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BEFORE THE ARIZONA CORPORATION COMMISSION

COMMISSIONERS

BOB STUMP, CHAIRMAN
GARY PIERCE
BRENDA BURNS
SUSAN BITTER SMITH
BOB BURNS

IN THE MATTER OF SUN STREAMS, LLC'S TEN YEAR PLAN	Docket No. E-00000D-13-0002 **NOTICE OF FILING TEN YEAR PLAN**

In accordance with Arizona's Eighth Biennial Transmission Assessment process, Element Power, through its wholly owned subsidiary Sun Streams, LLC, files its Ten Year Plan for the substation and gen-tie transmission facilities associated with the proposed Sun Streams Solar Generating Project, including the System Impact Study prepared with respect to such facilities.

////

Arizona Corporation Commission
DOCKETED
JAN 17 2013
DOCKETED BY

DATED this 17th day of January, 2013.

MOYES SELLERS & HENDRICKS LTD.

Jay I. Moyes
Jason Y. Moyes
Attorneys for Sun Streams, LLC

Original and 13 copies filed this
17th day of January, 2013:

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

SUN STREAMS, LLC
Ten Year Plan
For Proposed Transmission Facilities
(in-service 2015)

Line Description	Sun Streams Solar Project Substation and Gen-tie Line
Size	
• Voltage	34.5/500 kV step up transformers and up to approximately 1,600 feet of 500 kV AC single circuit line from the high side of the step up transformer to a 500 kV bus at the Hassayampa Switchyard.
• Capacity	TBD; Estimated 150 MW
• Point of Origin	The proposed Sun Streams 34.5/500 kV substation in the NW ¼ of Section 14 (at the Sun Streams Solar Generating Project, an approximately 150 MW, PV-only solar facility proposed for development in portions of Sections 2, 11, 12, 13 and 14), all in T. 1 N., R. 6 W., G&SRB&M.
• Termination Point	A 500 kV bus at the existing Hassayampa Switchyard.
• Length	TBD. Up to 1,600 feet, depending upon the final substation configuration.
General Route	TBD. Subject to ACC siting approval, the gen-tie line will generally run east to west from the Sun Streams Solar Generating Project substation in the NW ¼ of Section 14 into the adjacent, existing Hassayampa Switchyard.
Purpose	The gen-tie line will interconnect the proposed Sun Streams Solar Generating Project with the regional transmission grid at the Hassayampa Switchyard.
Date	
• Estimated Construction Start	Q2 of 2014
• Estimated In-Service Date	Q2 of 2015
• Is Certificate Necessary?	Yes. (A *series* of at least 3 structures will be required to reach the Hassayampa Switchyard, thus triggering the "transmission line" definition.)
System Impact Study	See attached System Impact Study Report prepared by Salt River Project

END

Sun Streams Solar Project III

SYSTEM IMPACT STUDY REPORT

To

Western Arizona Transmission System Task Force
&
ANPP Engineering and Operating Committee

For

Sun Streams Solar Project III

Prepared by
Chuck-yan Wu
(WHenergy Consulting, Inc.)

October 5, 2011

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1 EXECUTIVE SUMMARY

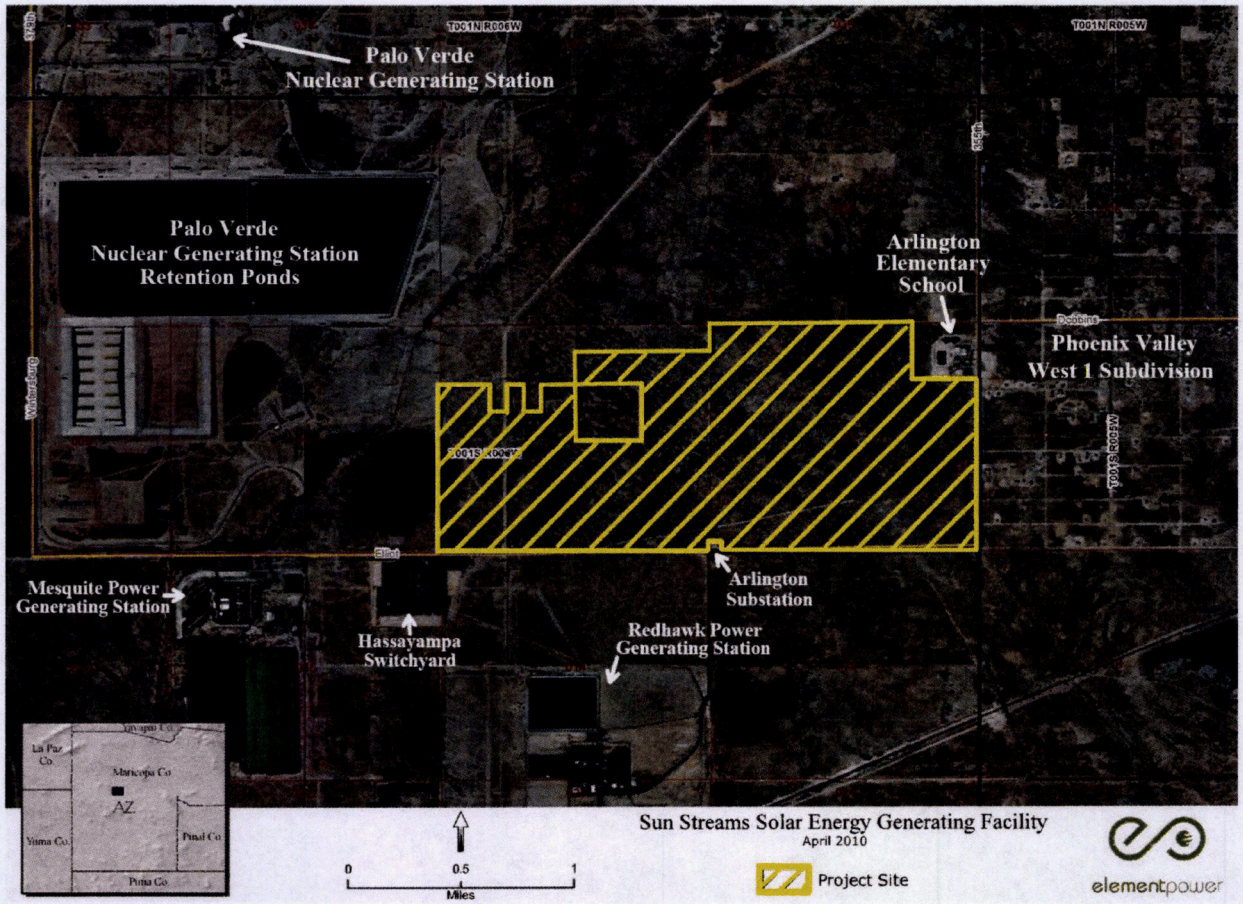
1.1 General

On July 13, 2010 Element Power US, LLC submitted interconnection requests to the ANPP Engineering and Operating ("E&O") Committee for interconnection of a 150 MW PV solar powered generation project, Sun Stream III ("SSIII"), to the Hassayampa 500kV Station.

SSIII proposes to construct and interconnect a new 150 MW net solar generation facility located approximately 200 feet from the Hassayampa Station. The SSIII Project will be connected to Hassayampa via a new dedicated 500kV line (approximately 200 feet) emanating from the plant and terminating at the Hassayampa 500kV switchyard. The expected operating date will be in 2013.

The location of the project is shown in Figure 1, and the project schematic one-line diagram is in Appendix A.

Figure 1. Location Map for Sun Stream III Project



Under the direction and in close coordination with the E&O Committee and Western Arizona Transmission System ("WATS"):

1. SSIII contracted with Chuck Wu of WHenergy ("WCI") to perform this System Impact Study(SIS).
2. An SIS Study Plan was prepared by WCI, SSIII and the WATS group to guide the parties through the interconnection study process. This study plan was finalized and approved by the WATS members.

1.2 Study Results and Conclusions

The SIS Study Plan included the performance of the following interconnection related studies:

- Power Flow Analysis
- Transient Stability Analysis
- Short Circuit Analysis

The Power Flow and Transient Stability Analysis mentioned above have previously been reviewed by WATS. The Short Circuit Analysis has now been completed and results included in this final draft for WATS review. For the SSR, it was determined that the performance of an SSR study was not necessary at this time.

1.2.1 Power Flow Analysis

The power flow base case used for the Power Flow Analysis was provided by WATS, who reviewed and updated the cases. The Power Flow Analysis is a critical component of the SIS for analyzing impacts of interconnecting the Projects to the transmission system.

Based on the power flow and contingency study results presented in **Section 2**:

1. For all lines in service (Category A, or N-0) condition, no elements in the studied system was loaded beyond it's normal continuous thermal rating. Therefore, no transmission upgrade will be required.

2. Under Category B, C and D contingency conditions, for the overloaded equipment listed in **Table 2.2**.

    - As the incremental impact of the SSIII to the transmission system is minimal, SSIII did not trigger the need for additional upgrades requirements.

3. Voltage support is adequate to accommodate SSIII as long as the Project can maintain self-sufficient VAR support at the interconnection point through generation excitation and/or shunt capacitors at the Project sites.

1.2.2 Transient Stability Analysis

The proposed SSIII will have minimal impact to the transmission system responses to contingencies studied and they do not require any additional upgrades.

Based on the transient stability study results showed in **Section 3**;

- The dynamic models of the SSIII projects were stable.

- There were no WECC transient stability criteria violation under the conditions studied.

- The system does not trigger any automatic load shedding under the conditions studied.

- The system response is stable and well damped under the conditions studied.
- The SSIII project have minimal impact to the dynamic stability of the transmission system under the conditions studied.

1.2.3 The Short Circuit Analysis

Based on the assumptions for 150MW Photovoltaic units and data base provided by WATS for the short circuit analysis, the project is expected to increase fault duty at the Point of Interconnection (POI) by approximately 167A as represented with 120% of the full output capability of the PV units. The ANPP owners will determine if these fault contribution levels contribute significantly to the breakers at Hassayampa as they are currently rated at 63,000A interrupting capability. Based on the results of this analysis, the incremental fault duty is increased by an additional 0.27% with the SSIII 150MW Project.

1.2.4 Sensitivity Study

- Power Flow Contingency Study with Palo Verde at 525kV

  There is no line overload for N-0.

  There is no additional line overload for N-1 and N-2 conditions.

- Transient Stability Contingency Study - replacing Gas Generators with PV units

  The system responses to the contingencies studied were stable. There is no WECC criteria violation for all the contingencies studied under this initial system condition.

- Power Flow Study with all Queued Projects

  There is no line overload for N-0.

  With all queued resource projects dispatched, there is no additional line overload for N-1 and N-2 conditions.

  There is no noticeable increase of voltage deviation under contingencies studied with all queued projects are dispatched.

- Power Flow and Transient Stability Study with all ANNP and Queued Generation Projects without Q11(Palo Verde – Sun Valley 500kV Line) and Q12 (Hassayampa – N. Gila #2 500kV line)

  In order to achieve the system condition, 530kV and bucking 800MVAR at Palo Verde, significant adjustment to the system were required.

  Under this condition, there is no line overload for N-0.

  There are 4 additional for N-2, and mainly due to generation re-dispatch in the Phoenix area.

  Transient voltage swings were worse but stable, and did not violate any WECC/NERC voltage criteria.

2 Power Flow Analysis

2.1 Study Criteria:

2.1.1 Normal Conditions

i. All transmission facility loadings must be below normal continuous ratings.

ii. Bus voltage deviation from the base case shall not exceed established operating limits (see Appendix 2).

iii. Sufficient transmission capacity will be provided without relying on or unduly imposing upon any other utility's transmission system.

iv. Major WECC transmission paths system listed in Table 1 will be monitored.

Table 1. List of Major WECC Path

WECC Path No.	Path Name	Path Rating
15	Path 15	5400
22	SOUTHWEST OF FOUR CORNERS	2325
23	FOUR CORNERS 345/500	840
26	PATH 26	4000
27	IPP	2400
46	WOR	10623
47	SOUTHERN NEW MEXICO (NM1)	1048
48	NORTHERN NEW MEXICO (NM2)	1970
49	EOR	9300
50	CHOLLA - PINNACLE PEAK	1200
51	SOUTHERN NAVAJO	2800 (2010)
58	ELDORADO - MEAD 230 KV LINES	1140
61	LUGO - VICTORVILLE 500 KV LINE	2400
62	ELDORADO - MCCULLOUGH 500 KV	2598
64	MARKETPLACE - ADELANTO	1200
65	PDCI	3100
66	COI	4800
81	CENTENNIAL	3000

2.1.2 Single Contingency Outage Conditions

i. For a single contingency, no transmission element will be loaded above its emergency rating. Summer ratings will be used for autumn conditions.

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

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

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

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

2.1.3 Credible Multiple Contingencies, including N-2 Contingencies

The N-2 disturbances (Category C or D) are considered to be very severe; such as, loss of two PV-Westwing 500 kV circuits or loss of one PV-Westwing and PV-Rudd 500 kV lines. Although local circuit overloads and voltage depressions may results, these shall not result in cascading outages.

2.1.4 Line Rating and Bus Voltage

A list of continuous and emergency ratings for the major transmission elements is provided in Appendix 1. A table showing minimum voltage limits for the critical buses in Arizona, Southern Nevada and Southern California is provided in Appendix 2. The project will accommodate all prompt updates from WATS member.

2.2 Study Assumptions:

2.2.1 Palo Verde 500 kV Operating Voltage and Reactive Power (VAR)

- Voltage at the Palo Verde 500 kV bus will be assumed to be 530 kV for the main study results. In addition, the PV/Hassayampa common bus will be bucking at 800 MVAr. WATS members will provide guidance on modeling this specific system condition.

- A sensitivity of Palo Verde operated at 525 kV with PV/Hassayampa bucking at 800 MVAr will also be studied. WATS members will provide guidance on modeling this specific system condition

- The Palo Verde Transmission System-Simultaneous Generation [Capability] (PVTS-SG) will be modeled at its maximum level of 10,406 MW. Generation capacities and schedules of the Palo Verde nuclear units and the combined-cycle units of those PVTS Interconnectors are shown in the following Table 2

2.2.2 Pre-Project Base Cases

WATS provided a WECC Heavy Winter base case (16hw2) as a starting base case for study development. The initial EOR flow is about 7009MW with 7361MW of PVTS-SG gross generation (Figure B-01, Appendix B).

The Pre-Project case was adjusted with the addition dispatch of PVTS-SG generations not already on-line. EOR flow was 7,800 MW, with 10781MW of gross PVTS-SG generation.

A case with EOR at 9300MW was also developed for sensitivity studies required for this project, with 10781MW of gross PVTS-SG generation.

These cases were reviewed and approved by the WATS group.

Table 2. PVTS-SG Capacity and Dispatch

Power Plant Owners	Power Plant Name	Number Of Units	2008 Maximum Generation Capacity	2008 Scheduled Gross Generation	2008 Power Plant Auxiliary Load	2008 Scheduled Generating Net Output
ANPP	Palo Verde	Unit.1	1,410 MW	1,410 MW	65 MW	1,345 MW
		Unit 2	1,407 MW	1,407 MW	65 MW	1342 MW
		Unit 3	1,410 MW	1,410 MW	65 MW	1,345 MW
Subtotal		3	4,227 MW	4,227 MW	195 MW	4,032 MW
Dynegy	AVEF	1	700 MW (193.3x2+313.3)	620 MW (158x2+304)	20 MW (6.7 MW x 3)	600 MW
Arizona Public Service	Red Hawk	2	1,098 MW ((180x2+189)x2)	1,080 MW ((175.5x2+189)x2)	40 MW (6.7 MW x 6)	1,040 MW
MACH Gen, LLC	Harquahala	3	1,164 MW ((250+138)x3)	1,164 MW ((250+138)x3)	24 MW ((5+3) x 3)	1,140 MW
Sempra Energy	Mesquite	2	1,382 MW ((185x2+321)x2)	1,288 MW ((167.5x2+309)x2)	28 MW (4.6 MW x 6)	1,260 MW
Gila River Power	Gila River	4	2,540 MW ((160x2+315)x4)	2,402 MW ((151x2+298.5)x4)	68 MW (5.66 MW x12)	2,334 MW
Subtotal		12	6,884 MW	6,554 MW	180 MW	6,374 MW
Total		15	11,111 MW	10,781 MW	375 MW	10,4 06 MW

*Includes 58 MW generation upgrade for Palo Verde Unit 1, effective Nov. 2005.
**Generation dispatch does not necessarily reflect power plant capacity.
***Generation including Gila River – Panda units.

2.2.3 Post-Project Base Cases

The Post-Project cases were developed by adding the proposed SSIII Project to the Pre-Project cases. The SSIII generation output was scheduled to Arizona/New Mexico by displacing generation from the Cholla generation plant.

2.2.4 Post-Project Sensitivity Cases and Stability Cases with 7% Generation Margin

The study plan required a series of sensitivity studies for various system conditions. The power flow cases developed for these study cases are summarized below in Table 3.

For transient stability study, all the cases included a 7% Palo Verde generation margin.

As noted in the table, sensitivity cases with 525kV at Palo Verde bus, and with all queued generation (plus all PVTS-GS generation) was studied for load flow and post-contingency only.

Power flow one-line diagrams for all the cases are included in **Appendix B.**

Table 3. Power Flow Cases for SSIII System Impact Studies – Including Sensitivity Cases and Stability Cases

		Case Name	PV Bus Bucking	PV Bus Voltage	PVTS-SG Gross Output		EOR Flow	Comments
	Original Case	Case 00	882MVAR	530kV	7361MW		7004MW	WATS Provided Base Case
Pre-Project	Base	Case 01a	800MVAR	530kV	10781MW		7799MW	Pre-project base case
	Stability Only	Case 01b	800MVAR	530kV	11078MW	7% PV Gen Margin	7815MW	
Post-Project	Base	Case 02a	811MVAR	530kV	10781MW		7808MW	Post-Project base case
	Stability Only	Case 02b	806MVAR	530kV	11078MW	7% PV Gen Margin	7813MW	
Post-Project	Power Flow Only	Case 03a	804MVAR	525kV	10781MW		7790MW	Sensitivity
Pre-Project	Base	Case 04a		530kV	10781MW		9302MW	Pre-project base case High EOR
	Stability Only	Case 04b		530kV	11078MW	7% PV Gen Margin	9319MW	
Post-Project	Post-Project	Case 05a		530kV	10781MW		9311MW	Post-Project base case High EOR
	Post-Project Stability Only	Case 05b		530kV	11078MW	7% PV Gen Margin	9322MW	
Post-Project	Stability Only	Case 06b		530kV	11078MW	7% PV Gen Margin	9300MW	Replace Gas Generation with PV (including Queued Projects) (Sensitivity)
	Power Flow Only	Case 07a		530kV	10781MW		9300MW	With all Queued Project** *(Sensitivity)*
	Power Flow Only	Case 08a	803MVAR	530kV	10781MW		7860MW	Hassayampa-N.Gila #2 & PV-SunValley Line Out (Sensitivity)
	Stability Only	Case 08b	795MVAR		11078MW	7% PV Gen Margin		

*PVTS-SG generation does not include queued project outputs.
** List of Queued Project see Appendix C. (Total net output 1690MW)

2.3 Power Flow and Contingency Analysis

The following contingencies were studied as directed by WATS in the Study Plan for post-contingency power flow to evaluate facility overload and voltage deviations.

N-1 Contingencies:

PF-1: Jojoba-Kyrene 500 kV line
PF-2: Hassayampa-Jojoba 500 kV line
PF-3: Palo Verde-Westwing 500 kV line
PF-4: Palo Verde-Rudd 500 kV line
PF-5: Navajo-Dugas 500 kV line
PF-6: Navajo-Moenkopi 500 kV line
PF-7: Navajo-Crystal 500 kV line
PF-8: Four Corners-Moenkopi 500 kV line
PF-9: Moenkopi-Yavapai 500 kV line
PF-10: Yavapai-Westwing 500 kV line
PF-11: Coronado-Cholla 500 kV line
PF-12: Coronado-Silverking 500 kV line
PF-13: Kyrene-Browning 500 kV line
PF-14: Browning-Silver King 500 kV line
PF-15: Crystal-McCullough 500 kV line
PF-16: Jajoba-Kyrene 500 kV line (same as PF-1)
PF-17: Peacock-Liberty 345 kV line
PF-18: Palo Verde-Colorado No.1 500 kV line
PF-20: Hassayampa – N. Gila No.1 500 kV line
PF-21: Hassayampa – N. Gila No.2 500 kV line
PF-22: Perkins-Mead 500 kV line
PF-23: Dugas-RACEWAY 500 kV (2009/2010)
PF-24: RACEWAY-Westwing 500 kV (2010)
PF-25: RACEWAY-Pin. Peak 500 kV (2010)
PF-26: Delany-Sun Valley 500 kV (2011)
PF-27: Lenzie-Northwest 500kV
PF-28: Harry Allen - Mead 500kV
PF-29: Mead - Marketplace 500kV
** PF-30: IV-N.Gila 500kV (Additional contingency studied)

N-2 Contingencies:

PF-51: Palo Verde-Westwing #2 and Palo Verde- Rudd 500kV lines (Category D)
PF-61: Palo Verde-Westwing #1 and Palo Verde- Rudd 500kV lines (Category D)
PF-62: Palo Verde-Westwing #1&#2 500 kV lines (Category D)

2.4 Study Results

2.4.1 Facility Thermal Loading

The incremental impact of SSIII project were studied for 2 conditions, initially with a EOR flow at about 7800MW with full output from PVTS-SG generation (Case 01a). The corresponding post-SSIII case was Case 02a).

