRDNO	DEVERS	230	1	795/795	108.00%	116.50%	121.60%	tran BUCK161 161 to BLY2CT2 16 ck 1
VSTA	DEVERS	230	1	1150/1150	167.8%	181.4%	191.5%	line DEVERS to VALLEYSC 500 ck 1

The percent loadings are on the Normal ratings.

Devers – Vista #1 & #2 230 kV Transmission Lines
Devers – San Bernardino #1 & #2 230 kV Transmission Lines

Finding:

The highest loadings on these transmission lines occurred for an N-1 loss of Devers - Valley 500 kV transmission line. This Project exacerbates the overloads that were previously identified with projects in the queue ahead of this Project.

Conclusion:

- The following is recommended to mitigate these overloads if those projects, including the proposed DPV2 line and its associated 230kV upgrades, that would otherwise mitigate the overloads, do not materialize:
  - Reconductor the transmission lines with 2B-1033 ACSR

Devers – Midpoint 500 kV Transmission Line Series Capacitor

Finding:

For the loss of several transmission lines, the loading on the Series Capacitor exceeds the thermal rating.

Conclusion:

Upgrade the series capacitor to 4000A.

Devers - Valley 500 kV Transmission Line GIS Riser and Wave Trap

Finding:

For the loss of several transmission lines, the loading on the GIS riser and wavetrap exceeds the thermal rating of 3000A.

Conclusion:

The TOT101 transmission line project resulted in overloads on this GIS riser and wavetrap and is expected to mitigate the overload. If that project does not materialize, then these components would require an upgrade to 4000A.

TABLE 5
BYTHE II GENERATION SYSTEM IMPACT STUDIES
WITH DPV2
N-1

From Bus Name	To Bus Name	TkV	ID	Normal/ N-1 Emergency Amp/MVA Ratings	(Pre-Project) (Case 2) Loading %	(Natural Flow) (Case 5) Loading %	(Compensa tion Increase) (Case 6) Loading %	Contingency Description
DEVERS	VALLEYSC	500	1	3000/3000	111.5%	118.20%	121.00%	line DEVERS to VSTA 230 ck 2
MOENKOPI	ELDORDO	500	1	1900/2600	101.50%	106.50%	101.80%	line MIDPINTS to DEVERS 500 ck 1
VSTA	SANBRDNO	230	2	3230/3710	113.41%	117.94%	123.0%	line ETIWANDA to SANBRDNO 230 ck 1
MIDPOINT	DEVERS	500	1	2700/3650	118.6%	133.8%	143.4%	line MIDPINTS to DEVERS 500 ck 2
MIDPOINT	DEVERS	500	2	2700/3650	138.40%	153.00%	164.8%	line MIDPINTS to DEVERS 500 ck 1
DEVERS	DEVERS	500/ 230	1	1120/1230 MVA	108%	116%	119%	line DEVERS to VALLEYSC 500 ck 1
DEVERS	DEVERS	500/ 230	2	1120/1230 MVA	108%	116%	119%	line DEVERS to VALLEYSC 500 ck 1
ETIWANDA	VISTA	230	1	2000/2000	98%	103.9%	105.2%	line DEVERS to VALLEYSC 500 ck 1
MIRLOMW	VISTA	230	1	2480/2850	107.2%	113.0%	114.4%	line DEVERS to VALLEYSC 500 ck 1
DEVERS	VISTA	230	1	2480/2850	110.9%	116.7%	118.3%	line DEVERS to VALLEYSC 500 ck 1
DEVERS	VISTA	230	2	2480/2850	110.9%	116.7%	118.3%	line DEVERS to VALLEYSC 500 ck 1

The percent loadings are on the Normal ratings.

San Bernardino-Vista 230kV #2 Transmission Line

The highest loadings on this transmission line occurred for an N-1 loss of the Etiwanda – San Bernardino 230kV or the Devers – Valley 500kV transmission lines.

Finding:

For the loss of the Etiwanda – San Bernardino 230kV line, this Project increases the loading on the San Bernardino-Vista 230kV line beyond its thermal conductor rating.

