ORIGINAL

0000061885

3 ore

BEFORE THE ARIZONA POWER PLANT

AND TRANSMISSION LINE SITING COMMITTEE

IN THE MATTER OF THE APPLICATION OF SOUTHERN CALIFORNIA EDISON COMPANY AND ITS ASSIGNEES IN CONFORMANCE WITH THE REQUIRMENTS OF ARIZONA REVISED STATUTES SECTIONS 40-360.03 AND 40-360.06 FOR A CERTIFICATE OF ENVIRONMENTAL COMPATIBILITY AUTHORIZING CONSTRUCTION OF A 500 kV ALTERNATING CURRENT TRANSMISSION LINE AND RELATED FACILITIES IN MARICOPA AND LA PAZ COUNTIES IN ARIZONA ORIGINATING AT THE HARQUAHALA GENERATING STATION SWITCHYARD IN WESTERN MARICOPA COUNTY AND TERMINATING AT THE DEVERS SUBSTATION IN RIVERSIDE COUNTY, CALIFORNIA.	CASE NO. 130 DOCKET NO. L-00000A-06-0295-00130 **NOTICE OF FILING**

Commission Staff ("Staff") hereby submits this Notice of Filing the power point slide presentation of Mr. Jerry Smith of the Utilities Division.

RESPECTFULLY SUBMITTED this 3rd day of October, 2006.

Christopher C. Kempley

Christopher C. Kempley, Esq.
Keith A. Layton, Esq.
Legal Division
Arizona Corporation Commission
1200 West Washington Street
Phoenix, Arizona 85007
(602) 542-3402

Original and twenty-five (25) copies of the foregoing filed this 3rd day of October, 2006 with:

Docket Control
Arizona Corporation Commission
1200 West Washington Street
Phoenix, Arizona 85007

Copies of the foregoing mailed this 3rd day of October, 2006 to:

Thomas H. Campbell
LEWIS & ROCA
40 North Central Avenue
Phoenix, Arizona 85004-4429
Attorneys for Applicant

William D. Baker
Ellis & Baker P.C.
7310 North 16th Street
Suite 320
Phoenix, Arizona 85020-5276

Timothy M. Hogan, Executive Director
Arizona Center for the Law in the Public Interest
202 East McDowell Road
Suite 153
Phoenix, Arizona 85004-4533

Jay Moyes
Steve Wene
Moyes Storey
1850 North Central Avenue
Suite 1100
Phoenix, Arizona 85004

Court S. Rich
Rose Law Group
6613 North Scottsdale Road
Suite 200
Scottsdale, Arizona 85250

Scott S. Wakefield
RUCO
1110 West Washington Street
Suite 220
Phoenix, Arizona 85007

Donald Begalke
P.O. Box 17862
Phoenix, Arizona 85011-0862

Thomas W. McCann
Central Arizona Water Conservation District
23636 North 7th Street
Phoenix, Arizona 85024

Walter Meek
Arizona Utility Investors Association
2100 North Central Avenue
Suite 210
Phoenix, Arizona 85004

Michael W. Patten
Laura Sixkiller
Roshka DeWulf & Patten
400 East Van Buren Street
Suit 800
Phoenix, Arizona 85004-2262

Patrick J. Black
Fennemore Craig P.C.
3003 North Central Avenue
Suite 2600
Phoenix, Arizona 85012

Larry K. Udall
Michael Curtis
Curtis Goodwin Sullivan Udall & Schwab PLC
2712 North 7th Street
Phoenix, Arizona 85006

Roseann Osorio

Arizona Corporation Commission

Docket No. L-00000D-06-0295-00130

Palo Verde – Devers 2 500 kV Project

Jerry D. Smith
Electric Utility Engineer

October 4, 2006

ACC Staff Witness

Name :	**Jerry D. Smith**
Title :	**Electric Utility Engineer**
Employer:	**Arizona Corporation Commission**
Address:	**Utilities Division** **1200 W. Washington** **Phoenix, AZ 85007**

Professional Background

- B.S.E.E – University of New MEXICO
- M.S.E.E. – New Mexico State University
- Registered Arizona P.E. – Electrical
- 27 Yrs. Engineering and Management Experience with the Salt River Project
- Utility Regulation Experience Since 2/99

Context of Case

Siting of Palo Verde – Devers 2 Places the Project at the Confluence of Several Major Public Policy Efforts:

- **EPAct 2005**
  - Sec 368 Western Corridor PEIS
  - Sec 1221 NIETC Congestion Assessment
  - Sec 1221 FERC Transmission Siting Authority
  - Title XII Electricity: ERO and Mandatory Reliability Standards
- **WGA Interstate Transmission Siting Protocol**
- **WECC Transmission Expansion Planning Policy Committee**
- **Transmission Planning Study Groups**
  - STEP: S.W. Transmission Expansion Planning
  - SWAT: S.W. Area Transmission
  - CRT: Colorado River Transmission
- **ACC Biennial Transmission Assessment**
- **New CAISO Tariff –MRTU Effective 11/1/2007**

Disappointments

- Siting Process Utilized for This Interstate Line is Not Consistent With The Intent of The WGA Interstate Transmission Line Siting Protocol
- No CPUC CEQA EIR / BLM EIS or DOE Sec 386 PEIS Response to ACC Staff Comments About Need for Consideration of Reliability Impacts When Placing Energy Facilities in Common Corridors/Contiguous ROW
- Negotiations Between SCE, APS, and Harquahala Have Not Been Timely and Nature of Agreement Has Not Been Divulged
- CAISO Made an Appearance in CPUC Proceedings But Not in Arizona Proceedings
- SCE Has Proceeded With PVD2 as Sole Owner Without An Open Invitation to Others
- Project Traverses Area of Arizona With Express Transmission Interest Noted by CRT Study Participants

ACC Staff's Challenge

- **Assure Proceeding Achieves the Following :**
  - Establish Sufficient Hearing Record for Commission Consideration of Balancing Test of Project
  - Accommodates Western Wholesale Market Needs While Preserving/Protecting AZ Consumers' Interest
- **How This Testimony Responds to the Challenge**
  - Broadens CPUC's "Tipping Point" Assessment of Project's Economic Value[1]
  - Provides Staff's "Thin Slice" Assessment of Project Benefit to Arizona and the West[2]
  - Offers Staff's Proposed Conditions

[1] **The Tipping Point**, How Little Things Can Make a Big Difference, Malcom Gladwell, 2000.

[2] **Blink**, The Power of Thinking Without Thinking, Malcom Gladwell, 2005

Impressions of CPUC's "Tipping Point" Assessment

- **Merits of SCE/CAISO TEAM Related Studies**
  - Only WECC Sub-region Using Such Models to Compare Effectiveness of Alternatives in Mitigating Congestion
  - Effectively Demonstrated Historical and Potential for Future Transmission Congestion of Path 49 (EOR)
  - Demonstrated Relative <u>Physical</u> Effectiveness of Various Transmission Alternatives in Mitigating Path 49 Congestion
  - Order of Magnitude <u>Fiscal</u> Impact on CAISO/CA Has Been Reasonably Established
- **TEAM Studies Performed by STEP, CAISO and SCE**
  - Assumed No Natural Gas Supply/Delivery Constraints for AZ Plants
  - Did Not Model Actual Market Behavior Outside of CAISO / CA
  - <u>Fiscal</u> Impact on Western Interconnection Appears to be Ill-Defined

ACC Staff's "Thin Slice" Assessment

- **Regarding Path 49 East of River (EOR)**
  - Considerable Evidence That Path is Congested
  - DOE Considers Path Warrants Remedy
  - PVD2 is One of a Family of Solutions Being Proposed and Implemented
  - PVD2 Addition Not Solely Sufficient to Fully Mitigate <u>Physical</u> Congestion of Path
- **Arizona Resource Adequacy Not Jeopardized**
- **Future Arizona Utility Resources Were Not Modeled in TEAM Studies - Will Likely Ameliorate Implied Arizona Market Impacts of PVD2**