An additional base case with EOR flow at 9300MW was developed (Case 03a) with full output from PVTS-SG generation.

- **Category A (N-0)Transmission Equipment Thermal Loading**

  There is no N-0 thermal overloaded equipment in the system studied. Table 2.1 listed the highly loaded transmission equipment for reference only.

Table 2.1. System Equipment Thermal Loading for N-0

Equipment	Normal Rating Amps/MVA	EOR 7800MW		EOR 9300MW		Worst % Normal Rating
		Pre-Project Case 01a	Post-Project Case 02a	Pre-Project Case 04a	Post-Project Case 05a	
Moenkopi - Eldordo 500 Ckt 1	1900	1451.3	1443.4	1812.6	1805.2	95%
Navajo - Crystal 500 Ckt 1	2200	1448	1443.1	1813.7	1809.2	82%
Ctryclub - Lincstrt 230 Ckt 1	1150	1040.1	1050.1	1062	1070.1	99%
Palovrde - Colriver 500 Ckt 1	2700	1852.8	1859.9	2173.6	2180.6	86%
Mead 345/230 Bank 1T	600	439	439.6	440	440.3	81%
Mead - Perkins 500 Ckt 1	2200	1480.7	1487.2	1565.5	1571.6	80%
Peacock - Mead 345 Ckt 1[1]	850[2]	752.9	753.9	723.6	724	94%
	1500[3]					53%
Midway X - Leathers 92 Ckt 1	829	782.1	782.1	782.1	782.1	94%

1. This equipment is part of the transformer-terminated Peacock-Mead 345kV line.
2. This is the continuous rating of the normally bypassed series capacitors at the Mead end and its corresponding flow as a percentage of this equipment rating.
3. This is the continuous rating of the most-limiting conductor line section and its corresponding flow as a percentage of this equipment rating.

Table 2.2. System Equipment Thermal Over Loading under N-1 Contingencies

Equipment	Emergency Rating Amps/MVA	EOR 7800MW		EOR 9300MW		Contingency Description	Worst % Emergency Rating	Incremental Impact %
		Pre-Project Case 01a	Post-Project Case 02a	Pre-Project Case 04a	Post-Project Case 05a			
Cholla 500/345 Bank 2T	500	**501.9**	450.9	478	433.6	Ess12-Coronado-Silverking	100%	-8.88%
Moenkopi - Rme 500 Ckt 1	2309	1835.8	1829	**2397.8**	**2391.5**	Ess07-Navajo-Crystal	104%	-0.27%
Moenkopi - Eldordo 500 Ckt 1	2750	2159.6	2149.3	2690	2680.2	Ess07-Navajo-Crystal	98%	-0.42%
Gila - Knob 161 Ckt 1[3]	667	**679.1**	**682.1**	**931.5**	**934.5**	Ess30-Iv-Ngila	148%	0.45%
Knob - Pilotknb 161 Ckt 1[3]	592	456.6	457.6	**704.7**	**705.7**	Ess30-Iv-Ngila	123%	0.17%
Elcentsw - Pilotknb 161 Ckt 1[3]	570	418.5	420.4	**661.5**	**663.3**	Ess30-Iv-Ngila	122%	0.33%
Pilotknb 161/92 Bank 1T[3]	75	51	51.3	**88.9**	**89.1**	Ess30-Iv-Ngila	125%	0.40%
Imprlvly - Elcentro 230 Ckt 1[3]	881	764.7	765.8	**1087.6**	**1088.6**	Ess30-Iv-Ngila	126%	0.12%
J.Hinds - Mirage 230 Ckt 1	599	**610.3**	**610.4**	**757.6**	**757.6**	Ess18-Pv-Colorador	128%	0.02%

RED indicates overload beyond emergency rating of the equipment.
Blue indicates overload beyond normal rating of the equipment.
1. Worst % Emergency Rating listed the worst among the 4 cases (including the pre-project condition) studied.
2. Transmission Lines are rated in Amps, and Transformers are rated in MVA
3. The N-1, first run without any planned or existing Remedial Action Schemes (RAS), resulted in these overload violations of the local IID and WAPA systems. However, with the planned SLRC Project's Gila 230/161-kV transformer-tripping RAS applied to the North Gila-Imperial Valley 500kV line outage, the underlying 161kV and 230kV system violations of the local IID and WAPA systems were entirely mitigated.

- **Transmission Equipment Thermal Overload Under Category B (N-1) Contingencies**

  Under the listed N-1 contingencies studied, SSIII has very minor impact to the system. All the equipment that were overloaded, as in Table 2.2, were pre-project overloaded. Most overloads were due to higher EOR flow. J. Hinds – Mirage 230kV line should have been upgraded by the time SSIII will be on line.

  Without application of the planned SLRC Project's remedial action scheme (RAS), the North Gila-Imperial Valley 500kV line outage showed overload violations of various lines in the local IID and WAPA systems in both pre and post SSIII study cases. However, with application of the planned SLRC Project's Gila 230/161-kV transformer-tripping RAS, these local system overloads were entirely mitigated.

- **Transmission Equipment Thermal Overload Under Category C (N-2) and D Contingencies**

  There is no equipment thermal overload under Category C and D contingencies studied.

2.4.2 Voltage Performance Following Contingencies

There is no voltage deviation criteria violation in all the cases following the contingencies studied. **Tables 2.3** listed all the 230kV and above buses with more than 3.5% voltage deviations (negative) followings contingencies as compared to the pre-contingency voltage.

The worst voltage deviations were observed in SDG&E area after the loss of Palo Verde – Colorado River 500kV line, and the Colorado River 500kV bus after the loss of IV – N. Gila 500kV line.

Overall, the SSIII Project has minimal impact to voltage issues relative to the pre-Project conditions.

2.5 Observations and Recommendations

Based on the power flow and contingency study results presented above:

1. For all lines in service (Category A, or N-0) condition studied, no element in the studied system was loaded beyond it's normal continuous thermal rating. Therefore, no transmission upgrade will be required.

2. Under Category B, C and D contingency conditions studied, the overloaded equipment listed in **Table 2.2**.

   - As the incremental impact of the SSIII to the transmission system is minimal, SSIII did not trigger the need for additional upgrades requirements.

3. Voltage support is adequate to accommodate SSIII as long as the Project can maintain self-sufficient VAR support at the interconnection point through generation excitation and/or shunt capacitors at the Project.

Table 2.3 Voltage Deviation* Following Contingencies (Category B, C, D)

Bus No.	Bus Name	kV	EOR 7800MW		EOR 9300MW		Contingency Description	Max Dev
			Pre-Project Case 01a	Post-Project Case 02a	Pre-Project Case 04a	Post-Project Case 05a		
22468	MIGUEL	500	-0.02	-0.02	-0.033	-0.033	ESS18-PV-ColoradoR	-0.041
24900	COLRIVER	500	-0.023	-0.024	-0.039	-0.04	ESS30-IV-NGila	-0.04
22885	CENTRALS	500	-0.019	-0.019	-0.031	-0.032	ESS18-PV-ColoradoR	-0.039
22360	IMPRLVLY	500	-0.017	-0.017	-0.029	-0.029	ESS18-PV-ColoradoR	-0.038
22472	MIGUELMP	500	-0.019	-0.019	-0.031	-0.031	ESS18-PV-ColoradoR	-0.038
22888	CENTRMPS	500	-0.018	-0.019	-0.03	-0.03	ESS18-PV-ColoradoR	-0.038
19038	MEAD	500	-0.019	-0.019	-0.029	-0.029	ESS18-PV-ColoradoR	-0.036
22536	N.GILA	500	-0.013	-0.014	-0.023	-0.023	ESS18-PV-ColoradoR	-0.035
24097	MOHAVE	500	-0.018	-0.018	-0.03	-0.03	ESS18-PV-ColoradoR	-0.035
26044	MARKETPL	500	-0.018	-0.018	-0.029	-0.029	ESS18-PV-ColoradoR	-0.035
26048	MCCULLGH	500	-0.018	-0.018	-0.029	-0.029	ESS18-PV-ColoradoR	-0.035
26120	MKTPSVC	500	-0.018	-0.018	-0.029	-0.029	ESS18-PV-ColoradoR	-0.035
27204	HLTAP	500	-0.018	-0.018	-0.029	-0.029	ESS18-PV-ColoradoR	-0.035

* Note: Voltage criteria allow a 5% deviation post-contingency for N-1.

3 Transient Stability Analysis

3.1 Study Criteria:

1. Transient voltage dips must meet the following WECC Reliability Criteria:.

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

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

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

3.2 Study Assumptions:

a) A 7% generation margin will be added to the three Palo Verde generating units to ensure plant stability for any critical N-1 single contingency outage.

b) A single-line-to-ground fault (SLG) at the Palo Verde 500 kV bus with a subsequent loss of the two Palo Verde-Westwing 500 kV circuits shall not result in a loss of synchronism for the Palo Verde plant or a wide spread of WECC cascading outages. WATS will provide SLG fault impedance at Palo Verde 500kV Bus and the timing of series capacitor by-passing and reclosing, and line clearing time.

c) PV/Hassayampa common bus was be modeled to buck 800 MVAr

d) The corresponding dynamics data file for the WATS approved base cases was used for all stability analysis.

e) The dynamic data for the generator turbine, governor, excitation system and power system stabilizer was provided by SSIII and was incorporated into the dynamics data file.

f) All stability simulations were run for a minimum of 10 seconds.

3.3 Transient Stability Analysis

Performed a transient stability analysis to investigate the Palo Verde generator stability for both the pre and post-SSIII Project configuration.

A 7% generation margin was added to the three Palo Verde generating units to ensure plant stability for all critical N-1 contingencies. However, as agreed in the study plan the 7% generation margin was not added for the single-line to ground fault at the Palo Verde 500 kV bus with a subsequent loss of the Palo Verde-Westwing No.1 and No.2 500 kV circuits.

Transient stability was simulated for all pre-project base cases to determine if there are any violations prior to modeling the SSIII Solar and AV2 Solar facilities. Pre-project transient stability issues (if any) will be addressed with the appropriate entity. Once it is determined that there are no pre-project violations SSIII facilities will be inserted and transient stability contingencies will be evaluated to determine transient stability impacts (if any).

Transient stability studies were performed on cases with PV/Hassayampa common bus modeled bucking 800 MVAr.

The following list of major disturbances were simulated to evaluate the Palo Verde stability performance.

<u>N-1 Contingencies</u>

TR-1: Three-phase fault at Hassayampa 500 kV bus with outage of the Hassayampa-N. Gila No.1 500 kV line.

TR-2: Three-phase fault at Palo Verde 500 kV bus with outage of the Palo Verde-ColoradoRiver No.1 500 kV line.

TR-3: Three-phase fault at Palo Verde 500 kV bus with outage of the Palo Verde-Westwing No.1 500 kV line.

TR-4: Three-phase fault at Palo Verde 500 kV bus with outage of the Palo Verde-Rudd 500 kV line.

TR-5: Three-phase fault at Hassayampa 500 kV bus with outage of the Hassayampa-Jojoba 500 kV line.

TR-6: Three-phase fault at Jojoba 500 kV bus with outage of the Jojoba-Kyrene 500 kV line.

TR-7: Three-phase fault at Hassayampa 500 kV bus with outage of the Hassayampa-Delany 500 kV line.

TR-8: Three-phase fault at Harquahala Jct 500 kV bus with outage of the Delany-Sun Valley 500 kV line.

TR-9: Trip Palo Verde Unit 1.

N-2 Contingencies

TR-10: Single line-to-ground fault at Palo Verde 500 kV bus with outage of both Palo Verde-Westwing No.1 and No.2 500 kV lines. (Category D)

TR-11: Single line-to-ground fault at Palo Verde 500 kV bus with outage of Palo Verde-Westwing #2 and the Palo Verde-Rudd 500 kV lines. (Category C)

TR-12: Trip Palo Verde Units 1 and 2.

Multiple Outage Disturbance (Category D)

TR-13: Sensitivity study will evaluate loss of Hassayampa-N.Gila No.1 and No.2 500 kV lines for a three-phase fault at Hassayampa 500 kV bus.

TR-14: Three-Phase fault at Perkins 500 kV bus with loss of the Perkins-Mead 500 kV line and Two Palo Verde-Westwing 500 kV lines (contingency due to line crossing).

Transient stability plots with a WATS member provided list for all contingencies are depicted in an appendix to show system damping. In addition, any WECC performance criteria violations will be documented.

3.4 Study Results for Transient Stability of the System

The inverter dynamic model used in this study for SSIII is in **Appendix E**.

For system and project dynamic model validation, all cases were run with a "no fault" condition to determine any pre-project or SSIII project dynamic modeling issues. Results showed all models and cases were stable (flat line). The outputs of the cases were attached in **Appendix D.1** for reference. The results show the dynamic models were stable.

Table 3.1 is a summary of transient stability study results for the contingencies listed previously. There is no WECC transient stability criteria violations under all system conditions and under the contingencies studied. The transient stability plots for this set of study were attached in **Appendix D.2**.

3.5 Observations and Recommendations

Based on the transient stability study results:

- The dynamic models of the SSIII projects were stable.
- There were no WECC transient stability criteria violation under the conditions studied.

- The system does not trigger any automatic load shedding under the conditions studied.
- The system response is stable and well damped under the conditions studied.
- The SSIII Project has minimal impact to the dynamic stability of the transmission system under the conditions studied.

Table 3.1 Relative Comparison of Worst Bus Voltage Deviation and Lowest Bus Frequencies (with 7% PV Margin)

	Case 01b		Case 02b		Case 04b		Case 05b		Case 06b	
	EOR 7800MW Pre-Project		**EOR 7800MW Post ESS3 Project**		**EOR 9300MW Pre-Project**		**EOR 9300MW Post ESS3 Project**		**Sensitivity Case PV replace Gas units**	
Contingency	**Worst Voltage Dip**	**Lowest Frequency**	**Worst Voltage Dip**	**Lowest Frequency**	**Worst Voltage Dip**	**Lowest Frequency**	**Worst Voltage Dip**	**Lowest Frequency**	**Worst Voltage Dip**	**Lowest Frequency**
TR01-Hassy-NGila1	15.5% @COMANCHE 345	59.603Hz @COMANCHE 345	15.5% @COMANCHE 345	59.598Hz @COMANCHE 345	16.3% @N.GILA 500	59.608Hz @COMANCHE 345	16.2% @N.GILA 500	59.604Hz @COMANCHE 345	16.2% @N.GILA 500	59.609Hz @COMANCHE 345
TR02-PV-ColoradoR	18.6% @N.GILA 500	59.605Hz @COMANCHE 345	18.8% @N.GILA 500	59.603Hz @COMANCHE 345	18.1% @TS8 230	59.602Hz @COMANCHE 345	17.9% @TS8 230	59.601Hz @COMANCHE 345	18.6% @TS8 230	59.602Hz @COMANCHE 345
TR03-PV-WWing	16.8% @PALOVRDE 500	59.608Hz @COMANCHE 345	17% @PALOVRDE 500	59.598Hz @COMANCHE 345	15.5% @N.GILA 500	59.615Hz @COMANCHE 345	15.5% @COMANCHE 345	59.604Hz @COMANCHE 345	15.8% @N.GILA 500	59.612Hz @COMANCHE 345
TR04-PV-Rudd	17% @PALOVRDE 500	59.603Hz @COMANCHE 345	17.2% @PALOVRDE 500	59.605Hz @COMANCHE 345	15.9% @N.GILA 500	59.607Hz @COMANCHE 345	15.9% @N.GILA 500	59.604Hz @COMANCHE 345	16.3% @N.GILA 500	59.61Hz @COMANCHE 345
TR05-Hassy-Jojoba	15.5% @COMANCHE 345	59.607Hz @COMANCHE 345	15.5% @COMANCHE 345	59.602Hz @COMANCHE 345	15.5% @COMANCHE 345	59.615Hz @COMANCHE 345	15.5% @COMANCHE 345	59.604Hz @COMANCHE 345	15.5% @COMANCHE 345	59.607Hz @COMANCHE 345
TR06-Jojoba-Kyrene	9% @GILABEND 230	59.845Hz @GIL-ST1 18	9.1% @GILABEND 230	59.844Hz @GIL-ST1 18	8.1% @GILABEND 230	59.823Hz @GIL-ST1 18	8.2% @GILABEND 230	59.822Hz @GIL-ST1 18	6.6% @N.GILA 500	59.797Hz @PVQ3-ST2 13.8
TR09-PV-G1	15.4% @COMANCHE 345	42.72Hz @PINONCYN 115	15.5% @COMANCHE 345	39.899Hz @STANLEY 115	15.5% @COMANCHE 345	59.496Hz @COMANCHE 345	15.6% @COMANCHE 345	43.519Hz @HESSBDW 13.8	15.5% @COMANCHE 345	59.493Hz @COMANCHE 345
TR10-PV-WWing-dlo-slg	5.4% @RUDD 500	59.942Hz @PORTAL 4.8	5.5% @RUDD 500	59.94Hz @PORTAL 4.8	4% @COLRIVER 500	59.951Hz @GIL-CT1 18	4% @COLRIVER 500	59.949Hz @GIL-CT1 18	4.5% @N.GILA 500	59.944Hz @Q08 PG1 34.5
TR11-PV-WW2-Rudd-dlo-slg	4.3% @DELANY 500	59.947Hz @HGC-CT1 16	4.4% @DELANY 500	59.945Hz @HGC-CT1 16	3.7% @N.GILA 500	59.951Hz @GIL-CT1 18	3.7% @N.GILA 500	59.95Hz @GIL-CT1 18	4.1% @N.GILA 500	59.942Hz @Q08 PG1 34.5
TR12-PV-G2-RAS	15.8% @COMANCHE 345	59.378Hz @COMANCHE 345	15.8% @COMANCHE 345	59.368Hz @COMANCHE 345	15.8% @COMANCHE 345	39.751Hz @CALUMET 345	15.8% @COMANCHE 345	46.432Hz @COMANCHE 345	15.8% @COMANCHE 345	59.374Hz @COMANCHE 345
TR13-Hassy-NGila1-2	21.4% @COLRIVER 500	59.581Hz @COMANCHE 345	21.4% @COLRIVER 500	59.578Hz @COMANCHE 345	31.9% @BOUSE AZ 161	59.577Hz @COMANCHE 345	31.5% @BOUSE AZ 161	59.576Hz @COMANCHE 345	30.6% @BOUSE AZ 161	59.578Hz @COMANCHE 345
TR14-Perkins-Mead-PV-WW12	11.2% @COLRIVER 500	59.851Hz @NEWMN4G1 13.8	11.4% @COLRIVER 500	59.848Hz @NEWMN4G1 13.8	10.5% @COLRIVER 500	59.87Hz @NEWMN4G1 13.8	10.4% @COLRIVER 500	59.869Hz @NEWMN4G1 13.8	11.5% @COLRIVER 500	59.853Hz @NEWMN4G1 13.8

4 Short Circuit Analysis

Short circuit studies was performed to evaluate the incremental impact of the addition of the SSIII Solar Project at the Point of Interconnection (POI), specifically the Hassayampa Switchyard, and other substations beyond the POI. The studies were conducted in accordance with ANPP interconnection requirements. For this analysis, only three-phase and single-phase to ground faults were conducted for all buses contained in the model.

Southwest utilities (e.g. SRP, TEP, APS, EPE, PNM, WAPA, IID, etc.) participate in the Southwest Area Transmission (SWAT) Short Circuit Work Group (SCWG). Within the group, members agree to solution assumptions and options (i.e. phase shifter modeling, series capacitor flashing, pre-fault voltages, etc.) for performing fault duty studies and evaluating results. SWAT has also coordinated with the Western Arizona Transmission Study group (WATS) to ensure that common cases are used for short circuit analysis, including additional regional queue projects that impact the ANPP system.

Members use PTI and ASPEN programs and routinely convert databases for use between the two programs. The analysis for the SSIII Solar Project was conducted using the ASPEN One-Liner V11.8 program.