Conclusion:

The following 2 alternatives are recommended to mitigate this N-1 overload for the above scenarios:

- Construct a second San Bernardino – Vista 230 kV transmission line. The second line would reduce the loading on the San Bernardino – Vista line, or

- SCE is currently evaluating the need for a second Devers – Valley 500 kV transmission line. If the new line is constructed, it would mitigate the overload on the San Bernardino – Vista 230 kV transmission line. Accelerating the second Devers – Valley line project to the operation date of the Project, if feasible, would mitigate this transmission line overload.

Moenkopi – Eldorado 500 kV Transmission Line Series Capacitor

Finding:

For the loss of several transmission lines, the loading on these capacitors exceed the thermal rating.

The overloads are on the normal rating but do not exceed the emergency ratings. However, the emergency rating is only for 30 minutes.

Conclusion:

These series capacitors may need upgrades to a higher rating.

Devers - Valley 500 kV Transmission Line GIS Riser and Wave Trap

Finding:

For the loss of several transmission lines, the loading on the GIS riser and wavetrap exceeds the thermal rating of 3000A.

Conclusion:

Project TOT101 resulted in overloads on this GIS riser and wavetrap and is expected to mitigate the overload. If that project does not materialize, then these components would require an upgrade to 4000A.

Midpoint - Devers 500 kV Series Capacitor #1 & #2

Finding:

For the loss of either Midpoint – Devers 500 kV transmission line, the loading on the either Midpoint – Devers series capacitor exceeds the emergency thermal limitation of 3645A.

Conclusion:

The following 2 alternatives are recommended to mitigate this N-1 overload for the above scenarios:

- Install series capacitors capable of 4500 Amps, or

- Trip the Blythe 2 generation

Devers 500/230 #1&#2 Transformers

Finding:

For the N-1 loss of Devers – Valley 500 kV transmission line, the Devers 500/230 kV transformers bank exceed the thermal limitations of 110% of the normal rating.

Conclusion:

The following 2 alternatives are recommended to mitigate this N-1 overload for the above scenarios:

- Install a third Devers 500/230 kV transformer bank, or

Etiwanda – Vista 230 kV Transmission Line

Finding:

For the loss of the Devers – Valley 500 kV Transmission Line, the loading on the Etiwanda – Vista 230 kV transmission line exceeds the thermal capabilities of the line riser, disconnects, and wavetrap of 2000A.

Conclusion:

Upgrade the line risers, disconnects, and wavetrap at the Etiwanda Substation 230 kV to 3000A.

Mira Loma – Vista 230 kV Transmission Line

Finding:

For the loss of the Devers – Valley 500 kV Transmission Line, the loading on the Mira Loma – Vista 230 kV transmission line exceeds the thermal capabilities of the line riser, disconnects, and wavetrap of 2000A.

Conclusion:

Upgrade the line risers, disconnects, and disconnects to 3000A.

Devers – Vista 230 kV Transmission Lines #1 & #2

Finding:

For the loss of the Devers – Valley 500 kV transmission line, the loading on the Devers – Vista 230 kV transmission lines exceed its thermal limitation of 2850A.

Conclusion:

The following are 2 alternatives to mitigate these overloads:

- These transmission lines will be upgraded to 2B-1033 ACSR for the DPV2 transmission line project. Upgrade to the transmission lines to 2B-1590 ACSR.
- Accelerate the second Devers – Valley 500 kV transmission line project to the operating date of BEP2.

N-2 Contingency Results:

TABLE 6
BYTHE II GENERATION SYSTEM IMPACT STUDIES
WITHOUT DPV2
N-2

From Bus Name	To Bus Name	TkV	ID	Normal/ N-2 Emergency Amp Ratings	(Pre-Project) (Case 1) Loading %	(Natural Flow) (Case 3) Loading %	(Compensation Increase) (Case 5) Loading %	Contingency Description
DEVERS	SANBRDNO	230	2	1150/1150	121.60%	131.10%	136.60%	line outage 13
DEVERS	VALLEYSC	500	1	3000/3000	103.80%	112.50%	116.60%	line outage 36
DEVERS	VSTA	230	2	1240/1240	152.20%	162.10%	166.40%	line outage 36
SANBRDNO	DEVERS	230	1	795/795	171.70%	185.10%	193.00%	line outage 10
VSTA	DEVERS	230	1	1150/1150	162.30%	172.90%	177.50%	line outage 36

The percent loadings are on the Normal ratings.