"Thin Slice" Assessment (Continued)

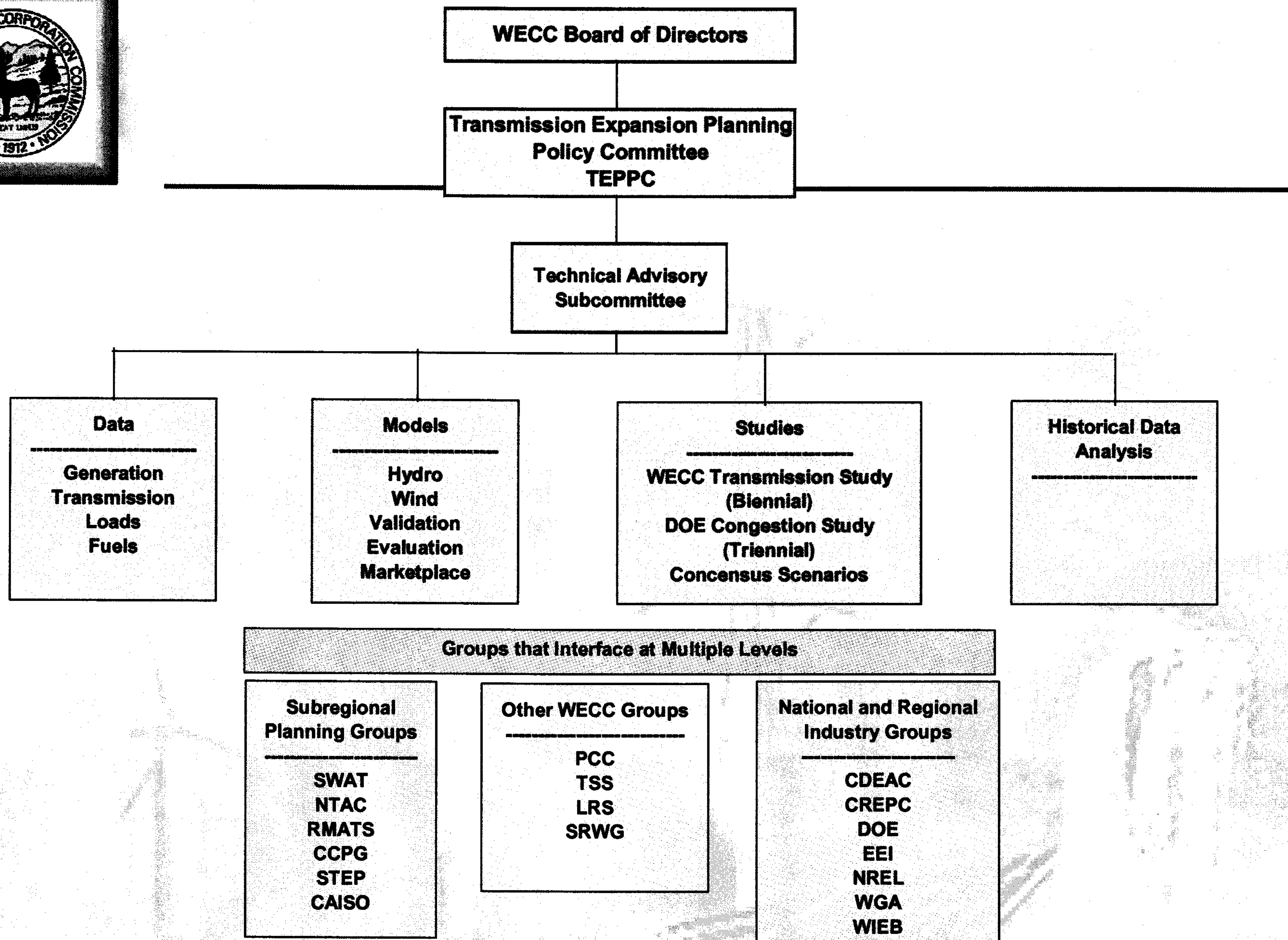
- The Only AZ Termination Acceptable to Staff is Harquahala Junction Switchyard
- SCE's Proposed PVD2 Line Route, Design and 130 Feet Separation From PVD1 Adds Unacceptable Reliability Risk / Consequences
- Use of Special Protection Scheme for Loss of Two Palo Verde to Devers Lines is an Unacceptable Condition Given Staff Efforts to Mitigate Extreme Outage Conditions at Palo Verde Hub

ACC Staff Conclusions

- **Wholesale Market Need for More Transmission Capacity Between Arizona and California has Been Established by The Industry**
- **Palo Verde – Devers 2 is Among a Family of Alternatives Proposed to Mitigate Congestion**
- **Unless Properly Conditioned with Proper Arizona Termination**
  - Proposed Route/Design Adds New Reliability Risks and Consequences
  - Extreme Contingency Risks at Palo Verde Hub Are Not Mitigated and Prevailing Palo Verde Hub Commercial Practices Are Compromised
  - Open Access Seams Issues Between CAISO and Arizona Transmission Network Will Be Exacerbated
- **ACC Staff Proposes Conditions That**
  - Resolves The Above Concerns
  - Preserves/Protects AZ Consumers' Quality of Service Interest
  - While Accommodating The Western Wholesale Market Needs

ACC Staff Proposed Conditions – Foundation & Purpose -

- Assure Arizona's EHV System Reliability is Not Adversely Impacted
- Mitigate Reliability Risks & Consequences of Extreme Contingencies at Palo Verde Hub
- Ensure Non-discriminatory Open Access Transmission Principals and Palo Verde Hub Commercial Practices Are Not Compromised
- Preserve Operational Reliability Obligations Imposed by ACC on Palo Verde Hub Plants
- Protect Arizona's Access to Limited Natural Gas Pipeline Capacity for AZ Retail Natural Gas Customers and Energy Production for Other EOR Power Plant Customers


WECC Board of Directors
Transmission Expansion Planning Policy Committee TEPPC
Technical Advisory Subcommittee
Data
Generation
Transmission
Loads
Fuels
Models
Hydro
Wind
Validation
Evaluation
Marketplace
Studies
WECC Transmission Study (Biennial)
DOE Congestion Study (Triennial)
Concensus Scenarios
Historical Data Analysis
Groups that Interface at Multiple Levels
Subregional Planning Groups
SWAT
NTAC
RMATS
CCPG
STEP
CAISO
Other WECC Groups
PCC
TSS
LRS
SRWG
National and Regional Industry Groups
CDEAC
CREPC
DOE
EEI
NREL
WGA
WIEB

3rd Biennial Transmission Assessment – Key Conclusions

- Existing and Planned Transmission Facilities Meet Load Serving Requirements of Arizona in a Reliable Manner. (Without the Planned Facilities a Different Conclusion May Have Been Reached)
- The Palo Verde to TS5 to Raceway and Palo Verde to Browning (SEV) Projects Will Significantly Increase the Outlet Capability of the Palo Verde Hub to Arizona.
- Existing Transmission from Palo Verde to California is Inadequate to Allow All Palo Verde Hub Generation Full Access to California Market Under Weak Arizona Market Conditions.

Applicability of 3rd BTA Key Planning Requirements

- Utilities & Staff to Develop / Implement More Stringent RMR Study Criteria for 2006 BTA.
- Study Extreme Contingency Outages of Arizona's Major Transmission Stations and Generation Hubs to Identify Associated Risks and Consequences if Mitigating Infrastructure Improvements Not Planned.
- Compliance with WECC and NERC (N-1-1): Single Contingency Criteria Overlapped with Bulk Power System Facility Maintenance for Year 1 of the BTA.