Additional Queue Projects were added to the SWAT Short Circuit Base Case:

- ANPP Q2 – 700MW PV to Mesquite to Hassayampa
- ANPP Q3 – 500MW PV to Jojoba
- ANPP Q8 – 125MW PV to Hassayampa
- ANPP Q9 – 125MW PV to Hassayampa
- ANPP Q11 – Palo Verde to Delaney to Sun Valley 500kV line
- ANPP Q12 – Hassayampa to North Gila #2 500kV
- ANPP Q13 – 200MW PV to Hassayampa
- APS Q38 – 400MW Solar at Delaney
- APS Q39 – 800MW Solar at Delaney
- APS Q56/57 – 300MW Solar at Delaney
- APS Q43 – 500MW Solar at HooDoo Wash (HAA-NG Line)
- APS Q65 – 480MW Solar at HooDoo Wash
- APS Q73 – 480MW Solar at HooDoo Wash
- APS Q44b – 300MW Solar at Qx Substation (HAA-NG Line)
- APS Q51 – 150MW Solar at Qx Substation
- APS Q58/59/60 – 238MW Solar at Qx Substation

For the pre-project case, benchmarking of the existing data base was performed

For the post-project cases including the SSIII (ANPP Q15), the WATS provided short circuit data base was modified in coordination with the SWAT SCWG and ANPP data, and incorporate the specific models for the SSIII Solar Project for the incremental short circuit fault levels of the project. .

4.1 SSIII Model Assumptions

The model for the SSIII was developed to accommodate the development of the Project as a single 150MW Photovoltaic (PV) and related facilities. The facilities to interconnect the SSIII to the Hassayampa 500kV switchyard include a short 500kV tie line, a 500/34.5kV step up transformer and an equivalent model for the 150MW solar PV. The details of the short circuit models for the SSIII are listed below.

Interconnect Facilities

500kV Transmission Line: (100MVA base, 0.4 miles in length, 2-954ACSR per phase)
R: 0.00003 X: 0.0009

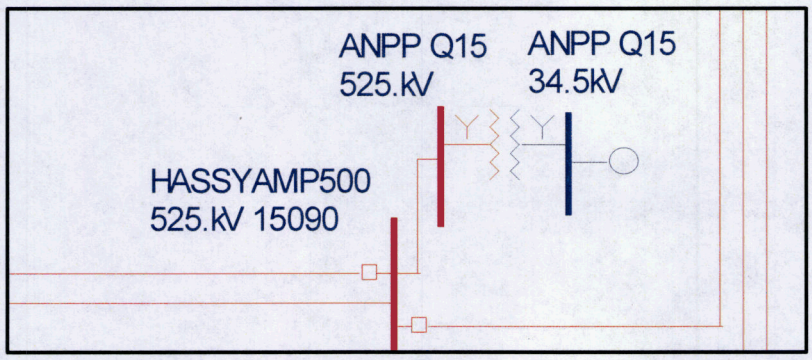
R0: 0.0001 X0: 0.00027

Step-Up Transformer:
500/34.5kV, Wye-solid grounded-Wye-solid grounded
100/133/167 MVA
X = 10%, X0 = 10% (100MVA base)
X/R = 46

Equivalent Generator Data (for limiting fault current to 120% full PV output current of 3,012A at 34.5kV):
Terminal Voltage: 34.5kV
Max PV Output MW Rating: 150MW
Max PV Output Current Rating: 2,501A (at 34.5kV bus)
Subtransient Reactance (representation only) = X"d = 0.8334 p.u. (150MVA base)
(note that this represents a fault contribution of 3,012A delivered to the 34.5kV bus and ignores collector losses)

The above models were added to the ANPP pre-project base case based on the assumptions provided by SSIII proponents; Figure 2 illustrates the model that was developed in the ASPEN One-Liner post-project case.

Figure 2: ANPP Q15 Solar Project ASPEN Model



4.2 Short Circuit Analysis Results

To perform the short circuit study, the SSIII addition was modeled in the short circuit case supplied by the ANPP using the ASPEN One-Liner V11.8 software. Three-phase and single-phase to ground faults were simulated at all buses contained in the model.

Pre-Project Benchmark Case
The benchmark or pre-project was conducted to determine the fault levels at selected buses per the direction of the ANPP, specifically; Table 4.1 summarizes the comparison between the expected fault levels to that of the pre-project base case for this analysis.

Post-Project with SSII (Q15 150MW PV)
With the addition of the SSIII with 150MW PV units modeled as described in the Assumptions section of the report, the post-project short circuit study results indicated that the expected fault duty at the point of interconnection to the Hassayampa 500kV switchyard is approximately 61,676A (three-phase) and 62,567A (single-phase-to ground). The incremental fault duties due to the SSIII were found to be 167A (three-phase) and 167A (single-phase-to-ground). It should be noted that the incremental fault current for

this analysis was limited to 3,012A at their respective 34.5kV bus, this value represents 120% of the full output of 150MW at 34.5kV (2,510A).

Table 4.1: Post-Project PV Fault Levels and Incremental Impact at Selected Buses

ANPP REGIONAL BUSES FOR BENCHMARKING					BENCHMARK	
					3LG	1LG
BUS	KV	LOCATION	AREA	ZONE	Phase(A)	Gnd(A)
HASSYAMP500	525	HAA500	14	151	52116.8	53498.4
PALO Verde	525	PV500	14	151	52562.3	54998.3
JOJOBA	525	JOJOBA	14	144	29961.9	24079.6
WESTWING_W1	230	WESTWING	14	143	52025.4	47975.1
WESTWING_500	525	WESTWING	14	143	33635.8	27790.1
KYRENE_230	230	KYRENE	14	151	53581.1	49986.1

Table 4.2 provides a summary of the pre-project, post-project and incremental fault duties buses at the point of interconnection point (Hassayampa) and nearby buses. Additional fault levels and details (X/R ratio etc.) are contained in Attachment E of this report for buses with incremental fault levels.

Table 4.2: Post-Project PV Fault Levels and Incremental Impact at Selected Buses

ANPP Q15 SOLAR PROJECT 150MW PV SHORT CIRCUIT ANALYSIS SUMMARY					PRE -PROJECT		POST-Q15 PV PROJECT		INCREMENTAL	
					3LG	1LG	3LG	1LG	3LG	1LG
BUS	KV	LOCATION	AREA	ZONE	Phase(A)	Gnd(A)	Phase(A)	Gnd(A)	Phase(A)	Gnd(A)
HASSYAMP500	525	POI	14	151	61509.1	62399.5	61676.3	62566.7	167.20	167.20
ANPP Q15	525	Q15	14	151	52932.4	48619.4	53099.7	48788.9	167.30	169.50
PALOVRDE_500	525	PALOVRDE	14	151	61869.6	63975.4	62018.8	64112.7	149.20	137.30
JOJOBA	525	JOJOBA	14	151	31722.5	26964.0	31744.3	26975.7	21.80	11.70
WESTWING_500	525	WESTWING	14	143	34610.0	28130.0	34630.3	28139.1	20.30	9.10
WESTWING_W1	230	WESTWING	14	143	52778.9	48347.7	52793.4	48356.2	14.50	8.50
KYRENE_500	525	KYRENE	14	151	53966.8	50276.9	53974.3	50281.3	7.50	4.40

4.3 Observations and Recommendations

Based on the assumptions for the Project's 150MW PV units and data supplied by the ANPP for the short circuit analysis are expected to increase fault duty at the POI by approximately 167A as represented with 120% of the full output capability of the PV units. The ANPP owners will determine if these fault contribution levels contribute significantly to the breakers at Hassayampa as they are currently rated at 63,000A interrupting capability. Based on the results of this analysis, the incremental fault duty is increased by an additional 0.27% with the SSIII 150MW Project.

5 Sensitivity Study

WATS members requested 5 sensitivity studies to be conducted.

- A power flow only study with Palo Verde bus at 525kV (Case 3a).
- A full sensitivity study with EOR at 9300MW (Case 4 & 5). The study results were tabulated in the previous section (Section 3) along with the case for EOR at 7800MWs.
- A Stability only study displacing Gas Generators with PV units (case 6b).
- A power flow only study with all queued projects (case 7a).
- A power flow and stability study with all ANNP and all queued projects, except Q11 (Palo Verde-Sun Valley 500 kV line) and Q12 (Hassayampa-North Gila 500 kV #2 line) (case 8a, 8b).

The list of queued projects as of 10/06/2010 is in Attachment C.

5.1 Power Flow Contingency Study Results with Palo Verde at 525kV

The sensitivity study results were tabulated with the original base case and post SSIII project at 150MW for easy comparison. The power flow case one-line is showed in Figure B-06 (case03a) of Appendix B.

5.1.1 Line Loading sensitivity

Tables 5.1 summarized the relative sensitivity of line loading due to the voltage at Palo Verde. It listed all incremental impact of 1% or more, or lines were overloaded.

There is no line overload for N-0.

With Palo Verde bus at 525kV, there is no additional line overload for N-1 and N-2 conditions. All line overloads were pre-project overloads.

The overload on Gila River 500/230 transformer is due to Jojoba 230kV loop-in. Due to this project, there are two 230kV lines from Gila River to Liberty. When Gila River - Liberty is out of service, and leave Gila River-Jojoba-TS4-Liberty in, then there is no load connected to Jojoba. Results showed that the transformer loading is reduced to about 410MVA (73%). This project is delayed indefinitely by APS.

5.1.2 Voltage Deviation under Contingencies

Table 5.2 showed that there is no noticeable increase of voltage deviation under contingencies studied when Palo Verde bus is at 525kV.

Table 5.1. Incremental Line Loading with Palo Verde at 525kV

Equipment	Normal Rating Amps/MVA	Emergency Rating Amps/MVA	EOR 7800MW			Contingency Description	Worst % Emergency Rating	Incremental Impact %
			Pre-Project Case 01a	Post-Project Case 02a	Post-Project Case 03a (PV at 525kV)			
Cholla 500/345 Bank 1T	500	500	343.5	303.4	345	Basecase	69%	8.32%
	500	500	493	443	493.3	Ess12-Coronado-Silverking	99%	10.06%
Cholla 500/345 Bank 2T	500	500	349.7	308.9	351.2	Basecase	70%	8.46%
	500	500	**501.9**	450.9	**502.2**	Ess12-Coronado-Silverking	100%	10.26%
Gilarivr 500/230 Bank 1T	560	560	511.8	507.5	515.4	Ess02-Hassy-Jojoba	92%	1.41%
	560	560	558.6	**563.8**	**563.1**	Ess51-Pv-Ww2-Rudd-Dlo-Slg	108%	-0.12%
	560	560	558.6	**563.8**	**563.1**	Ess61-Pv-Ww1-Rudd-Dlo-Slg	108%	-0.12%
Anderson - Kyrene 230 Ckt 1	1960	2000	979.6	964.3	984.5	Basecase	58%	1.01%
Mead 345/230 Bank 1T	600	600	439	439.6	447	Basecase	81%	1.23%
	600	600	522.4	522.9	530.4	Ess07-Navajo-Crystal	95%	1.25%
Gila - Knob 161 Ckt 1[4]	606	667	**679.1**	**682.1**	**686.7**	Ess30-Iv-Ngila	148%	0.69%
Gila 161/230 Bank 1T[4]	300	300	**319.2**	**320.4**	**320.4**	Ess30-Iv-Ngila	136%	0.00%
Liberty - Libtyphs 230 Ckt 1	1298	1298	650.7	653.1	692.2	Basecase	65%	3.01%
	1298	1298	942.7	946	979.3	Ess18-Pv-Colorador	94%	2.57%
	1298	1298	1015.1	1018.9	1047.3	Ess22-Mead-Perkins	98%	2.19%
J.Hinds - Mirage 230 Ckt 1	599	599	**610.3**	**610.4**	**612.1**	Ess18-Pv-Colorador	128%	0.28%

RED indicates overload beyond emergency rating of the equipments.
Blue indicates overload beyond normal rating of the equipments.
1. Worst % Emergency Rating listed the worst among the 3 cases (including the pre-project condition) studied.
2. Maximum Incremental Impact compares PV at 525kV and PV at 530kV, both post SSIII.
3. Transmission Lines are rated in Amps, and Transformers are rated in MVA
4. The N-1, first run without planned or existing RAS, resulted in these overload violations of the local WAPA system. However, with the planned SLRC Project's Gila 230/161-kV transformer-tripping RAS applied to the North Gila-Imperial Valley 500kV line outage, the underlying system violations of the local WAPA system were entirely mitigated.

Table 5.2 Voltage Deviation* Following Contingencies (Category B, C, D)

Bus No.	Bus Name	kV	EOR 7800MW			Contingency Description	Max Dev
			Pre-Project Case 01a	Post-Project Case 02a	Post-Project Case 03a (PV at 525kV)		
22468	MIGUEL	500	-0.02	-0.02	-0.02	ESS18-PV-ColoradoR	-0.041
24900	COLRIVER	500	-0.023	-0.024	-0.024	ESS30-IV-NGila	-0.04
22885	CENTRALS	500	-0.019	-0.019	-0.019	ESS18-PV-ColoradoR	-0.039
22360	IMPRLVLY	500	-0.017	-0.017	-0.018	ESS18-PV-ColoradoR	-0.038
22472	MIGUELMP	500	-0.019	-0.019	-0.019	ESS18-PV-ColoradoR	-0.038
22888	CENTRMPS	500	-0.018	-0.019	-0.019	ESS18-PV-ColoradoR	-0.038
19038	MEAD	500	-0.019	-0.019	-0.019	ESS18-PV-ColoradoR	-0.036
22536	N.GILA	500	-0.013	-0.014	-0.014	ESS18-PV-ColoradoR	-0.035
24097	MOHAVE	500	-0.018	-0.018	-0.018	ESS18-PV-ColoradoR	-0.035
26044	MARKETPL	500	-0.018	-0.018	-0.018	ESS18-PV-ColoradoR	-0.035
26048	MCCULLGH	500	-0.018	-0.018	-0.018	ESS18-PV-ColoradoR	-0.035
26120	MKTPSVC	500	-0.018	-0.018	-0.018	ESS18-PV-ColoradoR	-0.035
27204	HLTAP	500	-0.018	-0.018	-0.018	ESS18-PV-ColoradoR	-0.035

*Note: Voltage criteria allow a 5% deviation post-contingency for N-1.

5.2 *Transient Stability Contingency Study Results - Displacing Gas Generators with PV units*

The power flow one-line is shown in Figure B-11 (case06b) in Appendix B. The system response to contingencies study are shown in Figure D.2.49 through Figure D.2.60 in Appendix D.2.

The system responses to the contingencies studied were stable. There is no WECC criteria violation for all the contingencies studied under this initial system condition. A numerical comparison of voltage deviation and frequency deviation for this condition is listed in Table 5.3 (identical to Table 3.1, repeated here for easy reference).

Table 5.3 Relative Comparison of Worst Bus Voltage Deviation and Lowest Bus Frequencies (with 7% PV Margin)

	Case 01b		Case 02b		Case 04b		Case 05b		Case 06b	
	EOR 7800MW Pre-Project		**EOR 7800MW Post ESS3 Project**		**EOR 9300MW Pre-Project**		**EOR 9300MW Post ESS3 Project**		**Sensitivity Case PV replace Gas units**	
Contingency	**Worst Voltage Dip**	**Lowest Frequency**	**Worst Voltage Dip**	**Lowest Frequency**	**Worst Voltage Dip**	**Lowest Frequency**	**Worst Voltage Dip**	**Lowest Frequency**	**Worst Voltage Dip**	**Lowest Frequency**
TR01-Hassy-NGila1	15.5% @COMANCHE 345	59.603Hz @COMANCHE 345	15.5% @COMANCHE 345	59.598Hz @COMANCHE 345	16.3% @N.GILA 500	59.608Hz @COMANCHE 345	16.2% @N.GILA 500	59.604Hz @COMANCHE 345	16.2% @N.GILA 500	59.609Hz @COMANCHE 345
TR02-PV-ColoradoR	18.6% @N.GILA 500	59.605Hz @COMANCHE 345	18.8% @N.GILA 500	59.603Hz @COMANCHE 345	18.1% @TS8 230	59.602Hz @COMANCHE 345	17.9% @TS8 230	59.601Hz @COMANCHE 345	18.6% @TS8 230	59.602Hz @COMANCHE 345
TR03-PV-WWing	16.8% @PALOVRDE 500	59.608Hz @COMANCHE 345	17% @PALOVRDE 500	59.598Hz @COMANCHE 345	15.5% @N.GILA 500	59.615Hz @COMANCHE 345	15.5% @COMANCHE 345	59.604Hz @COMANCHE 345	15.8% @N.GILA 500	59.612Hz @COMANCHE 345
TR04-PV-Rudd	17% @PALOVRDE 500	59.603Hz @COMANCHE 345	17.2% @PALOVRDE 500	59.605Hz @COMANCHE 345	15.9% @N.GILA 500	59.607Hz @COMANCHE 345	15.9% @N.GILA 500	59.604Hz @COMANCHE 345	16.3% @N.GILA 500	59.61Hz @COMANCHE 345
TR05-Hassy-Jojoba	15.5% @COMANCHE 345	59.607Hz @COMANCHE 345	15.5% @COMANCHE 345	59.602Hz @COMANCHE 345	15.5% @COMANCHE 345	59.615Hz @COMANCHE 345	15.5% @COMANCHE 345	59.604Hz @COMANCHE 345	15.5% @COMANCHE 345	59.607Hz @COMANCHE 345
TR06-Jojoba-Kyrene	9% @GILABEND 230	59.845Hz @GIL-ST1 18	9.1% @GILABEND 230	59.844Hz @GIL-ST1 18	8.1% @GILABEND 230	59.823Hz @GIL-ST1 18	8.2% @GILABEND 230	59.822Hz @GIL-ST1 18	6.6% @N.GILA 500	59.797Hz @PVQ3-ST2 13.8
TR09-PV-G1	15.4% @COMANCHE 345	42.72Hz @PINONCYN 115	15.5% @COMANCHE 345	39.899Hz @STANLEY 115	15.5% @COMANCHE 345	59.496Hz @COMANCHE 345	15.6% @COMANCHE 345	43.519Hz @HESSBDW 13.8	15.5% @COMANCHE 345	59.493Hz @COMANCHE 345
TR10-PV-WWing-dlo-slg	5.4% @RUDD 500	59.942Hz @PORTAL 4.8	5.5% @RUDD 500	59.94Hz @PORTAL 4.8	4% @COLRIVER 500	59.951Hz @GIL-CT1 18	4% @COLRIVER 500	59.949Hz @GIL-CT1 18	4.5% @N.GILA 500	59.944Hz @Q08 PG1 34.5
TR11-PV-WW2-Rudd-dlo-slg	4.3% @DELANY 500	59.947Hz @HGC-CT1 16	4.4% @DELANY 500	59.945Hz @HGC-CT1 16	3.7% @N.GILA 500	59.951Hz @GIL-CT1 18	3.7% @N.GILA 500	59.95Hz @GIL-CT1 18	4.1% @N.GILA 500	59.942Hz @Q08 PG1 34.5
TR12-PV-G2-RAS	15.8% @COMANCHE 345	59.378Hz @COMANCHE 345	15.8% @COMANCHE 345	59.368Hz @COMANCHE 345	15.8% @COMANCHE 345	39.751Hz @CALUMET 345	15.8% @COMANCHE 345	46.432Hz @COMANCHE 345	15.8% @COMANCHE 345	59.374Hz @COMANCHE 345
TR13-Hassy-NGila1-2	21.4% @COLRIVER 500	59.581Hz @COMANCHE 345	21.4% @COLRIVER 500	59.578Hz @COMANCHE 345	31.9% @BOUSE AZ 161	59.577Hz @COMANCHE 345	31.5% @BOUSE AZ 161	59.576Hz @COMANCHE 345	30.6% @BOUSE AZ 161	59.578Hz @COMANCHE 345
TR14-Perkins-Mead-PV-WW12	11.2% @COLRIVER 500	59.851Hz @NEWMN4G1 13.8	11.4% @COLRIVER 500	59.848Hz @NEWMN4G1 13.8	10.5% @COLRIVER 500	59.87Hz @NEWMN4G1 13.8	10.4% @COLRIVER 500	59.869Hz @NEWMN4G1 13.8	11.5% @COLRIVER 500	59.853Hz @NEWMN4G1 13.8

5.3 Power Flow Study Results with all Queued Projects

The list of queued projects as of 10/06/2010 is in Attachment C. The queued projects (before SSIII) included 5 generation projects, totaling 1670MW of new resources. The one-line diagram showing the new resource and dispatch is in Figure B-12 (case 07a) in Appendix B. The queued projects are labeled as Q2, Q3, Q8, Q9 and Q13.

5.3.1 Line Loading sensitivity

Tables 5.4 summarized the line loading with all queued projects dispatched.

There is no line overload for N-0.

With all queued resource projects dispatched, there is no additional line overload for N-1 and N-2 conditions. All line overloads were pre-project overloads, as discussed in Section 3, all line overload listed are due to the increased dispatch on EOR and WOR without application of planned Remedial Action Schemes (RAS).

