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ORIGINAL

Our File Number 43431-00001

January 30, 2006

VIA HAND DELIVERY

Arizona Corporation Commission
Docket Control – Utilities Division
1200 W. Washington Street
Phoenix, Arizona

Re: Southern California Edison – Ten Year Plan
Docket No: E-00000D-05-0040

Attached for filing in the above docket is the original and thirteen (13) copies of Southern California Edison Company's 2006-2015 Ten-Year Plan.

Very truly yours,

LEWIS AND ROCA LLP

Thomas H. Campbell
Attorneys for Southern California Edison Company

THC/bjg
Attachments

cc: Michael Mackness (w/encs.)

SOUTHERN CALIFORNIA EDISON COMPANY

2006-2015

TEN-YEAR PLAN

Prepared for the

Arizona Corporation Commission

January 2006

SOUTHERN CALIFORNIA EDISON COMPANY
2006-2015
TEN-YEAR PLAN

General Information

Pursuant to A.R.S. § 40-360.02, Southern California Edison ("SCE") submits its 2006-2015 Ten-Year Plan ("Plan") to the Arizona Corporation Commission ("Commission"). The attached Plan (contained in Attachment A) describes planned transmission facilities of 115 kV or higher voltage that SCE may construct in Arizona over the next ten-year period. Pursuant to A.R.S. § 40-360(1), underground facilities are not included.

This Plan provides tentative information that, pursuant to A.R.S. § 40-360.02(F), is subject to change at the discretion of SCE without notice based on land usage, growth pattern changes, regulatory or legal developments, or for other reasons. At this time, SCE plans to go forward with two projects: (1) the Series Capacitor Upgrade Project (2006) ("Series Capacitor I"); and, (2) the Devers-Palo Verde No. 2 (2009) ("DPV2"). However, SCE cannot be certain that it is going forward with the third project described in the Plan, the Series Capacitor Upgrade Project (2010) ("Series Capacitor II"). SCE will need to perform the technical studies and economic analyses to cost-justify and design the third project. Series Capacitor I and DPV2 were approved in 2004 and last year, respectively, by the California Independent System Operator, the Western Arizona Transmission System Group, and the Western Electricity Coordinating Council. Series Capacitor II described in the Plan will be analyzed in several stakeholder processes, including those before the California Independent System Operator's Southwest Transmission Expansion Plan process, the Western Arizona Transmission System process, and the Western Electricity Coordinating Council Regional Planning Process. Series Capacitor I and DPV2 described in Attachment A must be coordinated with other utilities that own or have rights on the existing Devers-Palo Verde 500 kilovolt transmission line.

As the Commission is aware, transmission projects are complex and many issues will need to be resolved. Regulatory requirements, changes in underlying assumptions such as generation expansion, and other utilities' plans, may substantially impact the Plan, and could result in changes to anticipated in-service dates and project scopes.

The three maps (shown as Diagrams 1, 2 and 3) attached to this report provide a general illustration of line routing. They are general maps and subject to revision. Specific routing will be determined by the Arizona Power Plant and Transmission Line Siting Committee and the Arizona Corporation Commission when issuing a Certificate of Environmental Compatibility and through subsequent right-of-way acquisition.

Different levels of certainty are associated with the projects in SCE's Plan. Series Capacitor I, currently in the engineering and construction stage, involves SCE's joint participation in upgrading series capacitors in two 500 kV lines interconnecting Arizona, Southern Nevada, and Southern California (defined as the East of the River path or Path 49), scheduled for operation in 2006. SCE will be upgrading the existing Devers-Palo Verde 500 kV line. The final design of the project may not require changes to transmission lines, towers, or poles, but SCE has included the project in this filing in case that assumption is incorrect.

DPV2 will be a second 500 kV transmission line between SCE's existing Devers Substation (near Palm Springs) to the Harquahala Generating Station switchyard (west of Phoenix, Arizona), tentatively scheduled for operation in 2009. Further project planning may result in SCE extending the proposed line 15 miles further east to terminate in the Palo Verde/Hassayampa area. Although SCE's plans to build the DPV2 line are firm, SCE must still obtain licensing approvals from the California Public Utilities Commission and the Arizona Corporation Commission.

The more tentative project is Series Capacitor II, which involves SCE upgrading series capacitors in the Moenkopi-Eldorado 500 kV line. This operating date of this project is expected to be after operation of the new DPV2 line in 2010. The final design of the project may not require changes to transmission lines, towers, or poles, but SCE has included the project in this filing in case that assumption is incorrect.

Again, finalizing SCE's commitment to proceed with these three projects will depend on the location of future power generation development, continued customer load growth at currently forecast levels, economic transmission congestion relief, coordination with other transmission owners, and regulatory actions.

Pursuant to A.R.S. § 40-360.02(c)(7), where available the submitted Plan should also include technical study results and power flow stability analyses showing the effect in the current Arizona electric transmission system for the project identified. The available studies that have been performed are provided in Attachment B (WECC Accepted Path Rating Study - Southwest Power Link and Palo Verde – Devers 500 kV Series Capacitor Upgrade Project – Final Report) and Attachment C (Devers-Palo Verde No. 2 Project – Accepted Path 49 Rating Study Report). More technical details that support these narrative reports are available by contacting SCE. Written descriptions of each of the proposed transmission projects are provided in Attachment A.

ATTACHMENT A

SOUTHERN CALIFORNIA EDISON COMPANY
2006-2015
TEN-YEAR PLAN

Planned Transmission Project Descriptions

SOUTHERN CALIFORNIA EDISON COMPANY
2006-2015
TEN-YEAR PLAN
2006

Line Description	Series Capacitor Upgrade Project SCE's Participation: Palo Verde-Devers 500 kV line
Size	
a) Voltage	500 kV AC
b) Capacity	252.5 MW
c) Point of Origin	Palo Verde Switchyard
d) Intermediate Point	None
e) Point of Termination	Devers Substation
f) Length	N/A
Routing	The upgraded series capacitors will replace the existing series capacitors in the SCE's 500 kV line without a change of location.
Purpose	The upgrading of the series capacitors allows for the increase in transfer capability among Arizona, Southern Nevada and Southern California and has an economic value from an adequacy stand point.
Date	
a) Construction Start	2005
b) Estimated In-Service	2006

SOUTHERN CALIFORNIA EDISON COMPANY
2006-2015
TEN-YEAR PLAN
2009

Line Description	Devers-Palo Verde No. 2
Size	
a) Voltage	500 kV AC
b) Capacity	1200 MW
c) Point of Origin	Harquahala Substation
d) Intermediate Point	None
e) Point of Termination	Devers Substation
f) Length	230 miles (104 miles in Arizona and 126 miles in California)
Routing	The proposed line route between Devers and Harquahala parallels SCE's existing Palo Verde-Devers 500 kV line. Twenty miles of new right of way acquisition is required, assuming the existing BLM right of way is still available to SCE for the remaining 210 miles of the line route.
Purpose	This 500 kV line will increase transfer capability between Arizona and Southern California.
Date	
a) Construction Start	2007
b) Estimated In-Service	2009

SOUTHERN CALIFORNIA EDISON COMPANY
2006-2015
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2010

Line Description	Series Capacitor Upgrade Project SCE's Participation With APS: Moenkopi-Eldorado 500 kV line
Size g) Voltage h) Capacity i) Point of Origin j) Intermediate Point k) Point of Termination l) Length	 500 kV AC to be determined Moenkopi Substation None Eldorado Substation N/A
Routing	The upgraded series capacitors will replace the existing series capacitors in the SCE's 500 kV lines without a change of location.
Purpose	The upgrading of the series capacitors allows for the increase in transfer capability among Arizona, Southern Nevada and Southern California and has an economic value from an adequacy stand point.
Date c) Construction Start d) Estimated In-Service	 2009 2010

Diagram 1
Series Capacitor Upgrade Project (2006)

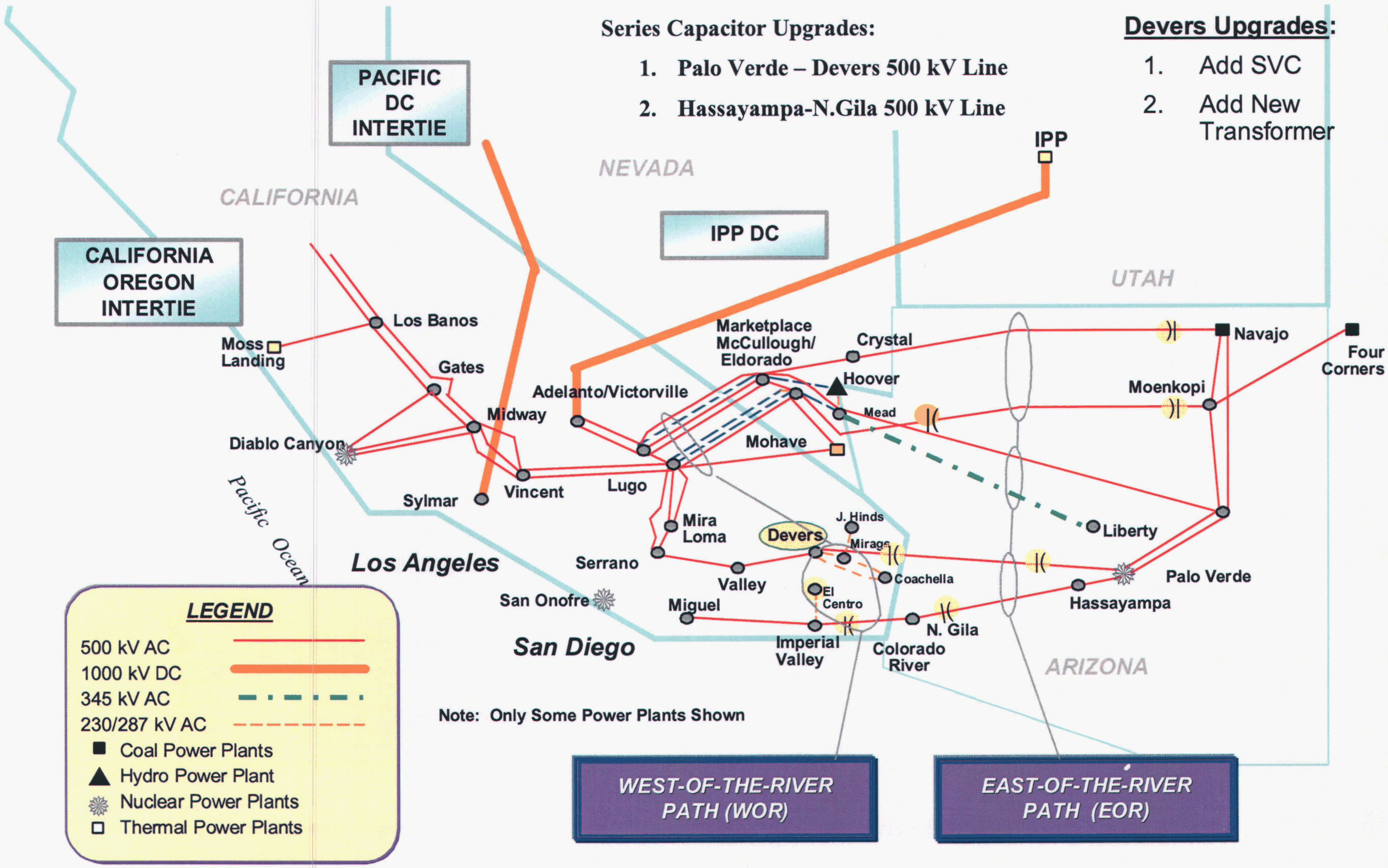
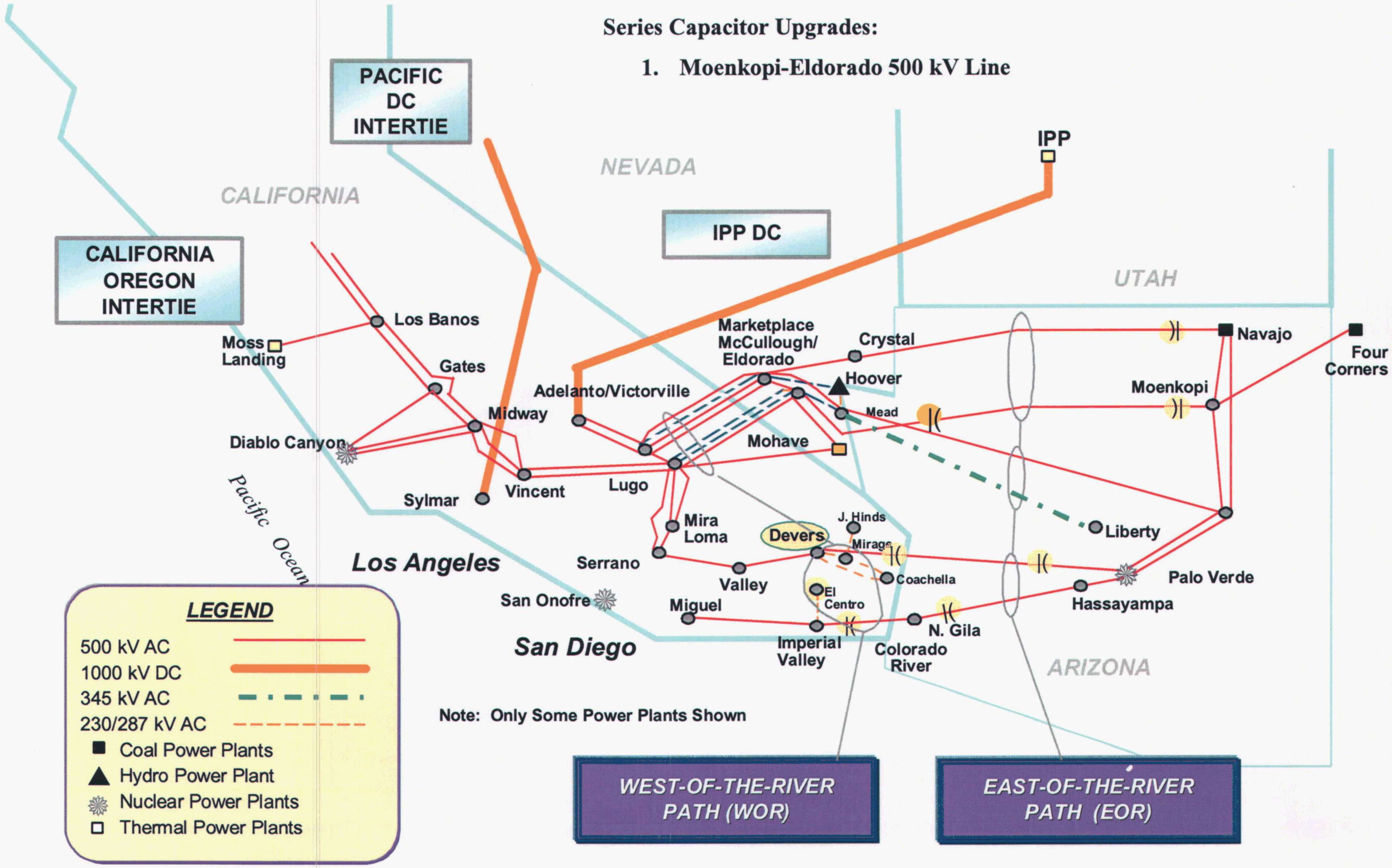


Diagram 2
Devers – Palo Verde No. 2 (2009)

Diagram 3
Series Capacitor Upgrade Project (2010)



ATTACHMENT B

SOUTHERN CALIFORNIA EDISON COMPANY
2006-2015
TEN-YEAR PLAN

WECC Accepted Path Rating Study
Southwest Power Link and Palo Verde – Devers 500 kV Series Capacitor Upgrade Project
Final Report

WECC Accepted Path Rating Study

Southwest Power Link and Palo Verde – Devers 500 kV Series Capacitor Upgrade Project

Increasing the East of River Path (Path 49) rating from 7550 MW to 8,055 MW

Final Report
December 2, 2004

Approved by the WECC Peer Review Group and Western Arizona Transmission System (WATS) Task Force on November 30, 2004

Executive Summary

The East of River (EOR) path, WECC Path 49, consists of five 500 kV lines and one 345 kV line. The present non-simultaneous east to west rating is 7,550 MW. The six transmission lines connect the EHV system in Arizona with the EHV system in southern Nevada and southern California. Recent generation development in Arizona, in particular in the vicinity of the Palo Verde Nuclear Generating Station, has caused the southern EOR system (the Palo Verde – Devers and Hassayampa – North Gila 500 kV lines) to experience substantial congestion over the last few years. Unless system upgrades take place, this congestion is expected to increase further as the need to import power from new reliable sources into California grows.

This project proposes to replace the existing series capacitors on the Palo Verde – Devers and Hassayampa – North Gila – Imperial Valley 500 kV lines with series capacitors with higher thermal ratings. Also a second 500/230 kV transformer bank is needed at Devers Substation and a 230/230 kV phase-shifter to control the flow on the Imperial Valley – El Centro 230 kV line is part of this project. One 400 MVAR Static Var Compensator (SVC) will be added to support the simultaneous increase of EOR flow and import to Southern California (SCIT). A detailed list of the Plan of Service can be found in Section 2.B.

In response to the need for increased transfer capability on the two southern EOR lines, San Diego Gas and Electric (SDG&E) submitted on behalf on Sempra Energy Resources (SER) a consolidated initial project announcement and a comprehensive progress report to WECC to increase the rating of WECC Path 49 on March 28, 2003. The upgrade of the two southern EOR lines was also identified in the regional stakeholder forum called "STEP" (Southwest Transmission Expansion Plan) and is referred to in that forum as the "Short Term Upgrade". All the necessary upgrades are located within the fences of existing substations. The planned in-service date of this project is June 1, 2006.

The studies performed in this report concluded that the rating of the East of River interface can be increased by 505 MW from 7,550 MW to 8,055 MW with the Plan of Service as outlined in this report and meet the NERC/WECC Planning Standards. In addition, the voltage support devices added as part of the project enable the Southern California Import Transmission (SCIT) system limit to be increased by 505 MW as well based on the studies described in this report. No negative impact on any other WECC path from the increased flow on EOR was identified in the studies.

Since the Palo Verde – Devers and Imperial Valley – North Gila 500 kV lines are part of West of River (WOR), it is expected that a WOR rating study will be performed to match the increase of the EOR upgrade, or a curtailment procedure shall be implemented to ensure safe operation of the WOR.

It is expected that the WECC Review Group/WATS approved version of this report will enable the project to enter Phase III of the WECC path rating process.

Appendix D	Powerflow Diagrams and Study Results for EOR/SCIT Simultaneous Cases, High Inertia (Mohave off)
Appendix E	EOR/SCIT Sensitivity Study with maximum EOR flow
Appendix F	EOR/Palo Verde Transmission System (PVTS)
Appendix G	EOR/Valley Voltage
Appendix H	EOR/G-2 of SONGS
Appendix I.1	EOR/Path 26 Sensitivity, COI at 4,800 MW and Path 15 at 2,200 MW
Appendix I.2	EOR/Path 26 Sensitivity, COI at 4,400 MW and Path 15 at 3,250 MW
Appendix J	List of Study Participants

1. CONCLUSIONS

- Non-simultaneous studies performed with the EOR path modeled at 8,055 MW did not identify any element with loading above it's applicable rating during conditions with all lines in service or with a single element or a credible double element out of service.

- The status of the Mohave Generating Station (1580 MW) does not impact 8,055 MW as a new EOR path rating.

- The non-simultaneous studies demonstrate that all applicable voltage criteria including transient stability and post-transient voltage stability (reactive margin and voltage deviation) are met with the EOR path modeled at 8,055 MW.

- The existing interaction between East of River and the Southern California Import Transmission (SCIT) system was analyzed as part of this study. Various scenarios with different inertia levels in Southern California and with different scheduling of the proposed 505 MW increase in EOR and SCIT together with the Mohave Generating Station being on/off are described in this report. The studies demonstrated that with the voltage support equipment as outlined in the Plan of Service, SCIT can be increased by the same amount as EOR, by 505 MW.

- Transient stability studies performed as part of the EOR/SCIT simultaneous studies identified the Welton Mohawk 161 kV bus in the Yuma area as experiencing the highest first swing voltage dip with the Project in service. Historically, as well as in the pre-project cases, the buses with the highest voltage dip have been located around Devers/Valley Substations.

- The addition of the dynamic voltage support devices at Devers and Valley Substations serve a dual purpose; to mitigate transient voltage dip at Devers and Valley Substations and to provide dynamic reactive support in the post transient timeframe to sustain the loss of major elements in the system, like the loss of Serrano – Valley 500 kV line, a two unit outage of the San Onofre Nuclear Generating Station or loss of the Imperial Valley – Miguel 500 kV line with subsequent generation tripping and cross tripping of the La Rosita – Imperial Valley 230 kV line. The shunt capacitors at the Valley 500 kV bus are needed to provide reactive support to the system during normal operations during times with high load or high imports.

- All non-simultaneous and EOR/SCIT simultaneous studies performed demonstrated that the system retains angular stability after the loss of the major outlet lines from Palo Verde Nuclear Generating Station and the Navajo Generating Station with a 7% unit margin applied to each plant.

- Several sensitivity studies as specifically requested by the WECC Review Group/Western Arizona Transmission System ("WATS") were performed as part of this study. None of the sensitivity studies identified any negative impacts on the system studied. Also, no simultaneous interaction with other paths other than SCIT was identified.

2. INTRODUCTION

2.A Introduction

East of River (EOR) or WECC Path 49 currently consists of six transmission lines:

Navajo – Crystal 500 kV (metered at Navajo)
Moenkopi – Eldorado 500 kV (metered at Eldorado)
Liberty – Mead 345 kV (metered at Liberty)
Perkins – Mead 500 kV (metered at Perkins)
Palo Verde – Devers 500 kV (metered at Palo Verde)
Hassayampa – North Gila 500 kV (metered at Hassayampa)

The present east to west, non-simultaneous EOR rating is 7,550 MW. This rating is based on normal system conditions, all lines in service and full series compensation as outlined in the 2004 Arizona Security Monitoring Manual. The current 7,550 MW limit is due to the continuous rating of the series capacitors on the Palo Verde – Devers and the Hassayampa – North Gila 500 kV lines. Also, various line outages may result in loadings of close to 100% of applicable emergency ratings on several EOR lines in addition to the 500/230 kV transformer at Devers Substation.

Given the current constraints in the EOR interface and the recent development of new generation in Eastern Arizona, the two southern 500 kV lines (Palo Verde – Devers and Hassayampa – North Gila) have experienced significant congestion that is projected to increase during the next few years unless system upgrades take place. Technical and economic studies performed have shown that an upgrade of the Palo Verde – Devers and the Hassayampa – North Gila – Imperial Valley 500 kV lines provides substantial technical and economic benefits[1].

On March 28, 2003, San Diego Gas and Electric (SDG&E) submitted on behalf on Sempra Energy Resources (SER) a consolidated initial project announcement and a comprehensive progress report to WECC to upgrade the rating of WECC Path 49. The comprehensive progress report entitled "SWPL & PV – Devers 500 kV Series Capacitor Upgrade Transfer Capability Study" proposed to increase the path rating by 760 MW to 8,310 MW through various series capacitor upgrades and substation additions. SDG&E also initiated the WECC Review Group process pursuant to the WECC document "Procedures For Regional

[1] For more information related to the economic benefits of upgrading the EOR system see the "2003 Status Report for the Southwest Transmission Expansion Plan (STEP)" posted on the California ISO's website at http://www2.caiso.com/docs/2004/03/08/2004030814004810105.doc

Planning Project Review and Rating Transmission Facilities", issued in December 2001 and revised on 5-21-02. The WECC accepted the Path 49 Regional Planning Report on May 19, 2004.

The WECC Path 49 Review Group and the Western Arizona Transmission System (WATS) have conducted joint meetings with the kick-off meeting taking place in San Diego on May 16, 2003. On June 24, 2004, the sponsorship of the upgrades was transferred from SER to the California ISO. Formal Phase 2 status for the project was granted by WECC on October 18, 2004.

Through various study work performed after March 28, 2003 as part of the Review Group process, the scope of the facilities needed to upgrade EOR was modified and the proposed increase was reduced from 760 MW to 505 MW. The upgrade of the series capacitor at Navajo on the Navajo – Crystal 500 kV line was found to be not needed, and the emergency rating on the Perkins – Mead 500 kV series capacitors limited the new rating to 8,055 MW for the outage of the Palo Verde – Devers 500 kV line.

2.B Plan of Service

The increased rating of the East of the River interface from 7,550 MW to 8,055 MW includes the following upgrades to the system:

- Increase the current carrying capability of the series capacitors on the Hassayampa – North Gila – Imperial Valley 500 kV line to 2200 A normal with 135% overload capability.

