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Arizona Corporation Commission
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AZ CORP COMMISSION
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January 28, 2011

Docket Control
Arizona Corporation Commission
1200 W. Washington
Phoenix, AZ 85007

RE: Arizona Public Service Company Ten-Year Transmission System Plan
Docket No. E-00000D-11-0017

In compliance with A.R.S. § 40-360.02, enclosed is Arizona Public Service Company's ("APS") 2011-2020 Ten-Year Transmission System Plan ("Ten-Year Plan") for major transmission facilities. This Ten-Year Plan includes the internal planning criteria and system ratings as required by Arizona Corporation Commission ("ACC") Decision No. 63876 (July 25, 2001):

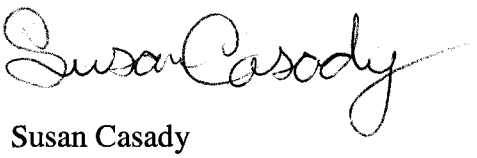
> IT IS FURTHER ORDERED that Transmission Owners are required to file, with their Ten-Year Plans, internal planning criteria and systems rating with limiting elements identified. (Decision No. 63876, p. 3).

The Ten-Year Plan as well as other APS reliability-related infrastructure investments are premised on a number of assumptions including future growth, resource mix, the regulatory treatment of such investments by the ACC and the Federal Energy Regulatory Commission ("FERC"), other state and federal policies affecting transmission, and, of course, APS's ability to finance large investments of this nature on commercially-reasonable terms.

The 2011-2020 Ten-Year Plan describes planned transmission lines of 115kV or higher that APS may construct over the next ten years. This Ten-Year Plan includes approximately 193 miles of new 500kV transmission lines, 65 miles of new 230kV transmission lines, 6 miles of new 115kV transmission lines, and 10 new bulk transformers. The APS investment needed to construct these projects is currently estimated to be approximately $450 million. When completed, these projects are expected to add approximately 2,000 megawatts ("MW") of additional Extra-High Voltage scheduling capability, as well as 1,000 MW of import capability into the Metropolitan Phoenix Area and 220 MW of import capability into Yuma. These new transmission projects, coupled with additional distribution and sub-transmission investments, will support reliable power delivery in APS's service territory, the state of Arizona, and the western United States.

If you have any questions regarding this information, please contact Erinn Andreasen at (602) 250-3276.

Sincerely,



Susan Casady

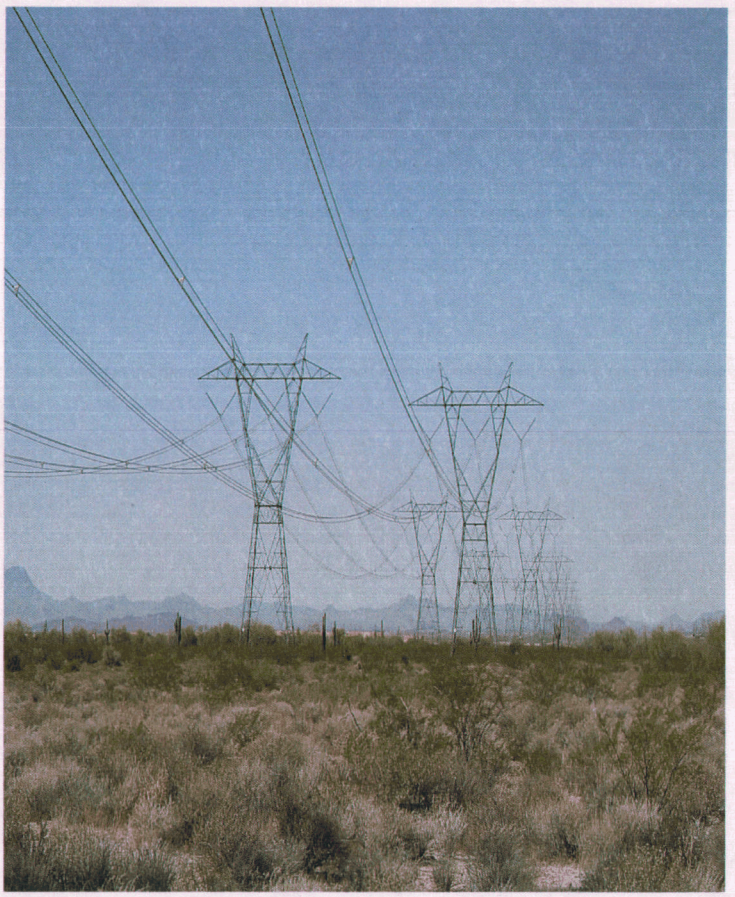
SC/kc

Attachments

cc: Ernest Johnson, Executive Director, Arizona Corporation Commission
Janice Alward, Chief Counsel, ACC Legal Division
Lyn Farmer, Chief Administrative Law Judge, ACC Hearing Division
Steve Olea, Director, ACC Utilities Division
John Foreman, Chairman, Arizona Power Plant and Transmission Line Siting Committee
Brian Bozzo, Manager, ACC Compliance & Enforcement
Terri Ford, Chief, ACC Telecomm & Energy
Jodi Jerich, Director, RUCO

ARIZONA PUBLIC SERVICE COMPANY
2011–2020
TEN-YEAR TRANSMISSION SYSTEM PLAN

Prepared for the
Arizona Corporation Commission



January 2011

ARIZONA PUBLIC SERVICE COMPANY
2011 - 2020
TEN-YEAR TRANSMISSION SYSTEM PLAN

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* Projects are included in APS's response to Decision No. 70635 (December 11, 2008), Docket No. E-00000D-07-0376 regarding transmission for renewable energy projects and were approved as such in Decision No. 72057 (January 6, 2011), Docket No. E-01345A-10-0033. See additional information in the Ten-Year Transmission System Plan related to development plans and in-service dates.

ARIZONA PUBLIC SERVICE COMPANY
2011–2020
TEN-YEAR TRANSMISSION SYSTEM PLAN

GENERAL INFORMATION

Pursuant to A.R.S. § 40-360.02, Arizona Public Service Company ("APS") submits its 2011-2020 Ten-Year Transmission System Plan ("Ten-Year Plan"). Additionally, pursuant to Arizona Corporation Commission ("Commission") Decision No. 63876 (July 25, 2001) concerning the first Biennial Transmission Assessment ("BTA"), APS is including with this filing its Transmission Planning Process and Guidelines and maps showing system ratings on APS's transmission system. The Transmission Planning Process and Guidelines outline generally APS's internal planning for its high voltage and extra-high voltage ("EHV") transmission system, including a discussion of APS's planning methodology, planning assumptions, and its guidelines for system performance. The system ratings maps show continuous and emergency system ratings on APS's EHV system, and on its Metro, Northern, and Southern 230kV systems. The Ten-Year Plan is conducted and filed annually with the Commission.

This 2011–2020 Ten-Year Plan describes planned transmission lines of 115kV or higher voltage that APS may construct or participate in over the next ten-year period. Pursuant to A.R.S. § 40-360(10), underground facilities are not included. There are approximately 193 miles of 500kV transmission lines, 65 miles of 230kV transmission lines, 6 miles of 115kV transmission lines, and 10 bulk transformers contained in the projects in this Ten-Year Plan filing. The total investment for the APS projects and the anticipated APS portion of the participation projects as they are modeled in this filing is estimated to be approximately $450 million and the projects will add an expected 2,000 megawatts ("MW") of additional EHV scheduling capability. Also, over the next ten years the import capability into the Phoenix area

will increase by 1,000 MW, while the import capability into the Yuma area will increase by 220 MW.[1,2] The following table shows a breakdown of the projects contained in this Ten-Year Plan.

Description	Projects in Ten-Year Plan
500kV transmission lines	193 miles
230kV transmission lines	65 miles
115kV transmission lines	6 miles
Bulk Transformers	10
Total Investment	$450 million
Extra High Voltage Scheduling Capability	+2,000 MW[a]
Total Phoenix Area Import	+1,000 MW (+6.2 %)[a]
Yuma Area Import	+220 MW (+39 %)[a]

[a] Based on 2010 values.

In addition to the new projects described in this report, the Commission's Sixth BTA (Decision No. 72031 dated December 10, 2010) recommended that transmission plans should include information regarding planned transmission reconductor projects and substation transformer replacements. Below is a list of transformer replacements and additions. At this time, APS does not have any plans for reconductoring any existing transmission lines. These types of plans often change as they typically are in direct response to load growth or generator interconnections. Therefore, in-service dates for transformer replacement/additions and transmission reconductor projects change to reflect the load changes in the local system. Also, there may be projects added throughout the course of the planning year in-order to accommodate new generator interconnections.

[1] Import capability increase is predicated on the Palo Verde to North Gila 500kV and North Gila to TS8 230kV projects. The Palo Verde to North Gila project was identified as one of APS's primary renewable transmission projects in response to Decision No. 70635 (December 11, 2008) and was approved in Decision No. 72057 (January 6, 2011), Docket No. E-01345A-10-0033 as such.

[2] Import capability and scheduling capability are different numbers because "import" capability is an electrical ability to serve customers in a load pocket where "scheduling" capability is a contractual right to use the transmission line. Both are needed to reliably serve load.

Bulk Transformer Additions/Replacements

Description	Year
Black Peak 161/69kV Transformer Replacement	2011
Kyrene 500/230kV Transformer #3[a]	2011
Pinnacle Peak 230/69kV Transformer #4	2011
El Sol 230/69kV Transformer #3	2013
Buckeye 230/69kV Transformer #2 Replacement	2016
Lincoln St. 230/69kV Transformer #2	2016
Yavapai 230/69kV Transformer #2	2016
Palm Valley 230/69kV Transformer #2	2017
Raceway 230/69kV Transformer #2	2017
Scatter Wash 230/69kV Transformer #2	2017

[a] Participant project. SRP is the project manager.

Some of the facilities reported in past Ten-Year plan filings that have been completed, canceled, or deferred beyond the upcoming ten-year period are not included in this report. The projects at the end of this Ten-Year Plan that have "to be determined" in-service dates are projects that have been identified but that are either still outside of the ten-year planning window or have in-service dates that have not yet been established. They have been included in this filing for informational purposes. A summary of changes from last year's plan is provided below, along with a list of projects that have been added to this year's Ten-Year Plan. Also, a section is included that briefly describes projects still in the feasibility planning phase.

For convenience of the reader, APS has included system maps showing the electrical connections and in-service dates for all overhead transmission projects planned by APS for Arizona, the Phoenix Metropolitan Area, and the Yuma area. Written descriptions of each proposed transmission project are provided on subsequent pages in the currently expected chronological order of each project. The line routings shown on the system maps and the descriptions of each transmission line are intended to be general, showing electrical connections and not specific routings, and are subject to revision. Specific routing is recommended by the Arizona Power Plant and Transmission Line Siting Committee and ultimately approved by the

Commission when issuing a Certificate of Environmental Compatibility and through subsequent right-of-way acquisition. Pursuant to A.R.S. § 40-360.02(7), this filing also includes technical study results for the projects identified. The technical study results show project needs that are generally based on either security (contingency performance), adequacy (generator interconnection or increasing transfer capability), or both.