Findings:

N-2 contingencies resulted in loadings that exceed N-2 emergency ratings for the following transmission lines:

Devers – Valley 500 kV Transmission Line
Devers – Vista #1 & #2 230 kV Transmission Lines
Devers – San Bernardino #1 & #2 230 kV Transmission Lines

Devers – Valley 500 kV Transmission Line

The above proposed N-1 mitigation plan to upgrade the wavetrap and GIS riser on the Devers – Valley 500 kV transmission line would mitigate this N-2 overload.

Devers – Vista #1 & #2 230 kV Transmission Lines
Devers – San Bernardino #1 & #2 230 kV Transmission Lines

The proposed mitigation plan for the N-1 loss of the Devers-Valley 500 kV transmission line would mitigate this overload for the N-2.

TABLE 7
BYTHE II GENERATION SYSTEM IMPACT STUDIES
WITH DPV2
N-2

From Bus Name	To Bus Name	TkV	ID	Normal/ N-2 Emergency Amp Ratings	(Pre-Project) (Case 2) Loading %	(Natural Flow) (Case 5) Loading %	(Compensation Increase) (Case 6) Loading %	Contingency Description
DEVERS	VALLEYSC	500	1	3000/3000	122.2%	130.3%	134.2%	line outage 36
MOENKOPI	ELDORDO	500	1	1900/2600	101.5%	106.5%	101.8%	line outage 26
VSTA	SANBRDNO	230	2	3230/3710	131.52%	137.1%	140.0%	line outage 2

The percent loadings are on the Normal ratings.

Findings:

N-2 contingencies resulted in loadings that exceed N-2 emergency ratings for the following transmission lines:

Devers – Valley 500 kV Transmission Line
San Bernardino – Vista 230 kV Transmission Line
Moenkopi – Eldorado 500 kV Transmission Line

Devers – Valley 500 kV Transmission Line

The above proposed base case mitigation plan to upgrade the wavetrap and GIS riser on the Devers – Valley 500 kV transmission line would mitigate this N-2 overload.

San Bernardino – Vista 230 kV Transmission Line

The proposed mitigation plan for the N-1 loss of the San Bernardino – Etiwanda 230 kV transmission line to either construct a second San Bernardino – Vista 230 kV transmission line or accelerate the proposed Devers – Valley 500 kV transmission line would also mitigate this N-2 contingency overload.

Moenkopi – Eldorado 500 kV Transmission Line Series Capacitor

The proposed mitigation plan for the N-1 contingency would mitigate this overload for the N-2.

2. TRANSIENT STABILITY

No problems were identified for transient stability analyses.

Outages	Results
Blythe(WAPA) – Blythe (SCE) 161kV & Blythe – Eagle Mountain 161kV T/Ls	Stable
Blythe(WAPA) – Blythe (SCE) 161kV & Blythe – Julian Hinds 230kV T/Ls	Stable
Devers – Midpoint 500kV & Coachella – Ramon 230kV T/Ls	Stable
Devers – Midpoint 500kV & Palo Verde – Midpoint 500Kv T/Ls	Stable
Devers – Midpoint 500Kv T/L	Stable
Devers-Valley500Kv T/L	Stable
Devers - San San Bernardino 230kV T/L	Stable
Devers - San San Bernardino 230kV & San Bernardino – Vista 230Kv T/Ls	Stable
San Bernardino – Vista 230kV T/L	Stable
San Bernardino – Etiwanda 230Kv T/L	Stable
Palo Verde – Midpoint 500kV T/L	Stable

3. POST TRANSIENT

The Project does not result in large changes to the voltage stability characteristics of SCE's system. All single contingencies were within the 7% post-transient limit for percent voltage change. All double contingencies were well within the 10% post-transient limit for percent voltage change.

The highest voltage deviation occurred at SCE's Blythe Substation at 6.5% for the cases during natural flow for both with DPV2 and without DPV2.

The case diverged for the N-1 loss of Devers – Valley 500 kV transmission line for both pre and post project with DPV2 scenarios.