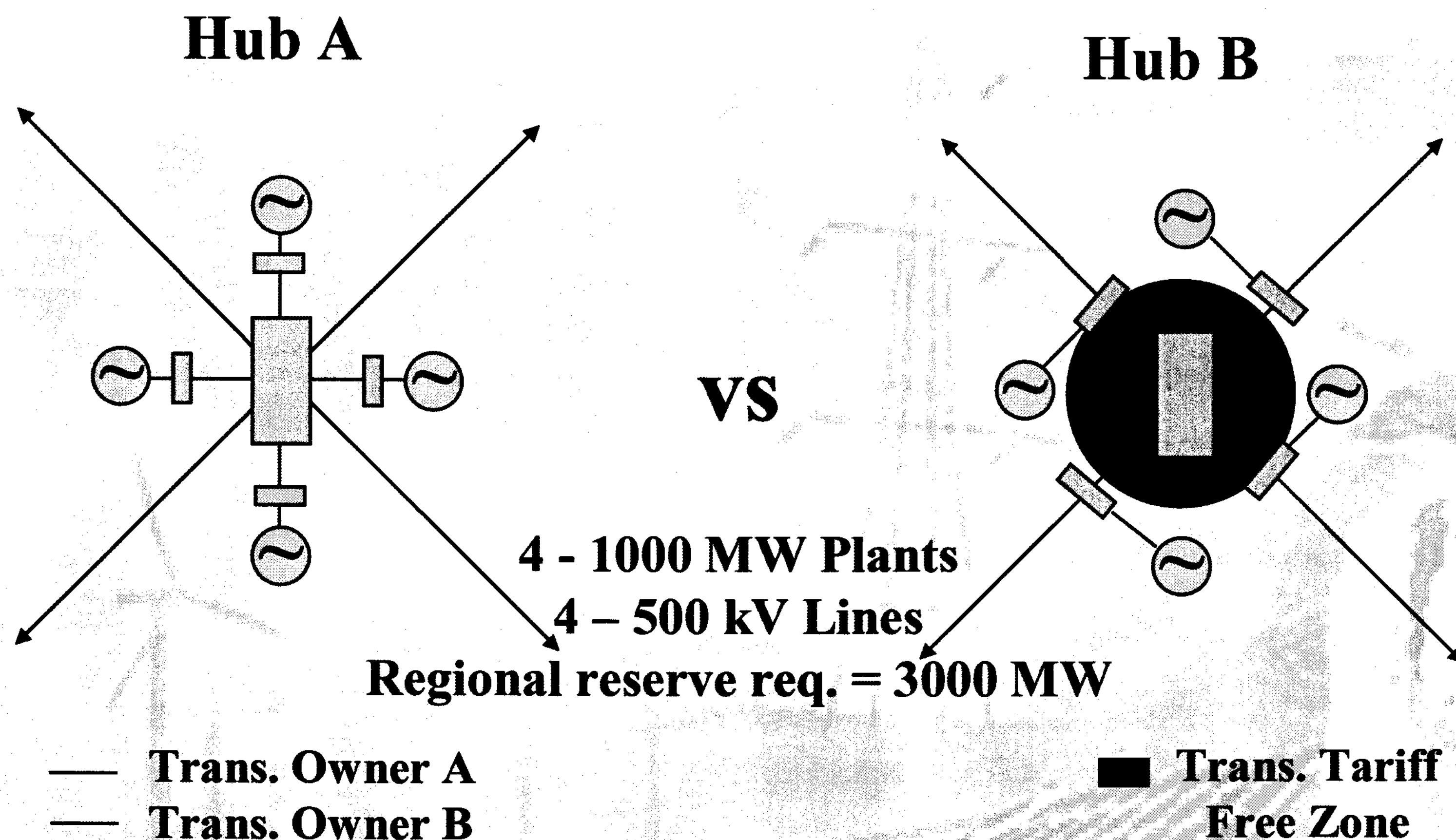
Implementation of 3rd BTA Planning Requirements

- **Study Extreme Contingencies**
  - Lose All Common Voltage Transformers at Each Major Station
  - Update Palo Verde/Hassayampa Hub Assessment
  - Loss of EHV Transmission Corridors
  - Explain How Ten-Yr Plan Facilities Mitigate Impact
  - Protection System:
    - Provide Inventory of All Protection Schemes,
    - Determine Adequacy of Redundancy & Coordination
    - Simulate Events Where Adequacy In Question
    - Quantify Risk Associated w/ Protection Misoperation
- **RMR Study**
  - Study Period: 2006 through 2014
  - Study Most Critical Extreme Contingency For Each Load Area

PV Hub Risk Assessment Recommendations

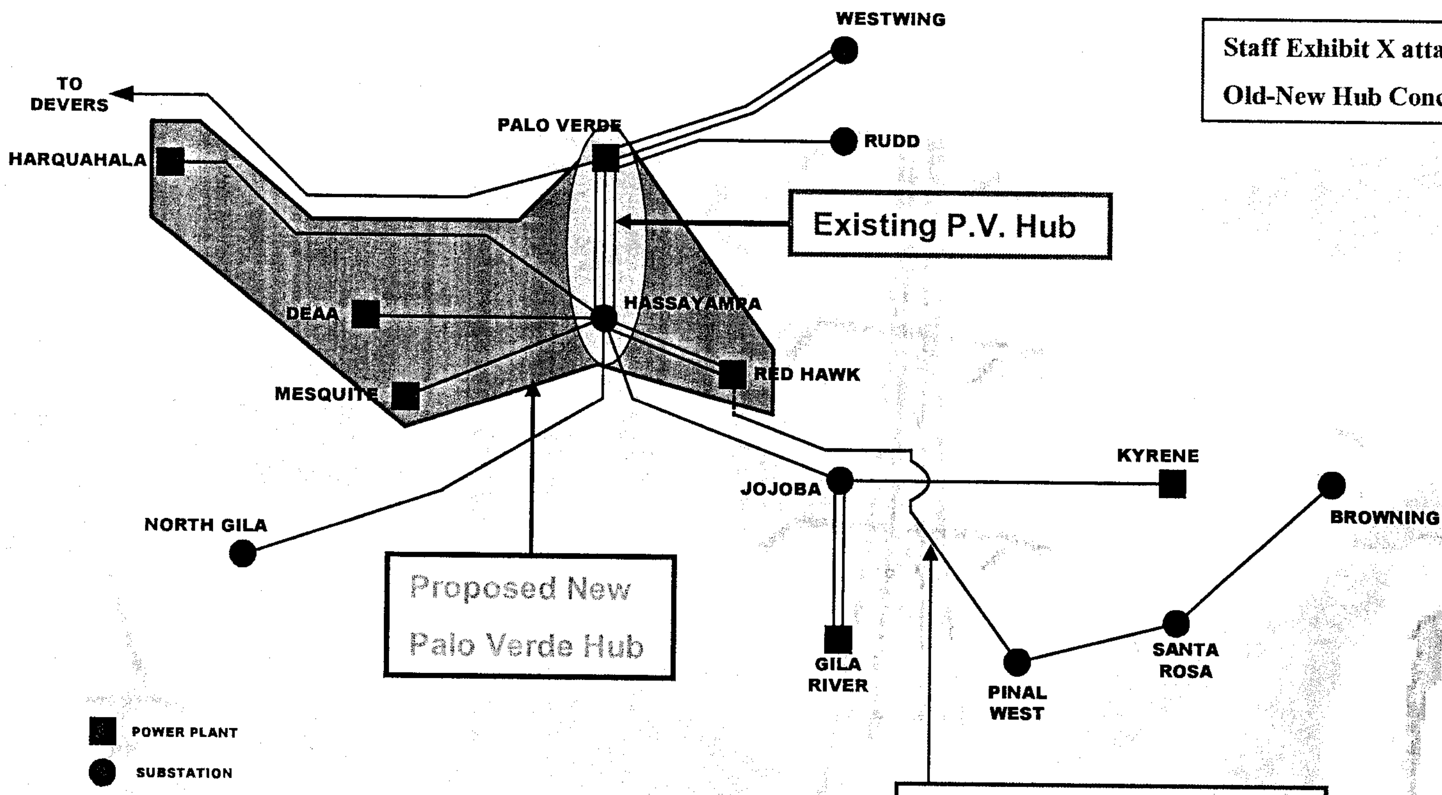
- Future generation or transmission projects should give consideration to risk mitigation for extreme events.
- For overall diversity, performance and risk mitigation: should consider terminating future lines at generating stations interconnected at the hub rather than at the Palo Verde or Hassayampa Switchyards.
- Future generators desiring to interconnect at the Palo Verde hub should also be interconnected to at least one other location in the transmission network.