APS participates in numerous regional planning organizations and in the WestConnect organization. Through membership and participation in these organizations, the needs of multiple entities, and the region as a whole, can be identified and studied. This allows for potentially maximizing the effectiveness and use of new projects. Regional organizations of which APS is a member include the Western Electricity Coordinating Council ("WECC"), the Southwest Area Transmission Planning ("SWAT"), and WestConnect. The plans included in this filing are the result of these coordinated planning efforts. APS provides an opportunity for other entities to participate in future planned projects. As a participant in the SWAT-Southeastern Arizona Transmission Study ("SATS") subcommittee, APS worked with other stakeholders in Cochise County to develop a transmission plan that will address the recommendations in the Fifth BTA regarding providing continuity of service (Decision No. 70635 dated December 11, 2008).[3]

As part of its planning process, APS is also evaluating the potential for renewable resource and associated transmission development. In response to the Fourth BTA order (Decision No. 69389 dated March 22, 2007), on August 6, 2008, the Joint Biennial Transmission Assessment Report on Renewables and Available Transmission Capability was submitted to the Commission on behalf of APS, Salt River Project, Tucson Electric Power, and Southwest

[3] Southwest Transmission Coop, Inc. ("SWTC"), on behalf of other participating utilities, will be submitting the Summary Report and Reference Filing of the Cochise County Technical Study Report as part of its Ten-Year Plan submittal.

Transmission Cooperative. That report described the collaborative efforts and analysis that was completed with the Southwest Area Transmission Sub-Regional Planning Group to address transmission for renewable resources, including an assessment of Available Transfer Capacity, a description of locations, and the transmission needed to bring renewable resources to load.

In addition, in response to the Fifth BTA order, and in collaboration with SWAT and its subgroups, other utilities, and stakeholders, APS developed plans to identify future renewable transmission projects and proposed funding mechanisms to construct the "top three" renewable transmission projects. APS submitted a Renewable Transmission Action Plan ("RTAP") report containing its prioritized renewable transmission projects to the Commission on October 30, 2009.[4] The projects selected were:

1. Delany – Palo Verde 500kV;
2. North Gila – Palo Verde 500kV #2;
3A. Palo Verde to Liberty;
3B. Gila Bend to Liberty; and
4. Delany – Blythe (Arizona Portion of Devers II).

Additionally, the specific development plans associated with the APS filing on October 30, 2009 required Commission approval because they proposed in-service dates that may be earlier and actions that may be more aggressive than what is necessary for the reliable service of APS customers under a traditional analysis.[5] On January 6, 2011, the Commission approved APS's

[4] In APS's recent rate settlement approved in Decision No. 71448 (dated December 30, 2009) the Company agreed to "commence permitting, design, engineering, right of way acquisition, regulatory authorization...and line siting for one or more new transmission lines or upgrades" and "to construct such transmission line(s) or upgrade(s)" once APS obtains all required permitting and authorizations (*see* Exhibit A, §15.4 of Decision No. 71448). APS intends to pursue the Delany to Palo Verde 500 kV line to begin complying with this commitment, as described in the Company's January 29, 2010 filing requesting approval of RTPs and their associated action plans.

[5] *See* APS filing dated January 29, 2010 requesting approval of RTPs and their associated action plans.

RTAP filing under Decision No. 72057, Docket No. E-01345A-10-0033 which allows APS to pursue the development steps indicated in the APS RTAP.

APS believes that the projects identified in this 2011-2020 Ten-Year Plan, with their associated in-service dates, will ensure that APS's transmission system meets all applicable reliability criteria. Changes in regulatory requirements, regulatory approvals, or underlying assumptions such as load forecasts, generation or transmission expansions, economic issues, and other utilities' plans, may substantially impact this Ten-Year Plan and could result in changes to anticipated in-service dates or project scopes. Additionally, future federal and regional mandates may impact this Ten-Year Plan specifically and the transmission planning process in general. This Ten-Year Plan is tentative only and, pursuant to A.R.S. § 40-360.02(F), is subject to change without notice at the discretion of APS.

CHANGES FROM 2010-2019 TEN-YEAR PLAN

The following is a list of projects that were changed or removed from APS's January 2010 Ten-Year Plan, along with a brief description of why the change was made.

Morgan-Pinnacle Peak 500kV Line

The Morgan-Pinnacle Peak 500kV line is not included in the 2011-2020 Ten-Year Plan because the project has been placed into service.

Morgan-Raceway-Avery-TS6-Pinnacle Peak 230kV Line

The Morgan-Raceway-Avery-TS6-Pinnacle Peak 230kV line is not included in the 2011-2020 Ten-Year Plan because the project has been placed into service. The new 230kV line that is in-service is from the Morgan to Raceway substations and from the Raceway to Pinnacle Peak substations. APS has added separate project descriptions for the future additions of the TS6 and Avery substations because the underlying Raceway-Pinnacle Peak 230kV line is now in-service and the substation additions are the only portions of the project for future years. Also, the TS6 substation has been renamed and is referred to as the Scatter Wash substation.

Flagstaff 345/69kV Interconnection

In the 2011-2020 Ten-Year Plan the substation APS will construct for the interconnection into Western's Flagstaff switchyard has been named Youngs Canyon.

In-Service Date Changes

Project Name	Previous In-Service Date	New In-Service Date
TS12 loop-in of Saguaro-Milligan 230kV line	2012	2016
Delany-Palo Verde 500kV line	2012	2013
Mazatzal loop in of Cholla-Pinnacle Peak 345kV line	2013	2014

With the exception of the Delany-Palo Verde project, the in-service dates shown in this table are based on load projects, not potential interconnections. New generation interconnections may accelerate the in-service date. The Delany- Palo Verde project is part of the approved Renewable Transmission Action Plan and would require a firm resource development to utilize the project in order to effect a 2013 in-service date. Without such development, the project would go in-service in 2014 with the Delany-Sun Valley project.

NEW PROJECTS IN THE 2011-2020 TEN-YEAR PLAN

The following are new projects planned within the 2011-2020 Ten-Year Plan that were not in the 2010-2019 Ten-Year Plan.

Hoodoo Wash Loop-in of Hassayampa-North Gila 500kV #1 Line

This project is for the interconnection of a new solar generation project by an Independent Power Producer ("IPP").

Q113 Loop-in of Moenkopi-Yavapai 500kV Line

This project is for the interconnection of a new wind generation project by an IPP.

CONCEPTUAL PROJECTS IN THE FEASIBILITY PLANNING PHASE

Palo Verde/Gila Bend Area To Valley Transmission Capacity

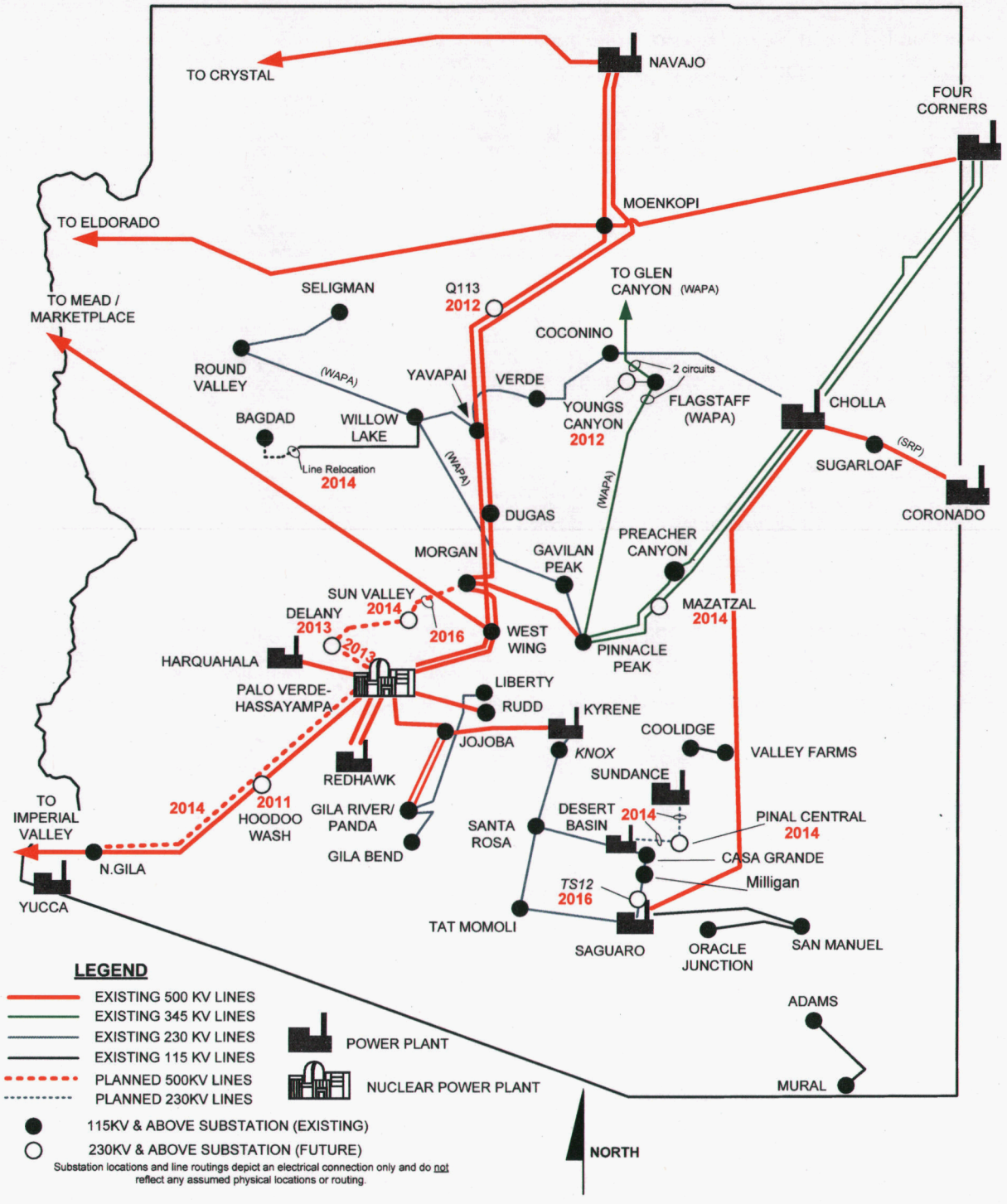
Additional transmission capacity will be studied from the Palo Verde/Gila Bend areas to the Phoenix load center. This transmission capacity is a robust component of the overall APS transmission and resource need. The areas around and west of Palo Verde as well as the Gila Bend area contain some of the best solar resources in the country. APS expects that at least a

portion of the future solar resources specified in the APS resource plan will be developed in relatively close proximity to these areas and will be supported by this transmission capacity. These areas also provide access to existing gas resources and, in the case of Palo Verde, potential new gas resources and market purchases. APS expects to need additional Palo Verde/Gila Bend transmission capacity, beyond what is shown in this plan, to deliver these resources to load and currently expects to require this additional capacity in the 2018-2019 timeframe absent a desire for advanced renewable resource development.