4. SHORT CIRCUIT DUTY

Three Phase Short Circuit Duty

Evaluate the need for circuit breaker replacement at 13 bulk power substations.

		Min	PRE CASE		POST CASE		
Bus Name	Bus KV	Rating	X/R	KA	X/R	KA	DELTA KA
LUGO	500	37.8	21.2	42.1	21.1	42.2	0.1
MIRALOMA	500	38.4	24.2	32.6	24.1	32.7	0.1
SERRANO	500	40	23.5	27.8	23.4	27.9	0.1
BARRE	230	45.6	18.5	48.9	18.5	49	0.1
CHINO	230	50	17.3	46.7	17.2	46.8	0.1
DEVERS	230	33	20.8	42.4	20.8	43.3	0.9
ETIWANDA	230	34	20.3	40	20.2	40.1	0.1
MIRAGE	230	25	9.5	15.1	9.5	15.2	0.1
MRLOMA E	230	63	22.8	53.5	22.7	53.6	0.1
MRLOMA W	230	63	20.6	49.3	20.5	49.4	0.1
OLINDA	230	37.7	14	26.9	13.9	27	0.1
SANBRDNO	230	50	21.9	38	21.8	38.1	0.1
SERRANO	230	63	23.5	51.6	23.5	51.7	0.1
VISTA	230	40	19.8	45.4	19.8	45.6	0.2
BLYTHESC	161	31.5	12.4	19.6	12.6	19.8	0.2
DEVERS	115	23	46	24.1	46.3	24.2	0.1
VALLEY A	115	0	53.4	17.6	53.3	17.7	0.1
VALLEY C	115	0	50.6	17.6	50.5	17.7	0.1

Single Line to Ground Short Circuit

Evaluate the need for circuit breaker replacement at 11 bulk power substations.

		Min	PRE CASE		POST CASE		
Bus Name	Bus KV	Rating	X/R	KA	X/R	KA	DELTA KA
Barre	230	45.6	13.1	42.4	13.1	42.5	0.1
Blythe	161	31.5	12.3	19.7	12.3	20	0.3
Chino	230	50	12.8	38.9	12.7	39	0.1
Devers	230	33	16.2	46	16.3	46.8	0.8
Lewis	230	45.6	15.4	39.1	15.4	39.2	0.1
Mira Loma	525	38.4	14.8	30.1	14.8	30.2	0.1
Mira Loma B	230	63	12.7	55	12.7	55.1	0.1
San Bernardino	230	50	19.2	40.3	19.2	40.4	0.1
Serrano	525	40	13.9	25.2	13.9	25.3	0.1

Vincent A	230	63	15.8	49.2	15.8	49.3	0.1
Vista	230	40	13.6	39.7	13.6	39.8	0.1

Evaluate the need for circuit breaker replacement at 11 bulk power substations.

		Min	PRE CASE		POST CASE		
Bus Name	Bus KV	Rating	X/R	KA	X/R	KA	DELTA KA
Barre	230	45.6	13.1	42.4	13.1	42.5	0.1
Blythe	161	31.5	12.3	19.7	12.3	20	0.3
Chino	230	50	12.8	38.9	12.7	39	0.1
Devers	230	33	16.2	46	16.3	46.8	0.8
Lewis	230	45.6	15.4	39.1	15.4	39.2	0.1
Mira Loma	525	38.4	14.8	30.1	14.8	30.2	0.1
Mira Loma B	230	63	12.7	55	12.7	55.1	0.1
San Ber'dino	230	50	19.2	40.3	19.2	40.4	0.1
Serrano	525	40	13.9	25.2	13.9	25.3	0.1
Vincent A	230	63	15.8	49.2	15.8	49.3	0.1
Vista	230	40	13.6	39.7	13.6	39.8	0.1

CONCLUSIONS

The following are recommended upgrades to mitigate the identified overloads:

1. Review feasibility and develop costs associated with upgrades to mitigate base case overloads

Without DPV2

If the DPV2 transmission line project does not materialize, then develop the costs to reconductor the west-of-Devers 230 kV transmission lines; Devers – Vista #1 & #2 and Devers – San Bernardino #1 230 kV transmission lines, and Midpoint – Devers 500 kV transmission lines for both the natural flow and the compensation level increase scenarios. The Project also compounds a base case overload on the Devers – San Bernardino 230 kV transmission line that was triggered by TOT101.