Hub Concepts



Existing & Proposed New Palo Verde Hub

Staff Exhibit X attachment:
Old-New Hub Concept-r1.ppt



- ACC Staff proposes the new Palo Verde Hub concept.
- Either APS or SRP will file with FERC for approval of the new P.V. Hub.

Implications Regarding Future Arizona Resource Needs

"We have nothing to fear but fear itself" – Franklin D. Roosevelt

- Per 2006 WECC power supply assessment - the Desert Southwest becomes deficient in planned reserve margins as early as 2008
- Approved CEC's for 8 Arizona plants totally 5575 MW not yet under construction terminate in 2007 and 2008
- PVD2 enables SCE access to 1200 of 6500 MW new gas-fired generation in AZ / NV[1] beginning in 2009 (Leaves 5300 MW for others)
- Arizona utilities have since 2003 had access to most of the generation for which SCE now seeks access
- Arizona utilities are pursuing Other Resources (many are located outside of Arizona)

[1] Assumed in SCE economic studies, Exhibit B-2 of Application, page 29 and Appendix C

Arizona Plants
Approved But Not Constructed

Plant	Technology	CEC Rating (MW)	Date of CEC Expiration	Project Status
Springerville 4	Coal	380	12/31/2009	2009 Construction Expected
Gila Bend	Combined Cycle	845	12/31/2006	Extension Pending
Bowie	Combined Cycle	1000	5/7/2007	Extension / IGCC Filing Likely
Sundance II	Combustion Turbine	90	7/9/2006	Phase I/II – Complete / Inactive
Arlington Valley II	Combined Cycle	600	5/12/2007	Phase I/II – Complete / Inactive
Redhawk 3 & 4	Combined Cycle	1060	2/23/2010	1 & 2 Complete, 3 & 4 Inactive
Welton Mohawk	Combined Cycle	520	8/18/2008	Seeking Contract
Allegheny La Paz	Combined Cycle	1080	5/16/2007	Inactive
	TOTAL	5575		

Future Arizona Resource Needs - Other Considerations -

- **APS / SRP have long term RFPs pending for XX MW of base load generation**
  - 1000 MW Desert Rock coal-fired plant proposed in vicinity of Four Corners
  - Ely & Mesquite coal–fired plants proposed in Nevada
  - Northern Lights / Frontier / APS Transwest Express transmission projects will enable Arizona access to new Wyoming Coal and Wind Generation
  - PWCC Contemplating New Nuclear Generation
- **New Mexico projecting 6000 MW wind development for export to / through AZ**
- **ACC 15% RPS in 2025 in rule making process**

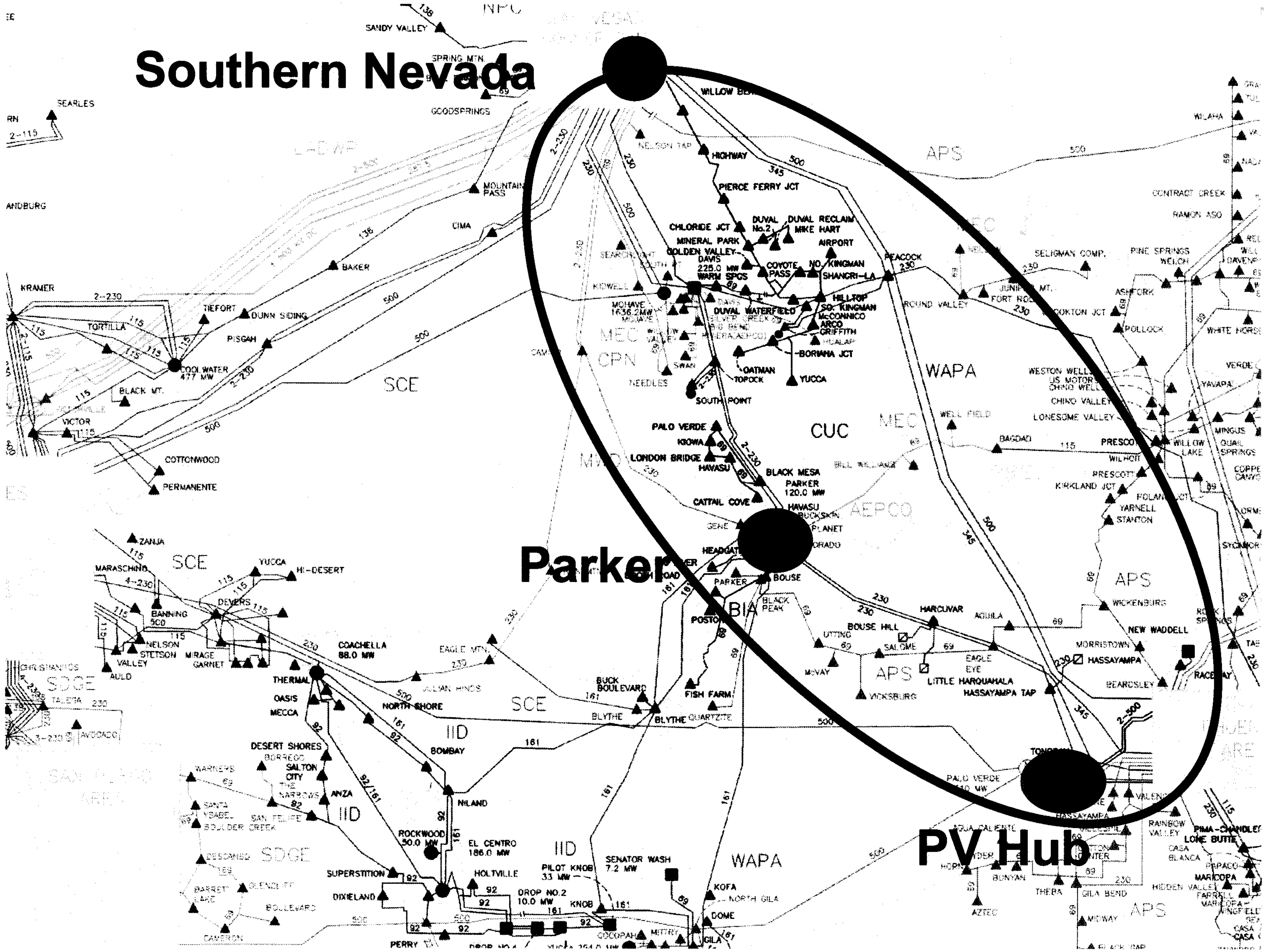
Colorado River Transmission Planning Committee