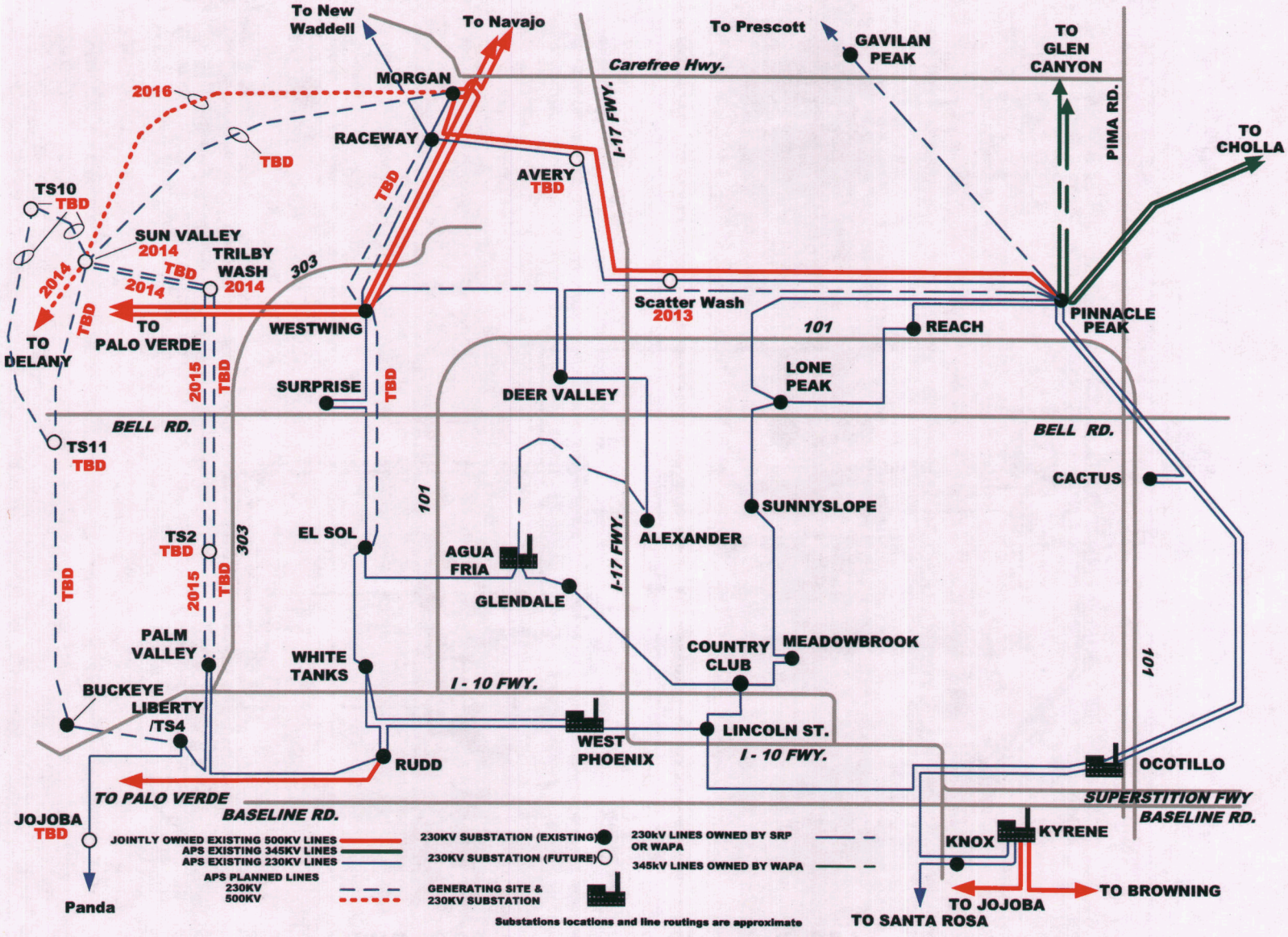
PLANNED TRANSMISSION MAPS

- Arizona EHV and Outer Divisions (*see page 11*)
- Phoenix Metropolitan Area (*see page 12*)
- Yuma Area (*see page 13*)

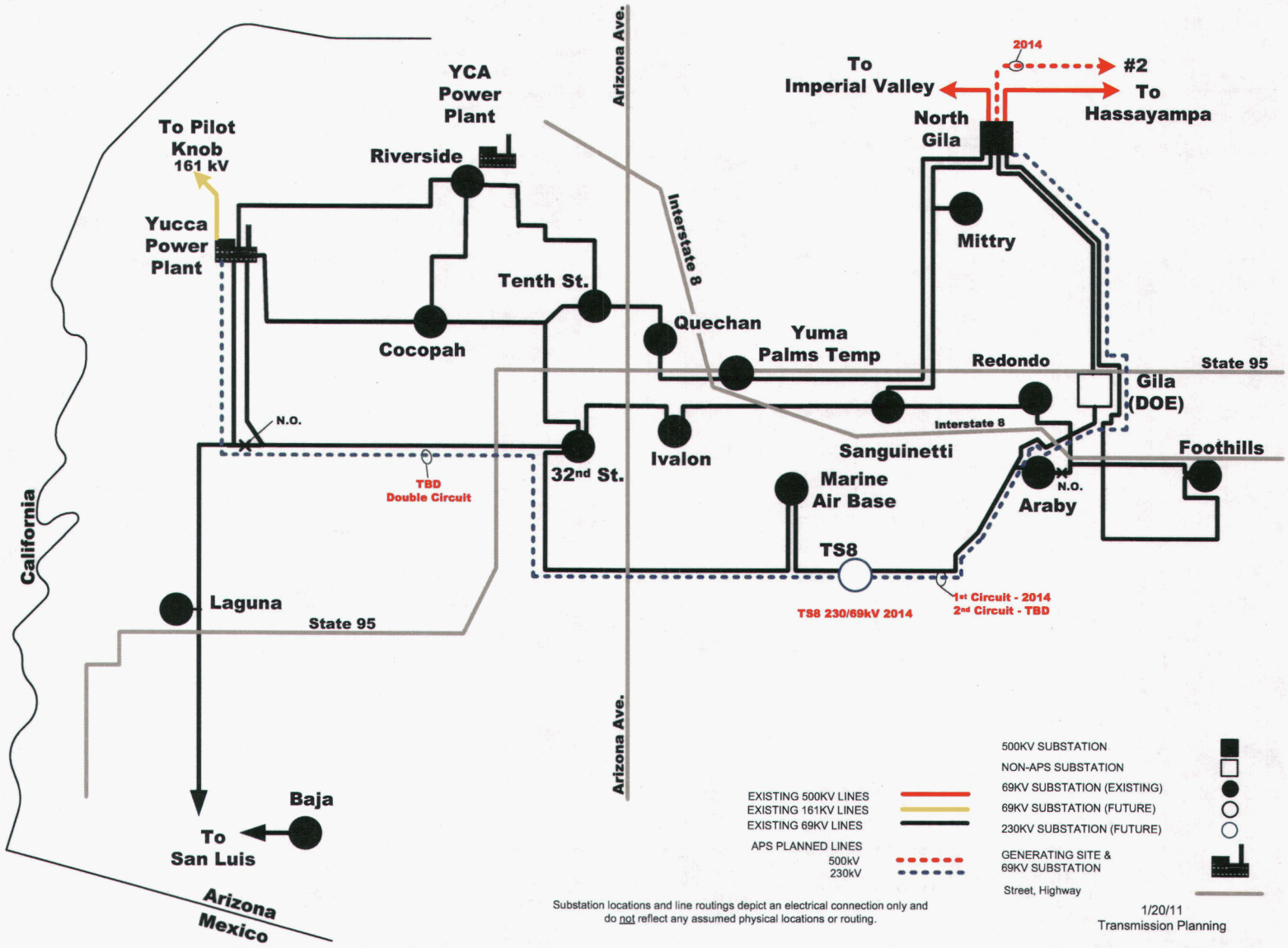
APS EHV & OUTER DIVISION 115/230 KV TRANSMISSION PLANS 2011 - 2020



PHOENIX METROPOLITAN AREA TRANSMISSION PLANS 2011-2020



Yuma Area Transmission Plans 2011- 2020



Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2011

Line Designation	Hoodoo Wash Loop-in of Hassayampa-North Gila 500kV #1 Line
Project Sponsor	Arizona Public Service Company
Other Participants	IID and SDG&E
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	3000A
(c) Point of Origin	Hassayampa-North Gila 500kV #1 line; approximately Sec. 34, T5S, R12W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Hoodoo Wash switchyard to be in-service by 2011; Sec. 34, T5S, R12W
(f) Length	Less than 1 mile
Routing	The Hoodoo Wash switchyard will be constructed less than 1 mile away from the Hassayampa-North Gila 500kV #1 line. The Hoodoo Wash switchyard will be located north of the existing line.
Purpose	This project is needed for the interconnection of the Agua Caliente Solar Project, which is a 290MW solar project. The switchyard is also the location of numerous other generator interconnection requests within APS's Generator Interconnection Queue.
Date	
(a) Construction Start	2010
(b) Estimated In Service	2011
Permitting / Siting Status	*Certificate of Environmental Compatibility ("CEC") issued 10/7/09 (Case No. 146, Decision No. 71281, Q43 500kV Transmission Line and Switchyard Interconnection Project). APS holds the CEC on behalf of the joint owners.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2012

Line Designation	Q113 Loop-in of Moenkopi-Yavapai 500kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	SRP, TEP and WAPA
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	3000A
(c) Point of Origin	Moenkopi-Yavapai 500kV line; approximately Sec. 31, T24N, R2E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Q113 switchyard to be in-service by 2012; Sec. 31, T24N, R2E
(f) Length	Less than 1 mile
Routing	The Q113 switchyard will be constructed adjacent to the Moenkopi-Yavapai 500kV line; approximately 13 miles north of Williams, AZ. The Q113 switchyard will be located west of the existing line.
Purpose	This project is needed for the interconnection of a large wind generation project, which is listed in the APS Generator Interconnection Queue as project # 113. The switchyard ownership is expected to be the same as the 500kV line.
Date	
(a) Construction Start	2011
(b) Estimated In Service	2012
Permitting / Siting Status	*It is anticipated that an application for a Certificate of Environmental Compatibility will be filed in 2011.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2012