Shiprock 345/230kV PS were listed as overload, it is mainly for the lack of an emergency rating of the transformer.

The overload on Gila River 500/230 transformer is due to Jojoba 230kV loop-in. Due to this project, there are two 230kV lines from Gila River to Liberty. When Gila River - Liberty is out of service, and leave Gila River-Jojoba-TS4-Liberty in, then there is no load connected to Jojoba. Results showed that the transformer loading is reduced to about 410MVA (73%). This project is delayed indefinitely by APS.

5.3.2 Voltage Deviation under Contingencies

Table 5.5 showed that there is no noticeable increase of voltage deviation under contingencies studied with all queued projects are dispatched.

Table 5.4. Line Loading with all Queued Projects

Equipment	Emergency Rating Amps/MVA	EOR 7800MW		EOR 9300MW		Contingency Description	Worst % Emergency Rating
		Base Case Pre-Project Case 01a	Post-SSIII Case 02a	Post-SSIII Case 05a	All Queued Project Case 07a		
Cholla 500/345 Bank 1T	500	493	443	426	405.9	Ess12-Coronado-Silverking	99%
Cholla 500/345 Bank 2T	500	**501.9**	450.9	433.6	413.2	Ess12-Coronado-Silverking	100%
Moenkopi - Rme 500 Ckt 1	2309	1835.8	1829	**2391.5**	1833.4	Ess07-Navajo-Crystal	104%
Moenkopi - Eldordo 500 Ckt 1	2750	2159.6	2149.3	2680.2	2356.3	Ess07-Navajo-Crystal	97%
Gilarivr 500/230 Bank 1T	560	537	542.6	506.7	**582**	Ess01-Jojoba-Kyrene	104%
	560	511.8	507.5	528.1	**611.1**	Ess02-Hassy-Jojoba	109%
	560	558.6	**563.8**	529.2	**602**	Ess51-Pv-Ww2-Rudd-Dlo-Slg	108%
	560	558.6	**563.8**	529.2	**602**	Ess61-Pv-Ww1-Rudd-Dlo-Slg	108%
Anderson - Kyrene 230 Ckt 1	2000	1787	1781.8	1911.4	1981.3	Ess51-Pv-Ww2-Rudd-Dlo-Slg	99%
	2000	1787	1781.8	1911.4	1981.3	Ess61-Pv-Ww1-Rudd-Dlo-Slg	99%
Mead 345/230 Bank 1T	600	551	552	576.1	**626.2**	Ess18-Pv-Colorador	104%
	600	**601.7**	**603.1**	**613.2**	**675.5**	Ess22-Mead-Perkins	113%
Gila - Knob 161 Ckt 1[3]	667	**679.1**	**682.1**	**934.5**	**987.8**	Ess30-Iv-Ngila	148%
Gila 161/230 Bank 1T[3]	300	**319.2**	**320.4**	**389**	**407.5**	Ess30-Iv-Ngila	136%
Knob - Pilotknb 161 Ckt 1[3]	592	456.6	457.6	**705.7**	**726.9**	Ess30-Iv-Ngila	123%
Elcentsw - Pilotknb 161 Ckt 1[3]	570	418.5	420.4	**663.3**	**697.7**	Ess30-Iv-Ngila	122%
Pilotknb 161/92 Bank 1T[3]	75	51	51.3	**89.1**	**93.4**	Ess30-Iv-Ngila	125%
Imprlvly - Elcentro 230 Ckt 1[3]	881	764.7	765.8	**1088.6**	**1107.1**	Ess30-Iv-Ngila	126%
J.Hinds - Mirage 230 Ckt 1	599	**610.3**	**610.4**	**757.6**	**768**	Ess18-Pv-Colorador	128%

RED indicates overload beyond emergency rating of the equipments.
Blue indicates overload beyond normal rating of the equipments.
1. Worst % Worst Rating listed the worst among the 4 cases (including the pre-project condition) studied.
2. Transmission Lines are rated in Amps, and Transformers are rated in MVA
3. The N-1, first run without planned or existing RAS, resulted in these overload violations of the local WAPA system. However, with the planned SLRC Project's Gila 230/161-kV transformer-tripping RAS applied to the North Gila-Imperial Valley 500kV line outage, the underlying system violations of the local WAPA system were entirely mitigated.

Table 5.5 Voltage Deviation* Following Contingencies (Category B, C, D)

Bus No.	Bus Name	kV	EOR 7800MW		EOR 9300MW		Contingency Description	Max Dev
			Base Case Pre-Project Case 01a	Post-SSIII Case 02a	Post-SSIII Case 05a	All Queued Project Case 07a		
22468	MIGUEL	500	-0.02	-0.02	-0.033	-0.041	ESS18-PV-ColoradoR	-0.041
24900	COLRIVER	500	-0.023	-0.024	-0.04	-0.04	ESS30-IV-NGila	-0.04
22885	CENTRALS	500	-0.019	-0.019	-0.032	-0.039	ESS18-PV-ColoradoR	-0.039
22360	IMPRLVLY	500	-0.017	-0.017	-0.029	-0.038	ESS18-PV-ColoradoR	-0.038
22472	MIGUELMP	500	-0.019	-0.019	-0.031	-0.038	ESS18-PV-ColoradoR	-0.038
22888	CENTRMPS	500	-0.018	-0.019	-0.03	-0.038	ESS18-PV-ColoradoR	-0.038
19038	MEAD	500	-0.019	-0.019	-0.029	-0.036	ESS18-PV-ColoradoR	-0.036
22536	N.GILA	500	-0.013	-0.014	-0.023	-0.035	ESS18-PV-ColoradoR	-0.035
24097	MOHAVE	500	-0.018	-0.018	-0.03	-0.035	ESS18-PV-ColoradoR	-0.035
26044	MARKETPL	500	-0.018	-0.018	-0.029	-0.035	ESS18-PV-ColoradoR	-0.035
26048	MCCULLGH	500	-0.018	-0.018	-0.029	-0.035	ESS18-PV-ColoradoR	-0.035
26120	MKTPSVC	500	-0.018	-0.018	-0.029	-0.035	ESS18-PV-ColoradoR	-0.035
27204	HLTAP	500	-0.018	-0.018	-0.029	-0.035	ESS18-PV-ColoradoR	-0.035

*Note: Voltage criteria allow a 5% deviation post-contingency for N-1.

5.4 Power Flow and Transient Stability Study Results without Q11(Palo Verde – Sun Valley 500kV Line) and Q12 (Hassayampa – N. Gila #2 500kV line)

The generation resources dispatched in the ANNP system is identical to case 7a. In order to achieve 530kV at PV hub and 800MVAR bucking, the following adjustments were made to the case:

- Re-inserted series caps on IV-N.Gila line.
- Changed schedules to SDG&E and SCE to offload EOR to 7860MW.
- Tuned off generation units at Coronado, Cholla and Sprinville.
- Turned on shunt capacitor banks in the Phoenix Metro area and adjusted the Westwing 500/230kV transformer taps.

The one-line diagram is shown in Figure B-13 of Appendix B.

5.4.1 Line Loading sensitivity

There is no line overload for N-0.

Tables 5.6 summarized the post-contingency line loading with all ANNP and queued generation projects dispatched, but without Q11(Palo Verde – Sun Valley 500kV Line) and Q12 (Hassayampa – N. Gila #2 500kV line).

The overload on Gila River 500/230 transformer is due to Jojoba 230kV loop-in. Due to this project, there are two 230kV lines from Gila River to Liberty. When Gila River - Liberty is out of service, and leave Gila River-Jojoba-TS4-Liberty in, then there is no load connected to Jojoba. Results showed that the transformer loading is reduced to about 488MVA (87%). This project is delayed indefinitely by APS.

For N-2, there are 4 additional line (transformer) overloads observed under this dispatch:

- Palo Verde - WestWing 500 # 1 (or #2) line for the loss of Palo Verde-WestWing(2 or 1) and Palo Verde-Rudd outage.
- Pinal_W 500/345 Bank #1 for the loss of Palo Verde – WestWing(1 and/or 2) (and/or) Rudd line.
- Rudd - Whitetnk 230 # 1 for the loss of Palo Verde – WestWing 1 and 2 line.
- Rudd 500/230 Bank 1,2,3,4 for the loss of Palo Verde – WestWing 1 and 2 line.

5.4.2 Voltage Deviation under Contingencies

Table 5.7 showed that there is no noticeable increase of voltage deviation under contingencies studied with this condition and dispatch.

5.4.3 Transient Response under Contingencies

The transient stability base case, Figure B-14 Appendix B, with 7% PV generation margin with 530kV PV initial voltage and 795MVAR bucking at PV bus. The system response to contingencies study are shown in Figure D.2.61 through Figure D.2.71 in Appendix D.2.

The system responses to the contingencies studied were stable. There is no WECC criteria violation for all the contingencies studied under this initial system condition. The voltage deviation and frequency deviation for all contingencies studied under this condition is listed in Table 5.8.

Table 5.9 tabulated voltage swings that approach criteria limit at 2 locations for 2 contingencies.

Table 5.6. Line Loading without Q11(Palo Verde – Sun Valley 500kV Line) and Q12 (Hassayampa – N. Gila #2 500kV line)

N	Equipment	Emergency Rating Amps/MVA	ESS3-07a EOR 9300MW ALIS	ESS3-8a EOR 7860MW HY-N. Gila #2 & PV-Sun Valley OOS	Contingency Description	Worst % Emergency Rating
N-1	Gilarivr 500/230 Bank 1T	560	582	676.7	Ess01-Jojoba-Kyrene	121%
N-1			540	621.6	Ess04-Pv-Rudd	111%
N-1			611.1	545.2	Ess02-Hassy-Jojoba	109%
N-2			602	722.1	Ess51-Pv-Ww2-Rudd-Dlo-Slg	129%
N-2			602	722.1	Ess61-Pv-Ww1-Rudd-Dlo-Slg	129%
N-2			555	678.3	Ess62-Pv-Wwing-Dlo-Slg	121%
N-1	Hassyamp - N.Gila 500 Ckt 1	3000	1645.8	2503.9	Ess18-Pv-Colorador	83%
N-1			2387.7	-	Ess21-Hassy-Ngila2	80%
N-2			1437.2	2413.9	Ess62-Pv-Wwing-Dlo-Slg	80%
N-2			1393.9	2235.2	Ess51-Pv-Ww2-Rudd-Dlo-Slg	75%
N-2			1393.9	2235.2	Ess61-Pv-Ww1-Rudd-Dlo-Slg	75%
N-1	Hassyamp - N.Gila 500 Ckt 2	2970	2376.2	-	Ess20-Hassy-Ngila1	80%
N-2	Jojoba - Kyrene 500 Ckt 1	3333	2345.6	3323.4	Ess62-Pv-Wwing-Dlo-Slg	100%
N-1	Moenkopi - Eldordo 500 Ckt 1	2750	2356.3	1972.7	Ess07-Navajo-Crystal	86%
N-1			2065.1	1717.2	Ess22-Mead-Perkins	75%
N-1			2014.1	1636	Ess18-Pv-Colorador	73%
N-1	Palovrde - Colriver 500 Ckt 1	5330	2940.4	2365.9	Ess30-Iv-Ngila	55%
N-2	Palovrde - Rudd 500 Ckt 1	3880	2502.1	3482.4	Ess62-Pv-Wwing-Dlo-Slg	90%
N-2	Palovrde - Westwing 500 Ckt 1	3480	3127.4	4249.9	Ess51-Pv-Ww2-Rudd-Dlo-Slg	122%
N-1	Palovrde - Westwing 500 Ckt 2	3480	2470.8	3227.1	Ess03-Pv-Wwing	93%
N-2			3127.4	4249.9	Ess61-Pv-Ww1-Rudd-Dlo-Slg	122%
N-1	Pinal_W 500/345 Bank 1T	672	414.8	642.4	Ess01-Jojoba-Kyrene	96%
N-1			408.5	639.5	Ess03-Pv-Wwing	95%
N-2			642.6	1033.1	Ess62-Pv-Wwing-Dlo-Slg	154%
N-2			509.2	786.6	Ess51-Pv-Ww2-Rudd-Dlo-Slg	117%
N-2			509.2	786.6	Ess61-Pv-Ww1-Rudd-Dlo-Slg	117%
N-1	Rudd 500/230 Bank 1,2,3,4	598	463	580.4	Ess01-Jojoba-Kyrene	97%
N-2			568.4	781.9	Ess62-Pv-Wwing-Dlo-Slg	131%
N-2	Anderson - Kyrene 230 Ckt 1	2000	1981.3	1855.8	Ess51-Pv-Ww2-Rudd-Dlo-Slg	99%
N-2			1981.3	1855.8	Ess61-Pv-Ww1-Rudd-Dlo-Slg	99%
N-1	Imprlvly - Elcentro 230 Ckt 1	881	1107.1	772.5	Ess30-Iv-Ngila	126%
N-1	J.Hinds - Mirage 230 Ckt 1	599	768	587	Ess18-Pv-Colorador	128%
N-1	Orme - Rudd 230 Ckt 1	2320	1773	2295.4	Ess01-Jojoba-Kyrene	99%
N-2	Rudd - Whitetnk 230 Ckt 1	2290	1818.5	2321.4	Ess62-Pv-Wwing-Dlo-Slg	101%
N-1	Elcentsw - Pilotknb 161 Ckt 1	570	697.7	419.7	Ess30-Iv-Ngila	122%
N-1	Gila - Knob 161 Ckt 1	667	987.8	682.4	Ess30-Iv-Ngila	148%
N-1	Gila 161/230 Bank 1T	300	407.5	320.4	Ess30-Iv-Ngila	136%
N-1	Knob - Pilotknb 161 Ckt 1	592	726.9	457.1	Ess30-Iv-Ngila	123%
N-1	Pilotknb 161/92 Bank 1T	75	93.4	51.4	Ess30-Iv-Ngila	125%

RED indicates overload beyond emergency rating of the equipments.
Blue indicates overload beyond normal rating of the equipment.
1. Worst % Worst Rating listed the worst among the 4 cases (including the pre-project condition) studied.
2. Transmission Lines are rated in Amps, and Transformers are rated in MVA

3. The N-1, first run without planned or existing RAS, resulted in these overload violations of the local WAPA system. However, with the planned SLRC Project's Gila 230/161-kV transformer-tripping RAS applied to the North Gila-Imperial Valley 500kV line outage, the underlying system violations of the local WAPA system were entirely mitigated.

Table 5.7 Voltage Deviation Following Contingencies (Category B, C, D)

Bus No.	Bus Name	kV	EOR 7860MW Case 08a	Contingency Description
24900	COLRIVER	500	-0.042	ESS20-Hassy-NGila1
15041	SILVERKG	500	-0.034	ESS12-Coronado-SilverKing
24801	DEVERS	500	-0.033	ESS20-Hassy-NGila1
24900	COLRIVER	500	-0.031	ESS62-PV-WWing-dlo-slg

Note: Voltage criteria allow a 5% deviation post-contingency for N-1 and 10% for N-2.

Table 5.8 Worst Transient Bus Voltage Deviation and Lowest Bus Frequencies (with 7% PV Margin)

Case 08b Sensitivity Hassayampa-N.Gila & PaloVerde-SunValley OOS		
	Worst Voltage Dip	Lowest Frequency
TR01-Hassy-NGila1	28.2% @COLRIVER 500	59.611Hz @NEWMN4G1 13.8
TR02-PV-ColoradoR	22.2% @Q8 115	59.585Hz @DELRANCH 14.4
TR03-PV-WWing	22.6% @Q8 115	59.692Hz @NEWMN4G1 13.8
TR04-PV-Rudd	22.7% @Q8 115	59.694Hz @NEWMN4G1 13.8
TR05-Hassy-Jojoba	19.4% @Q8 115	59.693Hz @NEWMN4G1 13.8
TR06-Jojoba-Kyrene	13.5% @GILABEND 230	59.777Hz @PVQ3-ST2 13.8
TR09-PV-G1	4.4% @DWORSHAK 115	59.83Hz @HYC 4G 4.16
TR10-PV-WWing-dlo-slg	14.1% @RUDD 500	59.855Hz @PORTAL 4.8
TR11-PV-WW2-Rudd-dlo-slg	7.8% @Q13_2 115	59.908Hz @Q08 PG1 34.5
TR12-PV-G2-RAS	6% @DWORSHAK 115	59.661Hz @CABAZON 33
TR14-Perkins-Mead-PV-WW12	26.8% @RUDD 500	59.693Hz @KMO 13G8 13.8

Table 5.9 Transient Stability Voltage Criteria Limits *

Contingency	*Bus Name*	*Initial (pu)*	*MinV (pu)*	*% Dip*	*@time*	*Duration @cycles*	*Time*
TR01-Hassy-NGila1	COLRIVER 500	1.063	0.763	28.2	0.67	34.7	0.371- 0.950
TR14-Perkins-Mead-PV-WW12	RUDD 500	1.077	0.788	26.8	0.71	36.0	0.412- 1.012
	COLRIVER 500	1.063	0.781	26.6	0.75	34.7	0.476- 1.055

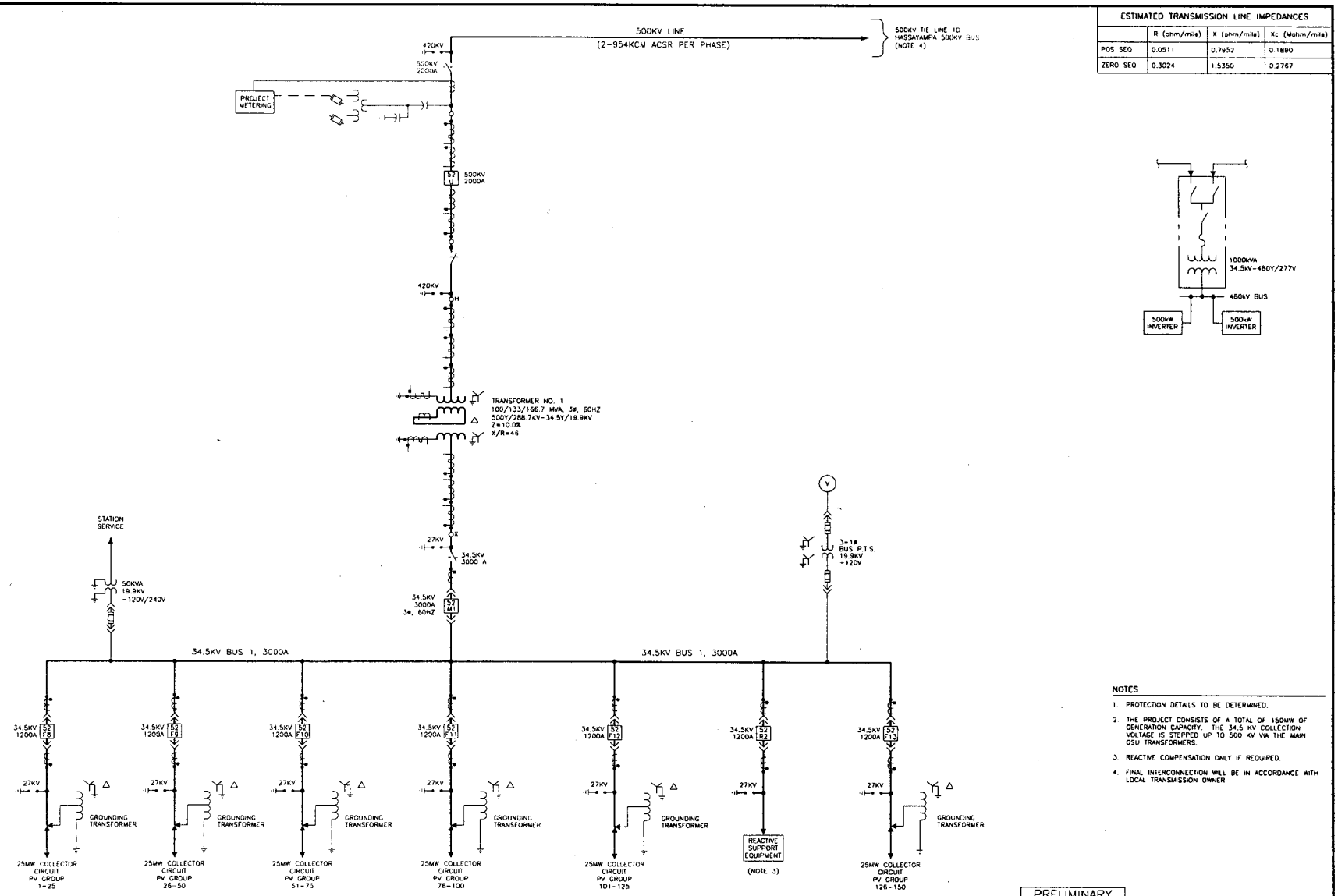
*Refer to Section 3.1 for criteria limits.