- Increase the current carrying capability of the series capacitors on the Palo Verde - Devers 500 kV line to 2700 A normal with 135% overload capability.

- Install a second 1120 MVA 500/230 kV transformer at Devers Substation.

- Install a 300 MVA 230/230 kV phase-shifting transformer at Imperial Valley Substation. This phase-shifter will be used to control the flow on the Imperial Valley – El Centro 230 kV line.

- Install a 400 MVAR Static Var Compensator (SVC) at Devers 500 kV Substation.

The California ISO Board of Governors approved these upgrades on June 24, 2004. The projected in-service date is June 1, 2006.

2.C Voltage support at Valley

To meet the NERC/WECC reliability criteria, SCE will install the following equipment at Valley Substation:

- Install 2 x 100 MVAR Static Var Compensators (SVC's) at Valley 115 kV Substation.

- Install 2 x 150 MVAR shunt capacitors at Valley 500 kV Substation

The planned in-service date for the Valley voltage support project is May 2006.

The purpose of the installation of the voltage support equipment at Valley and Devers Substations is two-fold; to mitigate the transient voltage dip in the Devers/Valley area for loss of the Hassayampa – North Gila 500 kV line and to provide additional voltage support at Valley Substation during conditions with heavy loads and/or high import to Southern California.

2.C Geographic Map of Major Transmission Lines in the Southwest

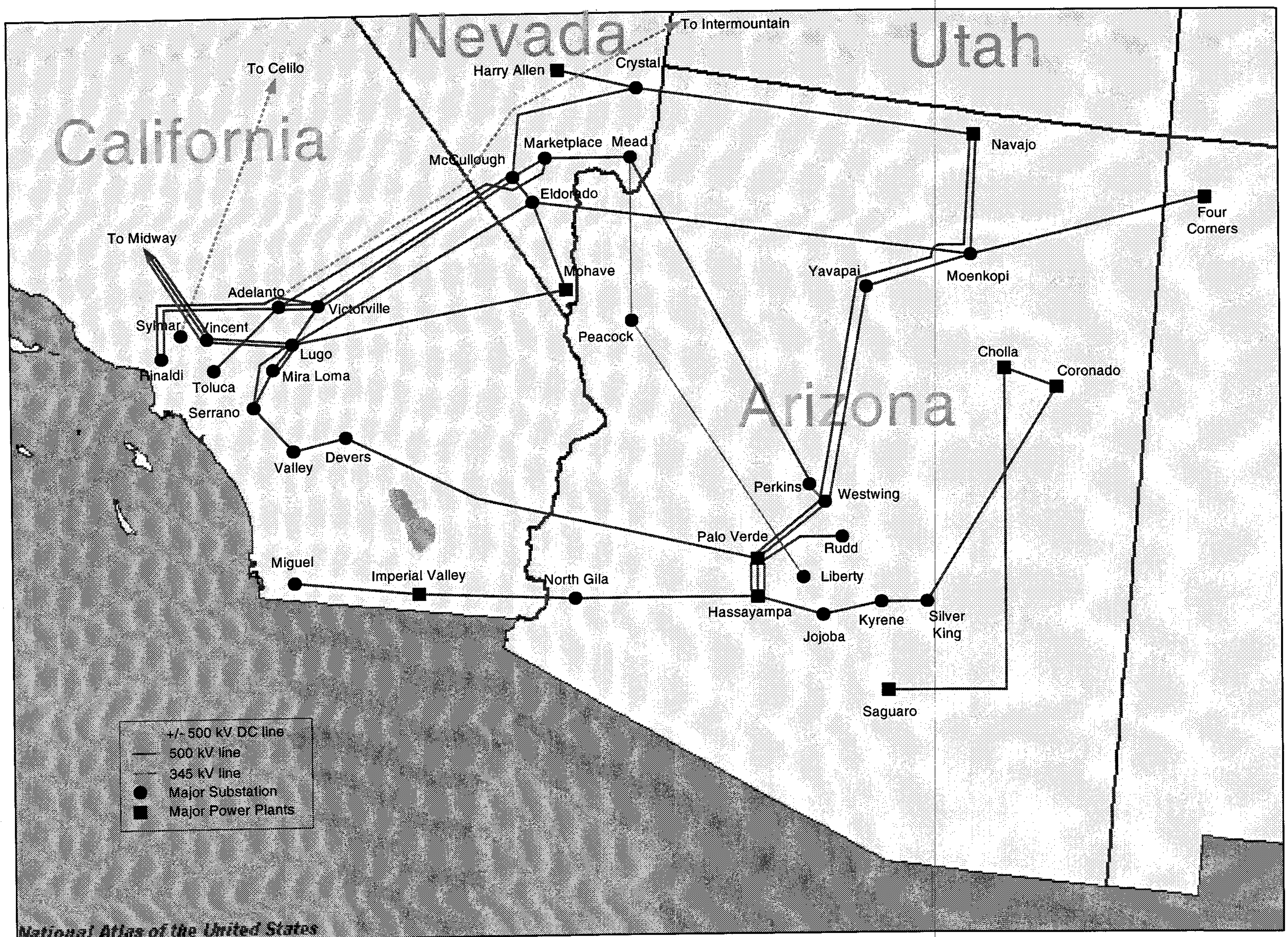


Figure 4; Geographic map of major transmission lines in the Southwest

2.D One Line Diagram of East and West of Colorado River Interfaces

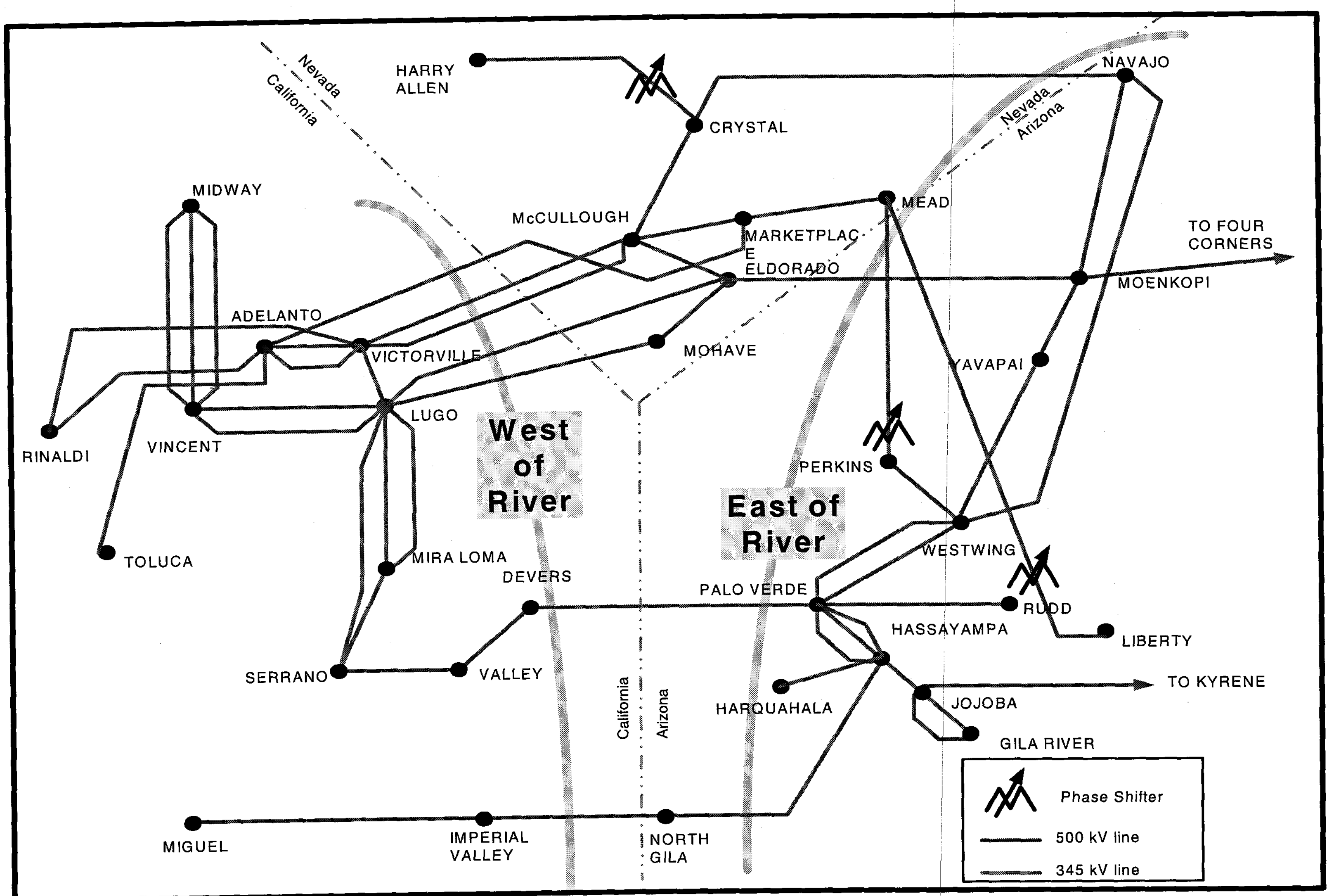


Figure 5; Map of 500 and 345 kV lines - East and West of River

3. STUDY OBJECTIVES

The objective of the study is to demonstrate that the rating of EOR can be increased from 7,550 MW to 8,055 MW and meet all applicable WECC/NERC Planning Standards. To achieve this increment of 505 MW, the Plan of Service as listed in 2.A is assumed. Technical assessment will be performed through powerflow, transient stability, and post-transient voltage stability analyses. The study effort will culminate in an Accepted Rating Report for submission to WECC Planning Coordination Committee giving the project WECC Phase 3 status.

4. STUDY CRITERIA AND STUDY ASSUMPTIONS

4.A Study Criteria

Powerflow

1. All line and transformer loadings must be below normal continuous ratings under pre-contingency conditions. For a single contingency, no transmission element will be loaded above its emergency rating.
2. Pre-disturbance bus voltages must be maintained between 0.95 p.u. and 1.05 p.u. and voltages for the major 500 kV buses in the Southwest cannot exceed 1.09 p.u.
3. The net VAR flow interchange with each interconnected utility shall be within limits established by the transmission owners.
4. Bus voltage deviations during contingency conditions shall not exceed 5% for single contingencies and 10% for double contingencies unless approved by the utility.

Transient Stability and Post Transient Voltage Deviation

1. Transient stability performance criteria are included in the WECC Standards. They are briefly summarized in the following table.

WECC DISTURBANCE-PERFORMANCE TABLE OF ALLOWABLE EFFECTS ON OTHER SYSTEMS

NERC and WECC Categories	Outage Frequency Associated with the Performance Category (outage/year)	Transient Voltage Dip Standard	Minimum Transient Frequency Standard	Post Transient Voltage Deviation Standard (See Note 2)
A	Not Applicable	Nothing in addition to NERC		
B	≥ 0.33	Not to exceed **25%** at load buses or **30%** at non-load buses. Not to exceed **20% for more than 20 cycles** at load buses.	Not below **59.6** Hz for 6 cycles or more at a load bus.	Not to exceed **5%** at any bus.
C	0.033 – 0.33	Not to exceed **30%** at any bus. Not to exceed **20% for more than 40 cycles** at load buses.	Not below **59.0** Hz for 6 cycles or more at a load bus.	Not to exceed **10%** at any bus.
D	< 0.033	Nothing in addition to NERC		

2. All machines in the system shall remain in synchronism as demonstrated by their relative rotor angles.
3. System stability is evaluated based on the damping of the relative rotor angles and the damping of the voltage magnitude swings.
4. The transient voltage dip should be maintained above 0.80 p.u. at Adelanto and Sylmar.
5. 7% unit margin should be applied to the Navajo Generating Station and the Palo Verde Nuclear Generating Station to demonstrate angular stability.

Reactive Margin/Post Transient Governor Load Flow

1. To demonstrate conformance with the NERC/WECC Planning Standards, the path flow level should be increased by 5 percent for single contingencies, and increased by 2.5% for double contingencies. Positive reactive margin is required in all cases.
2. For post-transient studies, generating units that cannot respond to low frequency with additional mechanical power will be modeled in the powerflow cases with the base load flag set to "1". This is consistent with WECC's Modeling and Validation Work Group's recommendation.
3. Generator MVAR limits are modeled as a single value for each generator since the reactive power capability curve can not be modeled in the powerflow program.
4. Shunt capacitors (132 MVAR) at Adelanto and Marketplace will be used if the post-transient voltage deviation exceeds 5% at those buses. Although modeled as shunt capacitors, the actual devices are automatically controlled SVC's.
5. Automatic Generation Control (AGC) is assumed to be suspended in the post transient time frame
6. Phase shifters are assumed to hold a fixed angle.
7. Voltage regulating transformers are modeled in the pre-disturbance position except where there is specific information to do otherwise.
8. Switched Shunt Devices: Switched shunts are locked in the pre-disturbance position unless specified by the utility. Note: SCE's Centralized Grid Capacitor Control (CGCC) will be utilized. The control scheme divides the 3000 MVAR of RMR capacitors into four regions, only one capacitor per region is switched on at a time in Sequential, Remote Operation Mode (based on local voltage and Von/Voff switching thresholds).

4.B Study Assumptions

1) Generation assumptions:

a. Mountainview units, connected at SCE's San Bernardino 230 kV Substation were assumed to be online in the cases.
b. Mountain Vista units 3 and 4 connected at SCE's Etiwanda 230 kV Substation were assumed to be offline in this study
c. A total of 6,300 MW of new generation is included in and around the Hassayampa switchyard. The details of the new generation in Arizona are as follows:

Harquahala	6 units 1170 MW
Arlington Valley	3 units 600 MW
Mesquite	6 units 1250 MW
Red Hawk	6 units 1000 MW
Gila River	12 units 2080 MW

d. The following new generation is included near Las Vegas in the Southern Nevada area:

Apex (Mirant) 3 units 550 MW
Bighorn 3 units 570 MW
Silverhawk 3 units 590 MW

e. Palo Verde nuclear units 1 and 2 were assumed to have completed the upgrade of their steam turbine:
   Palo Verde Unit 1: 1,403 MW
   Palo Verde Unit 2: 1,400 MW
   Palo Verde Unit 3: 1,352 MW
f. Both SONGS units are online in this study.
g. Blythe I Generation Project of approximately 520 MW is included.

2) New Transmission Project Assumptions

a. The Centennial Project in Southern Nevada is assumed to be in service.
b. The Miguel-Mission No. 2 230 kV line and the second Miguel 500/230 kV transformer are assumed to be in-service.
c. The third Sylmar 220/230 kV transformer is included.
d. The upgrade of PDCI (1550MW/1550MW) is assumed to have been completed.
e. In the study cases with Mohave offline, the compensation on the Mohave – Lugo 500 kV line was assumed to be 70% (both series capacitors in service). In the scenarios with Mohave online the compensation was modeled at the current level of 26 %.

3) WECC Major Path Flow/Path Rating Assumptions

The transmission paths listed below are the major paths for California. The non-simultaneous rating of each path is listed.

	Transfer Path	Path Rating (MW)
Path 49	EOR	8055
Path 46	WOR	10118
Path 26	M-V	3400(N-S)/3000(S-N)
Path 27	IPPDC	1920
Path 65	PDCI	3100
Path 66	COI	4800(N-S)/3675(S-N)
Path 45	CFE-SDG&E	800 (S-N)/408 (N-S)

4) Updates to the study cases

Numerous updates to the powerflow cases were received from the peer review group during the study process. Two changes had significant impact on the study results as compared to previous studies; the updated impedance on the Navajo – Crystal 500 kV line and the enhanced modeling of the Palo Verde – Devers 500 kV line (a five section line model replaced the old three section line model).

5. NON-SIMULTANEOUS STUDY

5.A Study Methodology

(1) The powerflow base cases and dynamic stability data including the new WECC approved governor models were developed in General Electric PSLF 13.1 format.

(2) For all areas outside the study area (Southern Nevada, Arizona and Southern California), the network topology and loads reflect information provided to WECC by each respective area.

(3) Compliance with the WECC/NERC Planning Standards is required.

A Heavy Autumn (HA) 2006 case was used to perform the non-simultaneous study. Due to the uncertainty surrounding the operational status of the Mohave Generating Station beyond 2005, two post-project scenarios were developed; with and without Mohave online. The pre-project cased modeled the EOR interface at the current path rating of 7,550 MW and the post-project cases modeled EOR at 8,055 MW. This resulted in the following three cases for the non-simultaneous portion of the path rating study:

Case 1:2006 HA pre-project case with Mohave offline
Case 2:2006 HA post-project case with Mohave offline
Case 3:2006 HA post-project case with Mohave online

In Case 3, with Mohave online, the 1,500 MW from Mohave was scheduled to the following entities:

SCE:	500 MW
SDG&E:	95 MW
DWP:	175 MW
NPC:	280 MW
PG&E:	450 MW

It should be noted that this does not reflect the ownership of Mohave. The powerflow cases are "flow based"; specific contracts and unit ownership are not modeled. In the cases with Mohave offline, the compensation on the Mohave – Lugo 500 kV line was set to 70% (35% compensation in each end of the line). 26% compensation was assumed in the scenario with Mohave online.

The generation from Imperial Valley was modeled at a reduced level to achieve the desired flow on the Hassayampa – North Gila 500 kV line; 120 MW of generation was modeled as online in the non-simultaneous cases.

5.B Summary Results Non-Simultaneous Cases

5.B.1 Powerflow

1. No transmission element was loaded above 100% of its continuous rating under base case conditions in the pre or post-project cases. For loss of a single element or loss of a credible double element, no transmission system element was loaded above its applicable emergency rating.

2. The series capacitor on the Hassayampa – North Gila 500 kV line was loaded at 98% of its 30 minute rating for loss of the Palo Verde – Devers 500 kV line and the Palo Verde – Devers 500 kV line was loaded at 93% of its 30 minute rating for loss of the Hassayampa – North Gila 500 kV line in the pre-project case.

3. The following table summarizes the flow distribution between the six EOR lines in the pre and post-project scenarios:

	Pre-Project (Mohave off)	Post-Project (Mohave off)	Post-Project (Mohave on)
Navajo – Crystal 500 kV	1464.6 MW	1497.3 MW	1472.6 MW
Eldorado – Moenkopi 500 kV	1418.7 MW	1454.9 MW	1415.3 MW
Liberty – Mead 345 kV	450.0 MW	450.0 MW	450.4 MW
Perkins – Mead 500 kV	1298.6 MW	1298.4 MW	1300.0 MW
Palo Verde – Devers 500 kV	1649.4 MW	1732.5 MW	1740.8 MW
Hassayampa – North Gila 500 kV	1268.9 MW	1622.3 MW	1676.3 MW

Powerflow diagrams of all EHV lines in the study area can be found in Appendix A.

4. The El Centro 230/161 kV transformer was loaded at 100% of its emergency rating for loss of the North Gila – Imperial Valley 500 kV line in the pre-project case.

5. The thermal limitation in the post-project cases was found to be the 30 minute rating on the series capacitors on the Perkins – Mead 500 kV line for loss of the Palo Verde – Devers 500 kV line.

6. The scenario with Mohave online increased the Palo Verde West flow as compared to the scenario with Mohave offline.

5.B.2 Post Transient Voltage Deviation

1. Bus voltage deviations did not exceed 5 percent of its initial voltage during single contingency conditions or 10 percent during double contingency conditions.

5.B.3 Reactive Margin

1. Positive margins were established following all contingencies applied in the pre and post-project cases. EOR was increased by 5% during single contingency conditions and by 2.5% during double contingency conditions.

2. The reactive margin was measured at four locations as described in the studyplan (Adelanto 500 kV (measured at Victorville 500 kV), Kyrene 230 kV, Pinnacle Peak 230 kV and Iron Mountain 230 kV Substations). The reactive margin was within criteria for each substation for all contingencies applied. Detailed results can be found in Appendix D.7.

5.B.4 Transient

1. All machines in the WECC interconnection remained in synchronism and were well damped. All disturbances met the NERC/WECC transient stability criteria. The SVC's at Devers and Valley Substations were not needed in any of the post-project cases in order to comply with the transient stability criteria.
2. The system retained angular stability after the loss of either the Navajo – Crystal 500 kV line or the Moenkopi – Eldorado 500 kV line with 7% unit margin on the Navajo units (additional 171 MW output). Also, with 7% unit margin on the Palo Verde units (additional 374 MW) the system retained angular stability after the loss of either the Palo Verde – Devers 500 kV line or the Hassayampa – North Gila 500 kV line.

Detailed results can be found in Appendix A.

6. SIMULTANEOUS EOR/SCIT STUDY

6.A Study Methodology

Powerflow cases were developed to assess the impact from the increased East of River flow on the Southern California Import Transmission (SCIT) system. Thermal, post-transient studies (reactive margin and voltage deviation) and transient stability studies were performed to study the relationship between SCIT and a heavily stressed EOR system in the projected 2006 timeframe. The WECC Review Group requested that two sets of scenarios be developed; low and high SCIT inertia.

The following methodology developed by the Review Group was used to stress the EOR and SCIT transmission paths in the simultaneous EOR/SCIT study cases:

1. The scenario with low inertia should have a reduced load level modeled in the study area (off-peak, about 75% of peak load) and the SCIT inertia should be around 75,000 MWS. The study cases with high inertia needs to model anticipated peak load conditions in Arizona, Southern Nevada and Southern California. The SCIT inertia should be around 100,000 MWS in the heavy summer cases.

2. The EOR and SCIT interfaces will be stressed in the pre-project cases to establish the simultaneous EOR/SCIT stability limit. The case that is marginally stable (any further increase in EOR or SCIT will cause a stability violation) will be used as a pre-project benchmark case. The benchmark case needs to meet all applicable reliability criteria.

3. The benchmark case needs to be at or above the SCIT nomogram (no margin) developed in 1996.

4. In the post-project cases, both EOR and SCIT will be increased by the proposed increment in EOR path rating, 505 MW. Additional voltage support will be added until the post-project case meets all applicable reliability criteria.

5. Available generation in the Hassayampa/Palo Verde area will be utilized to increase the EOR and SCIT flow in the post-project cases. Power will be scheduled in two different ways, to SCE/DWP/SDG&E based on a 55/30/15 split and to SCE/SDG&E based on a 85/15 split. The SCE/DWP/SDG&E units have to be located geographically inside Southern California.

6.B. Low Inertia EOR/SCIT Study

6.B.1. Study Assumptions and Methodology to stress EOR and SCIT

The following six cases were developed to perform the low inertia, simultaneous EOR/SCIT study:

1) Pre-project case with Mohave offline.
2) Post-Project with Mohave offline. The 505 MW increase in EOR and SCIT was scheduled to SCE and SDG&E based on a 85/15 split. Generation from Encina (SDG&E), Ormond Beach (SCE) and Alamitos (SCE) were reduced and generation from units connected to the Hassayampa 500 kV switchyard were increased.
3) Post-Project with Mohave offline. The 505 MW increase in EOR and SCIT was scheduled to SCE, DWP and SDG&E based on a 55/30/15 split. Generation from Encina (SDG&E), Ormond Beach (SCE), Alamitos (SCE), Castai (DWP) and Haynes (DWP) were reduced and generation

from units connected to the Hassayampa 500 kV switchyard were increased.

4) Pre-project case with Mohave online.
5) Post-Project with Mohave online. The 505 MW increase in EOR and SCIT was scheduled to SCE and SDG&E based on a 85/15 split. Generation from Encina (SDG&E), Ormond Beach (SCE) and Alamitos (SCE) were reduced and generation from units connected to the Hassayampa 500 kV switchyard were increased.
6) Post-Project with Mohave online, the 505 MW increase in EOR and SCIT was scheduled to SCE, DWP and SDG&E based on a 55/30/15 split. Generation from Encina (SDG&E), Ormond Beach (SCE), Alamitos (SCE), Castai (DWP) and Haynes (DWP) were reduced and generation from units connected to the Hassayampa 500 kV switchyard were increased.

In the scenarios with Mohave online, the 1,500 MW from Mohave was scheduled to the following entities:

SCE:	500 MW
DWP:	300 MW
NPC:	210 MW
PG&E:	490 MW

It should be noted that this does not reflect the ownership of Mohave, the powerflow cases are "flow based"; specific contracts and unit ownership are not modeled. In the cases with Mohave off the compensation on the Mohave – Lugo 500 kV line was set to 70% (35% compensation in each end of the line). 26% compensation was assumed in the scenario with Mohave online.

The following steps were taken to establish the stability limit in the pre-project benchmark study cases:

1) The flow on the Hassayampa – North Gila and Palo Verde – Devers 500 kV lines (PV West) was maximized. Due to the pre-project ratings on the series capacitors on these two lines, the flow could not exceed about 2900 MW (limited by the N-1 rating on Hassayampa – North Gila 500 kV line for loss of Palo Verde – Devers 500 kV line). (The current scheduling limit on Palo Verde West is 2,823 MW).
2) The SCIT paths were increased by removing generating units from SCE's coastal areas and San Diego, replacing internal generation with imports from outside the boundary of SCIT. Powerflow diagrams including flows on various paths and constrained interfaces in addition to the load, generation, and import levels in the study area can be found in Appendix B and C for each scenario.