Line Designation	Youngs Canyon 345/69kV Interconnection at Western's Flagstaff 345kV switchyard
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	345kV AC
(b) Facility Rating	100 MVA
(c) Point of Origin	Western's Flagstaff 345kV switchyard; Sec. 24, T21N, R9E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	A new Youngs Canyon 345/69kV substation to be in-service by 2012; Sec. 24, T21N, R9E
(f) Length	Less than 1 mile
Routing	A 345/69kV transformer will interconnect into Western's Flagstaff switchyard.
Purpose	This project is needed to provide the electrical source and support to the sub-transmission system in APS's northern service area. The project will provide increased reliability and continuity of service for the communities in northern Arizona.
Date	
(a) Construction Start	2011
(b) Estimated In Service	2012
Permitting / Siting Status	*It is not anticipated that a Certificate of Environmental Compatibility will be needed for this project.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2013

Line Designation	Scatter Wash loop-in of Pinnacle Peak-Raceway 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Pinnacle Peak-Raceway 230kV line; Sec. 8, T4N, R3E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Scatter Wash substation; Sec. 8, T4N, R3E
(f) Length	Less than 1 mile
Routing	The Scatter Wash substation will be located adjacent to the Pinnacle Peak-Raceway 230kV line.
Purpose	This project is needed to provide electric energy in the northern portions of the Phoenix Metropolitan area as well as increase the reliability and continuity of service for these areas.
Date	
(a) Construction Start	2011
(b) Estimated In Service	2013
Permitting / Siting Status	*Certificate of Environmental Compatibility issued on 6/18/03 (Case No. 120, Decision No. 65997, North Valley Project. The Scatter Wash Substation was referred to as TS6 in Case 120).*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2013[6]

Line Designation	Delany – Palo Verde 500kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	SRP, CAWCD
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Palo Verde Switchyard
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Future Delany switching station; approximately Sec. 25, T2N, R8W
(f) Length	Approximately 15 miles
Routing	Generally leaving the Palo Verde Hub vicinity following the Palo Verde-Devers #1 and the Hassayampa-Harquahala 500kV lines to the Delany Switchyard site in Sec. 25, T2N, R8W.
Purpose	This project is initially needed to interconnect multiple solar generation projects at the Delany switchyard. This line is also one section of a new 500kV path from Palo Verde around the western and northern edges of the Phoenix area and terminating at Pinnacle Peak. This is anticipated to be a joint participation project. APS will serve as the project manager.
Date	
(a) Construction Start	2012
(b) Estimated In Service	2013
Permitting / Siting Status	*Certificate of Environmental Compatibility issued 8/17/05 (Case No. 128, Decision No. 68063, Palo Verde Hub to TS5 500kV Transmission project). APS, as project manager, holds the CEC.*

[6] The in-service date of 2013 assumes a firm resource development to utilize the project in order to effect a 2013 in-service date. Without such development, the project would go in-service in 2014 with the Delany-Sun Valley project per approval of the APS Renewable Transmission Action Plan in Decision No. 72057 (1/6/11), Docket No. E-01345A-10-0033.

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2014

Line Designation	Mazatzal loop-in of Cholla – Pinnacle Peak 345kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	345kV AC
(b) Facility Rating	100 MVA
(c) Point of Origin	Cholla-Pinnacle Peak 345kV line; near Sec. 3, T8N, R10E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Mazatzal substation to be in-service by 2014; Sec. 3, T8N, R10E
(f) Length	Less than 1 mile
Routing	The Mazatzal 345/69kV substation will be constructed adjacent to the Cholla-Pinnacle Peak 345kV line corridor.
Purpose	This project is needed to provide the electric source and support to the sub-transmission system in the area of Payson and the surrounding communities. Additionally, improved reliability and continuity of service will result for the communities in the Payson area.
Date	
(a) Construction Start	2013
(b) Estimated In Service	2014
Permitting / Siting Status	*It is anticipated that an application for a Certificate of Environmental Compatibility will be filed in 2011.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2014

Line Designation	Bagdad 115kV Relocation Project
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	115kV AC
(b) Facility Rating	430 A
(c) Point of Origin	Bagdad Capacitor switchyard; Sec. 10, T14N, R9W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Bagdad Mine substation; Sec. 31, T15N, R9W
(f) Length	Approximately 5.5 miles
Routing	Beginning at the existing APS capacitor switchyard and extending in a southwesterly direction for approximately 1.5 miles, then turning in a northwesterly direction approximately 4 miles to the existing Bagdad Mine substation. The project primarily crosses federal BLM lands, private lands (owned by the mine) and a short segment on Arizona State Trust Lands.
Purpose	Freeport McMoRan Inc. has future plans to expand the mine in the location of the existing 115kV transmission line. They have requested that APS move the line in a southerly direction beyond the limits of the planned expansion.
Date	
(a) Construction Start	2013
(b) Estimated In Service	2014
Permitting / Siting Status	*Certificate of Environmental Compatibility issued on 7/16/09 (Case No. 143, Decision No. 71217, Bagdad 115kV Relocation Project).*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2014

Line Designation		Desert Basin – Pinal Central 230kV Line
Project Sponsor		Salt River Project
Other Participants		Arizona Public Service Company
Size		
(a)	Voltage Class	230kV AC
(b)	Facility Rating	To be determined
(c)	Point of Origin	Desert Basin Power Plant Switchyard; Sec. 13, T6S, R5E
(d)	Intermediate Points of Interconnection	
(e)	Point of Termination	Pinal Central substation to be in-service by 2013; Sec. 30, T6S, R8E
(f)	Length	Approximately 21 miles
Routing		For approximately 6 miles from the Desert Basin Generating Station in Casa Grande near Burris and Korsten Roads generally south and east to a point on the certificated SEV 500kV line near Cornman and Thornton Roads. At that point the 230kV line will be attached to the 500kV structures for approximately 15 miles to the proposed Pinal Central Substation south of Coolidge, AZ.
Purpose		Remove the Remedial Action Scheme that was previously installed on Desert Basin Generating Station; improve reliability of the 230kV system in the region by reducing the loading on existing lines in the area; increase local system capacity; reduce reliance on second party transmission system for delivery of Sundance Generation facility; create the first 230kV component of the CATS-HV proposed transmission system for the central Arizona area; and establish the Pinal Central Substation, identified as one of the future injection points of power and energy into the expanding central Pinal County load area, which will help local utilities serve local load.
Date		
(a)	Construction Start	2012
(b)	Estimated In Service	2014
Permitting / Siting Status		*Authority for the portion of the 230kV line to be attached to the 500kV structures is provided for in the CEC granted in Case No. 126, awarded in 2005 (Decision No. 68093(8/25) and No. 68291(11/14)), and subsequently confirmed in Decision No. 69183 (12/8/06), which approved SRP's compliance filing for Condition 23 of the CEC. SRP was granted a CEC for Case No. 132 in 2007 (Decision No. 69647 (6/6)) for the approximately six mile portion of the project not previously permitted from Desert Basin Generating Station to the vicinity of Cornman and Thornton Roads south of Casa Grande.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2014

Line Designation	Pinal Central – Sundance 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	ED-2
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Sundance substation; Sec. 2, T6S, R7E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Pinal Central substation to be in-service by 2013; Sec. 30, T6S, R8E
(f) Length	Approximately 6 miles
Routing	The project will originate at a new substation on the Sundance property, proceeding west and then south along Curry Road to the half-section between State Route 287 and Earley Road. The final west to east alignment connecting into the Pinal Central Substation will be located within an ACC-approved corridor and is subject to further design and right-of-way acquisition analysis.
Purpose	This project will serve increasing loads in Pinal County, and throughout the APS system, and will improve reliability and continuity of service for the communities in the area. Also, the project will increase the reliability of Sundance by providing a transmission line in a separate corridor than the existing lines that exit the plant. This project, in conjunction with the Desert Basin-Pinal Central 230kV project, will allow APS to reliably and economically deliver energy from Sundance over APS's transmission system. The project will be constructed as a 230kV double-circuit capable line, but initially operated as a single-circuit. The in-service date for the second circuit will be evaluated in future planning studies.
Date	
(a) Construction Start	2013
(b) Estimated In Service	2014
Permitting / Siting Status	*Certificate of Environmental Compatibility issued 4/29/08 (Case No. 136, Decision No. 70325, Sundance to Pinal South 230kV Transmission Line project). Note – the Pinal South substation is now referred to as Pinal Central.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2014

Line Designation	Delany – Sun Valley 500kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	SRP, CAWCD
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Future Delany switching station; approximately Sec. 25, T2N, R8W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Sun Valley substation to be in-service by 2014; Sec. 29, T4N, R4W
(f) Length	Approximately 28 miles
Routing	Generally follows the Palo Verde-Devers #1 lines until crossing the CAP canal. Then easterly, generally following the north side of the CAP canal to the new Sun Valley substation.
Purpose	This project will serve projected need for electric energy in the area immediately north and west of the Phoenix Metropolitan area. It will increase the import capability to the Phoenix Metropolitan area as well as increase the export/scheduling capability from the Palo Verde area to provide access to both solar and gas resources. The project will also increase the system reliability by providing a new transmission source to help serve the areas in the western portions of the Phoenix Metropolitan area. This is a joint participation project with APS as the project manager.
Date	
(a) Construction Start	2012
(b) Estimated In Service	2014
Permitting / Siting Status	*Certificate of Environmental Compatibility issued 8/17/05 (Case No. 128, Decision No. 68063, Palo Verde Hub to TS5 500kV Transmission project). APS, as project manager, holds the CEC.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2014

Line Designation	Sun Valley – Trilby Wash 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Sun Valley substation to be in-service by 2014; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Trilby Wash substation to be in-service by 2014; Sec. 20, T4N, R2W
(f) Length	Approximately 15 miles
Routing	East from the Sun Valley substation along the CAP canal to approximately 243rd Ave., south to the existing 500kV transmission line corridor, and then east along the corridor to the Trilby Wash substation.
Purpose	This project is required to serve the need for electric energy in the western Phoenix Metropolitan area. Also, the project will provide more capability to import power into the Phoenix Metropolitan area along with improved reliability and continuity of service for communities in the area including El Mirage, Surprise, Youngtown, Buckeye, and unincorporated Maricopa county. The first circuit is scheduled to be in-service for the summer of 2014 and the in-service date for the second circuit will be evaluated in future planning studies.
Date	
(a) Construction Start	2013
(b) Estimated In Service	2014
Permitting / Siting Status	*Certificate of Environmental Compatibility issued 5/5/05 (Case No. 127, Decision No. 67828, West Valley North 230kV Transmission Line project).*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2014[7]

Line Designation	Palo Verde Hub – North Gila 500kV #2 Line
Project Sponsor	Arizona Public Service Company
Other Participants	SRP, IID, WMIDD
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Hassayampa switchyard
(d) Intermediate Points of Interconnection	
(e) Point of Termination	North Gila substation; Sec. 11, T8S, R22W
(f) Length	Approximately 110 miles
Routing	This line will generally follow the route of the existing Hassayampa - North Gila 500kV #1 line.
Purpose	This project will increase the import capability for the Yuma area and export/scheduling capability from the Palo Verde area to provide access to both solar and gas resources. This is a joint participation project with APS as the project manager. This project will also allow the system to accommodate generation interconnection requests.
Date	
(a) Construction Start	2011
(b) Estimated In Service	2014
Permitting / Siting Status	*Certificate of Environmental Compatibility issued 1/23/08 (Case No. 135, Decision No. 70127, Palo Verde Hub to North Gila 500kV Transmission Line project).*

[7] The in-service date of 2014 is consistent with the approval of APS's Renewable Transmission Action Plan in Decision No. 72057 (1/6/11), Docket No. E-01345A-10-0033.