Status Update

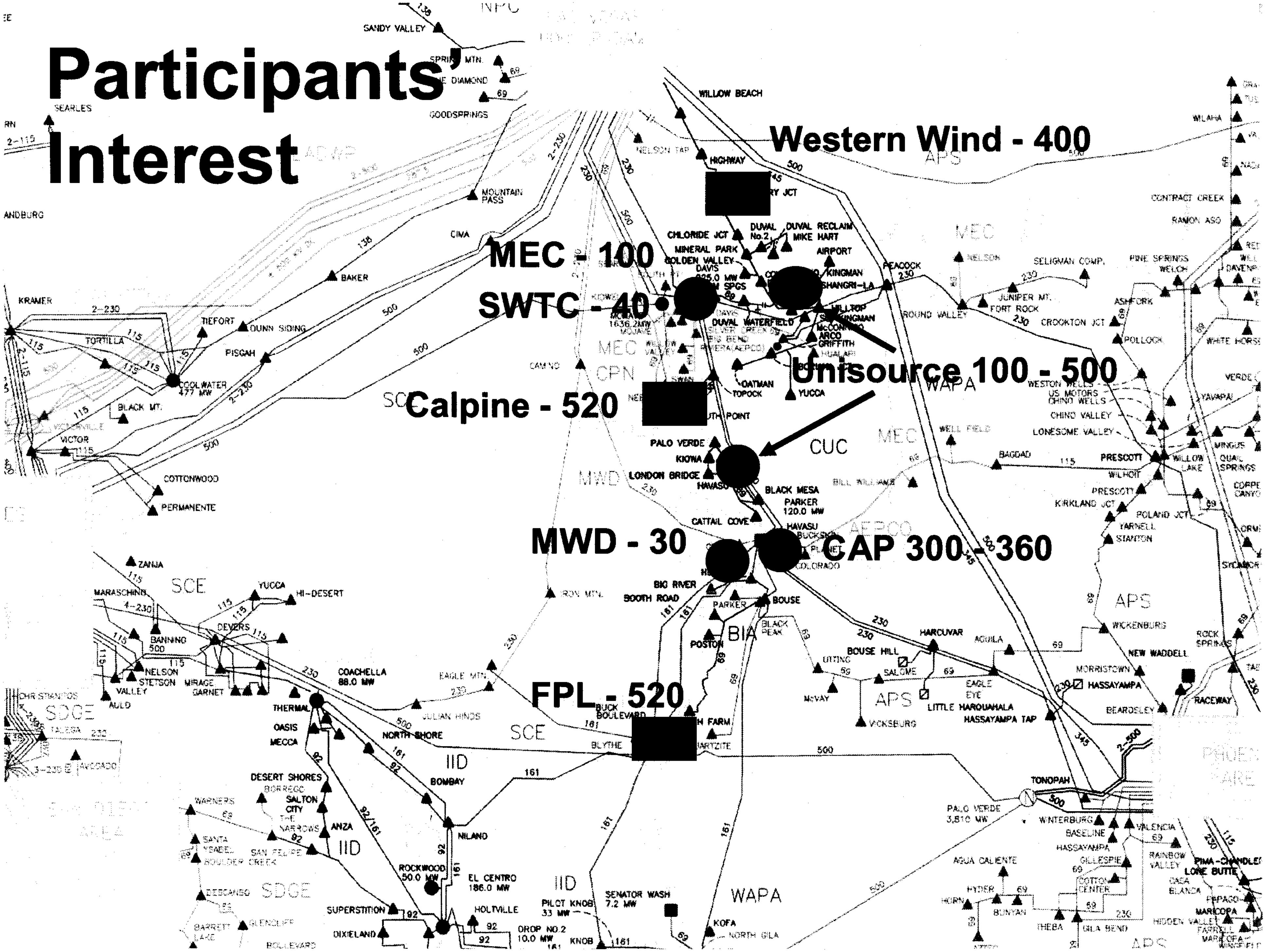
SWAT – May 4, 2005

Western Customer Study

- Effort to Expand Transmission Capacity into Northwestern Arizona
- Study Effort to be Directed by WAPA
- Region Bounded by Palo Verde, Parker, and Southern Nevada