Develop the cost for the series compensation increase. A study has been performed for series compensation increase up to 70% and confirmed that Thyristor Controlled Series Capacitors could be used to mitigate SSR concerns. Although a SSR study was performed with 70% series compensation on DPV1 and DPV2, further studies are required with the proposed new Midpoint 500 kV Substation. The series capacitors require a 4000A rating.

Although upgrading the Midpoint – Devers 500 kV series capacitor to accommodate the additional flow on DPV1 would mitigate thermal overloads, further engineering evaluation during the facility study would need to be performed to determine if there are any clearance limitations for base case conditions.

With DPV2

Develop the cost to upgrade the Devers – Valley 500kV transmission line GIS riser and wavetrap to 4000A

Develop the cost for increasing the series compensation level on DPV1 and DPV2.

2. Review feasibility and develop costs associated with upgrades to mitigate N-1 contingency overloads

Without DPV2

If the DPV2 transmission line project does not materialize, then develop the costs to reconductor the west-of-Devers 230 kV transmission lines; Devers – Vista #1 & #2 230 kV and Devers – San Bernardino #1 & #2. The above base case West-of-Devers 230kV mitigation alternatives would also mitigate the N-1 overloads on the Devers – Vista #1 & #2 and Devers – San Bernardino #1 230kV transmission lines.

The base case overload mitigation plan for the Midpoint – Devers 500kV series capacitors would also mitigate the N-1 overload on this capacitor.

Although upgrading the Midpoint – Devers 500 kV series capacitor to accommodate the additional flow on DPV1 would mitigate thermal overloads, further engineering evaluation during the facility study would need to be performed to determine if there are any clearance limitations for N-1 conditions.

Upgrade the Devers – Valley GIS riser and wavetrap.

With DPV2

Develop the costs to construct a second San Bernardino – Vista 230 kV transmission line, or

Develop the costs to accelerate the second Devers – Valley 500 kV transmission line project as an alternative to mitigate N-1 overloads on the San Bernardino – Vista #2 230 kV transmission line, or evaluate potential future SCE facility upgrades.

Develop the cost to upgrade the series capacitors to accommodate 4 N-1 500 Amps.

Develop the cost to install a third Devers 500/230 kV transformer bank.

Develop the cost to reconductor the Devers – Vista #1 & #2 230 kV lines to 2B-1590

Develop the cost to upgrade the Etiwanda – Vista 230 kV transmission line disconnects, line risers, and wavetrap at the Etiwanda Substation to 3000A.

Develop the cost to upgrade the Mira Loma – Vista 230 kV transmission line disconnects and risers to 3000A.

3. Review feasibility and develop costs associated with upgrades to mitigate N-2 contingency overloads

The base case or N-1 mitigation plans will mitigate the N-2 overloads.

4. Short Circuit Duty

Three Phase Short Circuit Duty

Evaluate the need for circuit breaker replacement at 13 bulk power substations.

		Min	PRE CASE		POST CASE		
Bus Name	Bus KV	Rating	X/R	KA	X/R	KA	DELTA KA
LUGO	500	37.8	21.2	42.1	21.1	42.2	0.1
MIRALOMA	500	38.4	24.2	32.6	24.1	32.7	0.1
SERRANO	500	40	23.5	27.8	23.4	27.9	0.1
BARRE	230	45.6	18.5	48.9	18.5	49	0.1
CHINO	230	50	17.3	46.7	17.2	46.8	0.1
DEVERS	230	33	20.8	42.4	20.8	43.3	0.9
ETIWANDA	230	34	20.3	40	20.2	40.1	0.1
MIRAGE	230	25	9.5	15.1	9.5	15.2	0.1
MRLOMA E	230	63	22.8	53.5	22.7	53.6	0.1
MRLOMA W	230	63	20.6	49.3	20.5	49.4	0.1
OLINDA	230	37.7	14	26.9	13.9	27	0.1
SANBRDNO	230	50	21.9	38	21.8	38.1	0.1
SERRANO	230	63	23.5	51.6	23.5	51.7	0.1
VISTA	230	40	19.8	45.4	19.8	45.6	0.2
BLYTHESC	161	31.5	12.4	19.6	12.6	19.8	0.2
DEVERS	115	23	46	24.1	46.3	24.2	0.1
VALLEY A	115	0	53.4	17.6	53.3	17.7	0.1
VALLEY C	115	0	50.6	17.6	50.5	17.7	0.1

Single Line to Ground Short Circuit

Evaluate the need for circuit breaker replacement at 11 bulk power substations.