6 Sub-synchronous Resonance (SSR)

The manufacturers of inverter should provide information regarding inverter impacts to any potential SSR issue, and should be studied during the facility phase study.

Appendix A – SSIII Schematic One-Line

ESTIMATED TRANSMISSION LINE IMPEDANCES			
	R (ohm/mile)	X (ohm/mile)	Xc (Mohm/mile)
POS SEQ	0.0511	0.7852	0.1890
ZERO SEQ	0.3024	1.5350	0.2767



NOTES

1. PROTECTION DETAILS TO BE DETERMINED.
2. THE PROJECT CONSISTS OF A TOTAL OF 150MW OF GENERATION CAPACITY. THE 34.5 KV COLLECTION VOLTAGE IS STEPPED UP TO 500 KV VIA THE MAIN GSU TRANSFORMERS.
3. REACTIVE COMPENSATION ONLY IF REQUIRED.
4. FINAL INTERCONNECTION WILL BE IN ACCORDANCE WITH LOCAL TRANSMISSION OWNER.

PRELIMINARY

NO	REVISIONS	DATE	ENG	DES/DFT	CHK

NO.	REVISIONS	DATE	ENG	DES/DFT	CHK
A	PRELIMINARY; ISSUED FOR REVIEW	05/20/10	SDM	JLD	

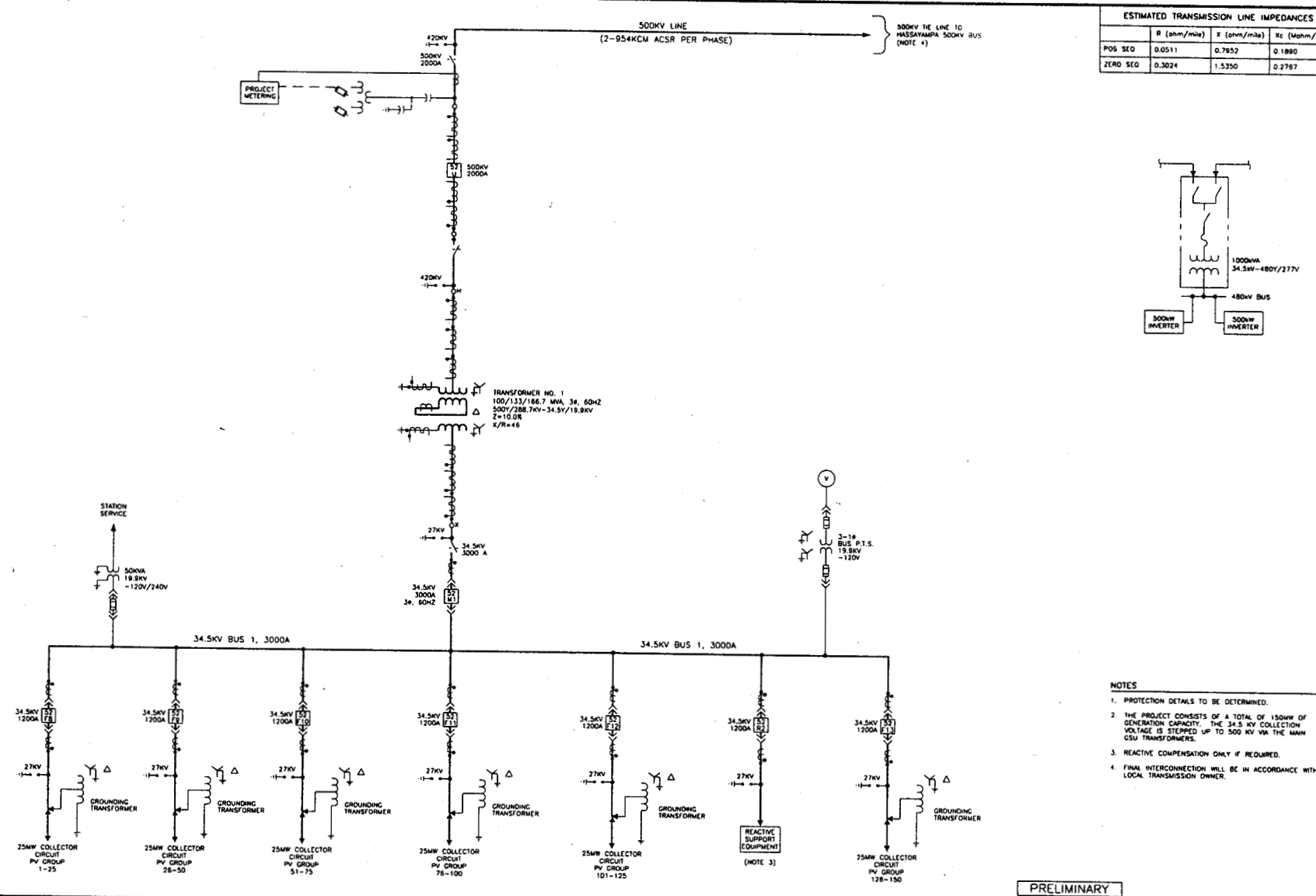
elementpower

Stantec

ENGINEERING RECORD	DATE
DES/DRFT BY: STC/NLV	05/19/10
ENGINEERED BY: STC/SDM	05/19/10
CHECKED BY:	
CADFILE: SS3-E-200-02.DWG	

SUN STREAM III SOLAR PROJECT
SOLAR COLLECTOR SUBSTATION
ONE LINE DIAGRAM

SCALE: NONE | DWG.NO. SS3-E-200 | SHEET 1 | REV A



ESTIMATED TRANSMISSION LINE IMPEDANCES			
	R (ohm/mile)	X (ohm/mile)	Xc (Mohm/mile)
POS SEQ	0.0511	0.7952	0.1890
ZERO SEQ	0.3024	1.5350	0.2767

NOTES

1. PROTECTION DETAILS TO BE DETERMINED.
2. THE PROJECT CONSISTS OF A TOTAL OF 150MW OF GENERATION CAPACITY. THE 34.5 KV COLLECTION VOLTAGE IS STEPPED UP TO 500 KV VIA THE MAIN GSU TRANSFORMERS.
3. REACTIVE COMPENSATION ONLY IF REQUIRED.
4. FINAL INTERCONNECTION WILL BE IN ACCORDANCE WITH LOCAL TRANSMISSION OWNER.

PRELIMINARY

NO.	REVISIONS	DATE	ENG	DES/DFT	CHK
A	PRELIMINARY; ISSUED FOR REVIEW	05/20/10	SDM	AD	

elementpower

Stantec

ENGINEERING RECORD	DATE
DES/DRFT BY: STC/MLV	05/19/10
ENGINEERED BY: STC/SDM	05/19/10
CHECKED BY:	
CADFILE: SS3-E-200-02.DWG	

SUN STREAM III SOLAR PROJECT
SOLAR COLLECTOR SUBSTATION
ONE LINE DIAGRAM

SCALE: NONE | DWG.NO. SS3-E-200 | SHEET 1 | REV A

Appendix B - Base Case and Study Case One-Line Overview

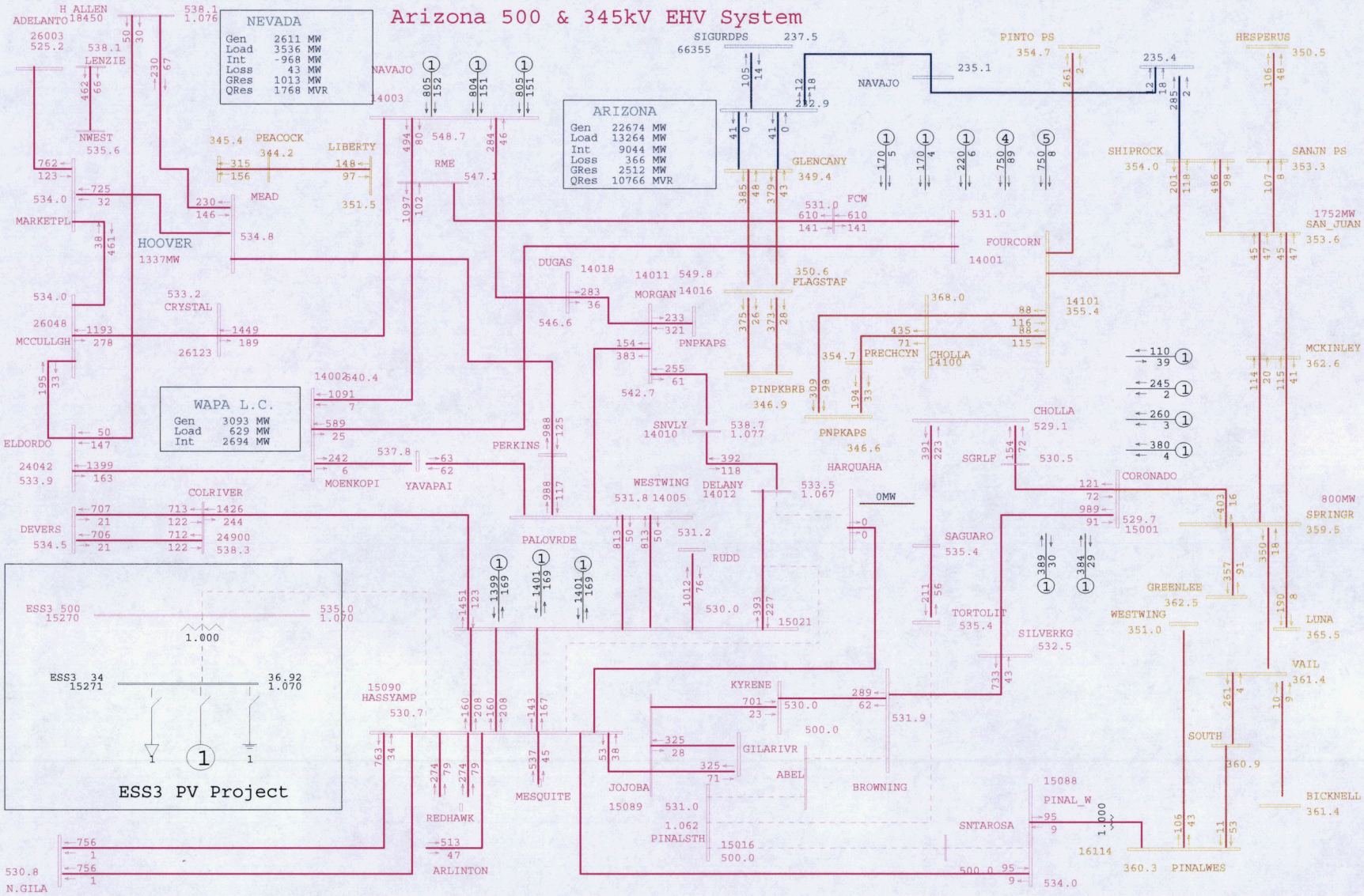


Figure B-01 Case00 WECC 16hw2 Case - One-line

General Electric International, Inc. PSLF Program Mon Apr 25 21:27:49 2011 ESS3-00.sav

	PreContingency: ESS3-00.sav	PVTS-SG GEN[7361][PV 4201][AVE 530][RHK 583][HQH 0][MsQ 1098][Gila 950]MW	MW/MVAR
	CASE NAME:ess3\ess3-00.sav	PV Bucking[882MVAR][(EOR) 7004][(WOR) 7212][SCIT 8364][PATH 22 770]MW	ess3-04.drw
	ARIZONA[LOAD 13264 XCHGE 9044 GEN 22674][ESS3 0 GROSS 0 NET]MW		Rating = 1

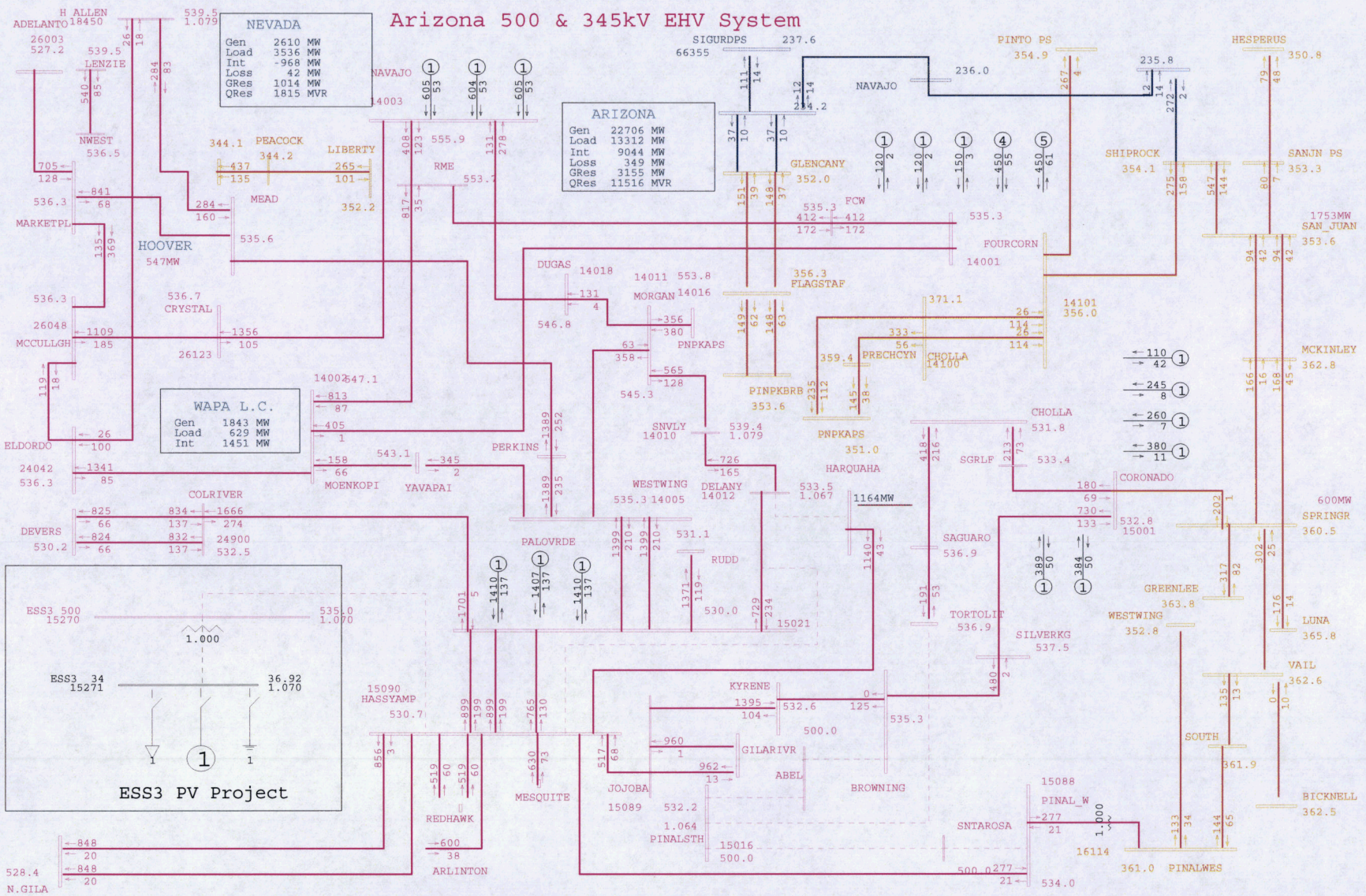


Figure B-02 Case01a-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:27:57 2011 ESS3-01a.sav

	PreContingency: ESS3-01a.sav CASE NAME:ess3\ess3-01a.sav ARIZONA[LOAD 13312 XCHGE 9044 GEN 22706][ESS3 0 GROSS 0 NET]MW	PVTS-SG GEN[10781][PV 4227][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW PV Bucking[800MVAR][(EOR) 7799][(WOR) 7253][SCIT 8304][PATH 22 356]MW	MW/MVAR ess3-04.drw Rating = 1

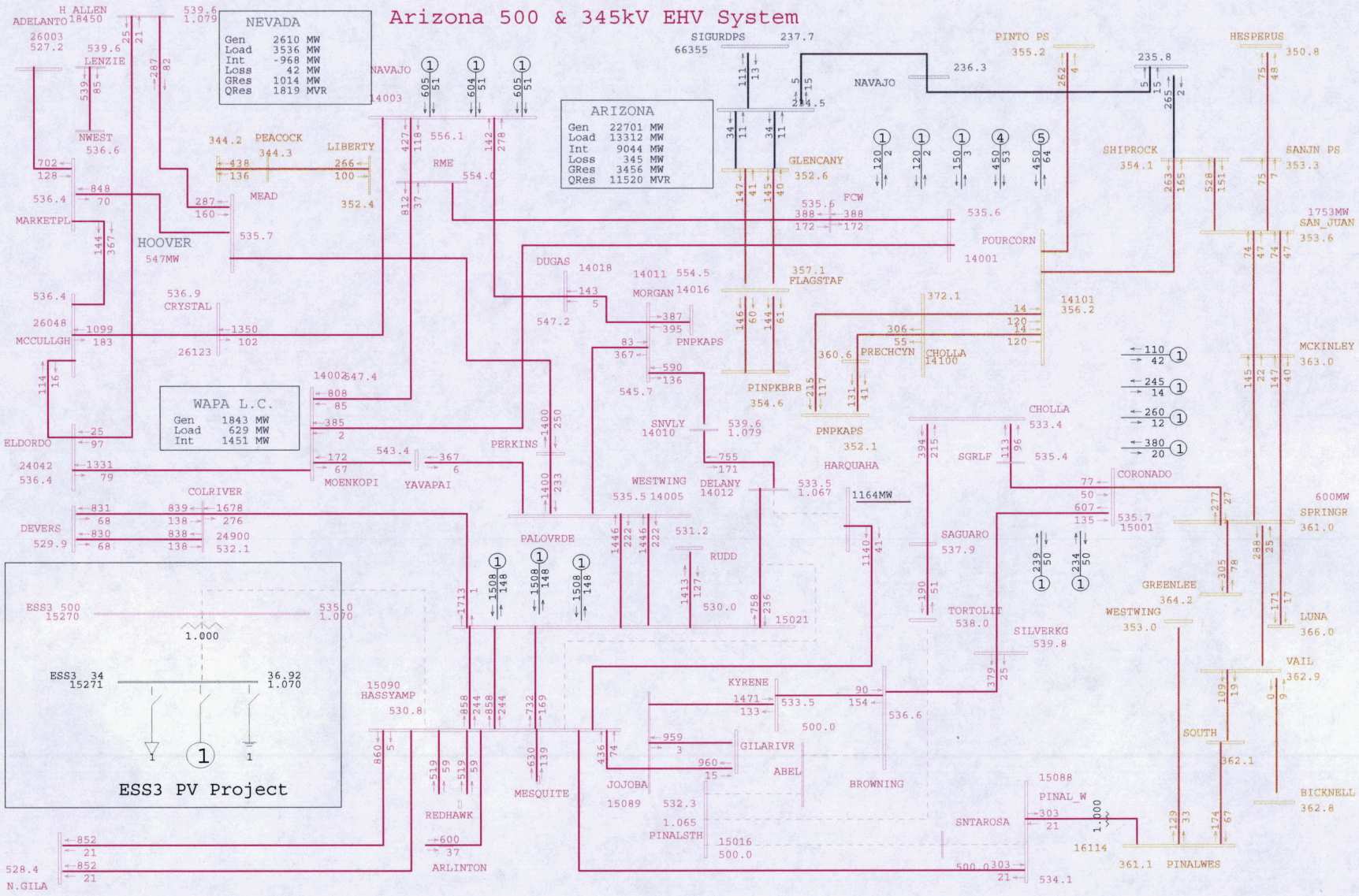


Figure B-03 Case01b-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:28:00 2011 ESS3-01b.sav

	PreContingency: ESS3-01b.sav	PVTS-SG GEN[11078][PV 4524][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW	MW/MVAR
	CASE NAME:ess3\ess3-01b.sav	PV Bucking[799MVAR][(EOR) 7815][(WOR) 7259][SCIT 8300][PATH 22 358]MW	ess3-04.drw
	ARIZONA[LOAD 13312 XCHGE 9044 GEN 22701][ESS3 0 GROSS 0 NET]MW		Rating = 1