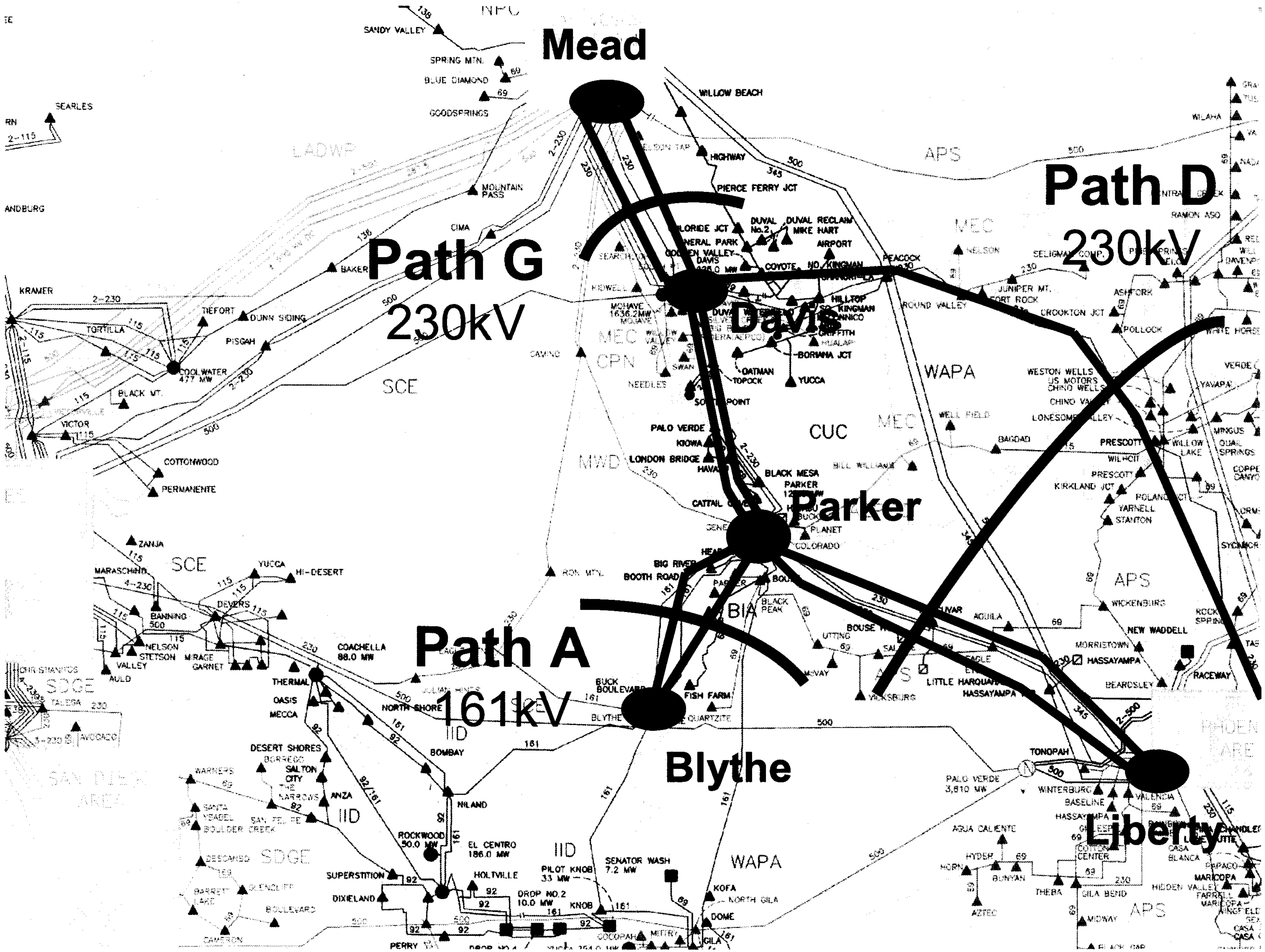

Southern Nevada
Parker
PV Hub
SCE
SDGE
IID
WAPA
APS
CUC
MEC
CPN
AEPCO
BIA
LADWP
SANDY VALLEY
SPRING MTN.
GOODSPRINGS
SEARLES
MOUNTAIN PASS
CIMA
BAKER
KRAMER
TIEFORT
DUNN SIDING
TORTILLA
PISGAH
COOL WATER 477 MW
BLACK MT.
VICTOR
COTTONWOOD
PERMANENTE
WILLOW BEACH
HIGHWAY
PIERCE FERRY JCT
CHLORIDE JCT
MINERAL PARK
GOLDEN VALLEY
DAVIS 225.0 MW
WARM SPGS
DUVAL No.2
DUVAL RECLAIM
MIKE HART
AIRPORT
COYOTE PASS
NO. KINGMAN
SHANGRI-LA
PEACOCK
HILLTOP
SO. KINGMAN
McCONNICO
ARCO
GRIFFITH
BORIANA JCT
DUVAL WATERFIELD
MOHAVE 1636.2MW
NEEDLES
SWAN
OATMAN
TOPOCK
YUCCA
SOUTH POINT
PALO VERDE
KIOWA
LONDON BRIDGE
HAVASU
BLACK MESA
PARKER 120.0 MW
CATTAIL COVE
BUCKSKIN
PLANET
BOUSE
BLACK PEAK
HARCUVAR
AGUILA
BOUSE HILL
SALOME
UTTING
McVAY
VICKSBURG
EAGLE EYE
LITTLE HARQUAHALA
HASSAYAMPA TAP
HASSAYAMPA
MORRISTOWN
WICKENBURG
NEW WADDELL
BEARDSLEY
ROUND VALLEY
SELIGMAN COMP.
FORT ROCK
PINE SPRINGS
WELCH
ASHFORK
POLLOCK
WHITE HORSE
CONTRACT CREEK
RAMON ASO
WILAHA
WESTON WELLS
US MOTORS
CHINO WELLS
CHINO VALLEY
LONESOME VALLEY
WELL FIELD
BAGDAD
PRESCOTT
WILHOIT
KIRKLAND JCT
YARNELL
STANTON
WILLOW LAKE
MINGUS
QUAIL SPRINGS
YAVAPAI
PALO VERDE
HASSAYAMPA
RAINBOW VALLEY
LONE BUTTE
CASA BLANCA
MARICOPA
HIDDEN VALLEY
GILA BEND
THEBA
BUNYAN
AZTEC
MIDWAY
ZANJA
YUCCA
HI-DESERT
MARASCHINO
BANNING
DEVERS
NELSON
STETSON
VALLEY
AULD
MIRAGE
GARNET
COACHELLA 88.0 MW
THERMAL
OASIS
MECCA
NORTH SHORE
EAGLE MTN.
JULIAN HINDS
BUCK BOULEVARD
BLYTHE
FISH FARM
QUARTZITE
BOMBAY
NILAND
DESERT SHORES
BORREGO
SALTON CITY
ANZA
SAN FELIPE
BOULDER CREEK
ROCKWOOD 50.0 MW
EL CENTRO 186.0 MW
HOLTVILLE
SUPERSTITION
DIXIELAND
PERRY
PILOT KNOB 33 MW
DROP NO.2 10.0 MW
KNOB
SENATOR WASH 7.2 MW
KOFA
NORTH GILA
DOME
GILA
COCOPAH
MITTRY
WARNERS
SANTA YSABEL
DESCANSO
BARRETT LAKE
GLENCLIFF
BOULEVARD
CAMERON
AVOCADO
TALEGA

Participants' Interest



Western Customer Study

- Primarily Looking at the HV Transmission System in the Northwestern Quadrant of Arizona
- Evaluate WAPA's Paths A, D, and G


Mead
Path G
230kV
Davis
Path D
230kV
Parker
Path A
161kV
Blythe
Liberty

Western Customer Study

Participants (12):

- LSE (4)
  - Aha Macav
  - Arizona Public Service
  - Mohave Electric Cooperative
  - Unisource Electric Service

Western Customer Study

Participants (12):

- **G&T (1)**
  - Southwest Transmission Coop.
- **Generators (3)**
  - Calpine
  - FP&L
  - Western Wind

Western Customer Study

Participants (12):

- State Authorities/Districts (3)
  - Arizona Power Authority
  - Central Az Water Conservation Dist.
  - Metropolitan Water District
- Federal PMA (1)
  - Western Area Power Administration

Western Customer Study

Open Study Group

Next Meeting – May 18th

Questions:

Kenneth Bagley (R.W. Beck)

480-367-4282

kbagley@rwbeck.com

CALIFORNIA ISO

California Independent
System Operator

California ISO Wheeling and Congestion Charges

Jeff Miller
California ISO

September 1, 2004

Overview

- Wheeling Charges
  - Losses – Based on TMM or GMM
  - Core Reliability Requirement
- Congestion Charges
  - Firm Transmission Rights - Today
  - Congestion Revenue Rights - Future

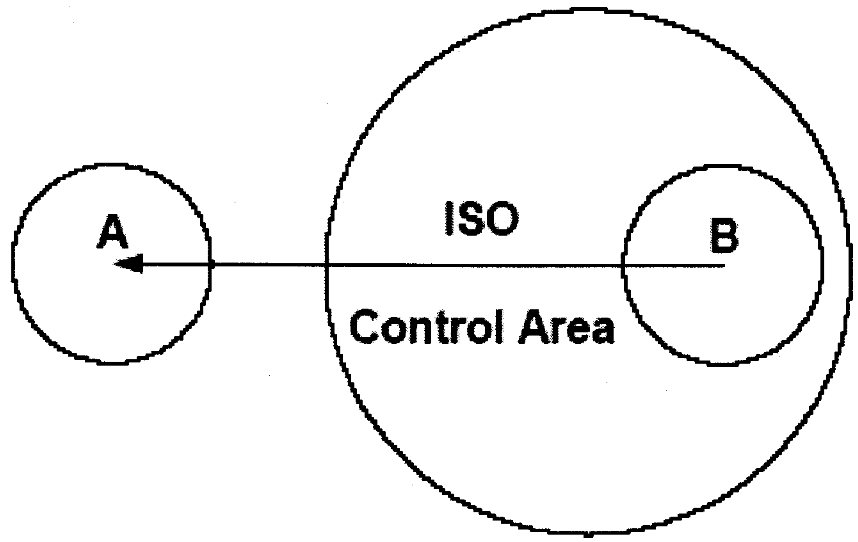
Wheeling Charges

- Charge assessed to SCs with schedules exiting/leaving the ISO Controlled Grid
- Based on gross exports, not net
- Based on actual flows (not always what you scheduled- may be curtailed)
- If exit point is below 200 kV, a Low Voltage Wheeling Access Charge is also incurred

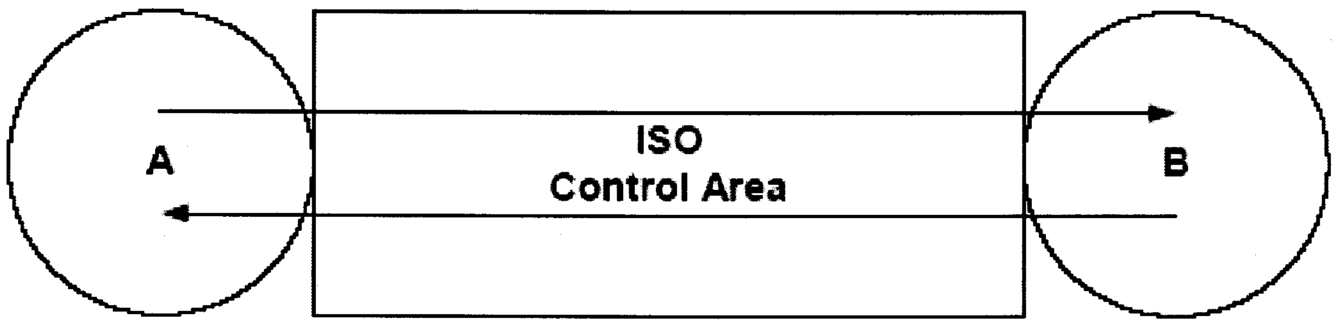
Wheeling Charges

- Wheeling Charges are Assessed on Energy Leaving the ISO Controlled Grid
  - Wheeling Out
  - Wheeling through
  - Wheeling to Non-PTO Load