		Min	PRE CASE		POST CASE		
Bus Name	Bus KV	Rating	X/R	KA	X/R	KA	DELTA KA
Barre	230	45.6	13.1	42.4	13.1	42.5	0.1
Blythe	161	31.5	12.3	19.7	12.3	20	0.3
Chino	230	50	12.8	38.9	12.7	39	0.1

Devers	230	33	16.2	46	16.3	46.8	0.8
Lewis	230	45.6	15.4	39.1	15.4	39.2	0.1
Mira Loma	525	38.4	14.8	30.1	14.8	30.2	0.1
Mira Loma B	230	63	12.7	55	12.7	55.1	0.1
San Ber'dino	230	50	19.2	40.3	19.2	40.4	0.1
Serrano	525	40	13.9	25.2	13.9	25.3	0.1
Vincent A	230	63	15.8	49.2	15.8	49.3	0.1
Vista	230	40	13.6	39.7	13.6	39.8	0.1

APPENDIX 1

N-1 CONTINGENCIES

line MOENKOPI to ELDORDO 500 ck 1
line HARQUAHA to DEVERS 500 ck 2
line MERCHANT to ELDORDO 230 ck 1
line MERCHANT to ELDORDO 230 ck 2
line MEAD S to ELDORDO 230 ck 1
line MEAD S to ELDORDO 230 ck 2
line BLYTHE to BLYTHESC 161 ck 1
line PARKER to GENE 230 ck 1
line COACHELV to DEVERS 230 ck 1
line COACHELV to DEVERS 230 ck 1
line RAMON to MIRAGE 230 ck 1
line RAMON to MIRAGE 230 ck 1
line BLYTHESC to EAGLEMTN 161 ck 1
line CAMINO to MEAD S 230 ck E
line CAMINO to MEAD S 230 ck W
line CAMINO to GENE 230 ck 1
line CENTER S to MESA CAL 230 ck 1
line ETIWANDA to SANBRDNO 230 ck 1
line ETIWANDA to VSTA 230 ck 1
line ETIWANDA to MIRALOME 230 ck 1
line LUGO to MIRALOMA 500 ck 3
line LUGO to MOHAVE 500 ck 1
line LUGO to SERRANO 500 ck 1
line LUGO to VINCENT 500 ck 1
line LUGO to VINCENT 500 ck 2
line MIRALOMW to VSTA 230 ck 1
line MOHAVE to ELDORDO 500 ck 1
line SANBRDNO to DEVERS 230 ck 1
line SANBRDNO to DEVERS 230 ck 1A
line DEVERS to VALLEYSC 500 ck 1
line DEVERS to SANBRDNO 230 ck 2
line DEVERS to SANBRDNO 230 ck 2A
line DEVERS to MIRAGE 230 ck 1
line DEVERS to VSTA 230 ck 2
line DEVERS to VSTA 230 ck 2A
line DEVERS to EISENHOW 115 ck 1
line VSTA to DEVERS 230 ck 1
line VSTA to DEVERS 230 ck 1A
line EAGLEMTN to IRON MTN 230 ck 1
line IRON MTN to CAMINO 230 ck 1