3) The number of Hassayampa units online was kept at a minimum. Previous Palo Verde Transmission System (PVTS) studies have shown the inertia/reactive support from the Hassayampa/Palo Verde units to impact the EOR/SCIT stability limit. It should be noted that high Palo Verde East flow adds stress to the system. High generation output from the units online at Hassayampa was therefore modeled. (A separate sensitivity study was performed with maximum Palo Verde East flow to assess the impact on the EOR/SCIT stability limit).
4) One of the two Mountainview plants (2 CT's and one ST) was assumed to be offline. Previous studies have shown that the presence of the Mountainview units has a positive impact on the voltage dip in the Devers area, which is the main limitation in the EOR/SCIT nomogram. The Mountainview plant will connect to SCE's San Bernardino 230 kV Substation which is connected to the Devers 230 kV Substation via two 230 kV transmission lines. The Etiwanda 3&4 units were assumed to be retired.
5) The amount of generation online at Imperial Valley was minimized in order to stress the PV West flow and mitigate the loss of the Imperial Valley – Miguel 500 kV line. Only 400 MW of the 1660 MW of generation recently completed in Mexico near Imperial Valley Substation was assumed to be online (any further reduction caused the Hassayampa – North Gila to experience an N-1 overload).
6) The phase shifters in the Four Corners area (TOT2A and TOT2B) were used to stress the EOR system in the pre and post-project cases.

6.B.2. Study Conclusions EOR/SCIT Simultaneous Study with Low Inertia

Based on the results of the study, the following conclusions can be made:

1. The SCIT flow in the pre-project benchmark cases was found to be almost 3,000 MW (with Mohave offline) and about 1,600 MW (with Mohave online) above the line in the 1996 SCIT nomogram (see Appendix B.6 and C.6).

2. In the pre-project study cases, 62.6 % (with Mohave offline) and 63.4 % (with Mohave online) of total load in SCE, DWP and SDG&E was served from imports through the five SCIT paths. In the post-project cases the corresponding import number is 64.8% (with Mohave offline) and 65.5 % (with Mohave online).

3. The pre-project benchmark cases were limited by the loss of Imperial Valley – Miguel 500 kV line due to very low level of generation online in SCE's coastal areas and at the same time high import. Any further

increase of either SCIT or EOR in the pre-project cases would have caused a voltage collapse for this outage.

4. The historically known voltage dip criteria violation in the Devers area was not the limiting element in the pre-project cases. Compared to similar previous studies this was attributed in large by the replacement of the three section line model of the Palo Verde – Devers 500 kV line by the more correct five section line model. (Transient stability studies showed that the five section line model reduced the need for dynamic voltage support at Devers by about 300 MVAR as compared to studies with the three section line model).

5. The status of Mohave did not impact the need for additional voltage support in the post-project cases. This conclusion is based on that both pre-project cases (with and without Mohave) are stressed to their respective stability limits. The stability limit for each scenario is different; the cases with Mohave offline have a higher operating point in the SCIT/EOR nomogram as compared to the cases with Mohave online. This can be attributed to the increase in the West of River flow in the scenarios with Mohave online. The inertia from the two Mohave units is also included in the total SCIT inertia as it is calculated today. Conditions with high WOR and EOR flow are more limiting with respect to the EOR/SCIT stability limit as compared to conditions with high EOR flow and high Path 26 flow (total SCIT flow is the same).

6. Transient voltage violations were identified in the post-project cases in the Devers/Valley area without additional voltage support. A four cycle, three phase fault on the Hassayampa 500 kV bus with subsequent loss of the Hassayampa – North Gila 500 kV line was identified to be the most limiting contingency. The addition of the voltage support devices as outlined in the Plan of Service mitigated these violations and significantly improved the voltage performance in the Devers/Valley area. With the addition of the voltage support in the post-project cases the bus with the highest transient voltage dip was identified to be the Welton Mohawk 161 kV bus (WAPA) in the Yuma area. (The bus with the highest transient voltage dip in the pre-project cases was the High Desert 115 kV bus (SCE), connected under Devers Substation). No significant difference was observed between the scenarios with the 505 MW increase in EOR and SCIT scheduled to SCE/SDG&E based on a 85/15 split and when the increase was scheduled to SCE/DWP/SDG&E based on a 55/30/15 split.

7. The addition of voltage support at Devers and Valley Substations in the post-project cases was also needed to prevent a voltage collapse after loss of the Imperial Valley – Miguel 500 kV line.

8. All machines in the WECC interconnection remained in synchronism and were well damped for all contingencies studied. All disturbances met the NERC/WECC transient stability criteria in all pre and post-project cases. Transient stability plots of the most limiting outage, a four cycle, three phase fault on the Hassayampa 500 kV bus with subsequent loss of the Hassayampa – North Gila 500 kV line can be found in Appendix B and C. Additional transient stability plots are available upon request.

9. The system retained angular stability after the loss of either the Navajo – Crystal 500 kV line or the Moenkopi – Eldorado 500 kV line with 7% unit margin on the Navajo units (additional 171 MW output). Also, with 7% unit margin on the Palo Verde units (additional 374 MW) the system retained angular stability after loss of either the Palo Verde – Devers 500 kV line or the Hassayampa – North Gila 500 kV line.

10. All pre and post-project cases met all applicable reliability criteria, including thermal, transient and post transient voltage (reactive margin and voltage deviation) criteria.

Detailed results can be found in Appendix B and C.

6.C. High Inertia EOR/SCIT Study

6.C.1. Study Assumptions and Methodology to stress EOR and SCIT

The following two cases were developed to perform the high inertia, simultaneous EOR/SCIT study:

1) Pre-project case (Mohave offline).
2) Post-Project, the 505 MW increase in EOR and SCIT scheduled to SCE and SDG&E pr. an 85/15 split (Mohave offline).

70 % compensation was modeled on the Mohave – Lugo 500 kV line in this scenario.

The following steps were taken to establish the stability limit in the pre-project benchmark study cases:

1) Flow on the Hassayampa – North Gila and the Palo Verde – Devers 500 kV lines (PV West) was maximized. Due to the pre-project ratings on the series capacitors on these two lines the flow could not exceed about 2850 MW (limited by the N-1 rating on Hassayampa – North Gila 500 kV line for loss of Palo Verde – Devers 500 kV line). The current scheduling limit on Palo Verde West is 2,823 MW.
2) 1,060 MW of the 1,660 MW of generation recently completed in Mexico near Imperial Valley Substation was modeled as online.

3) The SCIT paths were increased by removing generating units in SCE's coastal areas and San Diego, replacing internal generation with imports from outside of the boundary of SCIT. As can be seen in the table below, four of the five SCIT paths were maximized in both the pre and post-project scenario.

SCIT Path	Path Rating	Pre-Project case	Post-Project case
Path 26 (Midway – Vincent)	3,400 MW	3,400 MW	3,403 MW
Path 65 (Pacific DC Intertie)	3,100 MW	3,104 MW	3,104 MW
Path 27 Intermountain Power Project DC line	1,920 MW	1,925 MW	1,925 MW
North of Lugo[2]	1,200 MW[3]	1,463 MW	1,463 MW
Path 46 West of River	10,118 MW	6,832 MW	7,339 MW
Total SCIT flow[4]		**16,303 MW**	**16,809 MW**

4) All available resources in Southern Nevada were used to stress the West of the River flow. However, WOR did only reach a moderate level due to the Mohave units being offline and the presence of peak load conditions in Southern Nevada.
5) The phase shifters in the Four Corners area (TOT2A and TOT2B) were utilized to stress the EOR system in the pre and post-project cases.
6) The number of Hassayampa units online was kept at a minimum. Previous Palo Verde Transmission System (PVTS) studies have shown the inertia/reactive support from the Hassayampa/Palo Verde units to impact the EOR/SCIT stability limit. It should be noted that high Palo Verde East flow adds stress to the system. High generation output from the units online at Hassayampa was therefore modeled. (A separate sensitivity study was performed with maximum Palo Verde East flow to assess the impact on the EOR/SCIT stability limit).

6.C.2. Study Conclusions EOR/SCIT Simultaneous Study with High Inertia

Based on the results of the study the following conclusions can be made:

1. The SCIT/EOR operating point in the pre-project case satisfied the 1996 SCIT nomogram (no margin). The SCIT/EOR operating points in the pre and post-project cases are plotted in Appendix D.

2. The EOR and SCIT flows were limited by the thermal rating on the series capacitors on the Palo Verde – Devers and Hassayampa – North Gila – Imperial

[2] Not a WECC rated path
[3] Flow North of Lugo not limited to 1,200 MW
[4] Flow measured in receiving end

Valley 500 kV lines (the N-1 rating on Hassayampa – North Gila 500 kV in particular). This limited the total flow west of Palo Verde to about 2,850 MW in the pre-project case.

3. Generation re-dispatch was used to mitigate potential criteria violations in the pre-project case. All of these are considered to be "downstream" facilities from EOR:

   a) Loss of Imperial Valley – Miguel 500 kV line limited the import into San Diego. A potential voltage collapse limited the flow on the Imperial Valley – Miguel 500 kV line and required a certain amount of online generation within the SCE area. Also the San Luis Rey – San Onofre 230 kV line (South of SONGS) was loaded at 100% of its N-1 rating in the post-project case. Most of the internal generation in San Diego was therefore dispatched to mitigate for the Imperial Valley – Miguel 500 kV outage.
   b) Voltage deviation higher than 5% for loss of the PDCI (3,100 MW) limited the import into LADWP control area. Internal DWP generation was used to mitigate this in the pre-project case.
   c) Emergency overloading on Antelope – Vincent 230 kV line for loss of the PDCI (3,100 MW) required SCE generation from the Big Creek units to be dispatched. (The short term emergency rating was used to mitigate this in the post-project case).
   d) Post-transient voltage deviations in the Montrose/Hesperus 345 kV system limited the flow on TOT2A and TOT2B for loss of PDCI (3,100 MW). Some of the TOT phase shifters were also at or close to their angular limit.

4. No transient voltage dip criteria violations or undamped oscillations were found in either the pre or post-project cases even without the additional voltage support as outlined in the Plan of Service.

5. Voltage support at Devers was needed in the post-project case to prevent a voltage collapse after loss of Imperial Valley – Miguel 500 kV line. The additional voltage support devices at Valley and Devers Substations were found to be adequate to mitigate any post-transient voltage concerns for this outage in the analysis performed.

6. All machines in the WECC interconnection remained in synchronism and were well damped. All disturbances met the NERC/WECC transient stability criteria in both the pre and post-project case. Transient stability plots of the most limiting outage, a four cycle, three phase fault on the Hassayampa 500 kV bus with subsequent loss of the Hassayampa – North Gila 500 kV line can be found in Appendix D. Additional transient stability plots are available upon request.

7. The system retained angular stability after loss of either the Navajo – Crystal 500 kV line or the Moenkopi – Eldorado 500 kV line with 7% unit margin on the Navajo units (additional 171 MW output). Also, with 7% unit margin on the Palo

Verde units (additional 374 MW), the system retained angular stability after loss of either the Palo Verde – Devers 500 kV line or the Hassayampa – North Gila 500 kV line.

8. Both pre and post-project cases met all applicable reliability criteria, including thermal, transient and post transient voltage (reactive margin and voltage deviation) criteria

Detailed results can be found in Appendix D.

7. SENSITIVITY STUDIES

7.A EOR/SCIT Simultaneous Study with maximum EOR flow

Objective: To study the simultaneous interaction between SCIT and the increased flow on East-of-River. The study would assess the impact on transient stability performance and quantify the need for dynamic voltage support at Devers Substation. In the study, EOR should be modeled at its maximum pre-project (7,550 MW) and post-project(8,055 MW).

Study Methodology: An already developed SCIT/EOR case was used as a starting point. The pre-project case was a low SCIT inertia case with Mohave offline; the case is documented in Appendix B. EOR was increased by 314 MW, from 7,236 MW to 7,550 MW in the pre-project sensitivity scenario, primarily by utilization of the phase shifters located in the Four Corners area (TOT2A and TOT2B). Some of the SCIT paths were adjusted to ensure that the pre-project sensitivity case met all applicable reliability criteria. Total SCIT flow and SCIT inertia were kept at the same level as in the starting case in order to assess the impact from the increased EOR flow.

It should be noted that only the flow on the two northern EOR lines; the Moenkopi – Eldorado and Navajo – Crystal 500 kV lines picked up the additional 314 MW on the EOR interface in the pre-project case. The flow on the Palo Verde – Devers and Hassayampa – North Gila 500 kV lines ("PV West") was already at it's maximum in the starting case and could therefore not be increased any further.

The post-project sensitivity case was developed the same way as the post-project "base case" (from Appendix B). The additional EOR increase of 505 MW was scheduled to SCE and SDG&E based on a 85/15 split.

The following table summarizes important flows/parameters between the low inertia starting case ("Base Case") and the requested sensitivity:

	"Base Case"		Sensitivity with EOR @ max	
	Pre (MW)	Post (MW)	Pre (MW)	Post (MW)
EOR	7236	7742	7550	8055
SCIT	14,920	15,428	14,912	15,416
SCIT Inertia	75,900	75,900	76,800	76,800
Palo Verde West	2914	3245	2923	3240
Palo Verde East	1811	2005	1617	1856
WOR	7916	8431	7614	8135
PDCI	3104	3104	2002	2002
IPPDC	1925	1925	1754	1754
P-26	1295	1288	2439	2424
N. of Lugo	1098	1098	1307	1307
# of Hass. Units online	5 units	9 units	5 units	9 units

A powerflow diagram of the pre and post-project sensitivity cases is provided in Appendix E. Also transient stability plots of the most significant outage, a four cycle, three phase fault on the Hassayampa 500 kV bus with subsequent loss of the Hassayampa – North Gila 500 kV line is included in Appendix E.

Study Results: The increase in EOR flow in the sensitivity case did not increase the need for dynamic voltage support. In fact, the need for voltage support decreased from 160 MVAR in the "base case" scenario to 0 MVAR in the sensitivity case. This was attributed in large by the decrease in WOR and Palo Verde East as can be seen in the table above.

Study Conclusion: The additional flow modeled on the two northern EOR lines does not contribute to the need for dynamic voltage support to mitigate the transient voltage dip at Devers after a 3 phase fault on the Hassayampa 500 kV bus with the subsequent loss of the Hassayampa – North Gila 500 kV line.

7.B EOR/Palo Verde Transmission System (PVTS)

Objective: Study the simultaneous interaction between the increased flow on EOR and the Palo Verde Transmission System (PVTS). EOR will be modeled as high as possible, with the phase shifters at Perkins and Liberty bypassed to reflect a realistic operating scenario. The proposed 505 increase in EOR should added to the two southern EOR lines only. With the project in service, the PV West flow needs to be at 3,328 MW (2823 MW + 505 MW). At the same time, maximum Palo Verde East flow should be modeled. Maximum Palo Verde East is reached when the flow on Jojoba – Kyrene 500 kV line is at 2,000 A. Only a post-project scenario is required. The impact on transient stability performance including the need for dynamic voltage support at Devers Substation for an outage of the Hassayampa – North Gila 500 kV line should be investigated. SCIT flow and SCIT inertia do not need to be monitored.

Study Methodology:

The non-simultaneous 8,055 MW case without Mohave was selected as a starting case. The modifications needed in order to meet the study objective as described above were applied to the study case. This included updated values for all of the generating units including plant load connected to the Palo Verde/Hassayampa hub. The thermal rating (1,630 A) on the series capacitor at Navajo on the Navajo – Crystal 500 kV line was found to be the limiting element on the northern EOR system. With the total flow on the two southern EOR lines limited to 3,328 MW, the EOR flow reached 7,640 MW in the study case. The PV East flow was at 6,285 MW with all the units connected to the Palo Verde/Hassayampa switchyard modeled as online. The flow on Jojoba – Kyrene 500 kV line reached 1,963 A.

Study Results: The study case did not require any SVC at Devers 500 kV substation to meet the study criteria. The highest voltage dip on any load bus was found to be at 21.3% at the High Desert 115 kV bus. No voltage dips greater than 20% with a duration of 20 cycles or more were found without the SVC in place. Powerflow diagrams can be found in Appendix F together with transient stability plots of the 3 phase fault on Hassayampa 500 kV bus with subsequent loss of Hassayampa – North Gila 500 kV line.

Study Conclusion: No new dynamic voltage support is required in the scenario studied. The presence of the Mountainview generation project (1,000 MW) and the enhanced modeling of the Palo Verde – Devers 500 kV line in the study case may have reduced the voltage dip concern in the Devers area as compared to previous studies.

7.C EOR/Valley Voltage

Objective: Study the simultaneous interaction between the increased flow on EOR and the potential for voltage collapse at SCE's Valley Substation. Recent studies have shown the potential for voltage collapse at Valley Substation during conditions with peak load after an outage of the Serrano – Valley 500 kV line. With the Serrano – Valley 500 kV line out of service the entire load at Valley will be served from Devers over the Devers – Valley 500 kV line.

Study Methodology:

The 2006 Heavy Summer Case with a 1 in 10 year heat wave load forecast from SCE's 2004 Expansion Plan Studies was used as starting case. The case modeled a total of 1,346 MW of load on the Valley 115 kV system with 47 MVAR or reactive load. Existing reactive support includes 140 MVAR of shunt capacitors. The case was modified to include maximum South of Lugo flow (5,600 MW). The following contingencies were applied to the case:

N-1 loss of Serrano – Valley 500 kV line

N-1 of Devers – Valley 500 kV line

N-1 of Palo Verde – Devers 500 kV line

N-1 of Hassayampa – North Gila 500 kV line

N-2 of Lugo – Mira Loma No. 2 and 3 500 kV lines

N-2 of Mira Loma – Serrano No. 1 and 2 500 kV lines

G-2 of two San Onofre units

SCIT and EOR were increased by 505 MW in the post-project case. The Plan of Service including the 300 MVAR of shunt capacitors on the Valley 500 kV bus, two 100 MVAR SVC's on the Valley 115 kV bus and the 400 MVAR SVC at Devers 500 kV Substation were modeled. The same contingencies were applied to the post-project case.

Study Results: The pre-project case did not converge after the simulated loss of Serrano – Valley 500 kV line. All of the other contingencies listed above solved including the loss of two San Onofre units. With the project in service and the 505 MW increase in both EOR and SCIT all of the contingencies applied to the post-project case solved. This was attributed to the additional voltage support included as part of the Project. Powerflow diagrams can be found in Appendix G.

Study Conclusion: The Project reduces the likelihood of voltage collapse at Valley after loss of the Serrano – Valley 500 kV line. The shunt capacitors on the Valley 500 kV side were added to boost the voltage on the 500 kV system during conditions with heavy load and help prevent a sudden voltage collapse after loss of the Serrano – Valley 500 kV line. The primary purpose of the two SVC's added on the Valley 115 kV side is to prevent air-conditioner load from stalling for the same outage by keeping the 115 kV voltage at an acceptable level. All three SVC's, including the 400 MVAR SVC at the Devers 500 kV Substation help mitigate the transient voltage dip after loss of Hassayampa – North Gila 500 kV line.

7.D EOR/G-2 of SONGS

Objective: Study the simultaneous interaction between the increased flow on EOR and the impact from a double unit outage of San Onofre Nuclear Generating Station (SONGS). Assess whether or not SCIT can be increased by 505 MW after the Project is placed in service.

Study Methodology:

The already developed SCIT/EOR low inertia case with Mohave off was used as a starting point.

Due to a very high SCIT flow in the starting case it could not sustain the loss of both SONGS units. (The case did conform with the no-margin SCIT nomogram developed in 1996 but not with the current SCIT operating nomogram that limits the SCIT flow based on a double unit outage of the two San Onofre units). SCIT was therefore reduced by increasing the generation output from units already online in the coastal areas of SCE. The increased generation from SCE was scheduled to PG&E's system across path 26. EOR and the other four SCIT paths were kept at the same level. After SCIT was reduced to 14,273 MW in the pre-project case it converged for the loss of both SONGS units. The SCIT inertia was kept constant and the flow on Palo Verde West was close to it's maximum around 2900 MW. (This case was named the Pre-project case). The EOR/SCIT operating point in the Pre-project case was checked against the current operating nomogram to verify that the operating point is above the horizontal limit (ignoring the 500 MW margin applied to the current operating nomogram) An additional reduction of 50 MW from Redondo Beach (SCE) caused the pre-project case to not converge. This ensured that the pre-project case was really stressed to its post transient limit. SCE's Centralized Grid Capacitor Control (CGCC) algorithm was used in the post-transient studies. Also transient stability studies were performed to ensure that the pre-project case was stable and met all transient stability criteria.

EOR and SCIT were increased by 505 MW in the post-project case. The 505 MW was scheduled from Hassayampa to SCE (Ormond Beach and Alamitos) and SDG&E (Encina) based on a 85/15 split. Key flows/parameters are listed below:

	Pre (MW)	Post (MW)
EOR	7231	7740
SCIT	14,273	14,778
SCIT Inertia	75,900 MWS	75,900 MWS
Palo Verde West	2886	3202
Palo Verde East	1838	2072
WOR	7922	8435
PDCI	3104	3104
IPPDC	1925	1925
P-26	640	635
N. of Lugo	1098	1098
# of Hass. Units online	5 units	9 units

Also the new voltage support devices as outlined in the Plan of Service (POS) were included:

1) 2 x 150 MVAR shunt capacitors at Valley 500 kV bus
2) 2 x 100 MVAR SVC's at Valley 115 kV bus
3) 400 MVAR SVC at Devers 500 kV bus

Study Results: The post-project case solved after the loss of both San Onofre units. Powerflow diagrams can be found in Appendix H. Transient stability studies performed demonstrated that the post-project case met all transient stability criteria as well.

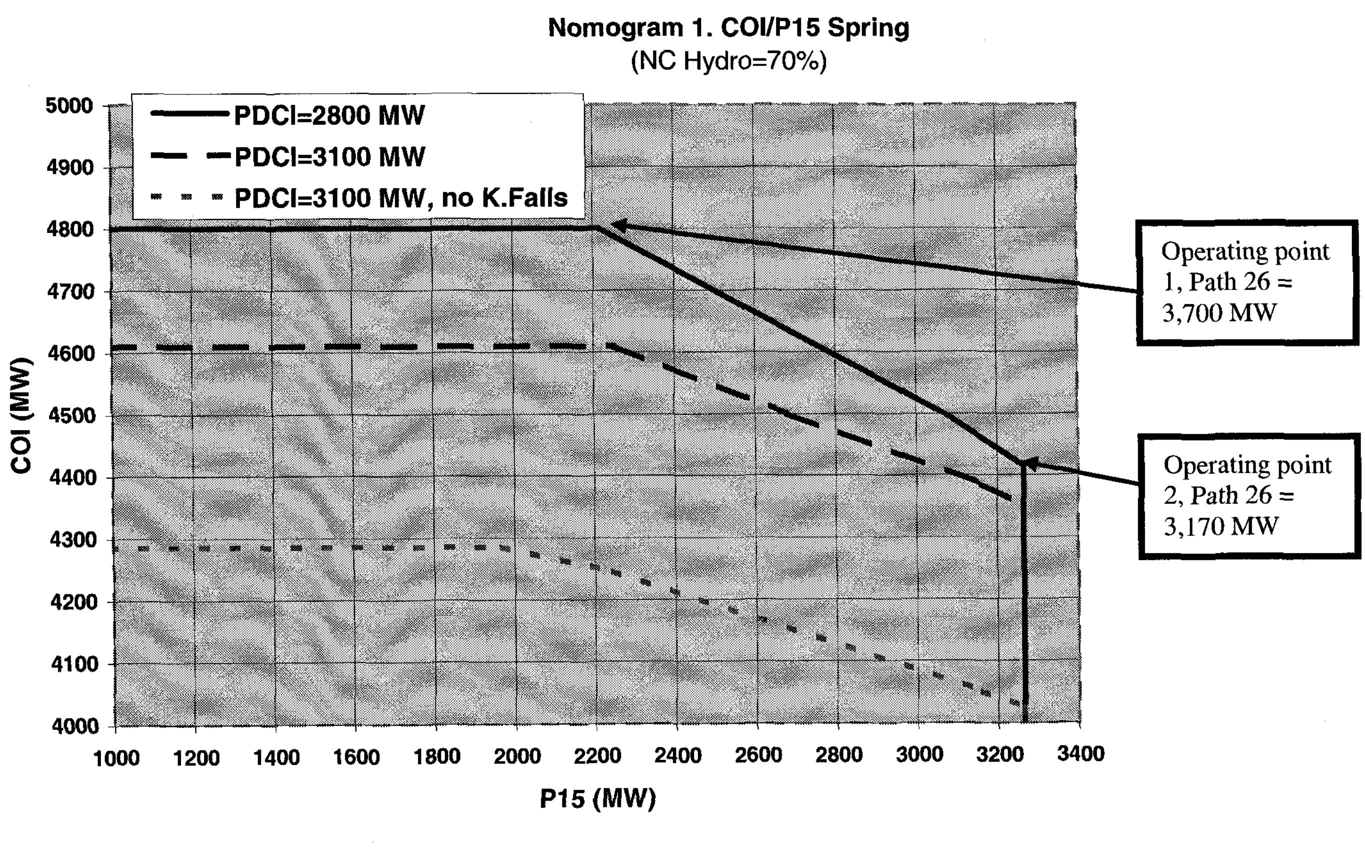
Study Conclusion: The SCIT limit can be increased by 505 MW with the project in service.