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2014[8]

Line Designation	North Gila – TS8 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	North Gila substation; Sec. 11, T8S, R22W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	TS8 230kV substation to be in-service by 2014; location to be determined
(f) Length	To be determined
Routing	The routing for this line has not yet been determined.
Purpose	This project serves the need for electric energy, improved reliability, and continuity of service for the greater Yuma area. This project is expected to be double circuit capable with one circuit in service in 2014 and the second circuit in service at a date to be determined.
Date	
(a) Construction Start	2012
(b) Estimated In Service	2014
Permitting / Siting Status	*It is anticipated that an application for a Certificate of Environmental Compatibility will be filed in 2011.*

[8] This project is linked with the Palo Verde to North Gila 500kV #2 project and will likely have the same in-service date.

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2015

Line Designation	Palm Valley – TS2 – Trilby Wash 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Palm Valley substation; Sec. 24, T2N, R2W
(d) Intermediate Points of Interconnection	TS2 substation to be in-service by TBD; Sec. 25, T3N, R2W
(e) Point of Termination	Trilby Wash substation to be in-service by 2014; Sec. 20, T4N, R2W
(f) Length	Approximately 12 miles
Routing	North from the Palm Valley substation, generally following the Loop 303 to Cactus Road, west on Cactus Road to approximately 191st Avenue, and then north on 191st Avenue to the Trilby Wash substation.
Purpose	This project will serve the need for electric energy in the western Phoenix Metropolitan area and additional import capability into the greater Phoenix Metropolitan area. The proposed second 230kV source for Trilby Wash provides improved system reliability and continuity of service for communities in the area; such as El Mirage, Surprise, Youngtown, Goodyear, and Buckeye. The first circuit is scheduled to be in-service for the summer of 2015; the in-service date for the second circuit will be evaluated in future planning studies. The in-service date for the TS2 substation is currently outside of the ten year planning horizon and will be continuously evaluated in future planning studies.
Date	
(a) Construction Start	2014
(b) Estimated In Service	2015
Permitting / Siting Status	*The Palm Valley-TS2 230kV line portion was sited as part of the West Valley South 230kV Transmission Line project and a Certificate of Environmental Compatibility was issued 12/24/03 (Case No. 122, Decision No. 66646). The Trilby Wash-TS2 230kV line portion was sited as part of the West Valley North 230kV Transmission Line project and a Certificate of Environmental Compatibility was issued 5/5/05 (Case No. 127, Decision No. 67828).*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2016

Line Designation	Morgan – Sun Valley 500kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	SRP, CAWCD
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Sun Valley substation to be in-service in 2014; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Morgan substation; Sec. 33, T6N, R1E
(f) Length	Approximately 40 miles
Routing	Generally the line will head north-northeast out of the Sun Valley substation and then east to the Morgan substation.
Purpose	This project will serve the electric energy needs in the northern Phoenix Metropolitan area. It will increase the import capability to the Phoenix Metropolitan area, as well as increase the export/scheduling capability from the Palo Verde Hub area, which includes both solar and gas resources. The project will also increase the reliability of the EHV system by completing a 500kV loop that connects the Palo Verde Transmission system, the Southern Navajo Transmission system, and the Southern Four Corners system. Additionally, the project will increase reliability by providing a second 500kV source for the Sun Valley substation and providing support for multiple Category C and D transmission contingencies. This project is anticipated to be 500/230kV double-circuit capable.
Date	
(a) Construction Start	2013
(b) Estimated In Service	2016
Permitting / Siting Status	*Certificate of Environmental Compatibility issued on 3/17/2009 (Case No. 138, Decision No. 70850, TS5-TS9 500/230kV Project) An application for right-of-way on the BLM portion of the project has been submitted and will require NEPA compliance prior to land acquisition and final engineering.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

2016

Line Designation	TS12 loop-in of Milligan – Saguaro 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	188 MVA
(c) Point of Origin	Milligan-Saguaro 230kV line; approximately Sec. 17, T10S, R10E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	TS12 substation to be in-service by 2016; Sec. 17, T10S, R10E
(f) Length	Less than 1 mile
Routing	The TS12 230/69kV substation will be constructed adjacent to the Milligan-Saguaro 230kV line, approximately 2 miles west of the Saguaro Generating Facility.
Purpose	This project is needed to provide electric energy in southern Pinal County as well as increase the reliability and continuity of service for these areas.
Date	
(a) Construction Start	2015
(b) Estimated In Service	2016
Permitting / Siting Status	*An application for a Certificate of Environmental Compatibility has not yet been filed.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	Avery loop-in of Pinnacle Peak-Raceway 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Pinnacle Peak-Raceway 230kV line; Sec. 8, T4N, R3E
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Avery substation; Sec. 15, T5N, R2E
(f) Length	Less than 1 mile
Routing	The Avery substation will be constructed adjacent to the Pinnacle Peak-Raceway 230kV line at approximately the Dove Valley Rd. and 39th Ave. alignments.
Purpose	This project is needed to provide electric energy in the northern portions of the Phoenix Metropolitan area as well as increase the reliability and continuity of service for these areas. The need date for this substation is continuously evaluated as the load growth in the area is monitored.
Date	
(a) Construction Start	TBD
(b) Estimated In Service	TBD
Permitting / Siting Status	*Certificate of Environmental Compatibility issued on 6/18/03 (Case No. 120, Decision No. 65997, North Valley Project).*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	Mural – San Rafael 230kV
Project Sponsor	Arizona Public Service Company
Other Participants	To be determined
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Mural substation
(d) Intermediate Points of Interconnection	
(e) Point of Termination	San Rafael substation
(f) Length	To Be Determined
Routing	The route for this project has not yet been determined. Generally the line will head west-northwest out of the Mural substation and then west to the San Rafael substation.
Purpose	This project was identified in the 2008 Biennial Transmission Assessment to serve the need for electric energy in the Cochise County area. It will increase the import capability to the Cochise County area, as well as increase the reliability of the local EHV system.
Date	
(a) Construction Start	To be determined
(b) Estimated In Service	To be determined
Permitting / Siting Status	*An application for a Certificate of Environmental Compatibility has not yet been filed.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	Jojoba loop-in of Liberty (TS4)-Panda 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	188 MVA
(c) Point of Origin	Liberty (TS4)-Panda 230kV line; Sec. 25, T2S, R4W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Jojoba 230/69 substation with an in-service TBD; Sec. 25, T2S, R4W
(f) Length	Less than 1 mile
Routing	The Jojoba 230/69kV substation will be constructed adjacent to the Liberty (TS4)-Panda 230kV line.
Purpose	This project will provide the electrical source and support to the sub-transmission system to serve the need for electric energy for the communities including Buckeye, Goodyear, and Gila Bend. The project will also increase the reliability and continuity of service for those areas.
Date	
(a) Construction Start	To be determined
(b) Estimated In Service	To be determined
Permitting / Siting Status	*Certificate of Environmental Compatibility issued 10/16/00 (Case No. 102, Decision No. 62960, Gila River Transmission Project) for the Gila River Transmission Project which included the interconnection of the 230kV substation.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	TS8 – Yucca 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Yucca substation; Sec. 36, T7S, R24W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	TS8 substation will be in-service in 2014; location to be determined
(f) Length	To be determined
Routing	The routing for this line has not yet been determined.
Purpose	This double circuit 230kV project will serve the need for electric energy, improve reliability, and continuity of service for the greater Yuma area. Additionally, this project will provide a second electrical source to the future TS8 substation. The ability to transmit electric energy generated by renewable resources in the region may be an additional benefit subject to study by APS in regional planning forums.
Date	
(a) Construction Start	To be determined
(b) Estimated In Service	To be determined
Permitting / Siting Status	*An application for a Certificate of Environmental Compatibility has not yet been filed.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	Sun Valley – TS10 –TS11 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Sun Valley substation to be in-service by 2014; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	A future TS10 substation; location to be determined
(e) Point of Termination	A future TS11 substation; location to be determined
(f) Length	To be determined
Routing	The routing for this line has not yet been determined.
Purpose	This project is needed to provide a transmission source to serve future load that emerges in the currently undeveloped areas northwest of the White Tank Mountains. This line is anticipated to be a 230kV line originating from the Sun Valley substation, with the future TS10 230/69kV substation to be interconnected into the 230kV line.
Date	
(a) Construction Start	To be determined
(b) Estimated In Service	To be determined
Permitting / Siting Status	*An application for a Certificate of Environmental Compatibility has not yet been filed.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	Buckeye – TS11 – Sun Valley 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Sun Valley substation to be in-service by 2014; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	A future TS11 substation; location to be determined
(e) Point of Termination	Buckeye substation; Sec. 7, T1N, R3W
(f) Length	To be determined
Routing	The routing for this line has not yet been determined.
Purpose	This project will serve the need for electric energy in the largely undeveloped areas west of the White Tank Mountains. This project will provide the first portion of the transmission infrastructure in this largely undeveloped area and will provide a transmission connection between the northern and southern transmission sources that will serve the area. Improved reliability and continuity of service will result for this portion of Maricopa County. It is anticipated that this project will be constructed with double-circuit capability, but initially operated as a single circuit. The in-service date and location of the TS11 230/69kV substation will be determined in future planning studies based upon the development of the area.
Date	
(a) Construction Start	To be determined
(b) Estimated In Service	To be determined
Permitting / Siting Status	*An application for a Certificate of Environmental Compatibility has not yet been filed.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	Morgan – Sun Valley 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Sun Valley substation to be in-service by 2014; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	To be determined
(e) Point of Termination	Morgan substation; Sec. 33, T6N, R1E
(f) Length	Approximately 40 miles
Routing	This line will be co-located with the Sun Valley to Morgan 500kV line, which generally heads north-northeast out of the Sun Valley substation and then east to the Morgan substation.
Purpose	This project is needed to provide a transmission source to serve future load that emerges in the currently undeveloped areas south and west of Lake Pleasant. This line will be co-located with the Sun Valley-Morgan 500kV line.
Date	
(a) Construction Start	To be determined
(b) Estimated In Service	To be determined
Permitting / Siting Status	*Certificate of Environmental Compatibility issued on 3/17/2009 (Case No. 138, Decision No. 70850, TS5-TS9 500/230kV Project).*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	Raceway – Westwing 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Westwing substation; Sec. 12, T4N, R1W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Raceway substation; Sec. 4, T5N, R1E
(f) Length	Approximately 7 miles
Routing	Northeast from Westwing substation paralleling existing transmission lines to the Raceway 230kV substation.
Purpose	This project will serve the need for electric energy in the far north and northwest parts of the Phoenix Metropolitan area and provide contingency support for multiple Westwing 500/230kV transformer outages. The in-service date will continue to be evaluated in future planning studies.
Date	
(a) Construction Start	To be determined
(b) Estimated In Service	To be determined
Permitting / Siting Status	*Certificate of Environmental Compatibility issued 6/18/03 (Case No. 120, Decision No. 65997, North Valley 230kV Transmission Line Project).*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	El Sol – Westwing 230kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Westwing substation; Sec. 12, T4N, R1W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	El Sol substation; Sec. 30, T3N, R1E
(f) Length	Approximately 11 miles
Routing	Generally following the existing Westwing-Surprise-El Sol 230kV corridor.
Purpose	This project will increase system capacity to serve the Phoenix Metropolitan area, while maintaining system reliability and integrity for delivery of bulk power from Westwing south into the APS Phoenix Metropolitan area 230kV transmission system.
Date	
(a) Construction Start	To be determined
(b) Estimated In Service	To be determined
Permitting / Siting Status	*Certificate of Environmental Compatibility issued 7/26/73 (Case No. 9, Docket No. U-1345). Note that this Certificate authorizes two double-circuit lines. Construction of the first double-circuit line was completed in March 1975. Construction of the second line, planned to be built with double-circuit capability, but initially operated with a single circuit, is described above.*