line MNTVIEW to SANBRDNO 230 ck 1
line MNTVIEW to SANBRDNO 230 ck 2
line PALOVRDE to DEVERS 500 ck 1
line MIDPINTS to DEVERS 500 ck 1 & PALOVRDE to MIDPINTS
line PALOVRDE to MIDPINTS 500 ck 1
line BUCK230 to J.HINDS 230 ck 1
line MIDPINTS to DEVERS 500 ck 1
tran CAMINO 230 to CAMINO 66 ck 1
tran ETIWANDA 230 to ETIWAN7A 66 ck 7
tran ETIWANDA 230 to ETIWANDA 66 ck 5
tran ETIWANDA 230 to ETIWANDA 66 ck 6
tran ETIWANDA 230 to ETIWANDA 66 ck 7
tran SANBRDNO 230 to SANBRDNO 66 ck 1
tran SANBRDNO 230 to SANBRDNO 66 ck 2
tran SANBRDNO 230 to SANBRDNO 66 ck 3
tran SANBRDNO 230 to P120_A 230 ck 1
tran SANBRDNO 230 to P120_B 230 ck 1
tran SANBRDNO 230 to P120_C 230 ck 1
tran VSTA 230 to VSTA 66 ck 1
tran VSTA 230 to VSTA 66 ck 2
tran VSTA 230 to VSTA 66 ck 3
tran VSTA 230 to VSTA 66 ck 4
tran VSTA 230 to VSTA 115 ck 5
tran VSTA 230 to VSTA 115 ck 6
tran EAGLEMTN 230 to EAGLEMTN 161 ck 1
tran EAGLEMTN 230 to EAGLEMTN 66 ck 4
tran GENE 230 to GENE69 N 69 ck 2
tran GENE 230 to GENE69 S 69 ck 1
line MEAD S to ELDORDO 230 ck 1
line MEAD S to ELDORDO 230 ck 2
line BLYTHE to BUCKBLVD 161 ck 1
line BUCK230 to J.HINDS 230 ck 1
line BUCK161 to BUCKPS2 161 ck 1 MIDPINTS 500 to BUCKPS2 161 ck 1
line BLYTHE to BUCK161 161 ck 1
tran BUCKBLVD 161 to BLYENG1 16 ck 1
tran BUCKBLVD 161 to BLYENG2 16 ck 1
tran BUCKBLVD 161 to BLYENG3 16 ck 1
tran BLY500 500 to BUCKBLVD 161 ck 1
tran BUCK161 161 to BLY2CT2 16 ck 1
tran BUCK230 230 to BUCKPS1 161 ck 1&tran BUCK161 161 to BUCKPS1 161 ck 1

line J.HINDS to MIRAGE 230 ck 1
line J.HINDS to EAGLEMTN 230 ck 1
line MIDWAY to VINCENT 500 ck 1

tran BUCK161 161 to BLY2ST1 16 ck 1
tran BUCK161 161 to BLY2CT1 16 ck 1
line IRON MTN 230.00 to CAMINO 230.00

N-2 CONTINGENCIES

"line outage 1"
from DEVERS 230.00 to SANBRDNO 230.00 & from ETIWANDA 230.00 to SANBRDNO 230.00

"line outage 2"
from DEVERS 230.00 to VSTA 230.00 & from ETIWANDA 230.00 to SANBRDNO 230.00

"line outage 3"
from ETIWANDA 230.00 to SANBRDNO 230.00 & from SANBRDNO 230.00 to DEVERS 230.00

"line outage 4"
from ETIWANDA 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to SANBRDNO 230.00

"line outage 5"
from ETIWANDA 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 6"
from VSTA 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 7"
from SANBRDNO 230.00 to DEVERS 230.00 & from VSTA 230.00 to SANBRDNO 230.00

"line outage 8"
from DEVERS 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to SANBRDNO 230.00

"line outage 9"
from DEVERS 230.00 to VSTA 230.00 & from VSTA 230.00 to SANBRDNO 230.00

"line outage 10"
from DEVERS 230.00 to SANBRDNO 230.00 & from DEVERS 230.00 to VSTA 230.00

"line outage 11"

from DEVERS 230.00 to SANBRDNO 230.00 & from SANBRDNO 230.00 to DEVERS 230.00

"line outage 12"
from DEVERS 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 13"
from DEVERS 230.00 to VSTA 230.00 & from SANBRDNO 230.00 to DEVERS 230.00

"line outage 14"
from DEVERS 230.00 to VSTA 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 15"
from SANBRDNO 230.00 to DEVERS 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 16"
from DEVERS 230.00 to MIRAGE 230.00 & from RAMON 230.00 to MIRAGE 230.00

line_17 "line outage 17"
from DEVERS 230.00 to MIRAGE 230.00 & from COACHELV 230.00 to DEVERS 230.00

"line outage 18"
from DEVERS 230.00 to MIRAGE 230.00 & & from J.HINDS 230.00 to MIRAGE 230.