7.E EOR/COI/P-26-P15

Objective: Study the simultaneous interaction between the increased flow on EOR under conditions with maximum COI, Path 26 (Midway – Vincent) and Path 15. COI, PDCI and Path 15 should be modeled at their maximum allowable level (according to the developed nomogram). Palo Verde West should be stressed to its maximum flow limit in the pre-project scenario. The post-project case will have the proposed 505 MW increase on EOR flowing on the two 500 kV lines west of Palo Verde to simulate maximum stress on the system. Two operating points based on the existing nomogram (see below) for Path 15, COI, PDCI and Northern California Hydro will be tested with maximum flow on Path 26 and Palo Verde West. The proposed 300 MW increase in the rating on Path 26 (total of 3,700 MW) will be modeled since it has received WECC Phase 2 status.

Study Methodology:

The base case used to perform the 3,400 MW WECC path rating study for Path 26 was used as a starting case. This represented a 2005 Heavy Spring Case with 3,400 MW on Path 26 and maximum Path 15 flow. The case was updated to reflect 2006 conditions. The desired flows on the various interfaces as depicted in the nomogram below were modeled. Two operating points were tested.



Operating Point 1:

To simulate Operating Point 1 (as shown on the nomogram), the flow on Path 26 was increased by 300 MW to 3,700 MW. Generation in the Midway area was utilized and scheduled into SCE to increase the Path 26 flow by the desired amount. The flow on Path 15, PDCI, COI and the level of Northern California Hydro were kept at the level as shown in the nomogram above. In addition, the flow on Palo Verde West (Palo Verde – Devers and Hassayampa – North Gila 500 kV lines) was increased until the thermal limit on the existing series capacitors was reached. Palo Verde West reached 2,848 MW when the series capacitor on the Hassayampa – North Gila 500 kV line was loaded at 100% of its N-1 rating for loss of the Palo Verde – Devers 500 kV line. Mohave was modeled as offline with the series compensation on Mohave – Lugo 500 kV line modeled at 70%. The phase shifters on both the Perkins – Mead 500 kV and Liberty – Peacock 345 kV lines were bypassed to simulate actual operation. A total of 1,333 MW of generation was tripped after the simultaneous loss of the Midway – Vincent No. 1 & 2 500 kV lines to avoid overloading the Midway – Vincent No. 3 500 kV line above it's short term emergency rating of 3,500 A. The following units[5], all located in the Midway area, were tripped for this double line outage:

La Paloma	4 x 230 MW	Total 920 MW
Sunset	1 x 75 MW	Total 75 MW
Texaco Sunrise	2 x 169 MW	Total 338 MW
		Total 1,333 MW

Generation connected to the Hassayampa 500 kV switchyard was increased in the post-project case with the power scheduled to SCE and SDG&E. The flow on Palo Verde West was increased by 505 MW to 3,341 MW. Flows in the pre and post-project cases on various interfaces are listed in the table below:

	Pre (MW)	Post (MW)
COI	4,800	4,800
PDCI	2,804	2,804
Path 15	-2,198	-2,202
IPPDC	1,854	1,854
SCIT	14,145	14,674
WOR	5,987	6,690
EOR	5,429	6,074
P-26	3,701	3,699
North of Lugo	103	-67
Palo Verde West	2,848	3,352

[5] A final determination of amount and location of generation needed to be tripped will be determined in the WECC Path Rating studies for Path 26

Operating Point 2:

To simulate Operating Point 2 (as shown on the nomogram), the same methodology as for Operating Point 1 was used. However, to achieve 3,250 MW on Path 15, all of the generation connected to Midway Substation had to be turned off (one of the two Diablo Canyon Nuclear units was still at maximum load). Generation in Northern California (PG&E) replaced the generation connected to Midway. Also the flow on Path 26 was reduced since no generation was available to be tripped for the double line outage of the Midway – Vincent No.1&2 500 kV lines. With the flow on Path 26 reduced to slightly less than 3,200 MW, the Midway – Vincent No. 3 500 kV line was loaded at 3,475 A or 99.3% of its short term emergency rating of 3,500 A for the outage of Midway – Vincent No. 1 & 2 500 kV lines. PDCI, COI and Northern California Hydro were kept at the same level as shown in the nomogram above. The flow on Palo Verde West was increased until the thermal limit on the existing series capacitors was reached, similar to what was done with the case simulating Operating Point 1.

Generation connected to the Hassayampa 500 kV switchyard was increased in the post-project case with the power scheduled to SCE and SDG&E. The flow on Palo Verde West was increased by 505 MW. Flows in the pre and post-project cases on various interfaces are listed in the table below:

	Pre (MW)	Post (MW)
COI	4,408	4,411
PDCI	2,804	2,804
Path 15	-3,252	-3,252
IPPDC	1,854	1,854
SCIT	13,656	14,208
WOR	6,028	6,752
EOR	5,466	6,138
P-26	3,169	3,170
North of Lugo	103	-67
Palo Verde West	2,837	3,342

Thermal powerflow analysis including N-0, N-1 and N-2 were conducted in both the pre and post-project scenario for Operating Point 1 & 2. Also post-transient voltage deviation and transient stability analysis were performed.

Study Results: No thermal overloads were found in any of the pre and post-project cases. Also, all buses had a voltage deviation less than 5% for single contingencies and 10% for double contingencies. No transient stability violations were identified in either the pre or post-project scenarios. Detailed results including powerflow plots of pre and post-project cases can be found in Appendix I.1 for the Operating Point 1 cases and in Appendix I.2 for Operating Point 2 cases.

Study Conclusion: No adverse impact was identified under conditions with maximum Palo Verde West flow and maximum North to South flow on PDCI, COI, Path 15 and Path 26.

7.F EOR/MWD pumps offline

Objective: Study the simultaneous interaction between the increased flow from EOR during conditions with no MWD pumps online. MWD indicated that there will be times during the year when all the pumps are offline at their five substations with pumps (Julian Hinds, Iron Mountain, Eagle Mountain, Gene and Intake). The primary concern is the potential for thermal overload.

Study Methodology:
Two cases were analyzed; EOR/SCIT High inertia case (without Mohave) and EOR/SCIT Low inertia case (with Mohave online). The case with high inertia has EOR modeled at 6741 MW and SCIT at 16,300 MW. The post-project case has a 505 MW increase in both EOR and SCIT (see Appendix D for documentation). The low inertia case has EOR modeled at 7102 MW and SCIT at 15,170 MW in the pre-project scenario with a 505 MW increase in the post-project case (see Appendix C).

The table below summarizes the amount of pump load modeled in these cases. The pumps were turned off to assess the impacts on the thermal loadings in the MWD system. To stress the system, generation from Alamitos was reduced by the same amount as the pump load.

	Pump load (MW), Low Inertia	Pump load (MW), High Inertia
Julian Hinds	55.8	74.4
Eagle Mountain	55.8	74.4
Iron Mountain	25.6	25.6
Gene	40.2	53.6
Intake	60.3	53.6
Total	237.7	281.6

The following contingencies were applied to each pre and post-project cases:

N-1 of Palo Verde – Devers 500 kV line
N-1 of Lugo – Mohave 500 kV line
N-1 of Hassayampa – North Gila 500 kV line
N-1 of Blythe – Eagle Mountain 161 kV line
N-1 of Blythe – Niland 161 kV line
N-1 of Mead – Camino No. 1 or 2 230 kV line

N-1 of Parker – Gene 230 kV line
N-1 of Iron Mountain – Camino 230 kV line
N-1 of Iron Mountain – Eagle Mountain 230 kV line
N-1 of Julian Hinds – Eagle Mountain 230 kV line
N-1 of Julian Hinds – Mirage 230 kV line
N-1 of Devers –Coachella Valley 230 kV line
N-1 of Ramon – Mirage 230 kV line
G-1 of one San Onofre unit

Study Results: No normal overload or any contingency overloads were found in the scenarios with the MWD pumps offline. The cases with a 505 MW increase in EOR and SCIT had little impact on the thermal loadings of the MWD transmission lines. For example, the flow on the Eagle Mountain to Julian Hinds decreased by about 7 MW (from 212 to 205 MW) in the scenario with high SCIT inertia. None of the contingencies applied to the cases with high inertia caused any of the MWD lines to load above 90% of their normal rating. The most significant outage was the outage of Palo Verde – Devers 500 kV line which caused the flow on Eagle Mountain – Julian Hinds 230 kV line to increase by 10 MW to 302 MW in the high inertia post-project case. None of the two MWD's remedial action schemes were triggered.[6]

In the low inertia case, the flow on Eagle Mountain – Julian Hinds decreased by 7 MW with the project in service. However, the contingency flow after an outage of the Palo Verde – Devers 500 kV line increased by 8 MW, from 317 MW to 325 MW due to higher flow on the two Palo Verde West lines in the post-project scenario. (The normal rating of the Eagle Mountain to Julian Hinds 230 kV line is 358.5 MW with an N-1 rating of 394.4 MW.) No other contingencies caused any of the MWD lines to load above 90% of their normal rating.

As expected, no post transient voltage deviations were found in any of the scenarios.

Study Conclusion:[7] The 505 MW increase in EOR and SCIT has little impact on the MWD transmission system between Mead and Julian Hinds Substations. The most significant outage is the outage of the Palo Verde – Devers 500 kV line.

[6] 1) If the line loading on the Iron Mountain – Eagle Mountain 230 kV line exceeds 250 MVA, an overloading scheme will trip the Eagle Mountain – Julian Hinds 230 kV line. 2) An overpower/undervoltage protection scheme will be triggered when a flow greater than 65 MW is measured from Julian Hinds to Mirage 230 kV line and the voltage is 90 percent or lower at the Julian Hinds 6.9 kV bus. These two conditions would initiate the tripping of the Julian Hinds – Mirage 230 kV line.

[7] On November 10, 2004 SCE informed WATS that the Mirage – Julian Hinds 230 kV line has been de-rated from 896 A normal and 1029 A emergency rating to 599 A (normal and emergency). Loss of Palo Verde – Devers 500 kV line loads the Mirage – Julian Hinds 230 kV line above 599 A in both the pre and post project scenario.. Given the large magnitude of the overload in the pre-project scenarios (up to 141%) and the limited impact from the EOR upgrade (about 6%), SCE has stated that this will be resolved outside the WECC path rating process.

ATTACHMENT C

SOUTHERN CALIFORNIA EDISON COMPANY
2006-2015
TEN-YEAR PLAN

Devers-Palo Verde No. 2 Project
WECC Accepted Path 49 Rating Study Report

SOUTHERN CALIFORNIA
EDISON®
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DEVERS – PALO VERDE NO. 2 (DPV2)

ACCEPTED PATH 49 RATING STUDY REPORT

VOLUME I – MAIN REPORT

JULY 25, 2005

Prepared by the Western Electricity Coordinating Council (WECC)
And Western Arizona Transmission System (WATS)
Peer Review Group

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

The Southern California Edison Company (SCE) is proposing to build a 230 mile, Harquahala-Devers 500 kV transmission line. Together with the new 500 kV line, other transmission-related reinforcements and procedures comprise the project plan of service, which is described in section III.B. The project is referred to as Devers-Palo Verde No. 2 or DPV2. DPV2 is being pursued to increase the transfer capability between Arizona and California by 1,200 MW for economic reasons. The planned operating date for DPV2 is 2009.

Like the existing Palo Verde-Devers 500 kV line, DPV2 will be a part of both the Arizona-California East-of-River path (Path 49) and Arizona-California West-of-River path (Path 46) definitions. Owing to this dual nature, the DPV2 Plan of Service (POS) ultimately will be designed to increase the non-simultaneous rating of Path 46 in addition to Path 49. However, the DPV2 Path 46 Rating Study will be done separately and in coordination with the Path 46 rating study to be completed for the Path 49 Series Capacitor Upgrade Project. In addition, owing to the uncertainty of continued operation of the Mohave Generating Plant, two complete DPV2 plans of service were developed, one with and the other without the Mohave Generating Plant in service. The main objective of this DPV2 Path 49 Rating Study (Study) is to establish a new Accepted Rating of 9,255 MW on Path 49 as a result of DPV2.

On October 10, 2003, SCE submitted a notification letter to the Western Electricity Coordinating Council (WECC) Planning Coordination Committee and the WECC Technical Studies Subcommittee formally initiating Phase 1 of the WECC rating process for DPV2. After completing Phase 1 requirements, TSS granted Phase 2 status to DPV2 on September 21, 2004. In addition to the WECC rating process, DPV2 has adhered to the Western Arizona Transmission System (WATS) regional planning requirements. On July 21, 2004, SCE formed a combined WECC/WATS Peer Review Group (PRG) to review and approve the Study, and prepare this final DPV2 Accepted Path 49 Rating Study Report (Report).

Based on the findings of this Study, the DPV2 POS is adequate to increase the Path 49 non-simultaneous rating by 1,200 MW from 8,055 MW to 9,255 MW, while meeting the NERC/WECC Planning Standards and the regional WATS planning requirements. With the inclusion of reactive support equipment in the DPV2 POS, the Southern California Import Transmission (SCIT) path simultaneous capability as defined in the SCIT Nomogram will also be increased by 1,200 MW. In addition, the DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with seven WECC defined Paths 26, 27, 41, 42, 64, 65 and the Centennial path at their respective maximum ratings. Nomograms and/or operating procedures will have to be implemented to mitigate the simultaneous interaction between Path 49 and Path 61. Conceptual nomograms have been developed in this Study. Summaries of the DPV2 POS requirements for each of the analyses are presented in the following Tables I.A and I.B. The POS will be further evaluated and defined during the aforementioned DPV2 Path 46 rating study.

At the request of PRG members, the Study includes assessments of 5 sensitivities for information purposes, which are described in section VIII of this Report. Finally, as described in Section IX of this Report, other studies in support of DPV2 are being conducted independent of this Study and will be reviewed in the appropriate forums.

SCE would like to express its gratitude to PRG members for their professionalism and expertise in providing support to this Study and completing the Report.

TABLE I.A

DPV2 Plan of Service Summary for Mohave On Line Scenario [A]

Analysis	Total Reactive Support (MVAr) [B]	Nomogram	Operating Procedure	SPS
Non-Simultaneous	0	Yes [C]	Yes [C]	Yes [C]
SCIT Nomogram	400	No	Yes [C]	Yes [C]
Path 26	400	No	Yes [C]	Yes [C]
Path 27	400	No	Yes [C]	Yes [C]
Path 41	550	Yes [D]	Yes [C]	Yes [C]
Path 42 [E]	N/A	N/A	N/A	N/A
Path 61	1,200 [G]	Yes [F]	Yes [G]	Yes [C]
Path 64	800	No	Yes [C]	Yes [H]
Path 65	400	No	Yes [C]	Yes [C]
Centennial Path	800	No	Yes [C]	Yes [H]

A – All analyses assume the following core plan of service elements:

1. Build new Harquahala-Devers 500 kV line
2. Rebuild Devers-San Bernardino 230 kV lines #1 and #2
3. Rebuild Devers-Vista 230 kV lines #1 and #2

B – The Reactive Support level shown represents the total amount required uniquely for each analysis (e.g. 800 MVAr is required for the conditions assumed in the Path 64 analysis, however, only 400 MVAr would be required for the conditions assumed in the Path 65 analysis; i.e. they are not additive).

C – Implement an integrated mitigation plan involving nomograms, operating procedures and an SPS (to trip generation in the Palo Verde area and load in Southern California) to relieve thermal overloads on 3 transmission facilities for DPV1 and DPV2 outage. Up to 1,125 MW of generation in Arizona and up to 1,350 MW of load in Southern California may be required for the double line outage.

D – Implement a nomogram to meet the stability criteria for the Hassayampa-N.Gila 500 kV line outage if at least 150 MVAr of shunt capacitors are not installed at Devers 500 kV bus or they are out of service.

E – The request to perform the Path 42 analysis was made for the Mohave Off Line scenario only.

F – Implement an OP to relieve a thermal overload on Victorville-Lugo 500 kV line for 5 line outages.

G – Implement a nomogram to meet the stability criteria for Hassayampa-N.Gila 500 kV line outage in lieu of installing an additional 400 MVAr SVC at Lugo 500 kV bus (i.e. to not exceed the 800 MVAr reactive power capability identified for Path 64 and the Centennial path, which is the basis for the reactive support equipment in the plan of service).

H – Install an SPS to trip up to 400 MW of generation in the Palo Verde area and up to 400 MW of load in Southern California to meet the stability and/or post transient planning standards for DPV1 and DPV2 outage. This requirement may be met with the same SPS to relieve the thermal overloads.

TABLE I.B

DPV2 Plan of Service Summary for Mohave Off Line Scenario [A]

Analysis	Total Reactive Support (MVAr) [B]	Nomogram	Operating Procedure	SPS
Non-Simultaneous	0	Yes [C]	Yes [C]	Yes [C]
SCIT Nomogram	500	No	Yes [C]	Yes [C]
Path 26	500	No	Yes [C]	Yes [C]
Path 27	500	No	Yes [C]	Yes [C]
Path 41	500	No	Yes [C]	Yes [C]
Path 42	500	No	Yes [C]	Yes [C]
Path 61	1,400 [E]	Yes [E]	Yes [D]	Yes [F]
Path 64	1,300	No	Yes [C]	Yes [F]
Path 65	500	No	Yes [C]	Yes [C]
Centennial Path	1,300	No	Yes [C]	Yes [F]

A – All analyses assume the following core plan of service elements:
1. Build new Harquahala-Devers 500 kV line
2. Rebuild Devers-San Bernardino 230 kV lines #1 and #2
3. Rebuild Devers-Vista 230 kV lines #1 and #2

B – The Reactive Support level shown represents the total amount required uniquely for each analysis (e.g. 1,300 MVAr is required for the conditions assumed in the Path 64 analysis, however, only 500 MVAr would be required for the conditions assumed in the Path 65 analysis; i.e. they are not additive).

C – Implement an integrated mitigation plan involving nomograms, operating procedures and an SPS (to trip generation in the Palo Verde area and load in Southern California) to relieve thermal overloads on 3 transmission facilities for DPV1 and DPV2 outage. Up to 1,125 MW of generation in Arizona and up to 1,350 MW of load in Southern California may be required for the double line outage.

D – Implement an OP to relieve a thermal overload on Victorville-Lugo 500 kV line for 3 line outages.

E – Implement a nomogram to meet the stability criteria for Hassayampa-N.Gila 500 kV line outage in lieu of installing an additional 100 MVAr SVC at Devers 500 kV bus (i.e. to not exceed the 1,200 MVAr reactive power capability identified for Path 64 and the Centennial path, which is the basis for the reactive support equipment in the plan of service).

F – Install an SPS to trip up to 400 MW of generation in the Palo Verde area and up to 400 MW of load in Southern California to meet the stability and/or post transient planning standards for DPV1 and DPV2 outage. This requirement may be met with the same SPS to relieve the thermal overloads.

II. STUDY OBJECTIVES AND SCOPE

The main objective of this DPV2 Path 49 Rating Study (Study) is to establish a new Accepted Rating of 9,255 MW on Path 49 as a result of DPV2, since DPV2 will be included in the Path 49 definition. To achieve this new rating, the Study must demonstrate that the Path 49 rating can be increased from 8,055 MW to 9,255 MW while meeting the NERC/ WECC Planning Standards and the regional WATS planning requirements (hereafter jointly referred to as Criteria). Specifically, in accordance with Phase 2 of the WECC "Procedures for Regional Planning Project Review and Rating Transmission Facilities" policy (WECC Rating Policy), the Study is designed to:

- Address comments on the DPV2 Comprehensive Progress Report.
- Address comments on the DPV2 Accepted Path 49 Rating Study.
- Demonstrate conformance with the NERC/ WECC Planning Standards.
- Identify the non-simultaneous transfer capability and simultaneous path transfer capability limits for a specific plan of service.
- Address the mitigation of simultaneous transfer capability problems relative to the existing system.

In addition, the Study included performing limited sensitivity analyses to check the interaction of DPV2 with other similarly situated projects and sub-regional projects to the extent these projects and sub-projects had developed a preferred plan of service that can be modeled in the Study.

The analyses performed in this Study were designed to be rigorous and extensive as indicated by the Study Scope of Appendix A, which provides details on the criteria, assumptions and methodology. As indicated in the Study Scope, essentially two complete analyses were performed owing to the uncertainty of continued operation of the Mohave Generating Plant. One analysis assumes that the Mohave Generating Plant will be in service when DPV2 goes into service in 2009. The other analysis assumes that the Mohave Generating Plant will be shut down.

Like the existing Palo Verde-Devers 500 kV line (DPV1), DPV2 will be a part of both the Path 49 and Arizona-California West-of-River (WOR) Path 46 definitions. Owing to this dual nature, the DPV2 Plan of Service ultimately will be designed to increase the non-simultaneous rating of Path 46 in addition to Path 49. However, the DPV2 Path 46 Rating Study will be done separately and in coordination with the Path 46 rating study is completed for the Path 49 Series Capacitor Upgrade Project (Upgrade Project). Accordingly, the DPV2 Path 46 rating analysis is not included in this Study. The Upgrade Project rating studies performed within the Western Electricity Coordinating Council and the Western Arizona Transmission System reliability forums provides the baseline for performing DPV2 non-simultaneous and simultaneous analyses.

Samples of general instructions for modeling single and double contingencies (also known as "switchdecks") simulated in the dynamic stability and post-transient power flow analyses for the non-simultaneous analysis are provided in Appendix B.

III. PROJECT DESCRIPTION

III.A BACKGROUND

Southern California Edison (SCE) is proposing to build a 230 mile, 500 kV transmission line from the Palo Verde area, near Phoenix, Arizona, to SCE's Devers substation, near Palm Springs, California. Together with the new 500 kV line, other transmission-related reinforcements comprise the overall plan of service. The project is named Devers-Palo Verde No. 2 (DPV2). DPV2 is being pursued to increase the transfer capability between Arizona and California by 1,200 MW. The expected operating date for DPV2 is 2009.

On October 10, 2003, SCE submitted a notification letter to the Western Electricity Coordinating Council Planning Coordination Committee (PCC) and the WECC Technical Studies Subcommittee (TSS) formally initiating Phase 1 of the WECC Rating Process for DPV2. Regional review of DPV2 was performed through the DPV2 Regional Planning Review Group, which met in November of 2003. The DPV2 Regional Planning Compliance Report was submitted to the WECC PCC on June 8, 2004. On September 14, 2004, PCC accepted as complete the DPV2 Regional Planning Compliance Report.

The DPV2 Comprehensive Progress Report (CPR), which provided the analysis used to define DPV2's conceptual plan of service, was submitted to the WECC on April 21, 2004. The DPV2 CPR indicated that the DPV2 plan of service could reliably achieve an incremental increase of 1,200 MW in the non-simultaneous rating of Path 49.

In accordance with the WECC path rating process, TSS granted Phase 2 status to DPV2 on September 21, 2004. On July 21, 2004, SCE formed a combined WECC/WATS Peer Review Group (PRG) to review and approve the Study, and prepare the final DPV2 Accepted Path 49 Rating Study Report (Report).

III.B PLAN OF SERVICE

To reliably increase the Path 49 rating by 1,200 MW while meeting the Criteria, the DPV2 Plan of Service (POS) will need to include the following facilities and procedures. Elements of the POS will be further evaluated and defined during the DPV2 Path 46 rating study and in other independent design studies performed outside of the WECC rating process.

1. __Devers - Harquahala 500 kV Line__

Build a new 230 mile-500 kV line between Harquahala Generating Company's Harquahala Switchyard in Arizona to SCE's Devers 500 kV Substation near Palm Springs, California. The line will be designed with 2B-2156 ACSR conductor and a nominal 50% series compensation that matches the series compensation equipment on the existing Palo Verde-Devers 500 kV line. The proposed route between Devers and Harquahala parallels the entire length of SCE's existing Palo Verde-Devers 500 kV transmission line, as shown on the diagram of section III.C.