Arizona Public Service Company
2011 – 2020
Ten-Year Plan
Planned Transmission Description

To Be Determined

Line Designation	Palo Verde – Saguaro 500kV Line
Project Sponsor	CATS Sub-Regional Planning Group Participants
Other Participants	To be determined
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	To be determined
(c) Point of Origin	Palo Verde switchyard; Sec. 34, T1N, R6W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Saguaro substation; Sec. 14, T10S, R10E
(f) Length	Approximately 130 miles
Routing	Generally south and east from the Palo Verde area to a point near Gillespie Dam, then generally easterly until the point at which the Palo Verde-Kyrene 500kV line diverges to the north and east. The corridor then continues generally south and east again, adjacent to a gas line corridor, until converging with the Tucson Electric Power Company's Westwing-South 345kV line. The corridor follows the 345kV line until a point due west of the Saguaro Generating Station. The corridor then follows a lower voltage line into the 500kV yard just south and east of the Saguaro Generating Station.
Purpose	The line will be needed to increase the adequacy of the existing EHV transmission system and permit increased power delivery throughout the state.
Date	
(a) Construction Start	To be determined
(b) Estimated In Service	To be determined
Permitting / Siting Status	*Certificate of Environmental Compatibility issued 1/23/1976 (Case No. 24, Decision No. 46802).*

A subsidiary of Pinnacle West Capital Corporation

TRANSMISSION PLANNING PROCESS AND GUIDELINES

APS Transmission Planning

January 2011

TRANSMISSION PLANNING PROCESS AND GUIDELINES

III. PLANNING ASSUMPTIONS

I. INTRODUCTION AND PURPOSE

The Transmission Planning Process and Guidelines (Guidelines) are used by Arizona Public Service Company (APS) to assist in planning its Extra High Voltage (EHV) transmission system (345kV and 500kV) and High Voltage transmission system (230kV and 115kV). In addition to these Guidelines, APS follows the Western Electricity Coordinating Council's (WECC) regional planning reliability criteria for system disturbance and performance levels. These WECC Reliability Criteria are (1) WECC/NERC Reliability Criteria for Transmission System Planning and (2) Minimum Operating Reliability Criteria, which can be found in their entirety on the WECC website; (http://www.wecc.biz/documents/library/procedures/CriteriaMaster.pdf). These Guidelines are for internal use by APS and may be changed or modified. Thus, others should not use these Guidelines without consultation with APS.

II. PLANNING METHODOLOGY

A. General

APS uses a deterministic approach for transmission system planning. Under this approach, system performance should meet certain specific criteria under normal conditions (all lines in-service) and for any single contingency condition (any one element out-of-service). In general, an adequately planned transmission system will:

- Provide an acceptable level of service that is cost-effective for normal and single contingency operating conditions.
- Maintain service to all firm loads for any single contingency outage; except for radial loads.
- Not result in overloaded equipment or unacceptable voltage conditions for single contingency outages.
- Not result in cascading for single or double contingency outages.
- Provide for the proper balance between the transmission import capability and local generation requirements for an import limited load area.

Although APS uses a deterministic approach for transmission system planning, the WECC reliability planning criteria provides for exceptions based upon a probabilistic approach. APS uses these probabilistic criteria when/where appropriate in the transmission planning process. Historical system reliability performance is analyzed on a periodic basis and the results are used in the design of planned facilities.

These planning methodologies, assumptions, and guidelines are used as the basis for the development of future transmission facilities. Additionally, consideration of potential alternatives to transmission facilities (such as distributed generation or new technologies) is evaluated on a case-specific basis.

As new planning tools and/or information become available revisions or additions to these guidelines will be made as appropriate.

B. Transmission Planning Process

APS' transmission planning process consists of an assessment of the following needs:

- Provide adequate transmission to access designated network resources in-order to reliably and economically serve all network loads.
- Support APS' and other network customers' local transmission and sub-transmission systems.
- Provide for interconnection for new resources.
- Accommodate requests for long-term transmission access.

During this process, consideration is given to load growth patterns, other system changes affected by right-of-way, facilities siting constraints, routing of future transportation corridors, and joint planning with neighboring utilities, governmental entities, and other interested stakeholders (see APS OATT Attachment (E)).

1. EHV Transmission Planning Process

APS' EHV transmission system, which consists of 500kV and 345kV, has primarily been developed to provide transmission to bring the output of large base-loaded generators to load centers, such as Phoenix. Need for new EHV

facilities may result from any of the bullet items described above. APS' annual planning process includes an assessment of APS' transmission capability to ensure that designated network resources can be accessed to reliably and economically serve all network loads. In addition, biennial Reliability Must-Run (RMR) studies are performed to ensure that proper balance between the transmission import capability and local generation requirements for an import limited load area are maintained.

2. 230kV Transmission Planning Process

APS' 230kV transmission system has primarily been developed to provide transmission to distribute power from the EHV bulk power substations and local generators to the distribution system and loads throughout the load areas.

Planning for the 230kV system assesses the need for new 230/69kV substations to support local sub-transmission and distribution system growth and the reliability performance of the existing 230kV system. This process takes into account the future land use plans that were developed by government agencies, Landis aerial photo maps, master plans that were provided by private developers, and APS' long-range forecasted load densities per square mile for residential, commercial, and industrial loads.

3. Transmission Facilities Required for Generation/Resource Additions

New transmission facilities may also be required in conjunction with generation resources due to (1) a "merchant" request by an Independent Power Producer (IPP) for generator interconnection to the APS system, (2) a "merchant" request for point-to-point transmission service from the generator (receipt point) to the designated delivery point, or (3) designation of new resources or re-designation of existing units to serve APS network load (including removal of an older units' native load designation). These studies/processes are performed pursuant to the APS Open Access Transmission Tariff (OATT).

C. Ten Year Transmission System Plans

Each year APS uses the planning process described in section B to update the Ten-Year Transmission System Plan. The APS Ten-Year Transmission System Plan identifies all new transmission facilities, 115kV an d above, and all facility replacements/upgrades required over the next ten years to reliably and economically serve the load.

D. Regional Coordinated Planning

1. Western Electricity Coordinating Council (WECC)

APS is a member of the WECC. The focus of the WECC is promoting the reliability of the interconnected bulk electric system. The WECC provides the means for:

- Developing regional planning and operating criteria.
- Coordinating future plans.
- Compiling regional data banks for use by the member systems and the WECC in conducting technical studies.
- Assessing and coordinating operating procedures and solutions to regional problems.
- Establishing an open forum with interested non-project participants to review the plan of service for a project.
- Through the WECC Transmission Expansion Policy Committee, performing economic transmission congestion analysis.

APS works with WECC to adhere to these planning practices.

2. Sub-Regional Planning Groups

Southwest Area Transmission Planning (SWAT) and other sub-regional planning groups provide a forum for entities within a region, and any other interested parties, to determine and study the needs of the region as a whole. It also provides a forum for specific projects to be exposed to potential partners and allows for joint studies and participation from interested parties.

3. WestConnect

APS and the other WestConnect members executed the WestConnect Project Agreement for Subregional Transmission Planning in May of 2007. This agreement promotes coordination of regional transmission planning for the WestConnect planning area by formalizing a relationship among the WestConnect members and the WestConnect area sub-regional planning groups including SWAT. The agreement provides for resources and funding for the development of a ten year integrated regional transmission plan for the WestConnect planning area. The agreement also ensures that the WestConnect transmission planning process will be coordinated and integrated with other planning processes within the Western Interconnection and with the WECC planning process.

4. Joint Studies

In many instances, transmission projects can serve the needs of several utilities and/or IPPs. To this end, joint study efforts may be undertaken. Such joint study efforts endeavor to develop a plan that will meet the needs and desires of all individual companies involved.

E. Generation Schedules

For planning purposes, economic dispatches of network resources are determined for APS' system peak load in the following manner:

a. Determine base generation available and schedule these units at maximum output.
b. Determine resources purchased from other utilities, IPPs, or power marketing agencies.
c. Determine APS' spinning reserve requirements.
d. Schedule intermediate generation (oil/gas steam units) such that the spinning reserve requirements, in section (c) above, are met.
e. Determine the amount of peaking generation (combustion turbine units) required to supply the remaining system peak load.

Phoenix area network resources are dispatched based on economics and any existing import limitations. When possible, spinning reserve will be carried on higher cost Phoenix area network generating units.

Generation output schedules for interconnected utilities and IPPs are based upon consultation with the neighboring utilities and IPPs or as modeled in the latest data in WECC coordinated study cases.