"line outage 19"
from KRAMER 230.00 to COLWATER 230.00 & & from KRAMER 230.00 to COLWATER 230.

line_20 "line outage 20"
from KRAMER 230.00 to LUGO 230.00 & & from KRAMER 230.00 to LUGO 230.

"line outage 21"
from KRAMER 230.00 to LUGO 230.00 & & from VICTOR 230.00 to LUGO 230.

"line outage 22"
from LUGO 500.00 to VINCENT 500.00 & from LUGO 500.00 to VINCENT 500.00

"line outage 23"
from MIDWAY 500.00 to VINCENT 500.00 & from MIDWAY 500.00 to VINCENT 500.00

"line outage 24"
from DEVERS 500.00 to VALLEYSC 500.00 & from MIDPINTS 500.00 to DEVERS 500.00

"line outage 25"
from DEVERS 500.00 to VALLEYSC 500.00 & from DEVERS 500.00 to DEVERS 230.00

"line outage 26"
from MIDPINTS 500.00 to DEVERS 500.00 & from DEVERS 500.00 to DEVERS 230.00

"line outage 27"
from VSTA 230.00 to DEVERS 230.00 & from COACHELV 230.00 to DEVERS 230.00

"line outage 28"
from DEVERS 230.00 to VSTA 230.00 & from SANBRDNO 230.00 to DEVERS 230.00

"line outage 29"
from LUGO 500.00 to MIRALOMA 500.00 & from LUGO 500.00 to MOHAVE 500.00

"line outage 30"
from ELDORDO 500.00 to LUGO 500.00 & from LUGO 500.00 to MIRALOMA 500.00

"line outage 31"
from LUGO 500.00 to SERRANO 500.00 & from LUGO 500.00 to VINCENT 500.00

"line outage 32"
from LUGO 500.00 to VINCENT 500.00 & from LUGO 500.00 to VICTORVL 500.00

"line outage 33"
from DEVERS 230.00 to SANBRDNO 230.00 & from ETIWANDA 230.00 to SANBRDNO 230.00

"line outage 34"

from DEVERS 230.00 to VSTA 230.00 & from ETIWANDA 230.00 to SANBRDNO 230.00

"line outage 35"
from ETIWANDA 230.00 to SANBRDNO 230.00 & from SANBRDNO 230.00 to DEVERS 230.00

"line outage 36"
from ETIWANDA 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to SANBRDNO 230.00

"line outage 37"
from ETIWANDA 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 38"
from VSTA 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 39"
from SANBRDNO 230.00 to DEVERS 230.00 & from VSTA 230.00 to SANBRDNO 230.00

"line outage 40"
from DEVERS 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to SANBRDNO 230.00

"line outage 41"
from DEVERS 230.00 to VSTA 230.00 & from VSTA 230.00 to SANBRDNO 230.00

"line outage 42"
from DEVERS 230.00 to SANBRDNO 230.00 & from DEVERS 230.00 to VSTA 230.00

"line outage 43"
from DEVERS 230.00 to SANBRDNO 230.00 & from SANBRDNO 230.00 to DEVERS 230.00

"line outage 44"
from DEVERS 230.00 to SANBRDNO 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 45"
from DEVERS 230.00 to VSTA 230.00 & from SANBRDNO 230.00 to DEVERS 230.00

"line outage 46"
from DEVERS 230.00 to VSTA 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 47"
from SANBRDNO 230.00 to DEVERS 230.00 & from VSTA 230.00 to DEVERS 230.00

"line outage 48"
from DEVERS 230.00 to MIRAGE 230.00 & from COACHELV 230.00 to DEVERS 230.00

l"line outage 49"
from DEVERS 230.00 to MIRAGE 230.00 & from RAMON 230.00 to MIRAGE 230.00

ONE-LINE DIAGRAMS

POWER FLOW TABLE OF RESULTS

POWER FLOW PLOT FILES

TRANSIENT STABILITY PLOTS