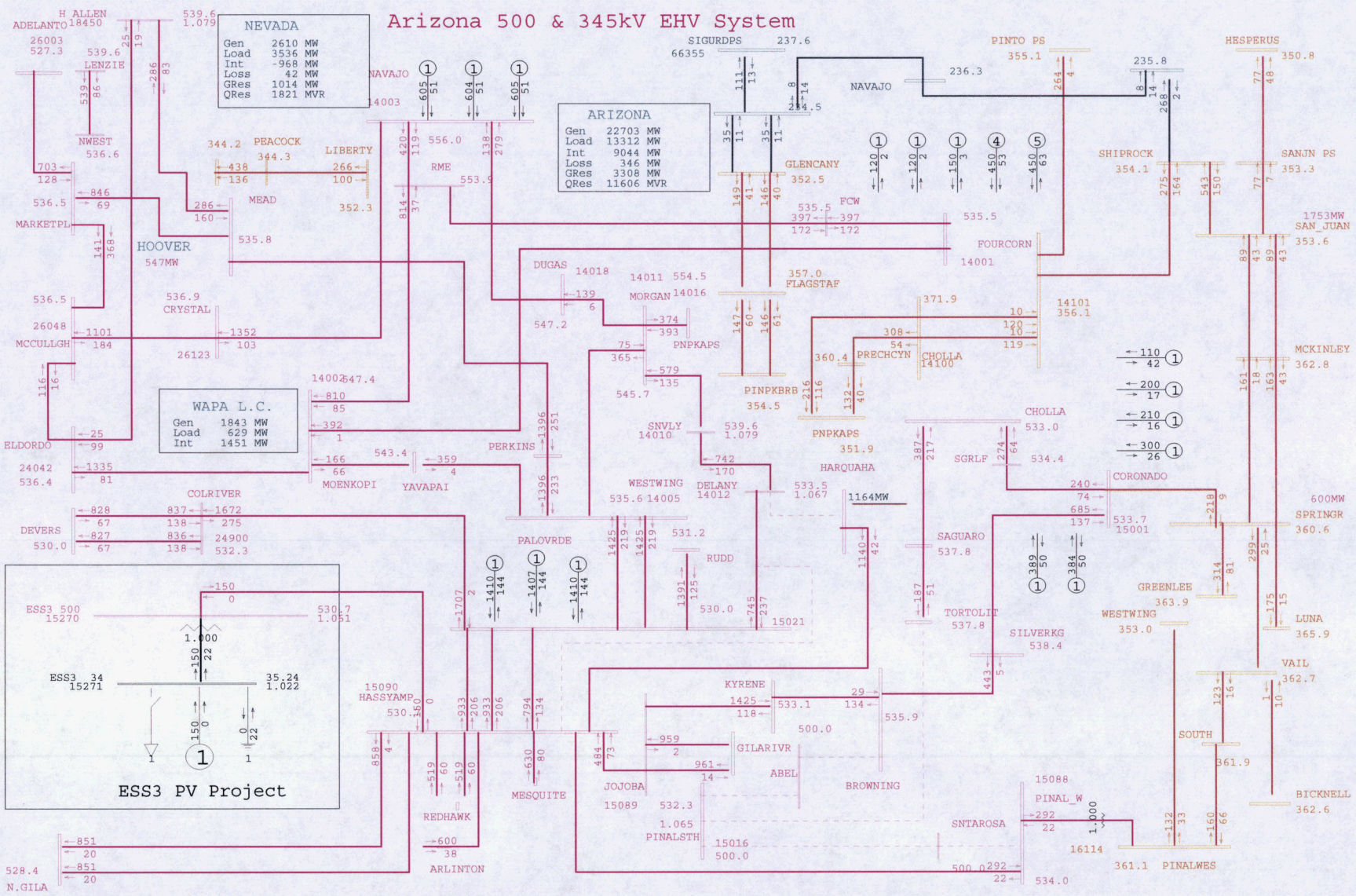


Figure B-04 Case02a-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:28:04 2011 ESS3-02a.sav

PreContingency: ESS3-02a.sav	PVTS-SG GEN[10781][PV 4227][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW	MW/MVAR
CASE NAME:ess3\ess3-02a.sav	PV Bucking[811MVAR][(EOR) 7808][(WOR) 7254][SCIT 8302][PATH 22 374]MW	ess3-04.drw
ARIZONA[LOAD 13312 XCHGE 9044 GEN 22703][ESS3 0 GROSS 150 NET]MW		Rating = 1

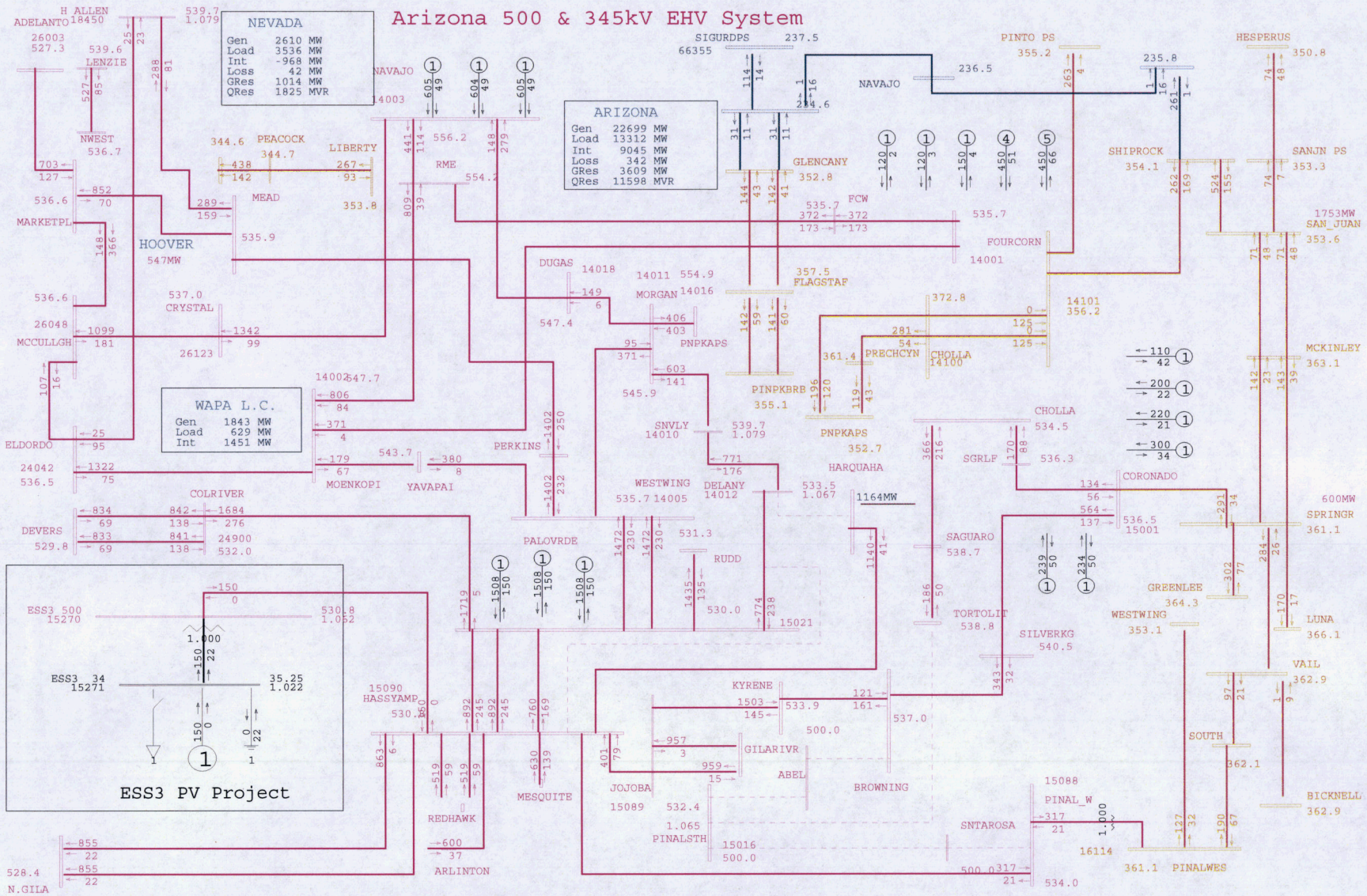


Figure B-05 Case02b-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:28:07 2011 ESS3-02b.sav

	PreContingency: ESS3-02b.sav	PVTS-SG GEN[11078][PV 4524][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW	MW/MVAR
	CASE NAME:ess3\ess3-02b.sav	PV Bucking[806MVAR][(EOR) 7813][(WOR) 7270][SCIT 8302][PATH 22 372]MW	ess3-04.drw
	ARIZONA[LOAD 13312 XCHGE 9045 GEN 22699][ESS3 0 GROSS 150 NET]MW		Rating = 1

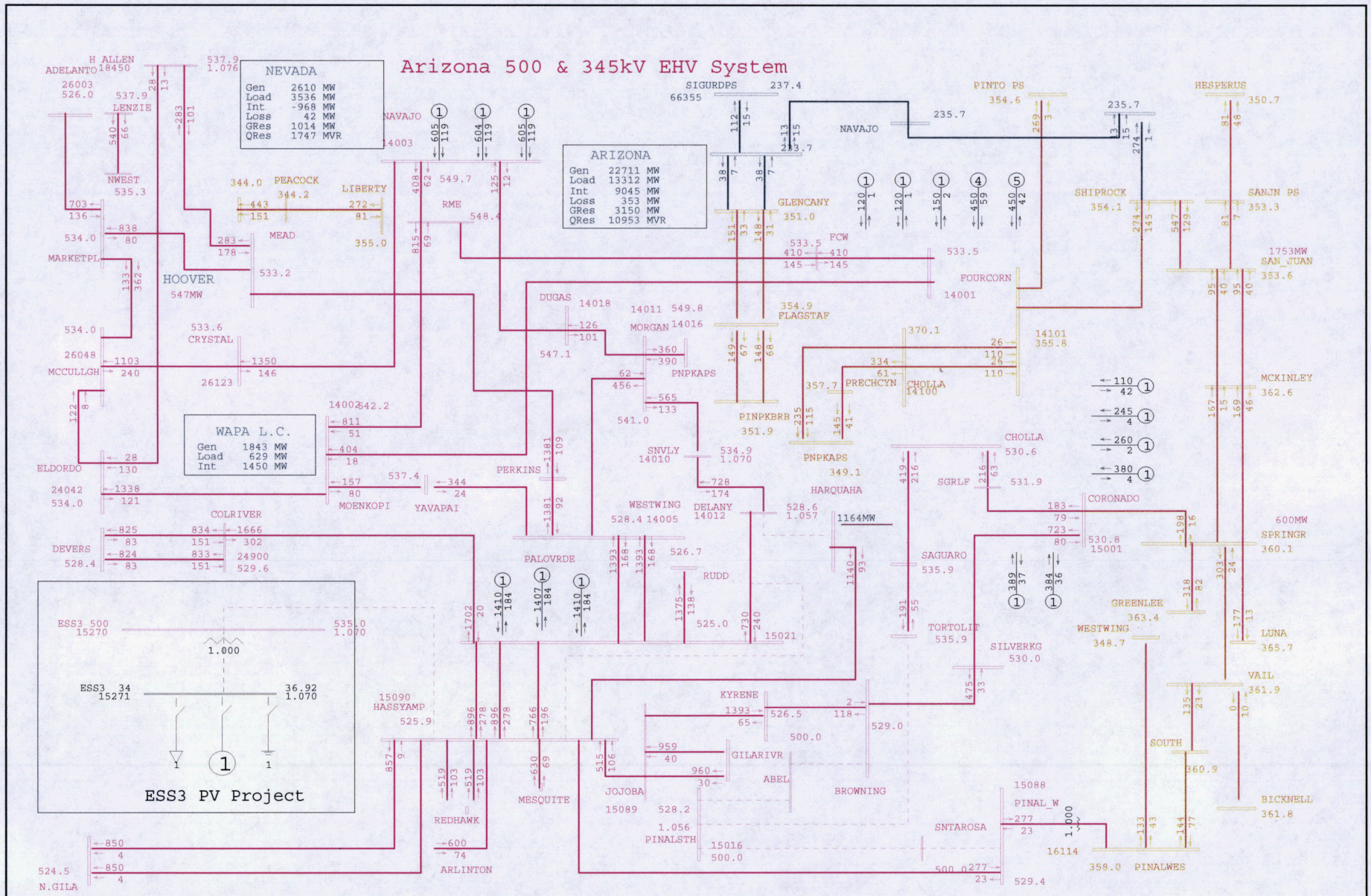


Figure B-06 Case03a-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:28:10 2011 ESS3-03a.sav

	PreContingency: ESS3-03a.sav CASE NAME:ess3\ess3-03a.sav ARIZONA[LOAD 13312 XCHGE 9045 GEN 22711][ESS3 0 GROSS 0 NET]MW	PVTS-SG GEN[10781][PV 4227][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW PV Bucking[804MVAR][(EOR) 7795][(WOR) 7250][SCIT 8300][PATH 22 354]MW	MW/MVAR ess3-04.drw Rating = 1

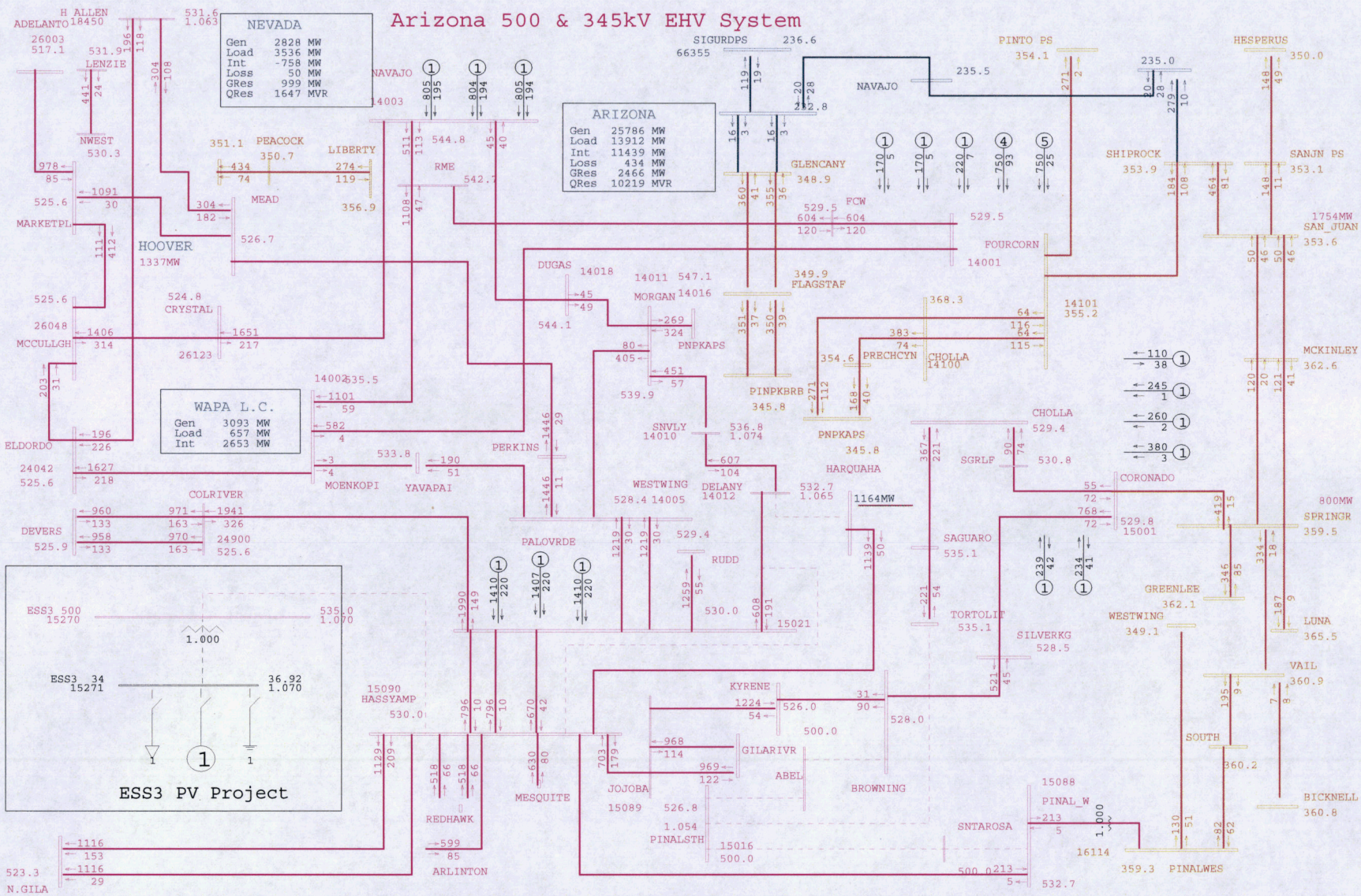


Figure B-07 Case04a-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:28:13 2011 ESS3-04a.sav

	PreContingency: ESS3-04a.sav	PVTS-SG GEN[10781][PV 4227][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW	MW/MVAR
	CASE NAME:ess3\ess3-04a.sav	PV Bucking[-391MVAR][(EOR) 9302][(WOR) 9525][SCIT 9944][PATH 22 716]MW	ess3-04.drw
	ARIZONA[LOAD 13912 XCHGE 11439 GEN 25786][ESS3 0 GROSS 0 NET]MW		Rating = 1

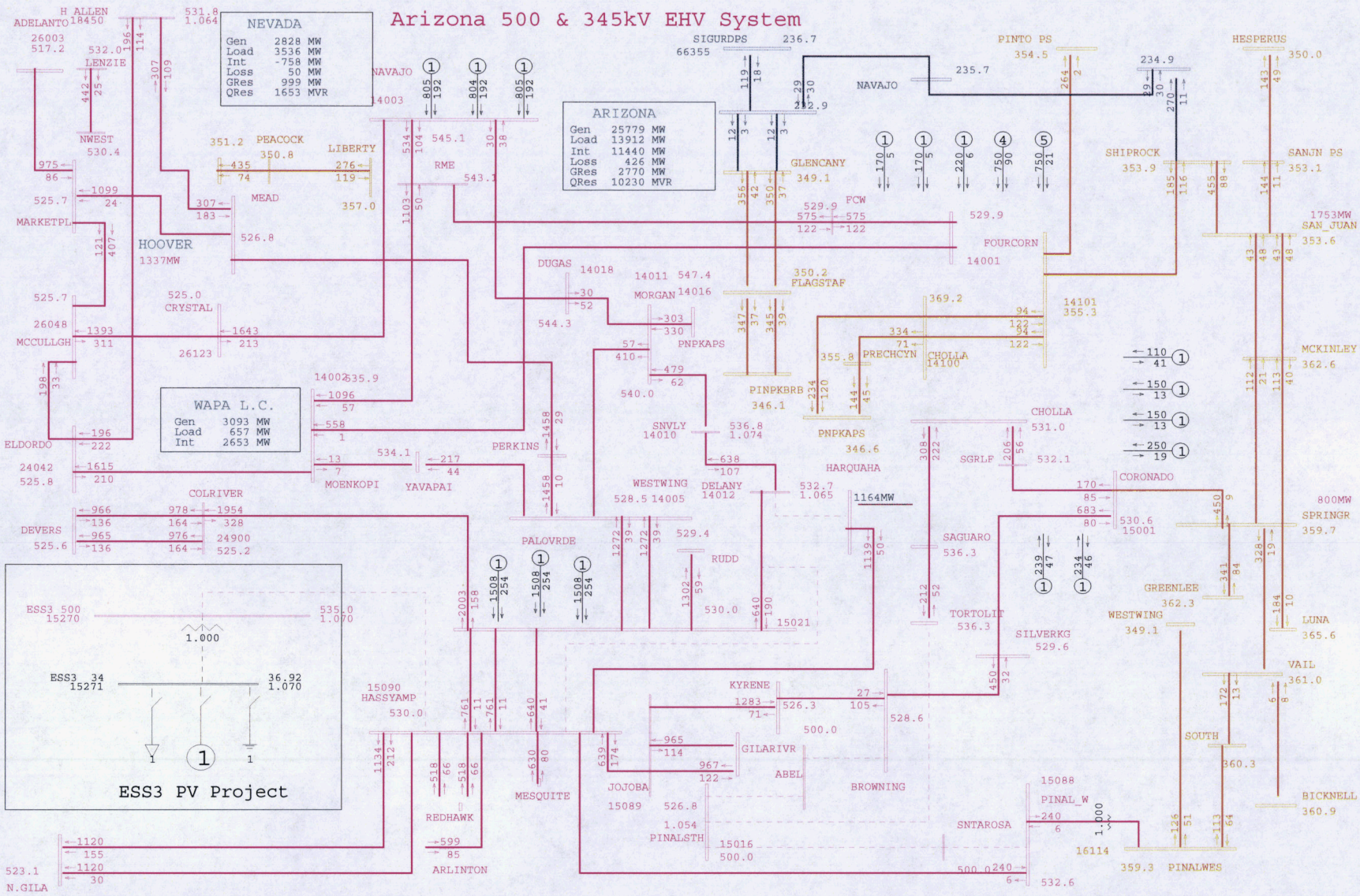


Figure B-08 Case04b-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:28:16 2011 ESS3-04b.sav

	PreContingency: ESS3-04b.sav	PVTS-SG GEN[11078][PV 4524][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW	MW/MVAR
	CASE NAME:ess3\ess3-04b.sav	PV Bucking[-409MVAR][(EOR) 9319][(WOR) 9529][SCIT 9944][PATH 22 751]MW	ess3-04.drw
	ARIZONA[LOAD 13912 XCHGE 11440 GEN 25779][ESS3 0 GROSS 0 NET]MW		Rating = 1