2. __Devers – San Bernardino 230 kV lines #1 and #2__

Rebuild and reconductor the Devers–San Bernardino 230 kV lines #1 and #2. The original single-circuit 230 kV tower lines will be removed and replaced with new double-circuit 230 kV tower structures, strung with bundled 1033 ACSR conductor. The conductor on the existing double circuit 230 kV towers will also be replaced with double bundled 1033 ACSR conductor.

3. ***Devers – Vista 230 kV lines #1 and #2***

Rebuild and reconductor the Devers–Vista 230 kV lines #1 and #2. The original single-circuit 230 kV tower lines will be removed and replaced with new double-circuit 230 kV tower structures, strung with bundled 1033 ACSR conductor. The conductor on the existing double circuit 230 kV towers will also be replaced with double bundled 1033 ACSR conductor.

4. ***230 kV Circuit Breakers***

Replace 13 230 kV circuit breakers at two locations and upgrade 4 circuit breakers at one location on the SCE system, as follows:

- Replace 11 CBs @ Devers Substation
- Replace 2 CBs @ Lewis Substation
- Upgrade 4 CBs @ SONGS Substation (by installing TRV L-G Capacitors)

5. ***Reactive Power Equipment***

As a minimum, install fixed shunt capacitors and SVC capacity at Devers 500 kV substation and SVC capacity at Lugo 500 kV substation as required for the scenarios with Mohave generating station continuing operation or retired, respectively. Below are the specific requirements for each scenario.

	Reactive Power Capacity (MVAr)	
	Mohave On Line	Mohave Off Line
Shunt Capacitors @ Devers 500 kV	300	300
SVCs or equivalent @ Devers 500 kV	500	600
SVCs or equivalent @ Lugo 500 kV	0	400

SCE reserves the right to design and install reactive power equipment and associated control parameters, which may differ with what was modeled in this Study, as long as it can be demonstrated that the performance is as good as or better than the results presented in this Report.

6. ***Special Protection System (SPS)***

Install a Special Protection System (SPS) that will be designed to drop generation in the Palo Verde area and load on SCE's system to ensure acceptable performance for the double contingency loss of the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines. The Study indicated that up to 1,125 MW of generation in the Palo Verde area may need to be tripped and 1,350 MW of load in SCE area may need to be dropped to meet the thermal criteria. Results also show that the generator tripping and load dropping requirements may be much lower if nomograms and operating procedures were integrated into the SPS design. SCE is committed to ensuring that the ultimate SPS mitigation plan will be designed to ensure acceptable performance for the double contingency loss of the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines. To this end, SCE intends to work closely with the CAISO, Arizona utilities and regulators, and generator owners outside of the WECC rating process to develop a workable generator dropping scheme to satisfy this SPS requirement. SCE plans to form a technical SPS study group comprised of interested stakeholders to develop the study scope and perform the studies as the basis for determining the ultimate SPS requirements. In fact, some internal studies have already been performed by SCE and the Salt River Project., which will be reviewed and discussed within the stakeholder group. The SPS design study will include analyses of different operating conditions, including the Palo Verde hub generation and COI/PDCI transfers. Under the guidance of WATS, the operating procedures currently used for operation of the East of River Path will be amended as needed to cover the double line outage and thermal overloads. The "Palo Verde West Operating Guidelines" and the "Agreement on Operating Procedure for Reduction in Loading on the East of River Path" are enforced by Arizona Public Service as the operator of Path 49 and will be amended as needed. This process will be reviewed and approved by WATS. Also, the specific generation/load dropping scheme will be evaluated carefully in the WECC Remedial Action Scheme Reliability Subcommittee (RASRS) during the design phase.

SCE reserves the right to develop and implement an SPS, which may differ with what was modeled in this Study, as long as it can be demonstrated that the performance is as good as or better than the results presented in this Report.

7. ***Nomogram***

Absent of or in coordination with other remediation, develop and implement the following new nomograms to meet the stability criteria:

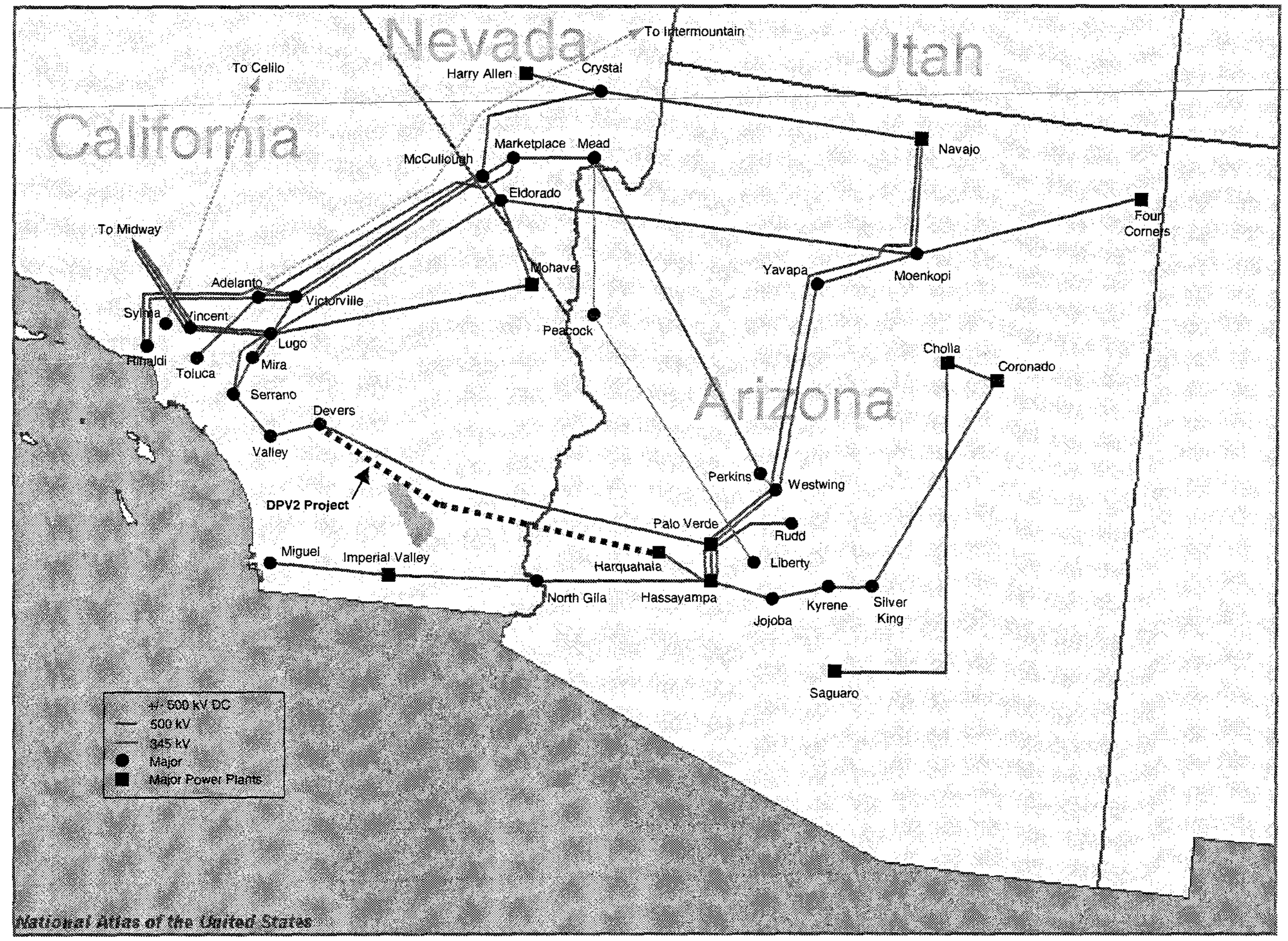
- Path 49 vs. Path 41 for loss of the Hassayampa-N.Gila 500 kV line,
- Path 49 vs. Path 61 for loss of the Hassayampa-N.Gila 500 kV line,
- Perkins phase shifter in vs. out of service for DPV1 and DPV2 double line outage

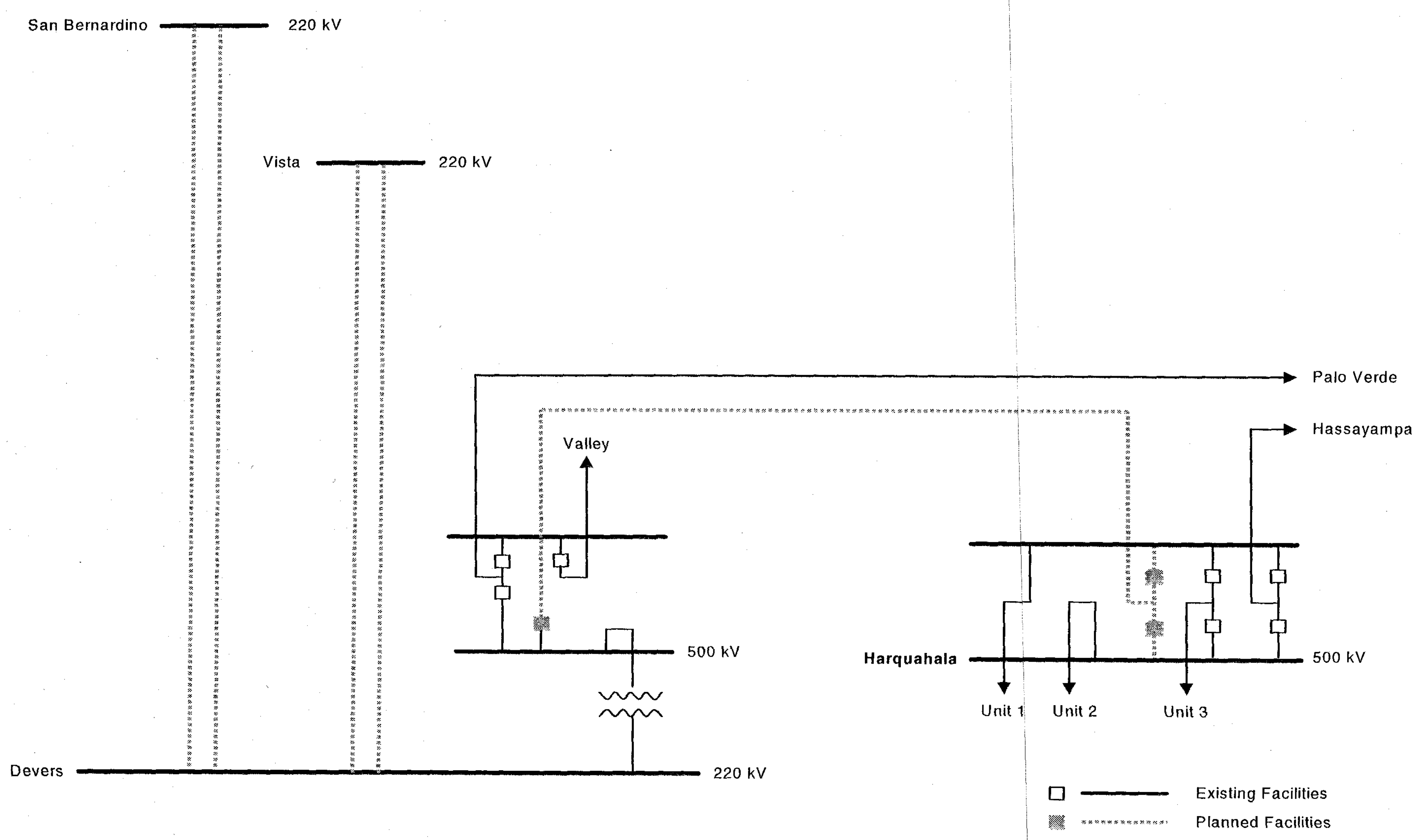
8. ***Operating Procedures***

Absent of or in coordination with other remediation, develop and implement new operating procedures to identify schedule reductions to relieve overloads on:

- Mead-Perkins 500 kV series capacitors and two Perkins phase shifters for loss of the Palo Verde-Devers and the Harquahala-Devers 500 kV lines as part of SPS,
- Victorville-Lugo 500 kV line for the following five single contingencies:
    1. Eldorado-Lugo 500 kV line
    2. Mohave-Lugo 500 kV line
    3. Devers-Valley 500 kV line
    4. N.Gila-IV 500 kV line
    5. Palo Verde-Devers 500 kV line

III.C GEOGRAPHIC MAP OF DPV2 IN RELATION TO DSW TRANSMISSION





III.D CONCEPTUAL ONE LINE DIAGRAM OF DPV2

IV. RESPONSES TO COMMENTS

IV.A DPV2 COMPREHENSIVE PROGRESS REPORT

The DPV2 Comprehensive Progress Report, which provided the analysis used to define the conceptual Plan-of-Service for DPV2, was submitted to the WECC on April 21, 2004. As established in the WECC rating review process, the 60-day review period began on April 21, 2004 and ended on June 21, 2004.

During the 60-day review period, SCE received several comments on the Comprehensive Progress Report. SCE responses to these comments are provided in Appendix C.

IV.B DPV2 ACCEPTED PATH 49 RATING STUDY

Since the formation of the PRG, stakeholders were given several opportunities to review and comment on all aspects of the Study. Throughout the study period, SCE solicited and received comments on the DPV2 rating analysis. SCE responses to these comments are provided in Appendix E.

V. FINDINGS OF NON-SIMULTANEOUS ANALYSIS

V.A OVERALL SUMMARY

In accordance with the WECC Rating Policy, the non-simultaneous analysis is based on the key assumption that Path 49 power flow will be at its maximum target rating of 9,255 MW while flows on other paths may be less than their respective maximum ratings. Details on the criteria, assumptions and methodology for the non-simultaneous analysis are provided in section III on page 6 of the Study Scope (Appendix A). Also, all facilities expected to be in service prior to DPV2 operation were provided by PRG members and represented in the base cases used to perform the analysis. The final non-simultaneous base cases were approved by the PRG.

Results indicate that the DPV2 POS is adequate to achieve a 1,200 MW non-simultaneous rating increase on Path 49 while meeting the Criteria.

Results indicated thermal overloads on three transmission elements (Perkins phase shifters and series capacitors on the Perkins-Mead 500 kV line) for loss of the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines. To the extent these overloaded facilities are not upgraded as part of a future project, SCE will need to develop and implement an SPS in conjunction with nomograms and operating procedures to relieve these overloads.

Details of the Non-Simultaneous Analysis results are provided in Appendix D.

V.B POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 can achieve a 1,200 MW increase in the non-simultaneous rating of Path 49 while meeting the thermal limits of the transmission system. However, in the absence of other pre-DPV2 remediation, employing an SPS together with nomograms and operating procedures would relieve overloads on the Mead-Perkins 500 kV series capacitors and the two Perkins phase shifters for the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines.

The "Control Area Summary of Pre-Contingency Base Cases," which was approved by the PRG, is provided in Appendix D.1.a. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix D.1.b. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix D.1.c.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix D.1.d. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the pre-or-post-project cases. Marginal loadings of 100.8% and 100.6% occurred on the two Perkins phase shifters in the pre-and-post-project cases, respectively, which are considered acceptable by the owners of the equipment.

2. For the single line outage of the Palo Verde-Devers 500 kV line in the pre-project case, marginal loadings of 100.9% of the emergency rating of the series capacitor of the Mead-Perkins 500 kV line and 101.9% of the emergency rating of the two Perkins phase shifters occurred. For the same outage, these loadings dropped well below 100% in the post-project case, as shown in the table below.

	Emergency Loading (%)		
Limiting Element	Pre-Project	Post-Project	Outage
Mead-Perkins Series Cap	100.9	86.3	PVDV
Mead-Perkins Phase Shifters	101.9	86.8	PVDV

3. For the double line outage of the Palo Verde-Westwing 500 kV No. 1 and 2 lines in the pre-project case, a loading of 106.8% of the emergency rating of the Hat WALC-Hassayampa 230 kV line occurred. For the same outage, the loading on this line dropped below 100% in the post-project case, as shown in the table below.

	Emergency Loading (%)		
Limiting Element	Pre-Project	Post-Project	Outage
Hat WALC-Hassyamp 230	106.8	97.8	PVWW1&2

4. For the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines in the post-project case, loadings of 119.5% of the emergency rating of the series capacitor of the Mead-Perkins 500 kV line and 116.8% of the emergency rating of the two Perkins phase shifters occurred.

5. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines, as

shown in the table below. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

Limiting Element	Emergency Loading (%) No SPS	With SPS	Outage
Mead-Perkins Series Cap	119.5	100.8	DPV1&2
Mead-Perkins Phase Shifters	116.8	100.4	DPV1&2

6. Implementing a nomogram and operating procedure, which operates the Perkins phase shifter in an out of service mode, resulted in reducing the thermal overload considerably on the series capacitor of the Mead-Perkins 500 kV line and the Perkins phase shifters. However, thermal overloads occurred on four other transmission lines, three of which had exhibited overloads under pre-DPV2 conditions. Those three lines are the Hat WALC-Hassayampa 230 kV line, the Ave 58-Bannister 161 kV line and the RTAP2-RTP1 92 kV line. IID has indicated that they are in the process of developing future plans to address pre-existing overloads on its system, including the Ave58-Bannister 161 kV line and the RTAP2-RTP1 92 kV line. As a pre-existing overload condition, the owners of the Hat WALC-Hassyamp 230 kV line should determine acceptable mitigation options and work with other affected parties. The fourth overload occurred on the Liberty 345 kV phase shifter. Even assuming separate mitigation of pre-existing overloaded facilities, the thermal overloads on the remaining three transmission facilities marginally exceed their respective limits, as shown in the table below.

Limiting Element	Emergency Loading (%) No SPS	With Nomogram	Outage
Mead-Perkins Series Cap	119.5	102.8	DPV1&2
Mead-Perkins Phase Shifters	116.8	100.6	DPV1&2
Hat WALC-Hassyamp 230	< 90.0	108.1	DPV1&2
AV58TP1-Bannister 161	< 90.0	102.2	DPV1&2
RTAP2-RTP1 92	< 90.0	105.5	DPV1&2
Liberty Phase Shifter	< 90.0	102.8	DPV1&2

7. Implementing an SPS together with a nomogram and operating procedure, which operates the Perkins phase shifter in an out of service mode, resulted in reduced tripping requirements. However, a thermal overload occurred on the Hat WALC-Hassayampa 230 kV line, which had exhibited an overload under pre-DPV2 conditions. As a pre-existing overload condition, the owners of the Hat WALC-Hassyamp 230 kV line should determine acceptable mitigation options and work with other affected parties. Such mitigation could include sympathetic tripping of the Hat WALC-Hassyamp 230 kV line in the event of the N-2 outage. Operating with the SPS, which trips 340 MW of generation at Harquahala and drops 386 MW of load in SCE's system, mitigates the remaining thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines, as shown in

the table below.

Limiting Element	Emergency Loading (%) No SPS	With SPS/Nmgrm	Outage
Mead-Perkins Series Cap	119.5	94.5	DPV1&2
Mead-Perkins Phase Shifters	116.8	94.3	DPV1&2
Hat WALC-Hassyamp 230	<90.0	103.6	DPV1&2

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the pre-or-post-project cases. Marginal loadings of 100.3% and 100.4% occurred on the two Perkins phase shifters in the pre-and-post-project cases, respectively, which were considered acceptable by the owners of the equipment.

2. For the single line outage of the Palo Verde-Devers 500 kV line in the pre-project case, marginal loadings of 100.7% of the emergency rating of the series capacitor of the Mead-Perkins 500 kV line and 101.6% of the emergency rating of the two Perkins phase shifters occurred. For the same outage, these loadings dropped well below 100% in the post-project case, as shown in the table below.

Limiting Element	Emergency Loading (%) Pre-Project	Post-Project	Outage
Mead-Perkins Series Cap	100.7	85.8	PVDV
Mead-Perkins Phase Shifters	100.6	86.4	PVDV

3. For the double line outage of the Palo Verde-Westwing 500 kV No. 1 and 2 lines in the pre-project case, a loading of 108.8% of the emergency rating of the Hat WALC-Hassayampa 230 kV line occurred. For the same outage, the loading on this line dropped below 100% in the post-project case, as shown in the table below.

Limiting Element	Emergency Loading (%) Pre-Project	Post-Project	Outage
Hat WALC-Hassyamp	108.8	98.4	PVWW1&2

4. For the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines in the post-project case, loadings of 118.4% of the emergency rating of the series capacitor of the Mead-Perkins 500 kV line and 116.0% of the emergency rating of the two Perkins phase shifters occurred.

5. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines, as shown in the table below. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

Limiting Element	Emergency Loading (%) No SPS	Emergency Loading (%) With SPS	Outage
Mead-Perkins Series Cap	118.4	99.5	DPV1&2
Mead-Perkins Phase Shifters	116.0	99.2	DPV1&2
Liberty Phase Shifter	< 90.0	90.8	DPV1&2

V.C DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis is that DPV2 can achieve a 1,200 MW increase in the non-simultaneous rating of Path 49 without new reactive power equipment or SPS while meeting the voltage dip, damping and frequency deviation limits of the transmission system. Acceptable performance also occurred for the Navajo and Palo Verde generation 7% margin analysis.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix D.2.a. The following subsections provide highlights of the analysis.

Mohave On Line

1. All machines in the WECC grid remained in synchronism and were damped. Also, all bus voltage dips and frequency deviations were well within their respective limits in both the pre-and-post-project cases.
2. The WECC grid remained stable for loss of either the Palo Verde-Devers 500 kV line or the Hassayampa-N.Gila 500 kV line with 7% unit margin on the Palo Verde generating units.
3. The WECC grid remained stable for loss of either the Navajo-Crystal 500 kV line or the Moenkopi-Eldorado 500 kV line with 7% unit margin on the Navajo generating units.
4. No reactive power equipment or SPS were needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. All machines in the WECC grid remained in synchronism and were damped. Also, all bus voltage dips and frequency deviations were well within their respective limits in both the pre-and-post-project cases.
2. The WECC grid remained stable for loss of either the Palo Verde-Devers 500 kV line or the Hassayampa-N.Gila 500 kV line with 7% unit margin on the Palo Verde generating units.
3. The WECC grid remained stable for loss of either the Navajo-Crystal 500 kV line or the Moenkopi-Eldorado 500 kV line with 7% unit margin on the Navajo generating units.
4. No reactive power equipment or SPS were needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

V.D POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that DPV2 can achieve a 1,200 MW increase in the non-simultaneous rating of Path 49 without new reactive power equipment or SPS while meeting the post-transient voltage deviation limits of the transmission system.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix D.3.a. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the pre-and-post-project cases.
2. Post-transient voltage deviations did not exceed 10% during double contingencies in both the pre-and-post-project cases.
3. No reactive power equipment or SPS were needed to meet the post-transient voltage deviation limits of the transmission system.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the pre-and-post-project cases.
2. Post-transient voltage deviations did not exceed 10% during double contingencies in both the pre-and-post-project cases.
3. No reactive power equipment or SPS were needed to meet the post-transient voltage deviation limits of the transmission system.

VI. FINDINGS OF SCIT NOMOGRAM SIMULTANEOUS ANALYSIS

VI.A OVERALL SUMMARY

In accordance with the WECC Rating Policy, rating studies need to determine simultaneous path transfer capability limits, as appropriate, for a specific plan of service. The Southern California Import Transmission (SCIT) Nomogram is an important simultaneous path that was assessed in this Study. SCIT defines acceptable flow limits on Path 49 in relation to 5 other paths that deliver power to Southern California. To ensure reliable delivery from the Palo Verde Hub to Southern California, the DPV2 POS will be designed to achieve a 1,200 MW rating increase on both Path 49 and the SCIT Path. To this end, the analysis was based on the key assumption that Path 49 and SCIT power flow increases will be made on a 1 to 1 basis (i.e. 1,200 MW increase on Path 49 and the SCIT Path). Details on the criteria, assumptions and methodology for the SCIT nomogram simultaneous analysis are provided in section IV.1 on page 14 of the Study Scope (Appendix A). The final SCIT Nomogram base cases were approved by the PRG.

Results indicate that the DPV2 POS is adequate to achieve a 1,200 MW simultaneous rating increase on Path 49 and the SCIT path while meeting the Criteria.

Results indicate that reactive power equipment needs to be installed in the Devers Substation area to achieve a 1,200 MW rating increase simultaneously on Path 49 and SCIT while meeting the Criteria. Specifically, 400 MVAr or 500 MVAr of reactive support is needed, under the scenario of Mohave on line or off line, respectively. Also, it was shown that different configurations of reactive support (e.g. SVCs, shunt capacitors) could be employed as long as the system performance of each option meets the Criteria.

Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

No SPS was needed to meet the stability or post transient criteria for the double line outage of the Palo Verde-Devers 500 kV line and the Harquahala-Devers 500 kV line or the Palo Verde-Devers 500 kV line and the Hassayampa-Harquahala 500 kV line.

Details of the SCIT Nomogram analysis results are provided in Appendix F.

VI.B POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 can achieve a 1,200 MW rating increase simultaneously on Path 49 and SCIT while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases," which was approved by the PRG, is provided in Appendix F.1.a. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix F.1.b. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix F.1.c.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix F.1.d.1 and Appendix F.1.d.2. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the pre-or-post-project cases. Marginal loadings of 100.8% and 100.8% occurred on the two Perkins phase shifters in the pre-and-post-project cases, respectively, which were considered acceptable by the owners of the equipment.

2. For the single line outage of the Palo Verde-Devers 500 kV line in the pre-project case, a loading of 105.3% of the emergency rating of the RTAP2 – RTP1 92 kV line and marginal loadings of 100.6% of the emergency rating of the two Perkins phase shifters, occurred. For the same outage, these loadings dropped well below 100% in the post-project case, as shown in the table below.

Emergency Loading (%)

Limiting Element	Pre-Project	Post-Project	Outage
RTAP2-RTP1	105.3	78.7	PVDV
Mead-Perkins Phase Shifters	101.9	86.2	PVDV

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the pre-or-post-project cases. Marginal loadings of 100.7% and 100.6% occurred on the two Perkins phase shifters in the pre-and-post-project cases, respectively, which were considered acceptable by the owners of the equipment.
2. For the single line outage of the Palo Verde-Devers 500 kV line in the pre-project case, a loading of 104.1% of the emergency rating of the RTAP2 – RTP1 92 kV line and marginal loadings of 100.7% of the emergency rating of the two Perkins phase shifters, occurred. For the same outage, these loadings dropped well below 100% in the post-project case, as shown in the table below.

	Emergency Loading (%)		
Limiting Element	Pre-Project	Post-Project	Outage
RTAP2-RTP1	104.1	78.3	PVDV
Mead-Perkins Phase Shifters	100.7	86.0	PVDV

3. For the single line outage of the N.Gila-IV 500 kV line in the pre-project case, a loading of 101.5% of the emergency rating of the Elcentsw 161/230 kV transformer bank occurred. For the same outage, this loading dropped below 100% in the post-project case, as shown in the table below.

	Emergency Loading (%)		
Limiting Element	Pre-Project	Post-Project	Outage
ELCENTSW 161/230	101.5	99.8	NGIV

4. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

VI.C DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis is that DPV2 POS must include reactive power equipment to achieve a 1,200 MW rating increase simultaneously on Path 49 and SCIT while meeting the voltage dip, damping and frequency deviation limits of the transmission system. Study findings indicate the need for 400 MVAr or 500 MVAr of reactive support in the Devers Substation area, under the scenario of Mohave on line and off line, respectively. No SPS is needed.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix F.2.a.1 and Appendix F.2.a.2. The following subsections provide highlights of the analysis.

Mohave On Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the pre-project case.

2. For all contingencies simulated with the exception of the Hassayampa-N.Gila 500 kV line outage and assuming pre-DPV2 reactive support only, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

3. Violations of the voltage dip and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line assuming pre-DPV2 reactive support only as shown in Appendix F.2.a.1.

4. For loss of the Hassayampa-N.Gila 500 kV line, with the addition of a 400 MVAr SVC at Devers 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were within their respective limits as shown in Appendix F.2.a.2.

5. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the pre-project case.

2. For all contingencies simulated with the exception of the Hassayampa-N.Gila 500 kV line outage and assuming pre-DPV2 reactive support only, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

3. Violations of the voltage dip and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line and assuming pre-DPV2 reactive support only as shown in Appendix F.2.a.1.

4. For loss of the Hassayampa-N.Gila 500 kV line, with the addition of a 500 MVAr of reactive support in various configuration options located in the area of Devers Substation, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were within their respective limits as shown in Appendix F.2.a.2.

5. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system

VI.D POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that DPV2 can achieve a 1,200 MW increase simultaneously on Path 49 and SCIT while meeting the post-transient voltage deviation limits of the transmission system. Also, no new reactive power equipment or SPS are needed.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix F.3.a. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the pre-and-post-project cases.

2. For loss of the Palo Verde–Devers 500 kV line, the post-transient voltage deviation was 5% at Miguel and Iron Mountain buses in the pre-project case only.

3. Post-transient voltage deviations did not exceed 10% during double contingencies in both the pre-and-post-project cases.

4. No reactive power equipment or SPS were needed to meet the post-transient voltage deviation limits of the transmission system.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the pre-and-post-project cases.

2. For loss of the Palo Verde–Devers 500 kV line, the post-transient voltage deviation was 5% at Miguel and Iron Mountain buses in the pre-project case only.

3. Post-transient voltage deviations did not exceed 10% during double contingencies in both the pre-and-post-project cases.

4. No reactive power equipment or SPS were needed to meet the post-transient voltage deviation limits of the transmission system.

VII. FINDINGS OF SIMULTANEOUS ANALYSES

In accordance with the WECC Rating Policy, rating studies may need to determine possible simultaneous impacts on other path ratings for a specific project plan of service. At the beginning of this Study, requests were made to assess what impacts DPV2 may have on the following 8 paths.

1. Path 26 (Midway-Vincent)
2. Path 27 (IPPDC)
3. Path 41 (Sylmar)
4. Path 42 (IID)
5. Path 61 (Victorville-Lugo)
6. Path 64 (Marketplace-Adelanto)
7. Path 65 (PDCI)
8. Centennial Path

Details on the criteria, assumptions and methodology for these simultaneous analyses are provided in section IV.2 on page 16 of the Study Scope (Appendix A).

The overall conclusion of the simultaneous analyses is that the DPV2 POS described in section III.B is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with seven of eight Paths at their respective maximum ratings while meeting the Criteria. Nomograms and/or operating procedures will be needed to mitigate the simultaneous interactions with Path 61. The DPV2 POS attributed to these simultaneous analyses include increasing the reactive power capability, and implementing nomograms, operating procedures and an SPS.

The dynamic stability analyses performed for these 8 paths identified reactive power levels that met the Criteria. Results indicated that the addition of a 300 MVAr shunt capacitor at Devers 500 kV bus and a 500 MVAr SVC at Devers 500 kV bus will achieve a 1,200 MW rating increase on Path 49 simultaneously with the other paths at their respective ratings in the Mohave On Line Scenario. For the Mohave Off Line Scenario, adding a 300 MVAr shunt capacitor at Devers 500 kV bus, a 600 MVAr SVC at Devers 500 kV bus and a 400 MVAr SVC at Lugo 500 kV bus will achieve a 1,200 MW rating increase on Path 49 simultaneously with the other paths at their respective ratings. Summaries of results of the reactive support analyses are presented in the following Tables VII.A and VII.B for the Mohave On Line and Off Line scenarios, respectively.

Details of the Simultaneous analyses results are provided in Appendix G.

TABLE VII.A

Simultaneous Analyses Reactive Support Summary

Post-DPV2 With Mohave On Line

Path	Reactive Support to Meet the Planning Criteria: New Shunt Capacitor @ Devers 500 kV (MVAr)	Reactive Support to Meet the Planning Criteria: Add New 2nd SVC @ Devers 500 kV (MVAr)	Reactive Support to Meet the Planning Criteria: Install New SVC @ Lugo 500 kV (MVAr)	Stability Results: Transient Voltage Dip (%) and Damping
NERC/WECC Planning Standard - Category B (Loss of Single Element)				
SCIT Benchmark	None	400	None	Valleysc 500 - 24.1 Devrsvc 500 - 23.7 Hi Deser 115 - 23.7 System < 20 cycles Damping >0
26 (Midway-Vincent)	None	400	None	Hi Deser 115 - 18.50 Devers 500 - 19.1 Devrsvc1 500 - 19.1 System < 20 cycles Damping >0
27 (IPPDC)	None	400	None	Hi Deser 115 - 23.7 Valleysc 500 - 24.2 Devrsvc1 500 - 23.8 Hi Deser 115 - 20 cycles Damping >0
41 (Sylmar)	150	400	None	Hi Deser 115 - 23.4 Valleysc 500 - 23.9 Devrsvc1 500 - 23.6 2 SCE 115 = 20 cycles Damping >0
42 (IID-SCE)				
61 (Victorville-Lugo)	300	500	400	El Nido 66 - 25.9 Valleysc 500 - 24.6 Olinda 66 - 24.4 System <= 20.2 cycles Damping >0
64 (Marketplace-Adelanto)	300	500	None	Padua 66 - 24.5 Valleysc 500 - 25.0 Valysvc2 500 - 24.0 System <= 20 cycles Damping >0
65 (PDCI)	None	400	None	Hi Deser 115 - 23.9 Valleysc 500 - 24.2 Devrsvc1 500 - 24.0 System <= 20.2 cycles Damping >0
Centennial	300	500	None	Hi deser 115 - 22.9 Valleysc 500 - 23.7 Devrsvc1 500 - 22.8 System < 20 cycles Damping >0

TABLE VII.B

Simultaneous Analyses Reactive Support Summary

Post-DPV2 With Mohave Off Line				
	Reactive Support to Meet the Planning Criteria			Stability Results
Path	New Shunt Capacitor @ Devers 500 kV (MVAr)	Add New 2nd SVC @ Devers 500 kV (MVAr)	Install New SVC @ Lugo 500 kV (MVAr)	Transient Voltage Dip (%) and Damping
NERC/WECC Planning Standard - Category B (Loss of Single Element)				
SCIT Benchmark	None	500	None	Valleysc 500 - 23.5 Devrsvc 500 - 22.7 Hi Desert 115 - 22.8 System < 20 cycles Damping >0
26 (Midway-Vincent)	None	500	None	Hi Deser 115 - 18.7 Devers 500 - 19.2 Devrsvc1 500 - 19.2 System < 20 cycles Damping >0
27 (IPPDC)	None	500	None	Hi Deser 115 - 22.9 Valleysc 500 - 23.6 Devrsvc1 500 - 22.8 System < 20 cycles Damping >0
41 (Sylmar)	None	500	None	Villa Pk 66 - 24.5 Valleysc 500 - 24.7 Valysvc2 115 - 23.7 30 SCE 115 = 20 cycles Damping >0
42 (IID-SCE)	None	400	None	N. Gila 69 - 11.5 Horsmesa 115 - 11.7 Devrsvc1 500 - 11.0 System < 20 cycles Damping >0
61 (Victorville-Lugo)	300	700	400	Villa pk 66 - 24.9 Serrano 230 - 23.8 Olinda 66 - 23.3 System <= 20.2 cycles Damping >0
64 (Marketplace-Adelanto)	300	600	400	Padua 66 - 23.8 Victorvl 287 - 24.7 Adelsvc 500 - 24.3 System <= 20 cycles Damping >0
65 (PDCI)	None	500	None	Hi Deser 115 - 22.3 Valleysc 500 - 22.8 Devrsvc1 500 - 22.4 System < 20 cycles Damping >0
Centennial	300	600	400	Padua 66 - 24.0 Victorvl 287 - 25.0 Adelsvc 500 - 24.6 System <= 20 cycles Damping >0

VII.A PATH 26

VII.A.1 OVERALL SUMMARY

The analysis is based on the key assumption that Path 49 and Path 26 power flows would be assessed at their respective maximum ratings, being 9,255 MW for Path 49 and 3,700 MW for Path 26. Also, these results are based on the assumption that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis would be in operation.

Results indicate that the DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 26 at its maximum rating of 3,700 MW while meeting the Criteria.

No SPS was needed to meet the stability or post transient criteria for the double line outage of the Palo Verde-Devers 500 kV line and the Harquahala-Devers 500 kV line or the Palo Verde-Devers 500 kV line and the Hassayampa-Harquahala 500 kV line.

Details of the Path 26 analysis results are provided in Appendix G.(series).1.

VII.A.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 can achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 26 at its maximum rating of 3,700 MW while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.a.1. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.b.1. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix G.1.c.1.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix G.1.d.1. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.7% occurred on each of the two Perkins phase shifters in the post-project sensitivity case, which was considered acceptable by the owners of the equipment.

2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-project case. For the double line outage of the Midway-Vincent 500 kV lines #1 & 2, a loading of 99.4% of the emergency rating of the Midway-Vincent 500 kV line #3 occurred. To be able to model the SPS of Path 26, which is required for this double line outage, this double line outage analysis was performed using the post-transient power flow.

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.6% occurred on each of the two Perkins phase shifters in the post-project sensitivity case, which was considered acceptable by the owners of the equipment.

2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-project case. For the double line outage of the Midway-Vincent 500 kV lines #1 & 2, a loading of 99.3% of the emergency rating of the Midway-Vincent 500 kV line #3 occurred. To be able to model the SPS of Path 26, which is required for this double line outage, this double line outage analysis was performed using the post-transient power flow.

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

VII.A.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 26 at its maximum rating of 3,700 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. No SPS is needed.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix G.2.a.1. The following subsections provide highlights of the analysis.

Mohave On Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system

VII.A.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 26 at its maximum rating of 3,700 MW while meeting the post-transient voltage deviation limits of the transmission system. Also, no SPS is needed.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix G.3.a.1. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

VII.B PATH 27

VII.B.1 OVERALL SUMMARY

The analysis is based on the key assumption that Path 49 and Path 27 power flows would be assessed at their respective maximum ratings, being 9,255 MW for Path 49 and 1,920 MW for Path 27. Also, these results are based on the assumption that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis would be in operation.

Results indicate that the DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 27 at its maximum rating of 1,920 MW while meeting the Criteria.

No SPS was needed to meet the stability or post transient criteria for the double line outage of the Palo Verde-Devers 500 kV line and the Harquahala-Devers 500 kV line or the Palo Verde-Devers 500 kV line and the Hassayampa-Harquahala 500 kV line.

Details of the Path 27 analysis results are provided in Appendix G.(series).2.

VII.B.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 can achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 27 at its maximum rating of 1,920 MW while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.a.2. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.b.2. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix G.1.c.2.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix G.1.d.2. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.8% occurred on each of the two Perkins phase shifters in the post-project sensitivity case, which was considered acceptable by the owners of the equipment.

2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-project case.

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.6% occurred on each of the two Perkins phase shifters in the post-project sensitivity case, which was considered acceptable by the owners of the equipment.

2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-project case.

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused

by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

VII.B.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 27 at its maximum rating of 1,920 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. No SPS is needed.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix G.2.a.2. The following subsections provide highlights of the analysis.

Mohave On Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system

VII.B.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 27 at its maximum rating of 1,920 MW while meeting the post-transient voltage deviation limits of the transmission system. Also, no SPS is needed.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix G.3.a.2. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

VII.C PATH 41

VII.C.1 OVERALL SUMMARY

The analysis is based on the key assumption that Path 49 and Path 41 power flows would be assessed at their respective maximum ratings, being 9,255 MW for Path 49 and 1,600 MW for Path 41. Also, these results are based on the assumption that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis would be in operation.

Results indicate that the DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 41 at its maximum rating of 1,600 MW while meeting the Criteria.

Results indicate that for the Mohave On Line Scenario, if adequate reactive support (at least 150 MVAr shunt capacitor under critical operating conditions) is not in service at Devers 500 kV substation, a nomogram can be implemented to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 41 at its maximum rating of 1,600 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system.

No SPS was needed to meet the stability or post transient criteria for the double line outage of the Palo Verde-Devers 500 kV line and the Harquahala-Devers 500 kV line or the Palo Verde-Devers 500 kV line and the Hassayampa-Harquahala 500 kV line.

Details of the Path 41 analysis results are provided in Appendix G.(series).3.

VII.C.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 can achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 41 at its maximum rating of 1,600 MW while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.a.3. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.b.3. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix G.1.c.3.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in

Appendix G.1.d.3. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.6% occurred on each of the two Perkins phase shifters in the post-project sensitivity case, which was considered acceptable by the owners of the equipment.

2. Except for the single line outage of the N.Gila-IV 500 kV line, no transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-project case.

3. For the single line outage of the N.Gila-IV 500 kV line, a loading of 100.8% of the emergency rating of the Elcentsw 161/230 kV transformer bank occurred. The above loading is marginally greater than the loading that occurred for the same outage in the pre-project SCIT nomogram simultaneous case, as shown in the table below. IID has indicated that they are in the process of developing future plans to address this overload.

	Emergency Loading (%)		
Limiting Element	Pre-Project SCIT	Path 41 Case	Outage
ELCENTSW 161/230	100.1	100.8	NGIV

4. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.5% occurred on each of the two Perkins phase shifters in the post-project sensitivity case, which was considered acceptable by the owners of the equipment.

2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-project case.

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

VII.C.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis for the Mohave On Line Scenario is the need to install a 150 MVAr shunt capacitor at Devers 500 kV bus or develop and implement a nomogram to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 41 at its maximum rating of 1,600 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. For the Mohave Off Line Scenario, the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 41 at its maximum rating of 1,600 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. No SPS is needed.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix G.2.a.3. The following subsections provide highlights of the analysis.

Mohave On Line

1. Except for the Hassayampa-N.Gila 500 kV line outage, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. Violations of the voltage duration criterion occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix G.2.a.3.1.

3. With the addition of a 150 MVAr shunt capacitor at Devers 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.3.2.

4. With the implementation of a nomogram similar to the conceptual nomogram provided in Appendix G.4.a.3, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.3.3.

5. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system

Mohave Off Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system

VII.C.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 41 at its maximum rating of 1,600 MW while meeting the post-transient voltage deviation limits of the transmission system. Also, no SPS is needed.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix G.3.a.3. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

VII.D PATH 42

VII.D.1 OVERALL SUMMARY

The analysis is based on the key assumption that Path 49 and Path 42 power flows would be assessed at their respective maximum ratings, being 9,255 MW for Path 49 and 600 MW for Path 42. Also, these results are based on the assumption that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis would be in operation. In accordance with the Imperial Irrigation District (IID), who made the request to perform this Path 42 analysis, the analysis was performed on the Mohave off line scenario only.

Results indicate that the DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 42 at its maximum rating of 600 MW while meeting the Criteria.

No SPS was needed to meet the stability or post transient criteria for the double line outage of the Palo Verde-Devers 500 kV line and the Harquahala-Devers 500 kV line or the Palo Verde-Devers 500 kV line and the Hassayampa-Harquahala 500 kV line.

Details of the Path 42 analysis results are provided in Appendix G.(series).4.

VII.D.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 can achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 42 at its maximum rating of 600 MW while meeting the thermal limits of the transmission system.

There were some pre-existing thermal loading violations on the Imperial Irrigation District (IID) and San Diego Gas & Electric (SDG&E) transmission systems under contingency conditions. These violations occurred in both the pre-and-post project cases. For the most part, the violations were less severe in the post-project cases than in the pre-project cases. However, 5 out of 31 overloads on IID's system resulted in post-project loadings marginally above the pre-project loadings. IID informed the PRG that they are developing future plans to mitigate these overloads. The one overload on SDG&E's system occurred only in the pre-project case.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.a.4. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.b.4. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix G.1.c.4.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix G.1.d.4. The following subsections provide highlights of the analysis.

Mohave Off Line

1. Except for the Rtap2-RTP1 92 kV transmission line, no transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the pre-or-post-project cases. However, marginal loadings of 100.5% and 100.6% occurred on the two Perkins phase shifters in the pre-and-post-project cases, respectively, which were considered acceptable by the owners of the equipment.

2. The Rtap2-RTP1 92 kV transmission line was loaded to 103.0% of its continuous rating under normal (i.e. non-contingency) conditions in the pre-project case. The same line had a lower loading of 102.5% in the post-project case, as shown in the table below. IID has indicated that they are in the process of developing future plans to address this overload.

	Emergency Loading (%)		
Limiting Element	Pre-Project	Post-Project	Outage
RTAP2-RTP1 92	103.0	102.5	None

3. For the single line outage of the Palo Verde-Devers 500 kV line in the pre-project case, marginal loadings of 100.8% of the emergency rating of the series capacitor of the Mead-Perkins 500 kV line and 100.5% of the emergency rating of the two Perkins phase shifters occurred. For the same outage, these loadings dropped well below 100% in the post-project case, as shown in the table below.

Limiting Element	Emergency Loading (%) Pre-Project	Post-Project	Outage
Mead-Perkins Series Cap	100.8	85.8	PVDV
Mead-Perkins Phase Shifters	100.5	86.4	PVDV

4. The RTAP2-RTP1 92 kV transmission line on IID's system was loaded above 100% of its emergency rating under 13 single contingency conditions in the pre-and-post-project cases. For these same 13 outages, the post-project loadings were below the pre-project loadings. One outage involves the new Harquahala-Devers 500 kV line, which exhibited performance similar to that of the existing Palo Verde-Devers 500 kV line outage in the post-project case. In the last outage, the loading dropped below 100% in the post-project case, as shown in the table below. IID has indicated that they are in the process of developing future plans to address this overload.

Limiting Element	Emergency Loading (%) Pre-Project	Post-Project	Outage
RTAP2-RTP1 92	131.9	114.8	PVDV
RTAP2-RTP1 92	121.2	119.4	IVMG
RTAP2-RTP1 92	N/A	114.3	HQDV
RTAP2-RTP1 92	106.0	104.6	MDPK
RTAP2-RTP1 92	105.0	104.3	LGVT
RTAP2-RTP1 92	104.9	104.0	MOEL
RTAP2-RTP1 92	104.9	104.0	NVCR
RTAP2-RTP1 92	104.3	103.8	LGMH
RTAP2-RTP1 92	104.2	103.8	ELLG
RTAP2-RTP1 92	104.1	103.6	MDMK
RTAP2-RTP1 92	101.9	101.4	VTSB
RTAP2-RTP1 92	101.8	101.4	DVOV
RTAP2-RTP1 92	101.7	101.1	DVVT 1
RTAP2-RTP1 92	101.7	101.1	DVVT 2
RTAP2-RTP1 92	100.9	99.0	SRVL

5. The AV58TP1-Bannister 161 kV transmission line on IID's system was loaded above 100% of its emergency rating under two single contingency conditions in the pre-and-post-project cases. For these same 2 outages, the post-project loadings were well below the pre-project loadings. One outage involves the new Harquahala-Devers 500 kV line, which exhibited performance similar to that of the existing Palo Verde-Devers 500 kV line outage in the post-project case, as shown in the table below. IID has indicated that they are in the process of developing future plans to address this

overload.

Limiting Element	Emergency Loading (%) Pre-Project	Post-Project	Outage
AV58TP1-Bannister 161	121.6	110.1	IVMG
AV58TP1-Bannister 161	111.4	106.2	PVDV
AV58TP1-Bannister 161	N/A	105.8	HQDV

6. The Niland-Midway 161 kV transmission line on IID's system was loaded above 100% of its emergency rating under three single contingency conditions in the pre-and-post-project cases. For these same 3 outages, the post-project loadings were below the pre-project loadings. One outage involves the new Harquahala-Devers 500 kV line, which exhibited performance similar to that of the existing Palo Verde-Devers 500 kV line outage in the post-project case. In the last two outages, these loadings dropped below 100% in the post-project case, as shown in the table below. IID has indicated that they are in the process of developing future plans to address this overload.

Limiting Element	Emergency Loading (%) Pre-Project	Post-Project	Outage
Niland-Midway 161	116.9	114.6	IVMG
Niland-Midway 161	114.6	104.2	PVDV
Niland-Midway 161	N/A	104.0	HQDV
Niland-Midway 161	102.6	100.5	MDPK
Niland-Midway 161	101.2	99.4	NVCR
Niland-Midway 161	101.1	99.3	MOEL

7. The Niland-CVSUB161 161 kV transmission line on IID's system was loaded above 100% of its emergency rating under a single contingency condition in the pre-project case. For the same outage, this loading dropped below 100% in the post-project case, as shown in the table below. IID has indicated that they are in the process of developing future plans to address this overload.

Limiting Element	Emergency Loading (%) Pre-Project	Post-Project	Outage
Niland-CVSUB161 161	101.8	94.5	PVDV

8. The Ramon-Mirage 230 kV transmission line on IID's system was loaded above 100% of its emergency rating under two single contingency conditions in the pre-and-post-project cases. For these two outages, the loadings in the post-project cases increased a relatively small amount above the loadings in the pre-project cases. In the last outage, the loading dropped below 100% in the post-project case, as shown in the table below. IID has indicated that they are in the process of developing future plans

to address this overload.

Limiting Element	Emergency Loading (%) Pre-Project	Emergency Loading (%) Post-Project	Outage
Ramon-Mirage 230	143.3	145.0	CODV
Ramon-Mirage 230	100.5	102.2	IVMG
Ramon-Mirage 230	101.6	98.5	PVDV

9. The Coachella-Devers 230 kV transmission line on IID's system was loaded above 100% of its emergency rating under two single contingency conditions in the pre-and-post-project cases. For these two outages, the loadings in the post-project cases increased a relatively small amount above the loadings in the pre-project cases, as shown in the table below. IID has indicated that they are in the process of developing future plans to address this overload.