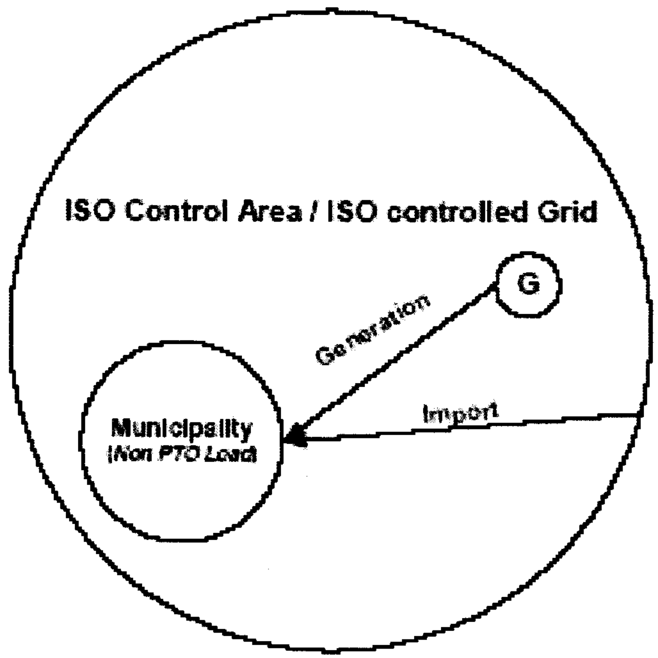
Wheeling Out



Wheeling Through



Wheeling to Non-PTO Load



Non-PTO Load

High Voltage vs. Low Voltage

High Voltage Wheeling Access Charges (HVAC)

- 200 kV and above
- ISO Grid wide rate (transition over 10 years- began Jan '01)
- Revenues spread to all TAC Areas/PTOs

Low Voltage Wheeling Access Charge (LVAC)

- Below 200 kV
- Utility specific rate
- Revenues flow back to specific utility

Example Charges

(for explanatory proposes only)

- Example base charge
  - Palo Verde to PG&E load - $0/MWh
  - Palo Verde to COB - $2.40/MWh
  - Devers to COB - $2.40/MWh
- Additional charges:
  - Losses – ISO delivers full schedule and bills for cost of making up losses
  - Core reliability requirement – Varies based on coincident demand of SC
  - Transaction charge - $1.49 per schedule
  - Congestion – Only if path is congested

Losses

- Meter Multipliers
  - Apply to generators and tie lines
  - Varies by location
  - Varies each hour
  - Posted on Oasis
- Generator Meter Multiplier Examples
  - South Bay – 0.9696
  - Big Creek – 1.0085
- Example Tie Meter Multiplier
  - Palo Verde - 0.95670
  - Malin – 0.98720

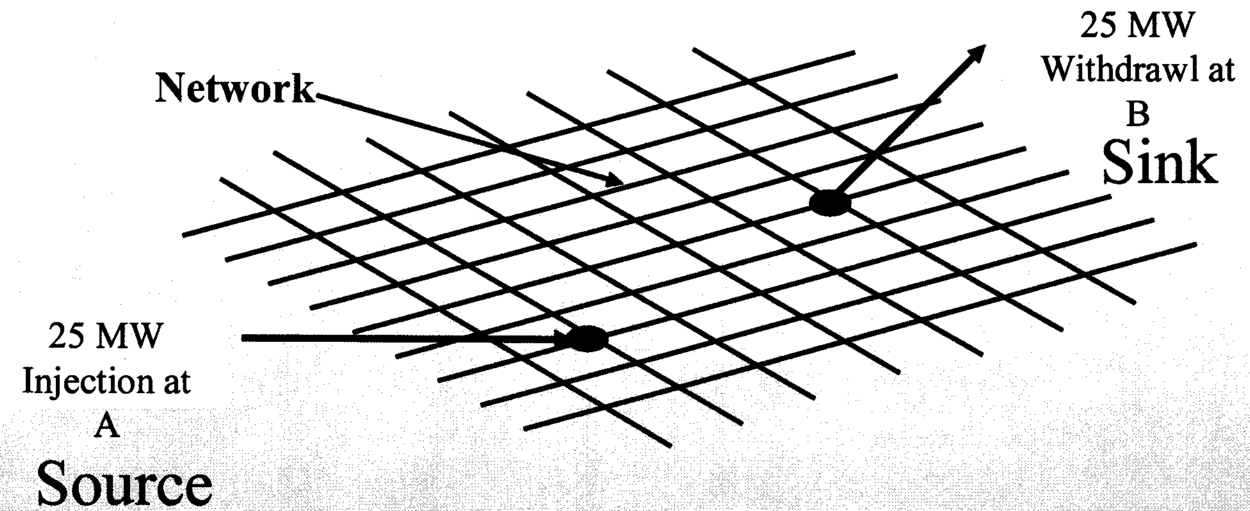
Congestion Charges

- ISO systems determine the cost of congestion for each hour
- Congestion costs may be hedged through the purchase of FTRs
- In the future, FTRs will transition to CRRs (with the implementation of nodal pricing)

Congestion Revenue Rights

- Point to Point Right (Source to Sink)
- CRR Holder is Obligated to Receive (or Pay) the difference in LMP Between Sink and Source
  - (LMP at Node A-LMP at Node B)xMW

Example



SOUTHERN CALIFORNIA
EDISON
An EDISON INTERNATIONAL Company

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

VOLUME I – MAIN REPORT **PAGE**

VOLUME II - DYNAMIC STABILITY PLOTS

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:

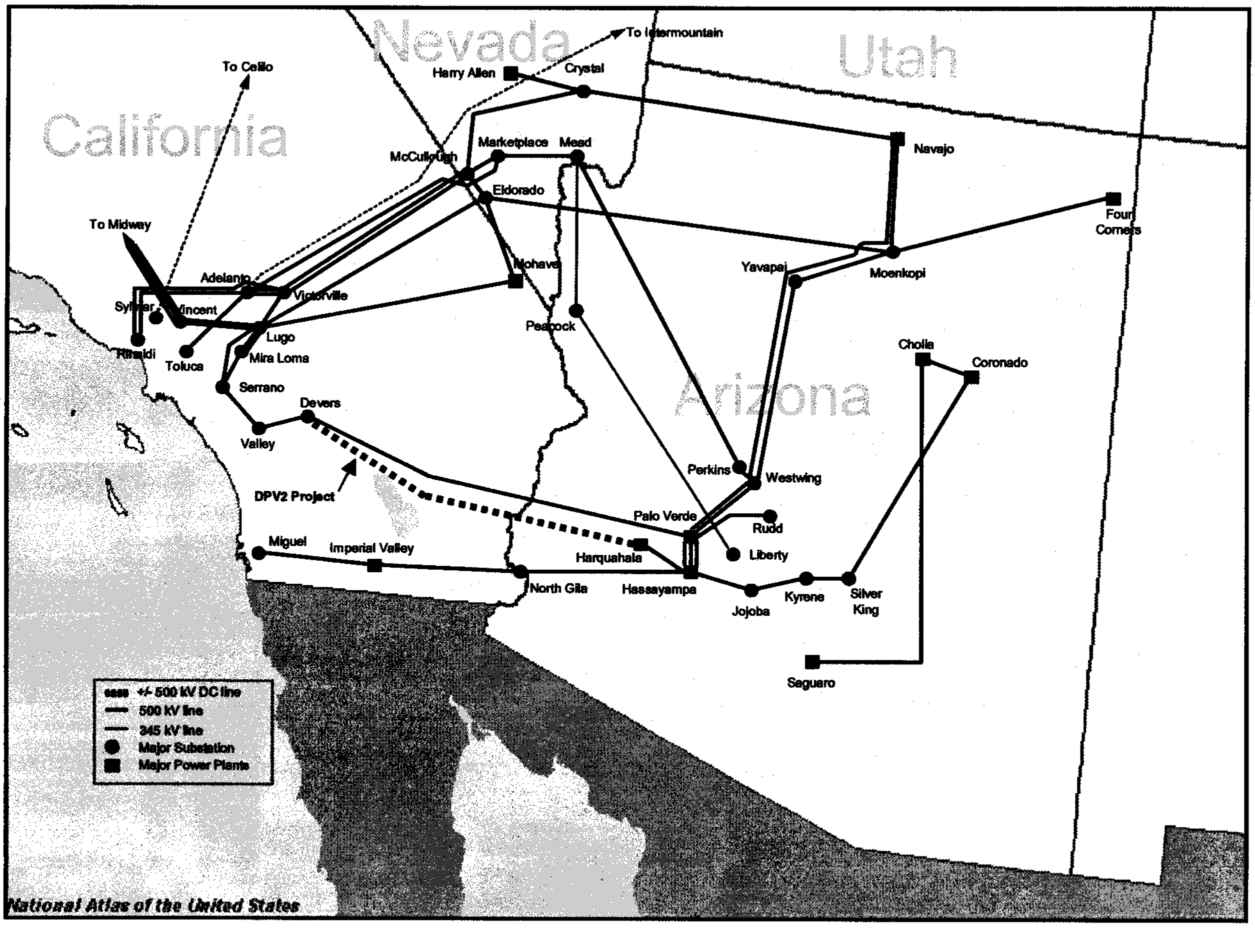
- Path 49 vs. Path 41 for loss of the Hassayampa-N.Gila 500 kV line,
- Path 49 vs. Path 61 for loss of the Hassayampa-N.Gila 500 kV line,
- Perkins phase shifter in vs. out of service for DPV1 and DPV2 double line outage

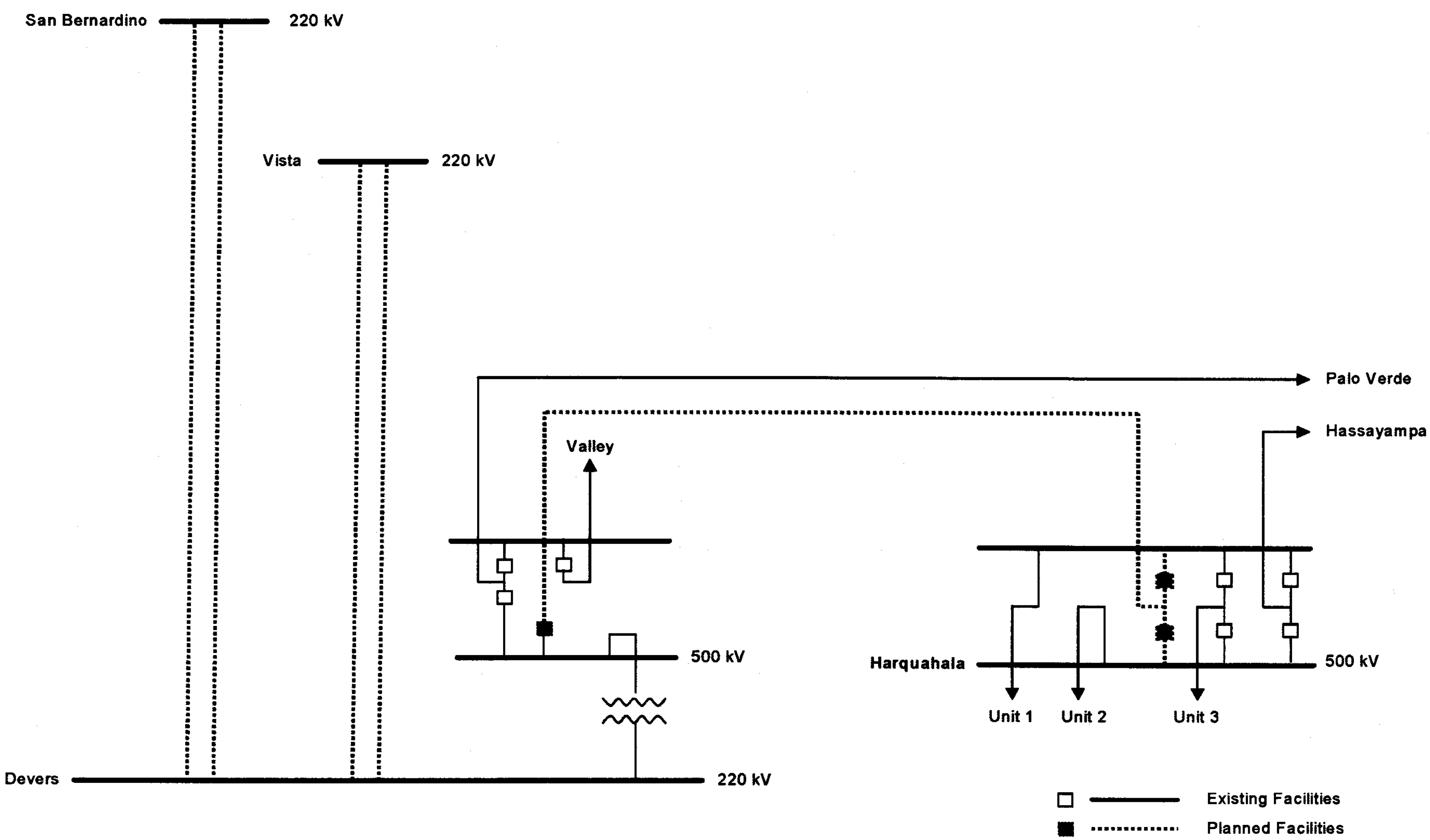
8. Operating Procedures

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.

<u>**Mohave On Line**</u>

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.

<u>**Mohave Off Line**</u>

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.

<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 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.

Limiting Element	Emergency Loading (%) 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.

Limiting Element	Emergency Loading (%) 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.

Limiting Element	Emergency Loading (%) 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			Stability Results
	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	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

Path	Reactive Support to Meet the Planning Criteria: New Shunt Capacitor @ Devers 500 kV (MVAr)	Add New 2nd SVC @ Devers 500 kV (MVAr)	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	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.

	Emergency Loading (%)		
Limiting Element	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.

	Emergency Loading (%)		
Limiting Element	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.

	Emergency Loading (%)		
Limiting Element	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.

	Emergency Loading (%)		
Limiting Element	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.

	Emergency Loading (%)		
Limiting Element	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.

	Emergency Loading (%)		
Limiting Element	Pre-Project	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.

	Emergency Loading (%)		
Limiting Element	Pre-Project	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.

	Emergency Loading (%)		
Limiting Element	Pre-Project	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.

	Emergency Loading (%)		
Limiting Element	Pre-Project	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.

Limiting Element	Emergency Loading (%) 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.

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.

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.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.

<u>Mohave On Line</u>

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.

<u>**Mohave On Line**</u>

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.

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 100.7% 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.

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.

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.

<u>Mohave On Line</u>

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.

<u>Mohave Off Line</u>

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