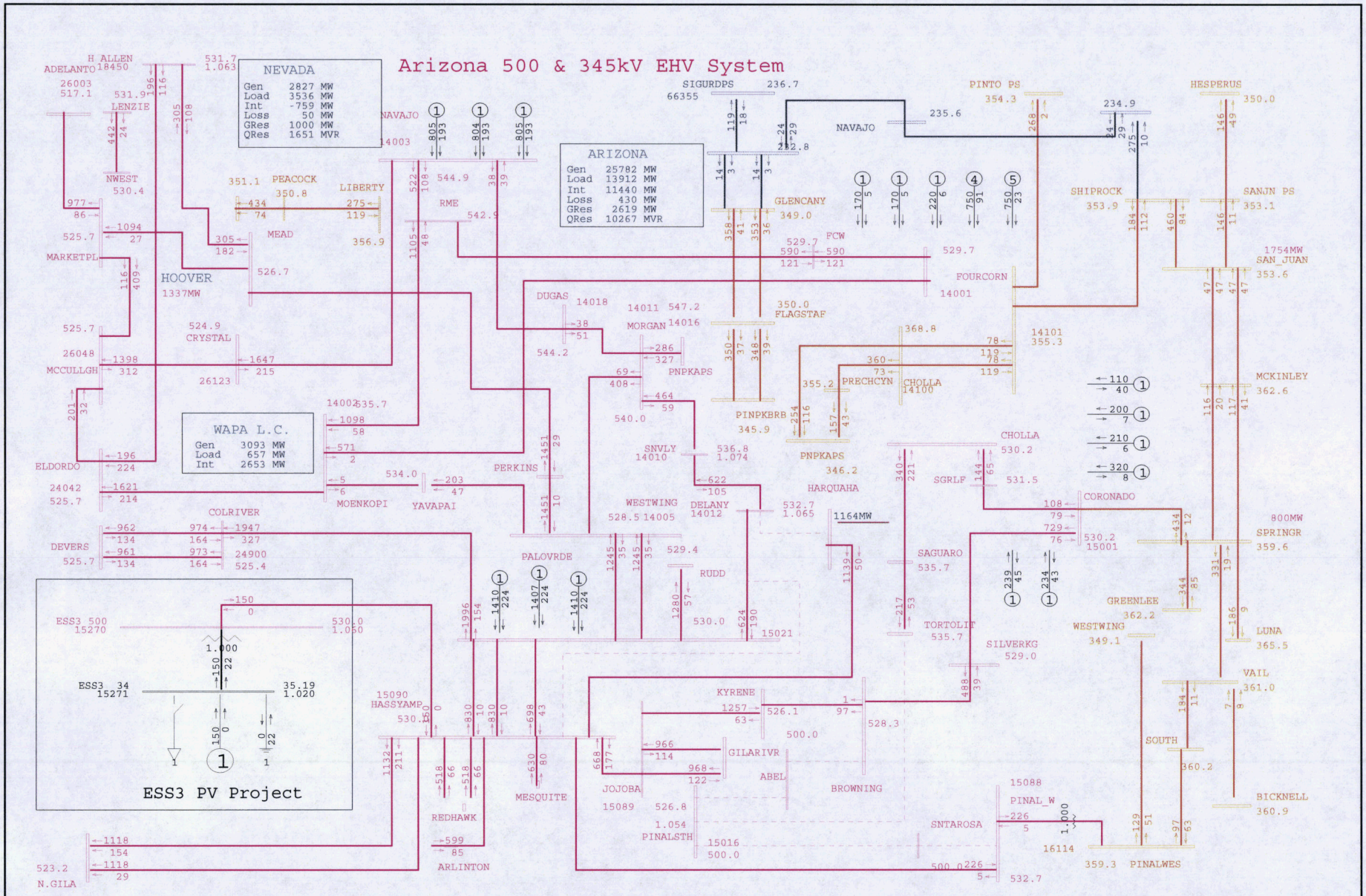


Figure B-09 Case05a-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:28:19 2011 ESS3-05a.sav

	PreContingency: ESS3-05a.sav CASE NAME:ess3\ess3-05a.sav ARIZONA[LOAD 13912 XCHGE 11440 GEN 25782][ESS3 0 GROSS 150 NET]MW	PVTS-SG GEN[10781][PV 4227][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW PV Bucking[-401MVAR][(EOR) 9311][(WOR) 9526][SCIT 9944][PATH 22 732]MW	MW/MVAR ess3-04.drw Rating = 1

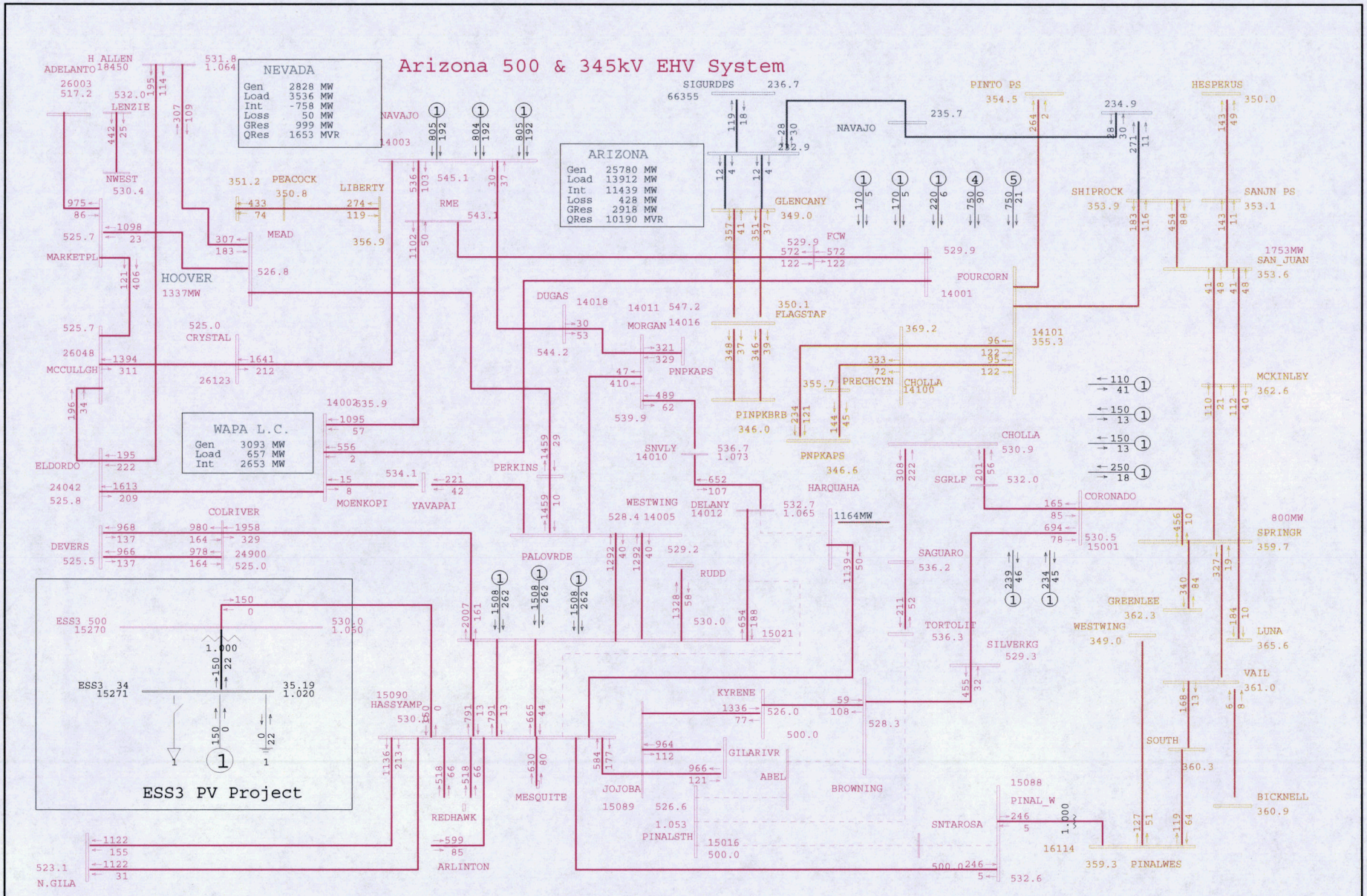


Figure B-10 Case05b-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:28:23 2011 ESS3-05b.sav

PreContingency: ESS3-05b.sav	PVTS-SG GEN[11078][PV 4524][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW	MW/MVAR
CASE NAME:ess3\ess3-05b.sav	PV Bucking[-434MVAR][(EOR) 9322][(WOR) 9532][SCIT 9942][PATH 22 752]MW	ess3-04.drw
ARIZONA[LOAD 13912 XCHGE 11439 GEN 25780][ESS3 0 GROSS 150 NET]MW		Rating = 1

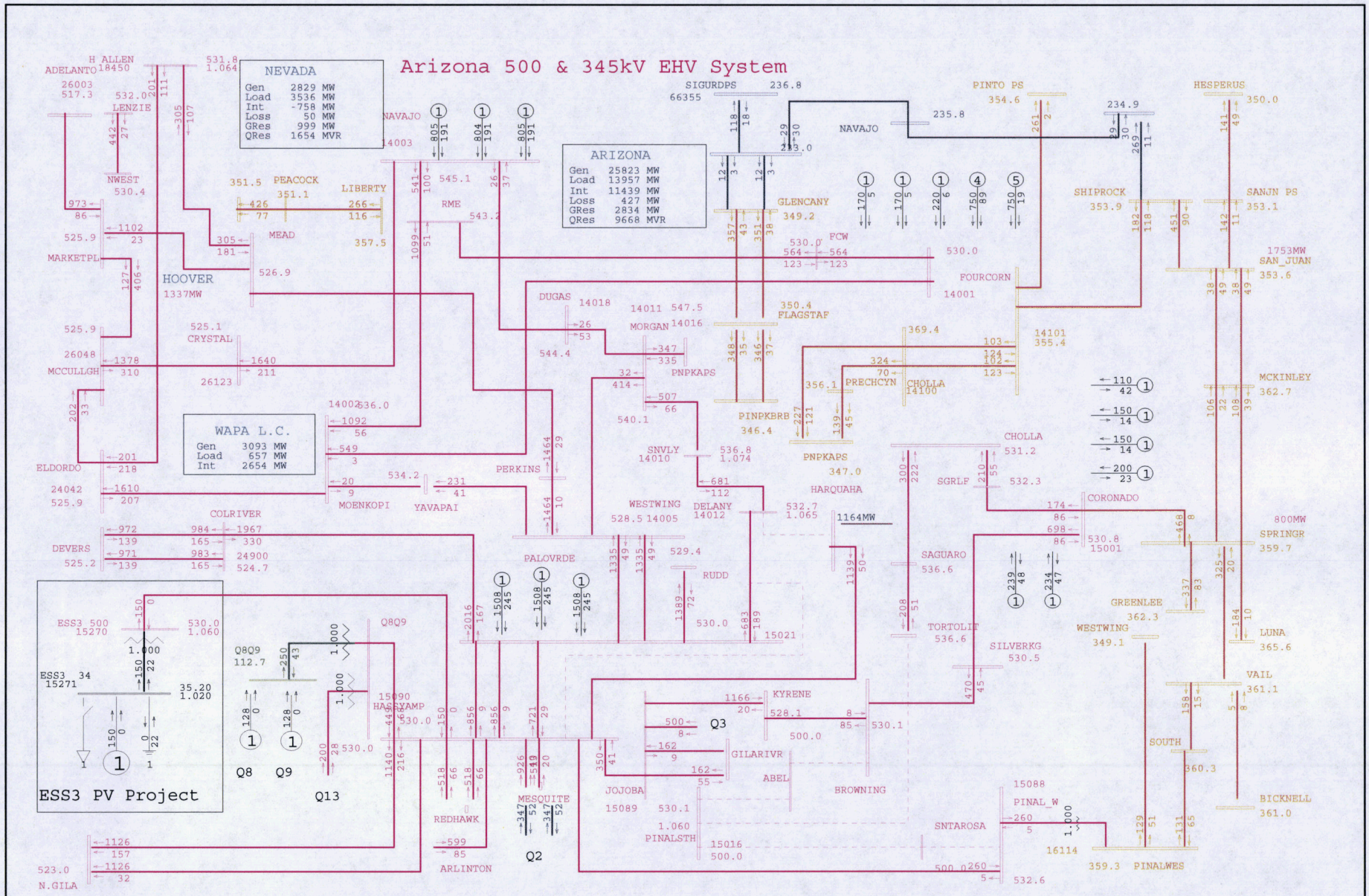


Figure B-11 Case06b-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:34:48 2011 ESS3-06b.sav

	PreContingency: ESS3-06b.sav	PVTS-SG GEN[11078][PV 4524][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 703]MW	MW/MVAR
	CASE NAME:ess3\ess3-06b.sav	PV Bucking[-259MVAR][(EOR) 9332][(WOR) 9534][SCIT 9940][PATH 22 759]MW	ess3-05.drw
	ARIZONA[LOAD 13957 XCHGE 11439 GEN 25823][ESS3 0 GROSS 150 NET]MW		Rating = 1

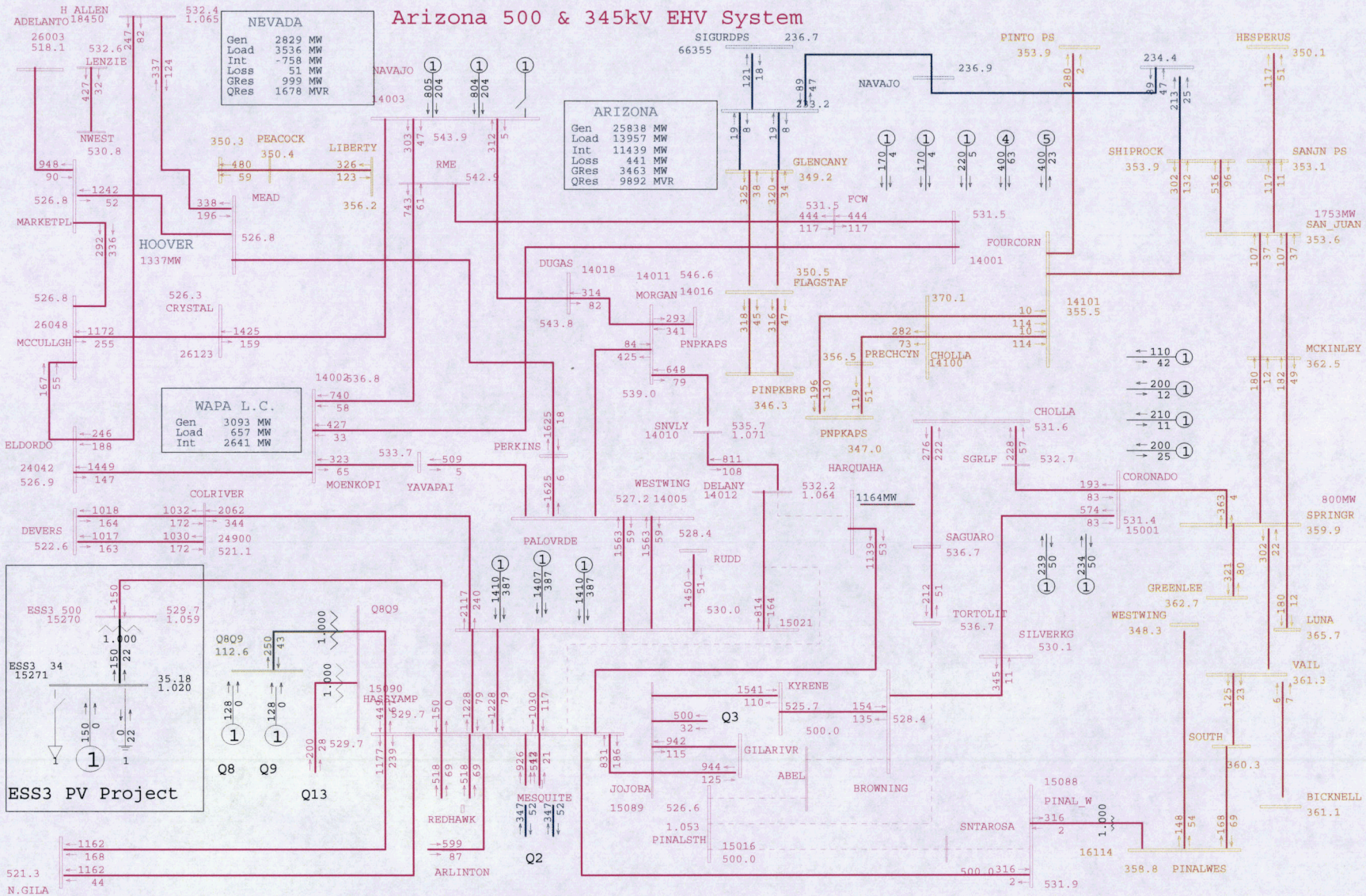


Figure B-12 Case07a-OneLine

General Electric International, Inc. PSLF Program Mon Apr 25 21:34:52 2011 ESS3-07a.sav

	PreContingency: ESS3-07a.sav CASE NAME:ess3\ess3-07a.sav ARIZONA[LOAD 13957 XCHGE 11439 GEN 25838][ESS3 0 GROSS 150 NET]MW	PVTS-SG GEN[12480][PV 4227][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW PV Bucking[-776MVAR][(EOR) 9338][(WOR) 9562][SCIT 9928][PATH 22 410]MW	MW/MVAR ess3-05.drw Rating = 1

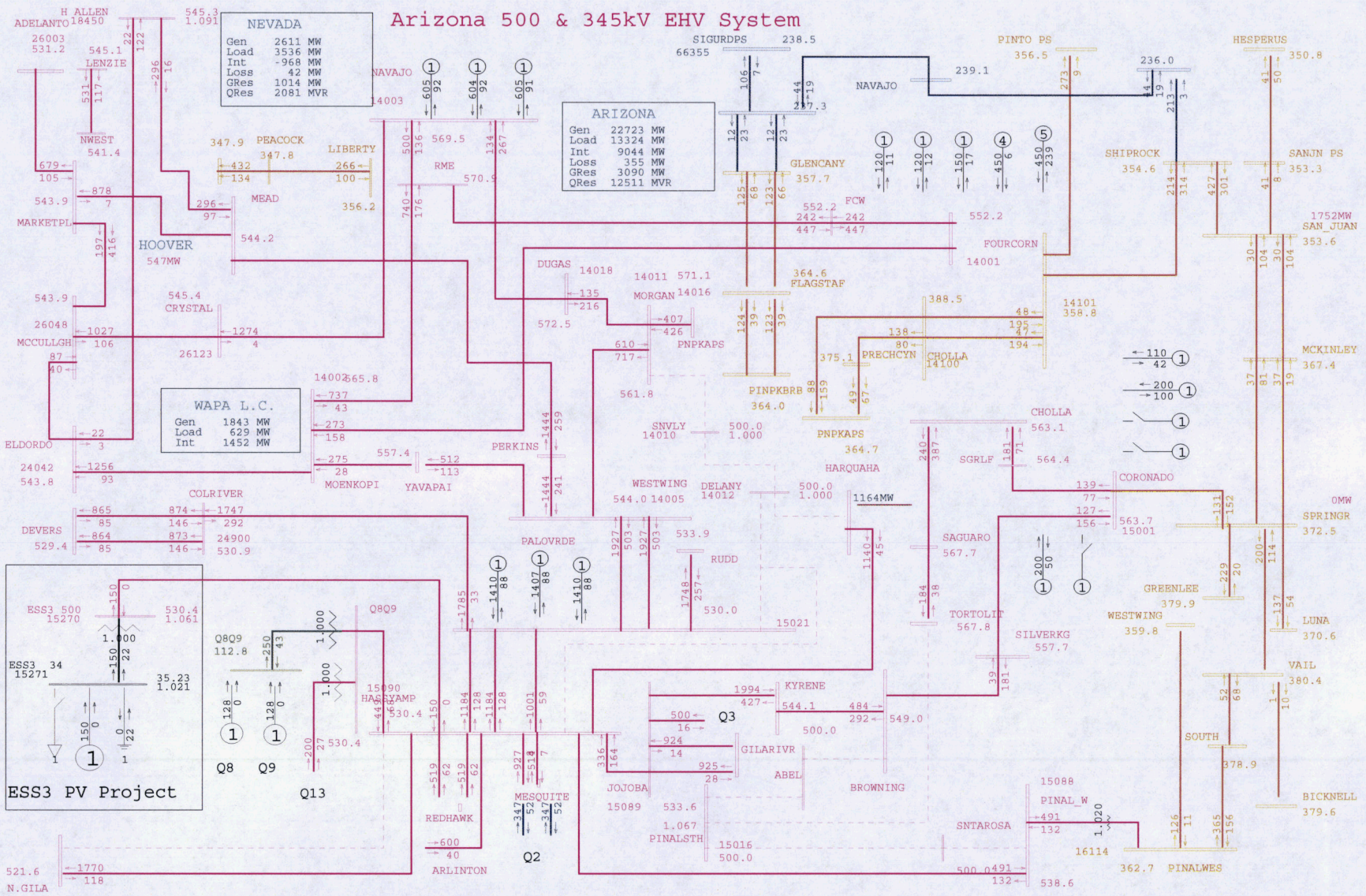


Figure B-13 Case08a-OneLine

General Electric International, Inc. PSLF Program Sat Sep 17 10:25:57 2011 ESS3-08a.sav