F. Load Projections

APS substation load projections are based on the APS Corporate Load Forecast. Substation load projections for neighboring interconnected utilities or power agencies operating in the WECC area are based on the latest data in WECC coordinated study cases. Heavy summer loads are used for the Ten-Year Transmission System Plans.

G. Alternative Evaluations

1. General

In evaluating several alternative plans, comparisons of power flows, transient stability tests, and fault levels are made first. After the alternatives are found that meet the system performance criteria in each of these three areas comparisons may be made of the losses, transfer capability, impact on system operations, and reliability of each of the plans. Finally, the costs of facility additions (capital cost items), costs of losses, and relative costs of transfer capabilities are determined. A brief discussion of each of these considerations follows.

2. Power Flow Analyses

Power flows of base case (all lines in-service) and single contingency conditions are tested and should conform to the system performance criteria set forth in Section IV of these Guidelines. Double or multiple contingencies are examined, but in general, no facilities are planned for such conditions. Normal system voltages, voltage deviations, and voltage extreme limitations are based upon operating experience resulting in acceptable voltage levels to

the consumer. Power flow limits are based upon the thermal ratings and/or sag limitations of conductors or equipment, as applicable.

3. Transient Stability Studies

   Stability guidelines are established to maintain system stability for single contingency, three-phase fault conditions. Double or multiple contingencies are examined, but in general, no facilities are planned for such conditions.

4. Short Circuit Studies

   Three-phase and single-phase-to-ground fault studies are performed to ensure the adequacy of system protection equipment to clear and isolate faults.

5. Reactive Power Margin Analyses

   Reactive Power Margin analyses are performed when steady-state analyses indicate possible insufficient voltage stability margins. V-Q curve analyses are used to determine post-transient voltage stability.

6. Losses Analyses

   A comparison of individual element and overall transmission system losses are made for each alternative plan being studied. The losses computed in the power flow program consist of the I^2R losses of lines and transformers and the core losses in transformers, where represented.

7. Transfer Capability Studies

   In evaluating the relative merits of one or more EHV transmission plans, both simultaneous and non-simultaneous transfer capability studies are performed to determine the magnitude of transfer capabilities between areas or load centers.

8. Subsynchronous Resonance (SSR)

   SSR phenomenon result from the use of series capacitors in the network where the tuned electrical network exchanges energy with a turbine generator at one or more of the natural frequencies of the mechanical system. SSR countermeasures are applied to prevent damage to machines as a result of transient current or sustained oscillations following a system disturbance. SSR studies are not used directly in the planning process. SSR countermeasures are determined after the transmission plans are finalized.

9. FACTS (Flexible AC Transmission System)

FACTS devices are a recent application of Power Electronics to the transmission system. These devices make it possible to use circuit reactance, voltage magnitude and phase angle as control parameters to redistribute power flows and regulate bus voltages, thereby improving power system operation. FACTS devices can provide series or shunt compensation. These devices can be used as a controllable voltage source in series or as a controllable current source in shunt mode to improve the power transmission system operations. FACTS will be evaluated as a means of power flow control and/or to provide damping to dynamic oscillations where a need is identified and it is economically justified.

10. Economic Evaluation

In general, an economic evaluation of alternative plans consists of a cumulative present worth or equivalent annual cost comparison of capital costs.

III. PLANNING ASSUMPTIONS

A. General

1. Loads

Loads used for the APS system originate from the latest APS Corporate Load Forecast. In most cases, the corrected power factor of APS loads is 99.5% at 69kV substations.

2. Generation and Other Resources

Generation dispatch is based on firm power and/or transmission wheeling contracts including network resources designations.

3. Normal Voltage Levels

a. Nominal EHV design voltages are 500kV, 345kV, 230kV, and 115kV.

b. Nominal EHV operating voltages are 535kV, 348kV, 239kV, and 119kV.

4. Sources of Databases

WECC Heavy Summer base cases are the sources of the databases. Loop flow (unscheduled flow), of a reasonable amount and direction, will be allowed for use in planning studies.

5. Voltage Control Devices

Devices which can control voltages are shunt capacitors, shunt reactors, tap-changing-under-load (TCUL) and fixed-tap transformers, static Volt Ampere Reactive (VAR) compensators, and machine VAR capabilities. If future voltage control devices are necessary, these devices will be evaluated based upon economics and the equipment's ability to obtain an adequate voltage profile on the EHV and HV systems.

6. Phase Shifters

In general, where phase shifters are used, schedules are held across the phase shifter in base case power flows and the phase shifter tap remains fixed in the outage cases.

7. Conductor Sizes

Existing transmission voltages utilized by APS are 230kV, 345kV, and 500kV. It is presently planned that the 345kV transmission system will not be expanded, thus all future APS EHV lines will be 500kV or 230kV. Planned 500kV lines will initially be modeled using tri-bundled 1780 kCM ACSR conductor (Chukar). Preferred construction for 230kV lines consists of 2156 kCM ACSS conductor on steel poles.

8. 69kV System Modeling

230kV facility outages may result in problems to the underlying 69kV system due to the interconnection of those systems. For this reason, power flow cases include a detailed 69kV system representation. Solutions to any problems encountered on the 69kV system are coordinated with the subtransmission planning engineers.

9. Substation Transformers

a. 500kV and 345kV Substations

Bulk substation transformer banks may be made up of one three-phase or three single-phase transformers, depending upon bank size and economics. For larger banks where single-phase transformers are used, a fourth (spare) single-phase transformer will be used in a jack-bus arrangement to improve reliability and facilitate connection of the spare in the event of an outage of one of the single-phase transformers. TCUL will be considered in the high voltage windings, generally with a range of plus or minus 10%. High voltage ratings will be 500kV or 345kV class and low voltage windings will be 230kV, 115kV, or 69kV class.

b. 230kV Substations

For high-density load areas, both 230/69kV and 69/12.5kV transformers can be utilized. 230/69kV transformers will be rated at 113/150/188 MVA with a 65°C temperature rise, unless otherwise specified. 69/12.5kV transformers will be rated at 25/33/41 MVA with a 65°C temperature rise, unless otherwise specified.

With all elements in service, a transformer may be loaded up to its top Forced Oil Air (FOA) rating without sustaining any loss of service life. For a single contingency outage (loss of one transformer) the remaining transformer or transformers may be loaded up to 20% above their top FOA rating, unless heat test data indicate a different overload capability. The loss of service life sustained will depend on the transformer pre-loading and the outage duration. Tap setting adjustment capabilities on 230/69kV transformers will be ±5% from the nominal voltage setting (230/69kV) at 2½% increments.

10. Switchyard Arrangements

a. 500kV and 345kV Substations

Existing 345kV switchyard arrangements use breaker-and-one-half, main-and-transfer, or modified paired-element circuit breaker switching

schemes. Because of the large amounts of power transferred via 500kV switchyards and the necessity of having adequate reliability, all 500kV circuit breaker arrangements are planned for an ultimate breaker-and-one-half scheme. If only three or four elements are initially required, the circuit breakers are connected in a ring bus arrangement, but physically positioned for a breaker-and-one-half scheme. The maximum desired number of elements to be connected in the ring bus arrangement is four. System elements such as generators, transformers, and lines will be arranged in breaker-and-one-half schemes such that a failure of a center breaker will not result in the loss of two lines routed in the same general direction and will minimize the impact of losing two elements.

b. 230kV Substations

Future 230/69kV substations should be capable of serving up to 452 Megavolt Amps (MVA) of load. 400 MVA has historically been the most common substation load level in the Phoenix Metropolitan area. Future, typical 230/69kV substations should accommodate up to four 230kV line terminations and up to three 230/69kV transformer bays. Based upon costs, as well as reliability and operating flexibility considerations, a breaker-and-one-half layout should be utilized for all future 230/69kV Metropolitan Phoenix Area substations, with provision for initial development to be a ring bus. Any two 230/69kV transformers are to be separated by two breakers, whenever feasible, so that a stuck breaker will not result in an outage of both transformers.

11. Series Capacitor Application

Series capacitors may be used on EHV lines to increase system stability, for increased transfer capability, and/or for control of power flow. The series capacitors may be lumped at one end of a line because of lower cost; however, the capacitors are generally divided into two banks, one at either end of a line, for improved voltage profile.

12. Shunt and Tertiary Reactor Application

Shunt and/or tertiary reactors may be installed to prevent open end line voltages from being excessive, in addition to voltage control. The open end line voltage must not be more than 0.05 per unit voltage greater than the sending end voltage. Tertiary reactors may also be used for voltage and VAR control as discussed above.

B. Power Flow Studies

1. System Stressing

Realistic generation capabilities and schedules should be used to stress the transmission system in order to maximize the transfer of resources during the maximum load condition.

2. Displacement

In cases where displacements (due to power flow opposite normal generation schedules) may have an appreciable effect on transmission line loading, a reasonable amount of displacement (Generation Units) may be removed in-order to stress a given transmission path.

C. Transient Stability Studies

1. Fault Simulation

When studying system disturbances caused by faults, two conditions will be simulated:

a. Three-phase-to-ground faults, and
b. Single-line-to-ground faults with a stuck circuit breaker in one phase with back-up delayed clearing.

2. Margin

a. Generation margin may be applied for the contingencies primarily affected by generation, or
b. Power flow margin may be applied for the contingencies primarily affected by power flow.

3. Unit Tripping

Generator unit tripping may be allowed in-order to increase system stability performance.

4. Machine Reactance Representation

For transient stability studies, the unsaturated transient reactance of machines with full representation will be used.

5. Fault Damping

Fault damping will be applied to the generating units adjacent to faults. Fault damping will be determined from studies that account for the effect of generator amortisseur windings and the SSR filters.

6. Series Capacitor Switching

Series capacitors, locations to be determined from short circuit studies, will be flashed and reinserted as appropriate.

D. Short Circuit Studies

Three-phase and single-phase-to-ground faults will be evaluated.

1. Generation Representation

All generation will be represented.

2. Machine Reactance Representation

The saturated subtransient reactance ($X"_d$) values will be used.

3. Line Representation

The transmission line zero sequence impedance (X_0) is assumed to be equal to three times the positive sequence impedance (X_1).

4. Transformer Representation

The transformer zero sequence impedance (X_0) is assumed to be equal to the positive sequence impedance (X_1). Bulk substation transformers are modeled as auto-transformers. The two-winding model is that of a grounded-wye transformer. The three-winding model is that of a wye-delta-wye with a solid ground.

E. Reactive Power Margin Studies

Using Q-V curve analyses, APS assesses the interconnected transmission system to ensure there are sufficient reactive resources located throughout the electric system to maintain post-transient voltage stability for system normal conditions and certain contingencies.