Limiting Element	Emergency Loading (%) Pre-Project	Emergency Loading (%) Post-Project	Outage
Coachella-Devers 230	133.9	135.2	RMMR
Coachella-Devers 230	112.3	113.1	CORM

10. The Coachella-Ramon 230 kV transmission line on IID's system was loaded above 100% of its emergency rating under a single contingency condition in the pre-and-post-project cases. For this outage, the loading in the post-project case increased a relatively small amount above the loading in the pre-project case, as shown in the table below. IID has indicated that they are in the process of developing future plans to address this overload.

Limiting Element	Emergency Loading (%) Pre-Project	Emergency Loading (%) Post-Project	Outage
Coachella-Ramon 230	124.3	125.5	CODV

11. The Friars-Mission 138 kV transmission line on SDG&E's system was loaded above 100% of its emergency rating under a single contingency condition in the pre-project case. For the same outage, this loading dropped well below 100% in the post-project case, as shown in the table below.

Limiting Element	Emergency Loading (%) Pre-Project	Emergency Loading (%) Post-Project	Outage
Friars-Mission 138	101.0	81.7	PVDV

12. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

VII.D.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 42 at its maximum rating of 600 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. No SPS is needed.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix G.2.a.4. The following subsections provide highlights of the analysis.

Mohave Off Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system

VII.D.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 42 at its maximum rating of 600 MW while meeting the post-transient voltage deviation limits of the transmission system. Also, no SPS is needed.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix G.3.a.4. The following subsections provide highlights of the analysis.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case. However, a marginal voltage deviation of 5.1% occurred at three Arizona buses (FOOTHILS 69 kV, N.GILA 69 kV and SW1 69 kV).

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

VII.E PATH 61

VII.E.1 OVERALL SUMMARY

The analysis is based on the key assumption that Path 49 and Path 61 power flows would be assessed at their respective maximum ratings, being 9,255 MW for Path 49 and 2.400 MW for Path 61. Also, these results are based on the assumption that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis would be in operation.

Results indicate that the DPV2 POS is not adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 61 at its maximum rating of 2,400 MW while meeting the Criteria.

Results indicate that nomograms, one for thermal and one for stability mitigation, can be implemented to manage a 1,200 MW rating increase on Path 49 simultaneously with Path 61 at its maximum rating of 2,400 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. Results also indicate that an operating procedure can be employed in conjunction with the nomogram to reduce Path 61 schedules to relieve thermal overloads on the Victorville-Lugo 500 kV line for 5 single contingency outages.

For the Mohave Off Line scenario, an SPS that trips Arizona generation and drops load in Southern California, is required to meet the voltage deviation criteria for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage. No SPS was needed for the Mohave On Line scenario to meet the stability or post transient criteria.

Details of the Path 61 analysis results are provided in Appendix G.(series).5.

VII.E.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 cannot achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 61 at its maximum rating of 2,400 MW while meeting the thermal limits of the transmission system. A thermal overload needs to be mitigated. In the absence of other remediation, a nomogram and operating procedure can be employed to reduce schedules to relieve thermal overloads on the Victorville-Lugo 500 kV line for 5 single contingency outages. The analysis was performed on two post-project sensitivity cases representing two nomogram "Corner Points."

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.a.5. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.b.5. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix G.1.c.5.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix G.1.d.5. The following subsections provide highlights of the analysis.

<u>Mohave On Line</u>

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.8% occurred on each of the two Perkins phase shifters in the two post-project sensitivity cases representing the two nomogram "Corner Points." Corner Point 1 represents flow limits of 8,555 MW and 2,400 MW on Path 49 and Path 61, respectively. Corner Point 2 represents flow limits of 9,255 MW and 1,900 MW on Path 49 and Path 61, respectively. Refer to the conceptual

nomogram provided in Appendix G.4.a.5.

2. The Victorville-Lugo 500 kV transmission line on SCE and LADWP's systems was loaded close to 100% of its emergency rating for five single contingency conditions in the post-project case representing nomogram Corner Point 1. For the same outage, this loading dropped well below 100% in the post-project case representing nomogram Corner Point 2, as shown in the table below.

	Emergency Loading (%)		
Limiting Element	Corner Point 1	Corner Point 2	Outage
Victorville-Lugo 500	101.1	94.5	ELLU
Victorville-Lugo 500	97.5	92.1	MOLU
Victorville-Lugo 500	95.6	84.7	DVVL
Victorville-Lugo 500	95.9	82.3	NGIV
Victorville-Lugo 500	95.0	82.2	PVDV

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.6% and 100.5% occurred on each of the two Perkins phase shifters in the two post-project sensitivity cases representing the two nomogram "Corner Points," respectively. Corner Point 1 represents flow limits of 8,555 MW and 2,400 MW on Path 49 and Path 61, respectively. Corner Point 2 represents flow limits of 9,255 MW and 1,700 MW on Path 49 and Path 61, respectively. Refer to the conceptual nomogram provided in Appendix G.4.b.5.

2. The Victorville-Lugo 500 kV transmission line on SCE and LADWP's systems was loaded close to 100% of its emergency rating for three single contingency conditions in the post-project case representing nomogram Corner Point 1. For the same outage, this loading dropped well below 100% in the post-project case representing nomogram Corner Point 2, as shown in the table below.

	Emergency Loading (%)		
Limiting Element	Corner Point 1	Corner Point 2	Outage
Victorville-Lugo 500	99.0	82.5	MOLU
Victorville-Lugo 500	99.0	82.3	ELLU
Victorville-Lugo 500	94.7	74.1	NGIV

3. For the single line outage of the N.Gila-IV 500 kV line, a loading of 101.8% of the emergency rating of the Elcentsw 161/230 kV transformer bank occurred in the post-project case representing nomogram Corner Point 2. The above loading is close to the 101.5% loading that occurred for the same outage in the pre-project SCIT nomogram simultaneous case. IID has indicated that they are in the process of developing future plans to address this overload.

	Emergency Loading (%)		
Limiting Element	Corner Point 1	Corner Point 2	Outage
ELCENTSW 161/230	< 90.0	101.8	NGIV

4. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

VII.E.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis for the Mohave On Line Scenario is the need to install a 300 MVAr shunt capacitor at Devers 500 kV bus and an additional 500 MVAr of SVC capacity at Devers 500 kV bus (i.e. 100 MVAr more than required to achieve 1,200 MW increase on the SCIT path) or develop and implement a nomogram to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 61 at its maximum rating of 2,400 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. For the Mohave Off Line Scenario, there is a need to install a 300 MVAr shunt capacitor at Devers 500 kV bus, an additional 700 MVAr of SVC capacity at Devers 500 kV bus (i.e. 200 MVAr more than required to achieve 1,200 MW increase on the SCIT path) and a 400 MVAr SVC at Lugo 500 kV bus or develop and implement a nomogram to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 61 at its maximum rating of 2,400 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. No SPS is needed.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix G.2.a.5. The following subsections provide highlights of the analysis.

<u>Mohave On Line</u>

1. Except for the Hassayampa-N.Gila 500 kV line outage, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix G.2.a.5.1.

3. With the addition of a 300 MVAr shunt capacitor and the addition of 500 MVAr of SVC capacity at the Devers 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.5.2.

4. With the implementation of a nomogram similar to the conceptual nomogram provided in Appendix G.4.c.5, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.5.3.

5. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. Except for the Hassayampa-N.Gila 500 kV line outage, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix G.2.a.5.1.

3. With the addition of a 300 MVAr shunt capacitor and the addition of 700 MVAr of SVC capacity at the Devers 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.5.2.

4. With the implementation of a nomogram similar to the conceptual nomogram provided in Appendix G.4.d.5, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.5.3.

5. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

VII.E.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 61 at its maximum rating of 2,400 MW while meeting the post-transient voltage deviation limits of the transmission system. No SPS is needed for the Mohave On Line scenario. However, for the Mohave Off Line scenario, an SPS that trips Arizona generation and drops load in Southern California, is required to meet the voltage deviation criteria for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in

Appendix G.3.a.5. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.

2. Except for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, no SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

3. For the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, an SPS that tripped Harquahala generating units CT1 (240 MW) and ST1 (123 MW) and dropped San Bernardino load (389 MW) resulted in acceptable post-transient voltage deviations.

VII.F PATH 64

VII.F.1 OVERALL SUMMARY

The analysis is based on the key assumption that Path 49 and Path 64 power flows would be assessed at their respective maximum ratings, being 9,255 MW for Path 49 and 1,200 MW for Path 64. Since Path 64 is part of the Path 46 definition, increasing Path 64 flow to its maximum rating of 1,200 MW correspondingly increases Path 46 flows close to its maximum rating. For example, with the Path 64 flow at 1,200 MW in the Mohave On Line scenario, the flow on Path 46 is 11,586 MW, which would be very close to the Path 46 target rating of 11,823 MW. This Path 46 target rating is based on increasing the existing Path 46 rating of 10,118 MW by 505 MW and 1,200 MW for the Upgrade Project and DPV2, respectively. In essence, this sensitivity is providing a glimpse of DPV2 performance requirements needed to achieve a 1,200 MW rating increase on Path 46. Also, this Path 64 base case has the same SCIT flow as the SCIT Benchmark case, in essence, making it another SCIT corner point case.

Results indicate that the DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 64 at its maximum rating of 1,200 MW while meeting the Criteria.

Results indicate that reactive power equipment needs to be installed on the SCE system to achieve a 1,200 MW rating increase simultaneously on Path 49 and Path 64 while meeting the Criteria. Specifically, the addition of a 300 MVAr shunt capacitor at Devers 500 kV bus and a 500 MVAr SVC at Devers 500 kV bus will achieve a 1,200

MW rating increase on Path 49 simultaneously with Path 64 at its maximum rating of 1,200 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. For the Mohave Off Line Scenario, adding a 300 MVAr shunt capacitor at Devers 500 kV bus, a 600 MVAr SVC at Devers 500 kV bus and a 400 MVAr SVC at Lugo 500 kV bus will achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 64 at its maximum rating of 1,200 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system.

An SPS that trips Arizona generation and drops load in Southern California, is required to meet the voltage deviation criteria for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage.

Details of the Path 64 analysis results are provided in Appendix G.(series).6.

VII.F.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 can achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 64 at its maximum rating of 1,200 MW while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.a.6. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.b.6. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix G.1.c.6.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix G.1.d.6. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.6% occurred on each of the two Perkins phase shifters in the post-project case.

2. For the single line outage of the N.Gila-IV 500 kV line, a loading of 102.3% of the emergency rating of the Elcentsw 161/230 kV transformer bank occurred in the post-project case. The above loading is marginally greater than the loading that occurred for the same outage in the pre-project SCIT nomogram simultaneous case. IID has indicated that they are in the process of developing future plans to address this overload.

	Emergency Loading (%)		
Limiting Element	Pre-Project SCIT	Path 64 Case	Outage
ELCENTSW 161/230	100.1	102.3	NGIV

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case.

2. For the single line outage of the N.Gila-IV 500 kV line, a loading of 101.9% of the emergency rating of the Elcentsw 161/230 kV transformer bank occurred in the post-project case. The above loading is marginally greater than the loading that occurred for the same outage in the pre-project SCIT nomogram simultaneous case. IID has indicated that they are in the process of developing future plans to address this overload.

	Emergency Loading (%)		
Limiting Element	Pre-Project SCIT	Path 64 Case	Outage
ELCENTSW 161/230	101.5	101.9	NGIV

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

VII.F.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis for the Mohave On Line Scenario is the addition of a 300 MVAr shunt capacitor at Devers 500 kV bus and a 500 MVAr SVC at Devers 500 kV bus will achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 64 at its maximum rating of 1,200 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. For the Mohave Off Line Scenario, adding a 300 MVAr shunt capacitor at Devers 500 kV bus, a 600 MVAr SVC at Devers 500 kV bus and a 400 MVAr SVC at Lugo 500 kV bus will achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 64 at its maximum rating of 1,200 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix G.2.a.6.1 and Appendix G.2.a.6.2. The following subsections provide highlights of the analysis.

Mohave On Line

1. Except for the Hassayampa-N.Gila 500 kV single-contingency line outage, all

machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix G.2.a.6.1.

3. With the addition of a 300 MVAr shunt capacitor and a 500 MVAr SVC at the Devers 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.6.2.

4. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. Except for the Hassayampa-N.Gila 500 kV single-contingency line outage and the double contingency of the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix G.2.a.6.1.

3. With the addition of a 300 MVAr shunt capacitor and a 600 MVAr SVC at the Devers 500 kV bus, and a 400 MVAr SVC at Lugo 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.6.2.

4. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines as shown in Appendix G.2.a.6.1.

5. With the addition of a 300 MVAr shunt capacitor and a 600 MVAr SVC at the Devers 500 kV bus, and a 400 MVAr SVC at Lugo 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.6.2.

6. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

VII.F.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 64 at its maximum rating of 1,200 MW while meeting the post-transient voltage deviation limits of the transmission system. An SPS, which trips Arizona generation and drops load in Southern California, is required to meet the voltage deviation criteria for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix G.3.a.6. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.

2. Except for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, post-transient voltage deviations did not exceed 10% during double contingencies in the post-project case.

3. For the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, the post-transient voltage deviation was 10.9% at Miguel 500 kV bus. Implementing an SPS that tripped Harquahala generating units CT1 (240 MW) and ST1 (123 MW) and dropped San Bernardino load (389 MW) resulted in acceptable post-transient voltage deviations. Also, the reactive power equipment identified in the Dynamic Stability Analysis Results in section VII.F.3 was represented.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.

2. Except for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, post-transient voltage deviations did not exceed 10% during double contingencies in the post-project case.

3. For the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, the post-transient voltage analysis did not converge, possibly indicating a voltage collapse. Implementing an SPS that tripped Harquahala generating units CT1 (240 MW) and ST1 (123 MW) and dropped San Bernardino load (389 MW) resulted in convergence and acceptable post-transient voltage deviations. Also, the reactive power equipment identified in the Dynamic Stability Analysis Results in section VII.F.3 was represented.

VII.G PATH 65

VII.G.1 OVERALL SUMMARY

The analysis is based on the key assumption that Path 49 and Path 65 power flows would be assessed at their respective maximum ratings, being 9,255 MW for Path 49 and 3,100 MW for Path 65. Also, these results are based on the assumption that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis would be in operation.

Results indicate that the DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 65 at its maximum rating of 3,100 MW while meeting the Criteria.

No SPS was needed to meet the stability or post transient criteria for the double line outage of the Palo Verde-Devers 500 kV line and the Harquahala-Devers 500 kV line or the Palo Verde-Devers 500 kV line and the Hassayampa-Harquahala 500 kV line.

Details of the Path 65 analysis results are provided in Appendix G.(series).7.

VII.G.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 can achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 65 at its maximum rating of 3,100 MW while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.a.7. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.b.7. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix G.1.c.7.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix G.1.d.7. The following subsections provide highlights of the analysis.

<u>Mohave On Line</u>

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.7% occurred on each of the two Perkins phase shifters in the post-project sensitivity case, which was considered acceptable by the owners of the equipment.

2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-project case.

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

<u>Mohave Off Line</u>

1. No transmission element was loaded above 100% of its continuous rating under

normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.6% occurred on each of the two Perkins phase shifters in the post-project sensitivity case, which was considered acceptable by the owners of the equipment.

2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-project case.
3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

VII.G.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 65 at its maximum rating of 3,100 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. No SPS is needed.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix G.2.a.7. The following subsections provide highlights of the analysis.

Mohave On Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.
2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.
2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system

VII.G.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with Path 65 at its maximum rating of 3,100 MW while meeting the post-transient voltage deviation limits of the transmission system. Also, no SPS is needed.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix G.3.a.7. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.

2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

VII.H CENTENNIAL PATH

VII.H.1 OVERALL SUMMARY

The analysis is based on the key assumption that Path 49 and the Centennial Path power flows would be assessed at their respective maximum ratings, being 9,255 MW for Path 49 and 3,000 MW for the Centennial Path. The flow on the Centennial Path is driven in large part to the heavy concentration of generation in the local southern Nevada area. The output of this local area generation is in large measure being scheduled to California over Path 46. Therefore, increasing the Centennial Path flow to its maximum rating of 3,000 MW correspondingly increased Path 46 flows close to its maximum expected rating. Like the Path 64 sensitivity analysis, this sensitivity is also providing a glimpse of DPV2 performance requirements needed to achieve a 1,200 MW rating increase on Path 46. Also like the Path 64 base case, this Centennial Path base case has the same SCIT flow as the SCIT Benchmark case, in essence, making it another SCIT corner point case.

Results indicate that the DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with the Centennial Path at its maximum rating of 3,000 MW while meeting the Criteria.

Results indicate that reactive power equipment needs to be installed on the SCE system to achieve a 1,200 MW rating increase simultaneously on Path 49 and the Centennial Path while meeting the Criteria. Specifically, the addition of a 300 MVAr shunt capacitor at Devers 500 kV bus and a 500 MVAr SVC at Devers 500 kV bus will achieve a 1,200 MW rating increase on Path 49 simultaneously with the Centennial Path at its maximum rating of 3,000 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. For the Mohave Off Line Scenario, adding a 300 MVAr shunt capacitor at Devers 500 kV bus, a 600 MVAr SVC at Devers 500 kV bus and a 400 MVAr SVC at Lugo 500 kV bus will achieve a 1,200 MW rating increase on Path 49 simultaneously with the Centennial Path at its maximum rating of 3,000 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system.

An SPS that trips Arizona generation and drops load in Southern California, is required to meet the voltage deviation criteria for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage.

Details of the Centennial Path analysis results are provided in Appendix G.(series).8.

VII.H.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 can achieve a 1,200 MW rating increase on Path 49 simultaneously with the Centennial Path at its maximum rating of 3,000 MW while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.a.8. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix G.1.b.8. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix G.1.c.8.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix G.1.d.8. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.6% occurred on each of the two Perkins phase shifters in the post-project case.

2. For the single line outage of the N.Gila-IV 500 kV line, a loading of 102.5% of the emergency rating of the Elcentsw 161/230 kV transformer bank occurred in the post-project case. The above loading is marginally greater than the loading that occurred for the same outage in the pre-project SCIT nomogram simultaneous case. IID has indicated that they are in the process of developing future plans to address this overload.

	Emergency Loading (%)		
Limiting Element	Pre-Project SCIT	Centennial Case	Outage
ELCENTSW 161/230	100.1	102.5	NGIV

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused

by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case.

2. For the single line outage of the N.Gila-IV 500 kV line, a loading of 101.4% of the emergency rating of the Elcentsw 161/230 kV transformer bank occurred in the post-project case. The above loading is marginally smaller than the loading that occurred for the same outage in the pre-project SCIT nomogram simultaneous case. IID has indicated that they are in the process of developing future plans to address this overload.

	Emergency Loading (%)		
Limiting Element	Pre-Project SCIT	Centennial Case	Outage
ELCENTSW 161/230	101.5	101.4	NGIV

3. Implementing an SPS, which trips 1,125 MW of generation at Harquahala and drops 1,350 MW of load in SCE's system, mitigates the thermal overloads caused by the double line outage of the Palo Verde-Devers and Harquahala-Devers 500 kV lines. Pending further studies, an operating procedure may be developed to reduce the amount of generation and load dropping.

VII.H.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis for the Mohave On Line Scenario is the addition of a 300 MVAr shunt capacitor at Devers 500 kV bus and a 500 MVAr SVC at Devers 500 kV bus will achieve a 1,200 MW rating increase on Path 49 simultaneously with the Centennial Path at its maximum rating of 3,000 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system. For the Mohave Off Line Scenario, adding a 300 MVAr shunt capacitor at Devers 500 kV bus, a 600 MVAr SVC at Devers 500 kV bus and a 400 MVAr SVC at Lugo 500 kV bus will achieve a 1,200 MW rating increase on Path 49 simultaneously with the Centennial Path at its maximum rating of 3,000 MW while meeting the voltage dip, damping and frequency deviation limits of the transmission system.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix G.2.a.8.1 and Appendix G.2.a.8.2. The following subsections provide highlights of the analysis.

Mohave On Line

1. Except for the Hassayampa-N.Gila 500 kV single-contingency line outage, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the

post-project case.

2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix G.2.a.8.1.

3. With the addition of a 300 MVAr shunt capacitor and a 500 MVAr SVC at the Devers 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.8.2.

4. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. Except for the Hassayampa-N.Gila 500 kV single-contingency line outage and the double contingency of the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.

2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix G.2.a.8.1.

3. With the addition of a 300 MVAr shunt capacitor and a 600 MVAr SVC at the Devers 500 kV bus, and a 400 MVAr SVC at Lugo 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.8.2.

4. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines as shown in Appendix G.2.a.8.1.

5. With the addition of a 300 MVAr shunt capacitor and a 600 MVAr SVC at the Devers 500 kV bus, and a 400 MVAr SVC at Lugo 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits as shown in Appendix G.2.a.8.2.

6. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

VII.H.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient to achieve a 1,200 MW rating increase on Path 49 simultaneously with the Centennial

Path at its maximum rating of 3,000 MW while meeting the post-transient voltage deviation limits of the transmission system. However, an SPS, which trips Arizona generation and drops load in Southern California, is required to meet the voltage deviation criteria for the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV double line outage.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix G.3.a.8. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.
2. Except for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, post-transient voltage deviations did not exceed 10% during double contingencies in the post-project case.
3. For the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, the post-transient voltage deviation was 10.9% at Miguel 500 kV bus. Implementing an SPS that tripped Harquahala generating units CT1 (240 MW) and ST1 (123 MW) and dropped San Bernardino load (389 MW) resulted in acceptable post-transient voltage deviations. Also, the reactive power equipment identified in the Dynamic Stability Analysis Results in section VII.H.3 was represented.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.
2. Except for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, post-transient voltage deviations did not exceed 10% during double contingencies in the post-project case.
3. For the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, the post-transient voltage analysis did not converge, possibly indicating a voltage collapse. Implementing an SPS that tripped Harquahala generating units CT1 (240 MW) and ST1 (123 MW) and dropped San Bernardino load (389 MW) resulted in convergence and acceptable post-transient voltage deviations. Also, the reactive power equipment identified in the Dynamic Stability Analysis Results in section VII.H.3 was represented.

VIII. FINDINGS OF SENSITIVITY ANALYSES

In accordance with the WECC Rating Policy, the rating study may need to assess reliability impacts of DPV2 together with other similarly situated projects. At the beginning of this Study, the EOR9000+ Project (EOR9000) was identified as a Phase 2 project. EOR9000 plans to increase Path 49 by 1,245 MW in the 2008 timeframe. To the extent criteria violations were found in the combined Phase 2 sensitivity analysis, mitigation measures would be identified that allow the combined Phase 2 projects to meet the Criteria. At a point in time when it becomes clear that both DPV2 and EOR9000 will be built, a rating study of the combined DPV2 and EOR9000 projects should be jointly pursued by the respective project sponsors.

Analyses of sensitivities, which are not related to other similarly situated Phase 2 projects or involved with existing paths, may be performed at the mutual agreement of the project sponsor and the entity making the request. Four requests of this type were made. To the extent that criteria violations were found in these sensitivities, no attempt was made at identifying mitigation measures in this Study. Below is the overall list of the five sensitivity analyses evaluated in this Study.

1. EOR9000
2. APS PV-TS5
3. SWAT CRT Midpoint Substation
4. IID 200 MW Request
5. MWD Pump Load Off

Details on the criteria, assumptions and methodology for these sensitivity analyses are provided in section V on page 18 of the Study Scope (Appendix A).

The conclusion of the similarly situated DPV2 and EOR9000 sensitivity analysis is that the DPV2 POS described in section III.B is not adequate to achieve a combined 2,445 MW rating increase on Path 49 while meeting the Criteria. Enhancements to the DPV2 POS, which would be required to meet the Criteria, include additional reactive support, more operating procedures, possibly more nomograms and an augmented SPS.

Results of the non-similarly situated sensitivities were mixed. The DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 simultaneously with APS's PV-TS5 project in service while meeting the Criteria. The SWAT CRT's Midpoint Substation sensitivity results indicated that power flowed from the 230 kV transmission grid to the Midpoint Substation, which was opposite of the desired flow direction. As for IID's request for an additional 200 MW on DPV2, the DPV2 POS is not adequate to achieve a 1,400 MW rating increase on Path 49 without additional reactive support. Finally, the DPV2 POS is adequate to achieve a 1,200 MW rating increase on Path 49 with MWD pump loads off line.