	PreContingency: ESS3-08a.sav	PVTS-SG GEN[10781][PV 4227][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW	MW/MVAR
	CASE NAME:ess3\ess3-8a.sav	PV Bucking[803MVAR][(EOR) 7860][(WOR) 7282][SCIT 8259][PATH 22 369]MW	ess3-05.drw
	ARIZONA[LOAD 13324 XCHGE 9044 GEN 22723][ESS3 150 GROSS 150 NET]MW		Rating = 2

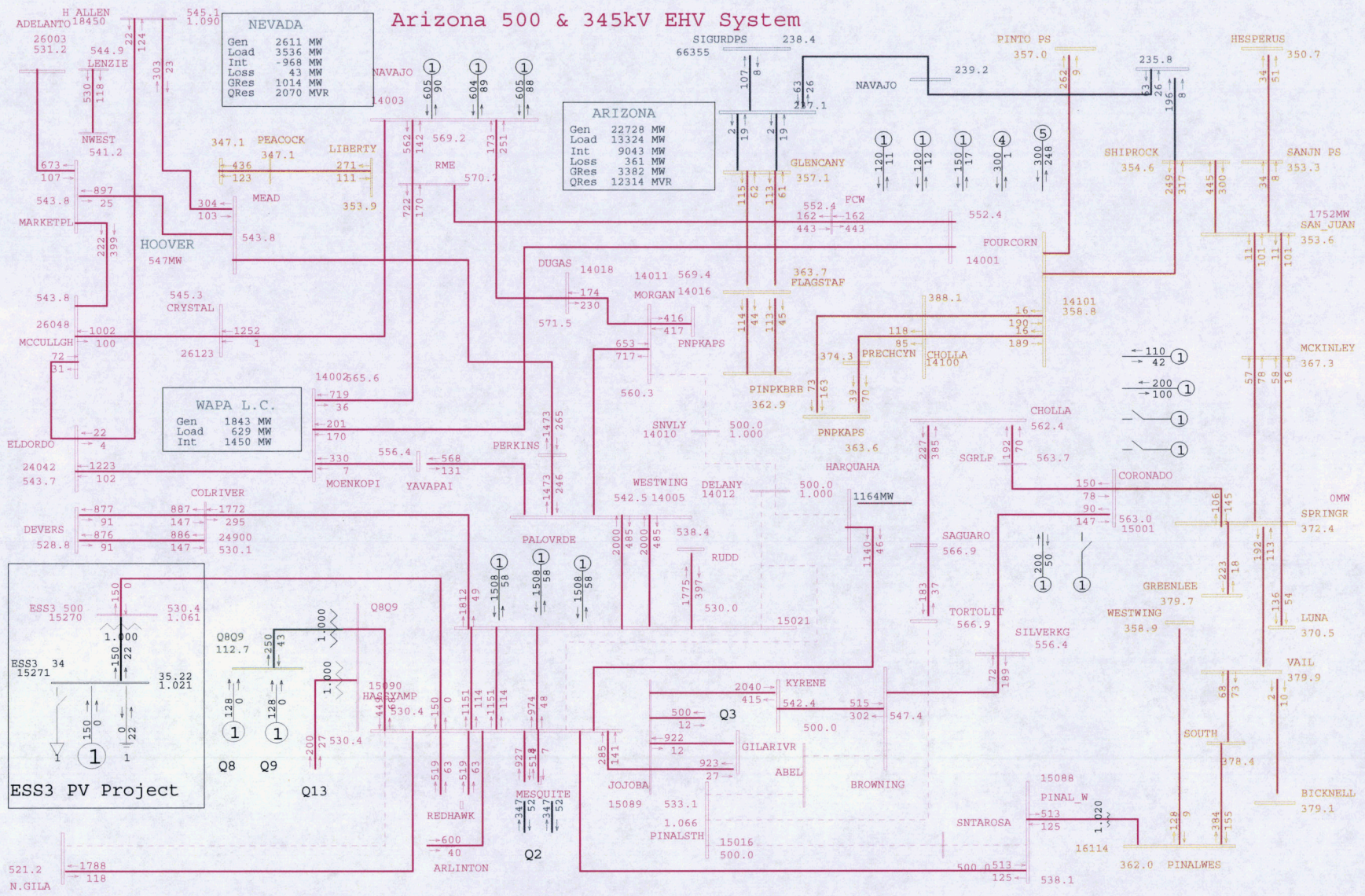


Figure B-14 Case08b-OneLine

General Electric International, Inc. PSLF Program Sat Sep 17 10:26:16 2011 ESS3-08b.sav

	PreContingency: ESS3-08b.sav CASE NAME:ess3\ess3-8b.sav ARIZONA[LOAD 13324 XCHGE 9043 GEN 22728][ESS3 150 GROSS 150 NET]MW	PVTS-SG GEN[11078][PV 4524][AVE 620][RHK 1080][HQH 1164][MsQ 1288][Gila 2402]MW PV Bucking[795MVAR][(EOR) 7882][(WOR) 7287][SCIT 8254][PATH 22 234]MW	MW/MVAR ess3-05.drw Rating = 2

Appendix C – ANPP Trans System Generation Interconnection Queue

SRP AS OPERATING AGENT
INTERCONNECTION QUEUE - ANPP 500 KV SWITCHYARD AND ANPP VALLEY TRANSMISSION SYSTEM
UPDATED: 10/6/2010

PV 500 KV SWITCHYARD OR ANPP VALLEY TRANSMISSION SYSTEM INTERCONNECTION RQUEST					GENERATOR LOCATION	TRANSMISSION LINE INTERCON	POINT OF INTERCONNECTION	GENERATING FACILITY				STUDY STATUS	
QUEUE POSITION	RECEIVED DATE	QUEUE DATE	STATUS	IN-SERVICE DATE REQUESTED	COUNTY & STATE		TRANS LINE OR STATION	GEN TYPE	FUEL	SUMMER MAX MW	WINTER MAX MW	WATS Preliminary Study (SIS)	Detailed Planning Study (FAS)
1	12/7/2006	12/7/2006	Withdrawn	10/1/2008		Hassayampa-Pinal West 500 kV line	JOJOBA 500 KV						
2	5/22/2007	5/22/2007	Study	3/1/2010	Maricopa, AZ		HASSAYAMPA 500 kV	PV	S	180	180	Complete	Complete
			Study	3/1/2011	Maricopa, AZ		HASSAYAMPA 500 kV	PV	S	180	180	Complete	Complete
			Study	3/1/2012	Maricopa, AZ		HASSAYAMPA 500 kV	PV	S	180	180	Complete	Complete
			Study	3/1/2014	Maricopa, AZ		HASSAYAMPA 500 kV	PV	S	180	180	Complete	Complete
3	2/11/2008	2/11/2008	Study	12/1/2012	Maricopa, AZ		JOJOBA 500 KV	CSP	S	500	500	Complete	Complete
4	2/26/2008	5/1/2008	Withdrawn	5/1/2011	Maricopa, AZ		GEN TIE LINE TO HASSAYAMPA 500 KV	CSP	S	125	125		
			Withdrawn	future	Maricopa, AZ		GEN TIE LINE TO HASSAYAMPA 500 KV	CSP	S	62.5	62.5		
			Withdrawn	future	Maricopa, AZ		GEN TIE LINE TO HASSAYAMPA 500 KV	PV	S	40	40		
5	7/31/2008	7/31/2008	Withdrawn	10/1/2012	Maricopa, AZ		HASSAYAMPA 500 kV	CSP	S	250	250		
6	10/27/2008	10/27/2008	Withdrawn	1/1/2013	Maricopa, AZ		JOJOBA 500 KV	CSP	S	440	440		
7	12/22/2008	12/22/2008	Withdrawn	7/1/2013	Maricopa, AZ		HASSAYAMPA 500 kV	CSP	S	500	500		
8	1/29/2009	1/29/2009	Study	6/30/2011	Maricopa, AZ		HASSAYAMPA 500 kV	CSP	S	125	125	Complete	In-progress
9	1/29/2009	1/29/2009	Study	12/31/2011	Maricopa, AZ		HASSAYAMPA 500 KV	CSP	S	125	125	Complete	In-progress
10	4/28/2009	4/28/2009	Withdrawn	1/1/2013	Maricopa, AZ		JOJOBA TO HASSAYAMPA 500KV TRANSMISSION LINE	CSP	S	440	440		
11	11/10/2009	11/10/2009	Study	6/1/2012		Palo Verde-Sun Valley 500 kV line	PALO VERDE 500 KV					In-progress	
12	11/10/2009	11/10/2009	Study	2014		Hassayampa-North Gila 500 kV line	HASSAYAMPA 500 KV					In-progress	
13	2/18/2010	2/18/2010	Scope	5/1/2013	Maricopa, AZ		HASSAYAMPA 500 KV	PV	S	200	200		
14	3/10/2010	3/10/2010	Withdrawn	1/1/2013	Maricopa, AZ		JOJOBA 500 KV	CSP	S	250	250		
15	7/13/2010	7/13/2010	Scope	12/31/2012	Maricopa, AZ		HASSAYAMPA 500 kV	PV	S	150	150		

Generator Type: CC = Combined Cycle, CT = Combustion Turbine, CSP = Concentrated Solar Power, H = Hydro, IC = Internal Combustion, ST = Steam Turbine
PV = Photovoltaic, WT = Wind Turbine

Fuel Type: B = Biomass, C = Coal, LFG = Landfill Gas, NG = Natural Gas, NU = Nuclear, O = Oil, S = Solar, W = Wind, WTR = Water

Appendix D – Dynamic Response Plots for Transient Stability Study

D.1 – Plots for No Fault Test Results – Model Stability Verification

D.2 – Plots for Dynamic Responses to Contingencies

Appendix E – Short Circuit Study Results Summary

BUS FAULT SUMMARY - ANPP Q 15

					PRE-ANPP Q15 PROJECT						POST-ANPP Q15 PROJECT						INCREMENTAL CONTRIBUTION	
					THREE PHASE FAULT (AMPS)			SINGLE LINE TO GROUND (AMPS)			THREE PHASE FAULT (AMPS)			SINGLE LINE TO GROUND (AMPS)				
NO	BUS	KV	AREA	ZONE	Phase Cur	Gnd Cur	X/R	Phase Cur2	Gnd Cur3	X/R4	Phase Cur5	Gnd Cur6	X/R7	Phase Cur8	Gnd Cur9	X/R10	3PH	SLG
0	ANPP Q15	34.5	14	150	0	0	0	0	0	0	19400.4	0	47	19370.9	19370.9	46.8	19400.4	19370.9
0	ANPP Q15	525	14	150	52932.4	0	29.6	48619.4	48619.4	25.4	53099.7	0	29.7	48788.9	48788.9	25.5	167.3	169.5
15090	HASSYAMP500 (POI)	525	14	151	61509.1	0	21.3	62399.5	62399.5	19.8	61676.3	0	21.4	62566.7	62566.7	19.8	167.2	167.2
15094	MESQUITE500	525	14	150	60205.4	0	22.1	59350.7	59350.7	16.6	60365	0	22.1	59500.6	59500.6	16.6	159.6	149.9
14009	REDHAWK500	525	14	143	58671.2	0	21.9	57552.6	57552.6	19	58821.7	0	22	57690.5	57690.5	19	150.5	137.9
15021	PALOVRDE_500	525	14	151	61869.6	0	21	63975.4	63975.4	19.6	62018.8	0	21	64112.7	64112.7	19.6	149.2	137.3
0	ANPP Q8-9-13	525	14	150	57164.2	0	17.4	55200.5	55200.5	14	57308.3	0	17.4	55331.1	55331.1	14.1	144.1	130.6
15092	ARLINGTON500	525	14	150	40196	0	24.1	31854.2	31854.2	14.7	40263.8	0	24.1	31893.1	31893.2	14.7	67.8	38.9
0	DELANEY 500	525	14	141	28126.6	0	24.4	23605.6	23605.6	9.9	28150	0	24.4	23618.2	23618.2	9.9	23.4	12.6
14008	JOJOBA	525	14	143	31722.5	0	25.5	26964	26964	12.6	31744.3	0	25.5	26975.7	26975.7	12.6	21.8	11.7
14005	WESTWING_500	525	14	143	34610	0	10.1	28130	28130.8	7.8	34630.3	0	10.1	28139.1	28139.9	7.8	20.3	9.1
15033	PERKINPS	525	14	151	33960	0	10.2	27232.5	27232.5	7.8	33979.4	0	10.2	27240.9	27240.9	7.8	19.4	8.4
15034	PERKINSSOUTH	525	14	151	33880.7	0	10.2	27180.3	27180.3	7.8	33900.1	0	10.2	27188.7	27188.7	7.8	19.4	8.4
15093	HARQUAHAL500	525	14	150	21330.1	0	26	17324.4	17324.4	18.4	21345.9	0	26	17332.4	17332.4	18.4	15.8	8
0	ANPP Q3	525	14	150	26429.9	0	25.4	22066.2	22066.2	14.9	26444.9	0	25.4	22073.9	22073.9	14.9	15	7.7
15230	RUDD_230	230	14	151	54330.8	0	13.9	46755.2	46755.2	8.2	54345.7	0	13.9	46763	46763	8.2	14.9	7.8
14231	WESTWING_W1	230	14	143	52778.9	0	15.8	48347.7	48347.7	11.2	52793.4	0	15.8	48356.2	48356.2	11.2	14.5	8.5
14259	WESTWING_E1	230	14	143	52747.3	0	15.8	48318	48318	11.2	52761.7	0	15.8	48326.5	48326.5	11.2	14.4	8.5
0	Q56/57	525	14	151	20651.4	0	22.9	17845.4	17845.4	14.2	20663.7	0	22.9	17852.1	17852.1	14.2	12.3	6.7
14007	GILA_RIVER	525	14	144	25892.3	0	27.7	24382.1	24382.1	19.4	25903.4	0	27.7	24389	24389	19.4	11.1	6.9
15061	RUDD_500	525	14	150	20978.5	0	20.5	16843.2	16843.2	9.1	20987.8	0	20.5	16847.5	16847.5	9.1	9.3	4.3
0	Q39	525	14	151	18601.2	0	7.7	14864.8	14864.8	6.5	18610.1	0	7.7	14868.9	14868.9	6.5	8.9	4.1
15207	KYRENE_230	230	14	150	53966.8	0	12.8	50276.9	50276.9	10.1	53974.3	0	12.8	50281.3	50281.3	10.1	7.5	4.4
0	QX	525	14	152	19128	0	8.9	12949.6	12949.6	10.2	19135	0	8.9	12952.4	12952.4	10.2	7	2.8
15201	AGUA_FRIA	230	14	151	43170.7	0	12	34587.8	34587.8	7.4	43177.6	0	12	34590.8	34590.8	7.4	6.9	3
14236	KYRENENEW230	230	14	151	51658.6	0	12.4	46387	46387	9.1	51665.4	0	12.4	46390.7	46390.7	9.1	6.8	3.7
14232	WHTTANKS_APS	230	14	143	37763.7	0	11	26362.5	26362.5	6.5	37769.7	0	11	26364.5	26364.5	6.5	6	2
15218	WHTTANKS_SRP	230	14	150	35565.7	0	11.2	27738	27738	7.1	35571.6	0	11.2	27740.4	27740.4	7.1	5.9	2.4
0	Q56/57	230	14	151	23172.8	0	32.9	4386.2	4386.2	50.6	23178.6	0	32.9	4386.4	4386.4	50.6	5.8	0.2
15208	ORME_230	230	14	150	36106	0	10.4	25182.3	25182.3	6.8	36111.6	0	10.4	25184.2	25184.2	6.8	5.6	1.9
14221	PINPK_APS	230	14	143	49324.5	0	10.6	48101.7	48101.7	9.1	49330.1	0	10.6	48105.2	48105.2	9.1	5.6	3.5
19661	PINPK_WAPA_N	230	14	197	49394.6	0	10.6	48143.8	48143.8	9.1	49400.2	0	10.6	48147.3	48147.3	9.1	5.6	3.5
19062	PINPK_WAPA_S	230	14	197	49404	0	10.5	48159	48159	9.1	49409.6	0	10.5	48162.6	48162.6	9.1	5.6	3.6
0	HOODOO	525	14	152	17855	0	7.3	12009.6	12009.6	8.1	17860.5	0	7.3	12011.7	12011.7	8.1	5.5	2.1
15211	PINPK_SRP	230	14	151	49091.7	0	10.5	47096.3	47096.3	8.9	49097.2	0	10.5	47099.7	47099.7	8.9	5.5	3.4
141565	PP230_WEST	230	14	144	49373.2	0	10.6	48139.3	48139.3	9.1	49378.7	0	10.6	48142.8	48142.8	9.1	5.5	3.5
15163	MESQUITE	230	14	150	29993.5	0	69.3	35032.2	35032.2	61	29998.7	0	69.3	35037.8	35037.8	61.1	5.2	5.6
94460	Q044B	525	14	151	16453	0	9.8	10947	10947	12.4	16458	0	9.8	10948.8	10948.8	12.4	5	1.8
94350	Q043U1	525	14	152	16925	0	5.2	11344.4	11344.4	5.5	16929.9	0	5.2	11346.3	11346.3	5.5	4.9	1.9
94360	Q043U2	525	14	152	16925	0	5.2	11344.4	11344.4	5.5	16929.9	0	5.2	11346.3	11346.3	5.5	4.9	1.9
14210	EL_SOL	230	14	143	34491.8	0	11.3	25895.3	25895.3	7.2	34496.7	0	11.3	25897.2	25897.2	7.2	4.9	1.9
150604	AGUAFRI_GT56	230	14	150	35663.4	0	10.3	27230.9	27230.9	6.4	35668.1	0	10.3	27232.7	27232.7	6.4	4.7	1.8
150603	AGUAFRIA_GT4	230	14	150	35463.4	0	10.2	27209.7	27209.7	6.4	35468.1	0	10.2	27211.6	27211.6	6.4	4.7	1.9
15088	PINAL_WEST	525	14	151	11531	0	19.5	8106.5	8106.5	12.5	11535.6	0	19.5	8108.4	8108.4	12.5	4.6	1.9
142329	WESTWING_E2	230	14	143	28579.4	0	20.6	28905.7	28905.7	10.9	28583.9	0	20.6	28908.9	28908.9	10.9	4.5	3.2
142330	WESTWING_W2	230	14	143	28592.5	0	20.6	28923.3	28923.3	10.9	28597	0	20.6	28926.5	28926.5	10.9	4.5	3.2
19052	LIBERTY_230	230	14	197	33367.5	0	11.1	25450.6	25450.6	6.4	33371.6	0	11.1	25452.2	25452.2	6.4	4.1	1.6
0	SUNVALY 500	525	14	141	11627.3	0	25.3	8334.2	8334.2	8.1	11631.3	0	25.3	8335.8	8335.8	8.1	4	1.6
191052	LIBERTY_TAP	230	14	197	32735.3	0	11	24788.4	24788.4	6.3	32739.2	0	11	24789.9	24789.9	6.3	3.9	1.5
15203	ANDERSON_230	230	14	150	32651.7	0	9	24827.1	24827.2	7.2	32655.4	0	9	24828.6	24828.6	7.2	3.7	1.5
14228	SURPRISE	230	14	144	28008.1	0	11.9	19366.2	19366.2	7.5	28011.7	0	11.9	19367.4	19367.4	7.5	3.6	1.2
14212	GLENDALE	230	14	143	31985	0	11	23479.4	23479.4	6.2	31988.5	0	11	23480.7	23480.7	6.2	3.5	1.3
15011	KYRENE_500	525	14	151	20076.1	0	17	18004.3	18004.3	13.1	20079.6	0	17	18006.2	18006.2	13.1	3.5	1.9
0	Q39	230	14	151	24425.4	0	19.8	13967.2	13967.2	26.6	24428.9	0	19.8	13968	13968	26.6	3.5	0.8
0	ANPP Q2	230	14	150	24600.8	0	35.2	27190.3	27190.3	32.9	24604.2	0	35.3	27193.3	27193.3	32.9	3.4	3

Appendix F – PV Solaron Inverter Dynamic Model