Details of the Sensitivity analyses results are provided in Appendix H.

VIII.A EOR9000+ PROJECT SENSITIVITY

VIII.A.1 OVERALL SUMMARY

The analysis is based on the key assumption that the Path 49 power flow would be assessed at its maximum rating of 10,500 MW assuming both DPV2 and EOR9000+ Projects in service. This 10,500 MW Path 49 rating is based on the assumption that DPV2 and the EOR9000+ Project would add 1,200 MW and 1,245 MW, respectively, to the current Path 49 rating of 8,055 MW.

The increase in SCIT path flow resulting from schedules to California was 1,200 MW for DPV2 and 645 MW for the EOR9000+ project. Also, these results are based on the assumption that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis would be in operation.

Results indicate that both DPV2 and EOR9000+ Projects can achieve a 10,500 MW rating increase on Path 49 while meeting the Criteria if enhancements to the DPV2 POS are made. These enhancements include additional reactive support, more operating procedures, possibly more nomograms and an augmented SPS.

Details of the EOR9000 analysis results are provided in Appendix H.(series).1.

VIII.A.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that both DPV2 and EOR9000+ Projects can achieve a 10,500 MW rating increase on Path 49 while meeting the thermal limits of the transmission system. However, additional reactive equipment and an operating procedure may be required to meet the thermal criteria. For the Mohave On Line Scenario, the addition of 700 MVAr and 100 MVAr of shunt capacitors at Devers and Valley 500 kV buses, respectively, will contribute to meeting the Criteria. Also, the addition of 1,200 MVAr, 200 MVAr and 800 MVAr of SVC capacity at Devers, Valley and Lugo 500 kV buses, respectively, will achieve a combined 2,445 MW rating increase on Path 49 while meeting the thermal limits of the transmission system. For the Mohave Off Line Scenario, the addition of 800 MVAr and 100 MVAr of shunt capacitors at Devers and Valley 500 kV buses, respectively, will contribute to meeting the Criteria. Also, the addition of 1,500 MVAr, 200 MVAr and 1,200 MVAr of SVC capacity at Devers, Valley and Lugo 500 kV buses, respectively, will achieve a combined 2,445 MW rating increase on Path 49 while meeting the thermal limits of the transmission system. In addition, thermal overloads need to be mitigated. In the absence of other remediation, an operating procedure could be employed to reduce schedules to relieve thermal overloads on two transmission facilities. An alternative mitigation is to develop and implement a nomogram to achieve the 2,445 MW Path 49 rating increase, which could reduce the number and amount of the aforementioned enhancements.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.a.1. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.b.1. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix H.1.c.1.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix H.1.d.1. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-projects case.
2. Except for loss of the N.Gila – IV 500 kV line, no transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-projects case.
3. For loss of the N.Gila – IV 500 kV line, the power flow case did not converge, possibly indicating unacceptable performance. Adding reactive power equipment identified in the Dynamic Stability Analysis Results in the corresponding section

VIII.A.3 allowed convergence, but resulted in a loading of 101.9% of the emergency rating of the Elcentsw 161/230 kV transformer bank.

4. An operating procedure could be employed to reduce schedules and consequently lower the loading on the Elcentsw 161/230 kV transformer bank to below its emergency rating.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case.
2. Except for loss of the N.Gila–IV 500 kV line, the Hassayampa–N.Gila 500 kV line, and the Vista–San Bernardino 230 kV line # 2, no transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-projects case.
3. For loss of the N.Gila–IV 500 kV line, the power flow case did not converge, possibly indicating unacceptable performance. Adding reactive power equipment identified in the Dynamic Stability Analysis Results in the corresponding section VIII.A.3 allowed convergence, but resulted in a loading of 108.7% of the emergency rating of the Elcentsw 161/230 kV transformer bank.
4. An operating procedure could be employed to reduce schedules and consequently lower the loading on the Elcentsw 161/230 kV transformer bank to below its emergency rating.
5. For loss of the Hassayampa–N.Gila 500 kV line, the power flow case did not converge, possibly indicating unacceptable performance. Adding reactive power equipment identified in the Dynamic Stability Analysis Results in the corresponding section VIII.A.3 allowed convergence and loadings below 100% of the facilities emergency ratings.
6. For loss of the Vista–San Bernardino 230 kV line # 2, a loading of 102.1% of the emergency rating of the Etiwanda-San Bernardino 230 kV line occurred in the post-projects case.
7. An operating procedure could be employed to reduce schedules and consequently lower the loading on Etiwanda-San Bernardino 230 kV line to below its emergency rating.

VIII.A.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis for the Mohave On Line Scenario is the addition of 700 MVAr and 100 MVAr of shunt capacitors at Devers and Valley 500 kV buses, respectively, will contribute to meeting the Criteria. Also, the addition of 1,200 MVAr, 200 MVAr and 800 MVAr of SVC capacity at Devers, Valley and Lugo 500 kV buses, respectively, will achieve a combined 2,445 MW rating increase on Path 49 while meeting the voltage dip, damping and frequency deviation limits of the transmission system. For the Mohave Off Line Scenario, the addition of 800 MVAr and 100 MVAr of shunt capacitors at Devers and Valley 500 kV buses, respectively, will contribute to meeting the Criteria. Also, the addition of 1,500 MVAr, 200 MVAr and 1,200 MVAr of SVC capacity at Devers, Valley and Lugo 500 kV buses, respectively, will achieve a combined 2,445 MW rating increase on Path 49 while meeting the voltage dip, damping and frequency deviation limits of the transmission system. An alternative mitigation is to develop and implement a nomogram to achieve the 2,445 MW Path 49 rating increase.

An SPS, which trips Arizona generation and drops load in Southern California, is required to meet the stability criteria for two double contingencies: the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines, and the Palo Verde-Devers 500 kV and Hassayampa-Harquahala 500 kV lines.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix H.2.a.1.1 and Appendix H.2.a.1.2. The following subsections provide highlights of the analysis.

Mohave On Line

1. Except for the Hassayampa-N.Gila 500 kV single-contingency line outage, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-projects case.
2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix H.2.a.1.1.
3. With the addition of a 700 MVAr shunt capacitor and a 1,200 MVAr SVC at the Devers 500 kV bus, a 100 MVAr shunt capacitor at the Valley 500 kV bus and a 100 MVAr SVC at each of the two Valley 115 kV buses, and a 800 MVAr SVC at the Lugo 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits during the Hassayampa-N.Gila 500 kV line outage, as shown in Appendix H.2.a.1.2.
4. A conceptual nomogram of the Hassayampa-N.Gila 500 kV line outage for this EOR9000+ sensitivity was not developed in this study. However, by implementing a nomogram similar to the conceptual nomogram provided in Appendix G.4.a.5 for Path 61, the WECC stability criteria could be met. This could be explored in a possible WECC rating study in the future, which would seek a Path 49 rating with both DPV2 and EOR9000+ projects.
5. Though not developed in this study, an SPS dropping generation in Arizona may provide acceptable performance for the Hassayampa-N.Gila 500 kV line outage. This could be explored in a possible WECC rating study in the future, which would seek a Path 49 rating with both DPV2 and EOR9000+ projects.
6. Except for the two double contingency outages of the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines, and the Palo Verde-Devers 500 kV and Hassayampa-Harquahala 500 kV lines, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations

were well within their respective limits in the post-projects case.

7. For the two double contingency outages, implementing an SPS that tripped Harquahala generating units CT1 (240 MW), CT2 (240 MW), ST1 (125 MW), ST2 (125 MW) and ST3 (125 MW) and dropped load at San Bernardino (389 MW) and Walnut (432 MW) resulted in acceptable bus voltage dips and frequency deviations. Also, the reactive power equipment identified in item 3 above was represented.

Mohave Off Line

1. Except for the Hassayampa-N.Gila 500 kV single-contingency line outage, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-projects case.
2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix H.2.a.1.1.
3. With the addition of a 800 MVAr shunt capacitor and a 1,500 MVAr SVC at the Devers 500 kV bus, a 100 MVAr shunt capacitor at the Valley 500 kV bus and a 100 MVAr SVC at each of the two Valley 115 kV buses, and a 1,200 MVAr SVC at the Lugo 500 kV bus, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips, duration and frequency deviations were within their respective limits during the Hassayampa-N.Gila 500 kV line outage, as shown in Appendix H.2.a.1.2.
4. A conceptual nomogram of the Hassayampa-N.Gila 500 kV line outage for this EOR9000+ sensitivity was not developed in this study. However, by implementing a nomogram similar to the conceptual nomogram provided in Appendix G.4.a.5 for Path 61, the WECC stability criteria could be met. This could be explored in a possible WECC rating study in the future, which would seek a Path 49 rating with both DPV2 and EOR9000+ projects.
5. Though not developed in this study, an SPS dropping generation in Arizona may provide acceptable performance for the Hassayampa-N.Gila 500 kV line outage. This could be explored in a possible WECC rating study in the future, which would seek a Path 49 rating with both DPV2 and EOR9000+ projects.
6. Except for the two double contingency outages of the Palo Verde-Devers 500 kV and Harquahala-Devers 500 kV lines, and the Palo Verde-Devers 500 kV and Hassayampa-Harquahala 500 kV lines, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-projects case.
7. For the two double contingency outages, implementing an SPS that tripped Harquahala generating units CT1 (240 MW), CT2 (240 MW), ST1 (125 MW), ST2 (125 MW) and ST3 (125 MW) and dropped load at San Bernardino (389 MW) and Walnut (432 MW) resulted in acceptable bus voltage dips and frequency deviations. Also, the reactive power equipment identified in item 3 above was represented.

VIII.A.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient for both DPV2 and EOR9000+ Projects to achieve a 10,500 MW rating increase on Path 49 while meeting the post-transient voltage deviation limits of the transmission system. However, an SPS, which trips Arizona generation and drops load in Southern California, is required to meet the voltage deviation criteria for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix H.3.a.1. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.
2. Except for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, post-transient voltage deviations did not exceed 10% during double contingencies in the post-project case.
3. For the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, the post-transient power flow case did not converge, possibly indicating unacceptable performance. Implementing an SPS that tripped Harquahala generating units CT1 (240 MW), CT2 (240 MW), ST1 (125 MW), ST2 (125 MW) and ST3 (125 MW) and dropped load at San Bernardino (389 MW) and Walnut (432 MW) resulted in acceptable post-transient voltage deviations. Also, the reactive power equipment identified in the Dynamic Stability Analysis Results in the corresponding section VIII.A.3 was represented.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in the post-project case.
2. Except for the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, post-transient voltage deviations did not exceed 10% during double contingencies in the post-project case.
3. For the Palo Verde-Devers 500 kV and the Harquahala-Devers 500 kV double line outage, the post-transient power flow case did not converge, possibly indicating unacceptable performance. Implementing an SPS that tripped Harquahala generating units CT1 (240 MW), CT2 (240 MW), ST1 (125 MW), ST2 (125 MW) and ST3 (125 MW) and dropped load at San Bernardino (389 MW) and Walnut (432 MW) resulted in acceptable post-transient voltage deviations. Also, the reactive power equipment identified in the Dynamic Stability Analysis Results in the corresponding section VIII.A.3 was represented.

VIII.B APS PV-TS5 PROJECT SENSITIVITY

VIII.B.1 OVERALL SUMMARY

The analysis is based on the key assumption that the Path 49 power flow would be assessed at its maximum rating of 9,255 MW assuming both DPV2 and PV-TS5 Projects in service. This 9,255 MW Path 49 rating is based on the assumption that DPV2 would add 1,200 MW and the PV-TS5 Project would add nothing to the current Path 49 rating of 8,055 MW. Also, these results are based on the assumption that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis would be in operation.

Results indicate that the DPV2 POS is adequate to achieve a 9,255 MW rating increase on Path 49 with both DPV2 and PV-TS5 Projects while meeting the Criteria.

No SPS was needed to meet the Criteria for the double line outage of the Palo Verde-Devers 500 kV line and the Harquahala-Devers 500 kV line or the Palo Verde-Devers 500 kV line and the Hassayampa-Harquahala 500 kV line.

Details of the APS PV-TS5 analysis results are provided in Appendix H.(series).2.

VIII.B.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that both DPV2 and PV-TS5 Projects can achieve a 9,255 MW rating increase on Path 49 while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.a.2. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.b.2. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix H.1.c.2.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix H.1.d.2. The following subsections provide highlights of the analysis.

<u>Mohave On Line</u>

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-projects case. However, a marginal loading of 100.7% occurred on each of the two Perkins phase shifters in the post-project case.
2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-projects case.

<u>Mohave Off Line</u>

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-projects case. However, a marginal loading of 100.6% occurred on each of the two Perkins phase shifters in the post-project case.

2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-projects case.

VIII.B.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient for both DPV2 and PV-TS5 Projects to achieve a 9,255 MW rating increase on Path 49 while meeting the voltage dip, damping and frequency deviation limits of the transmission system. No SPS is needed.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix H.2.a.2. The following subsections provide highlights of the analysis.

Mohave On Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.
2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. All machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.
2. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

VIII.B.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient for both DPV2 and PV-TS5 Projects to achieve a 9,255 MW rating increase on Path 49 while meeting the post-transient voltage deviation limits of the transmission system. Also, no SPS is needed.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix H.3.a.1. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.
2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.
2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

VIII.C SWAT CRT MIDPOINT SUBSTATION SENSITIVITY

VIII.C.1 OVERALL SUMMARY

The analysis is based on the key assumption that the Path 49 power flow would be assessed at its maximum rating of 9,255 MW assuming both DPV2 and a conceptual Midpoint Substation project are in service. This 9,255 MW Path 49 rating is based on the assumption that DPV2 would add 1,200 MW and the Midpoint Substation would add nothing to the current Path 49 rating of 8,055 MW.

Power flow results indicated that power flowed from the 230 kV transmission grid to the Midpoint Substation, which was opposite of the desired flow direction. Because of this reversed flow result, the requester of this sensitivity stated that no further analysis is warranted.

Details of the SWAT CRT Midpoint Substation analysis results are provided in Appendix H.(series).3.

VIII.C.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that in the absence of a phase shifter at Midpoint Substation, the power flows from the 230 kV grid to the Midpoint Substation.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.a.3. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.b.3. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix H.1.c.3.

Mohave On Line

1. The power flow from Midpoint Substation to the 230 kV grid with or without the pre-existing Buck Blvd phase shifter in service are reversed, as shown in the table below. The flows were metered at the Midpoint 500/230 kV transformer. The Midpoint phase shifter was out of service in both cases. The negative value indicates power is flowing from the 230 kV grid to the 500 kV system.

	Power Flow (MW)	
Transmission Line	w/ Phase Shifter	w/o Phase Shifter
Midpoint-Buck Blvd 230 kV	-2.4	-8.5

Mohave Off Line

1. The power flow from Midpoint Substation to the 230 kV grid with or without the pre-existing Buck Blvd phase shifter in service are reversed, as shown in the table below. The flows were metered at the Midpoint 500/230 kV transformer. The Midpoint phase shifter was out of service in both cases. The negative value

indicates power is flowing from the 230 kV grid to the 500 kV system.

	Power Flow (MW)	
Transmission Line	w/ Phase Shifter	w/o Phase Shifter
Midpoint-Buck Blvd 230 kV	-1.2	-5.2

VIII.D IID 200 MW REQUEST SENSITIVITY

VIII.D.1 OVERALL SUMMARY

The analysis is based on the key assumption that the Path 49 power flow would be assessed at its maximum rating of 9,455 MW assuming a 1,400 MW DPV2 project. This 9,455 MW Path 49 rating is based on the assumption that DPV2 would add 1,200 MW plus an additional 200 MW based on the IID's request to the current Path 49 rating of 8,055 MW. Also, these results are based on the assumption that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis would be in operation.

Results indicate that the DPV2 POS is not adequate to achieve a 9,455 MW rating increase on Path 49 while meeting the Criteria, without additional reactive support.

No SPS was needed to meet the Criteria for the double line outage of the Palo Verde-Devers 500 kV line and the Harquahala-Devers 500 kV line or the Palo Verde-Devers 500 kV line and the Hassayampa-Harquahala 500 kV line.

Details of the IID 200 MW Request analysis results are provided in Appendix H.(series).4.

VIII.D.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 including the IID 200 MW request can achieve a 9,455 MW rating increase on Path 49 while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.a.4. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.b.4. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix H.1.c.4.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix H.1.d.4. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-project case. However, a marginal loading of 100.6% occurred on each of the two Perkins phase shifters in the post-project case.
2. No transmission element was loaded above 100% of its emergency rating under

single contingency conditions in the post-project case. However, a marginal loading of 100.6% occurred on the Knob – Pilot Knob 161 kV line for loss of the N.Gila-IV 500 kV line.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-projects case. However, a marginal loading of 100.5% occurred on each of the two Perkins phase shifters in the post-project case.
2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-projects case.

VIII.D.3 DYNAMIC STABILITY ANALYSIS RESULTS

The key finding from the dynamic stability analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is not sufficient for DPV2 including the IID 200 MW request to achieve a 9,455 MW rating increase on Path 49 while meeting the voltage dip, damping and frequency deviation limits of the transmission system. No SPS is needed.

The "Path 49 Non-Simultaneous Stability Analysis Summary" is provided in Appendix H.2.a.4. The following subsections provide highlights of the analysis.

Mohave On Line

1. Except for the Hassayampa-N.Gila 500 kV single-contingency line outage, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.
2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix H.2.a.4.
3. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

Mohave Off Line

1. Except for the Hassayampa-N.Gila 500 kV single-contingency line outage, all machines in the WECC grid remained in synchronism and were damped, and all bus voltage dips and frequency deviations were well within their respective limits in the post-project case.
2. Violations of the voltage dip, duration and frequency deviation criteria occurred for loss of the Hassayampa-N.Gila 500 kV line as shown in Appendix H.2.a.4.
3. No SPS was needed to meet the voltage dip, damping and frequency deviation limits of the transmission system.

VIII.D.4 POST-TRANSIENT POWER FLOW ANALYSIS RESULTS

The key finding from the post-transient power flow analysis is that the reactive power equipment identified in the SCIT Nomogram Simultaneous analysis is sufficient for DPV2 including the IID 200 MW request to achieve a 9,455 MW rating increase on Path 49 while meeting the post-transient voltage deviation limits of the transmission system. Also, no SPS is needed.

The "Path 49 Non-Simultaneous Post Transient Analysis Summary" is provided in Appendix H.3.a.4. The following subsections provide highlights of the analysis.

Mohave On Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.
2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

Mohave Off Line

1. Post-transient voltage deviations did not exceed 5% during single contingencies in both the post-project case.
2. No SPS was needed to meet the post-transient voltage deviation limits of the transmission system.

VIII.E MWD PUMP LOAD OFF LINE SENSITIVITY

VIII.E.1 OVERALL SUMMARY

The analysis is based on the key assumption that the Path 49 power flow would be assessed at its maximum rating of 9,255 MW with the MWD pump loads off line. This sensitivity was limited to power flow analysis based on the requester's concern over possible impact on meeting facility thermal limitations.

Results indicate that the DPV2 POS is adequate to achieve a 9,255 MW rating increase on Path 49 with the MWD pump loads off line while meeting the Criteria

Details of the MWD Pump Load Off Line analysis results are provided in Appendix H.(series).5.

VIII.E.2 POWER FLOW ANALYSIS RESULTS

The key finding from the power flow analysis is that DPV2 with the MWD pump loads off line can achieve a 9,255 MW rating increase on Path 49 while meeting the thermal limits of the transmission system.

The "Control Area Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.a.5. The "Path Flow Summary of Pre-Contingency Base Cases" is provided in Appendix H.1.b.5. Also, "Power Flow Diagrams of Pre-Contingency Bases Cases" are provided in Appendix H.1.c.5.

The "Path 49 Non-Simultaneous Power Flow Analysis Summary," which lists the 5 highest transmission loadings for normal and contingency conditions, is provided in Appendix H.1.d.5. The following subsections provide highlights of the analysis.

Mohave On Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-projects case. However, a marginal loading of 100.8% occurred on each of the two Perkins phase shifters in the post-project case.
2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-projects case.

Mohave Off Line

1. No transmission element was loaded above 100% of its continuous rating under normal (i.e. non-contingency) conditions in the post-projects case. However, a marginal loading of 100.6% occurred on each of the two Perkins phase shifters in the post-project case.
2. No transmission element was loaded above 100% of its emergency rating under single contingency conditions in the post-projects case.

IX. OTHER STUDIES

Other studies described below are being performed separately to address specific aspects of the DPV2 project. These studies are not part of this Study and are being presented as information only. SCE will continue to perform these studies until completion and report findings to the PRG. SCE will pursue any mitigation actions including additions to the DPV2 plan of service that may be identified in these other studies to meet local, regional and WECC area planning and/or operational requirements.

1 SWITCHABLE SHUNT LINE REACTOR STUDY

This study was performed to determine the feasibility of making the shunt line reactors on the Devers-Palo Verde 500 kV #1 and 2 lines switchable rather than fixed. Given an open ended line condition, transmission and substation equipment may be exposed to unacceptably high voltages on the open-ended line. Results indicated that due to unacceptably high open-ended line voltages, the shunt line reactors must remain fixed.

2 SPS ARMING STUDY

The DPV2 Comprehensive Progress Report indicated the need to trip generation in Arizona and load in Southern California to achieve acceptable performance for the double contingency outage of the Devers-Palo Verde 500 kV #1 and 2 lines. This SPS Arming Study is focused on identifying more broadly and completely all of the criteria violations and key parameters (i.e. drivers) impacting this N-2 outage. Among others, the following potential drivers will be included in the study:

- Path 66 (COI) at appropriate heavy to maximum flow
- Palo Verde Hub at appropriate heavy to maximum flow

Also, the study will identify other possible mitigation options and evaluate the effectiveness of dropping generation at different locations in Arizona and in different amounts. Other options include tripping generation only and dropping load only in Southern California.

3 SHORT CIRCUIT STUDY

The Short Circuit Study is focused on determining any short circuit duty impacts on neighboring transmission systems due to DPV2. A separate review group has been formed to perform the study. The DPV2 Short Circuit Review Group has developed a study plan and is performing short circuit studies.

4 SUB SYNCHRONOUS RESONANCE (SSR) STUDY

SCE has contracted Mitsubishi Electric Power Products, Inc. to perform studies to determine any Sub Synchronous Resonance impacts on the Palo Verde generating plant due to DPV2. Also, impacts on the Navajo generating plant due to raising the series compensation to 70% on the Mohave-Lugo 500 kV line will be assessed.

5 PALO VERDE HUB – EXTREME CONTINGENCY STUDY

SCE has been working with representatives of Arizona Public Service, the Salt River Project and the Arizona Corporation Commission to identify extreme contingencies that need to be analyzed to assess the impact of DPV2 on system performance. This study will be performed and reviewed under the guidance of WATS.

6. PALO VERDE SIMULTANEOUS GENERATION CAPABILITY STUDY

SCE agrees to perform stakeholder - approved studies to determine the impact of the DPV2 Project, with a rating of 1200 MW, on the simultaneous generating capability, SGC, at the Palo Verde/Hassayampa Hub. If the analysis results show an impact to the SGC, then SCE will identify appropriate mitigation. This study work will be performed and reviewed under the guidance and approval of WATS.

7. IMPACT OF DVP2 ON PALO VERDE – COI INTERACTION

SCE agrees to perform stakeholder - approved studies to determine the impact of the DPV2 Project, with a rating of 1200 MW, on the Palo Verde – COI interface. Transfers on the COI Interface are limited by the simultaneous outage of 2 units of Palo Verde. This study sensitivity will determine the impact, if any, of the simultaneous two line outage of Palo Verde–Devers 500kV and Harquahala–Devers 500kV. There have been studies performed by SCE that have found a need for a Hassayampa generation and SCE local load SPS to mitigate the loss of the 2 lines for SCE local load voltage dip criteria violations. The preliminary results of the stability analysis show a need for approximately 400 MW of load and generation each that needs to be in the SPS. The ultimate value of load and generation required to be in the

SPS is dependant on the choice of many variables and the results may be higher in magnitude. This study work will be performed and reviewed under the guidance and approval of WATS.

X. APPENDICES

APPENDIX A - STUDY SCOPE

APPENDIX B - DYNAMIC AND POST TRANSIENT SWITCH DECKS

APPENDIX C - SCE RESPONSES TO COMMENTS ON WECC CPR

APPENDIX D - PATH 49 ANALYSIS DIAGRAMS & TABLES

APPENDIX E - SCE RESPONSES TO COMMENTS ON PATH 49 STUDY

APPENDIX F - SCIT ANALYSIS DIAGRAMS & TABLES

APPENDIX G - SIMULTANEOUS DIAGRAMS AND TABLES

APPENDIX H - SENSITIVITY DIAGRAMS AND TABLES