IV. SYSTEM PERFORMANCE

A. Power Flow Studies

1. Normal (Base Case Conditions)

a. Voltage Levels

1) General

(a) 500kV bus voltages will be maintained between 1.05 and 1.08 p.u. on a 500kV base.

(b) 345kV bus voltages will range between .99 and 1.04 p.u. on the 345kV system.

(c) 500kV and 345kV system voltages are used to maintain proper 230kV bus voltages.

(d) Voltage on the 230kV and 115kV system should be between 1.01 p.u. and 1.05 p.u.

(e) Tap settings for 230/69kV and 345/69kV transformers should be used to maintain low side (69kV) voltages of 1.03 to 1.04 p.u. Seasonal tap changes may be required.

2) Specific Buses

(a) APS Pinnacle Peak 230kV bus voltage should be between 1.025 p.u. and 1.035 p.u.

(b) APS Westwing 230kV bus voltage should be between 1.04 p.u. and 1.05 p.u.

(c) Saguaro 115kV bus voltage will be approximately 1.035 p.u.

(d) Voltage at the Prescott (DOE) 230kV bus should be approximately 1.02 p.u.

b. Facility Loading Limits

1) Transmission Lines

Transmission line loading cannot exceed 100% of the continuous rating, which is based upon established conductor temperature limit or sag limitation.

2) Underground Cable

Underground cable loading should not exceed 100% of the continuous rating with all elements in service. This rating is based on a cable temperature of 85°C with no loss of cable life.

3) Transformers

Transformers cannot exceed 100% of top FOA, 65°C rise, nameplate ratings.

4) Series Capacitors

Series Capacitors cannot exceed 100% of continuous rating.

c. Interchange of VARs

Interchange of VARs between companies at interconnections will be reduced to a minimum and maintained near zero.

d. Distribution of Flow

Schedules on a new project will be compared to simulated power flows to ensure a reasonable level of flowability.

2. Single Contingency Outages

a. Voltage Levels

Maximum voltage deviation on APS' major buses cannot exceed 5%. This deviation level yields a close approximation to the post-transient VAR margin requirements of WECC.

b. Facilities Loading Limits

1) Transmission Lines

Transmission line loading cannot exceed 100% of the lesser of the sag limit or the emergency rating (30-minute rating) which is based upon established conductor temperature limits.

2) Underground Cable

Underground cable loading should not exceed the emergency rating during a single-contingency outage. This rating is based on a cable temperature of 105°C for two hours of emergency operation with no loss of cable life.

3) Transformers

Transformers cannot exceed 120% of top FOA, 65°C rise, nameplate ratings.

4) Series Capacitors

Series Capacitors cannot exceed 100% of emergency rating.

c. Generator Units

Generator units used for controlling remote voltages will be modified to hold their base case terminal voltages.

d. Impact on Interconnected System

Single contingency outages will not cause overloads upon any neighboring transmission system.

B. Transient Stability Studies

Transient stability studies are primarily performed on the 500kV and 345kV systems.

1. Fault Simulation

Three-phase-to-ground faults and single-line-to-ground faults, simulating a stuck circuit breaker in one phase with back-up delayed clearing will be simulated. Fault clearing times of four cycles after fault inception (5 cycles for a 230kV fault) and a back-up clearing time of twelve cycles after fault inception is utilized. System elements are switched out at the appropriate clearing times, as applicable. Fault damping will be applied when applicable at fault inception.

2. Series Capacitor Switching

Series capacitors, at locations determined from short-circuit studies, will be flashed at fault inception and will be reinserted depending on their reinsertion types.

3. System Stability

The system will be considered stable if the following conditions are met:

a. All machines in the system remain synchronized as demonstrated by the relative rotor angles.

b. Positive system damping exists as demonstrated by the damping of relative rotor angles and the damping of voltage magnitude swings. For N-1 disturbances, voltages for the first swing after fault clearing should not drop below 75% of pre-fault value with maximum time duration of 20 cycles for voltage dip exceeding 20%.

4. Re-closing

Automatic re-closing of circuit breakers controlling EHV facilities is not utilized.

C. Short Circuit Studies

Fault current shall not exceed 100% of the applicable breaker fault current interruption capability for three-phase or single-line-to-ground faults.

D. Reactive Power Margin Studies

For system normal conditions or single contingency conditions, post-transient voltage stability is required with a path or load area modeled at a minimum of 105% of the path rating or maximum planned load limit for the area under study, whichever is applicable. For multiple contingencies, post-transient voltage stability is required with a path or load area modeled at a minimum of 102.5% of the path rating or maximum planned load limit for the area under study, whichever is applicable.

2010 SYSTEM RATING MAPS

PREPARED BY
Transmission Operations
Aug 2010

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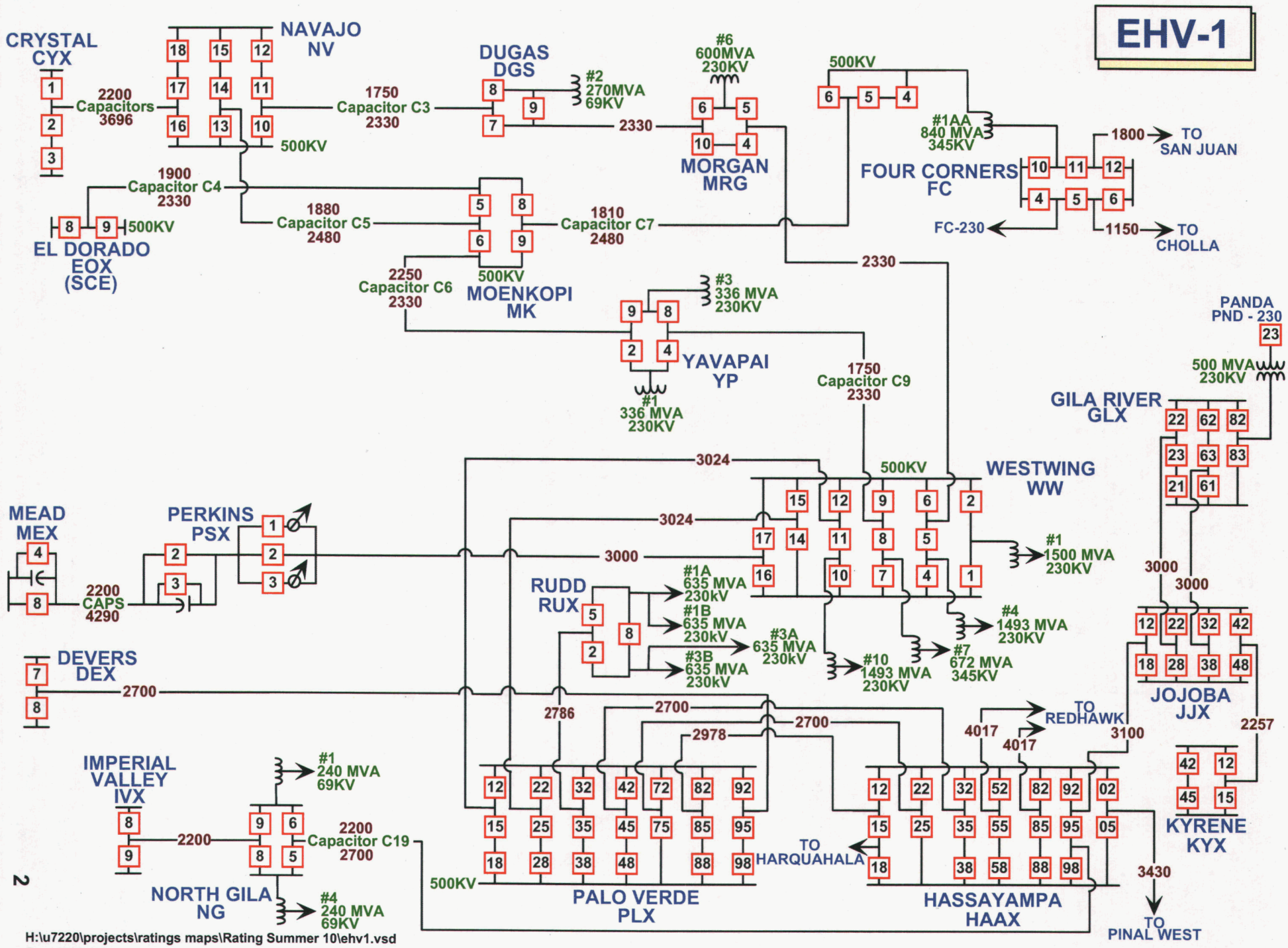
LEGEND
SYSTEM RATING MAPS

SYMBOL	DESCRIPTION
###	CURRENT LIMIT IN AMPS
—###—	LIMITING ELEMENT
###	CONDUCTOR LIMIT IN AMPS
	TRANSFORMER LIMITS ARE IN MVA
———	OVERHEAD TRANSMISSION LINE
– – – – – –	UNDERGROUND CABLE
M	MOTOR OPERATED SWITCH
V	VACCUM SWITCH
H	HYDRAULIC SWITCH
1	BREAKER NUMBER


EHV-1
CRYSTAL
CYX
NAVAJO
NV
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Capacitors
3696
1750
Capacitor C3
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DUGAS
DGS
#2
270MVA
69KV
2330
#6
600MVA
230KV
MORGAN
MRG
500KV
#1AA
840 MVA
345KV
FOUR CORNERS
FC
1800
TO
SAN JUAN
FC-230
1150
TO
CHOLLA
500KV
1900
Capacitor C4
2330
1880
Capacitor C5
2480
1810
Capacitor C7
2480
EL DORADO
EOX
(SCE)
500KV
2250
Capacitor C6
2330
MOENKOPI
MK
500KV
2330
#3
336 MVA
230KV
YAVAPAI
YP
#1
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230KV
1750
Capacitor C9
2330
PANDA
PND - 230
500 MVA
230KV
GILA RIVER
GLX
3024
3024
3000
500KV
WESTWING
WW
#1
1500 MVA
230KV
MEAD
MEX
PERKINS
PSX
2200
CAPS
4290
RUDD
RUX
#1A
635 MVA
230kV
#1B
635 MVA
230kV
#3A
635 MVA
230kV
#3B
635 MVA
230kV
#4
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230KV
#7
672 MVA
345KV
#10
1493 MVA
230KV
3000
3000
JOJOBA
JJX
DEVERS
DEX
2700
2786
2700
2700
2978
TO
REDHAWK
4017
4017
3100
2257
IMPERIAL
VALLEY
IVX
#1
240 MVA
69KV
2200
2200
Capacitor C19
2700
NORTH GILA
NG
#4
240 MVA
69KV
500KV
PALO VERDE
PLX
TO
HARQUAHALA
HASSAYAMPA
HAAX
3430
TO
PINAL WEST
KYRENE
KYX
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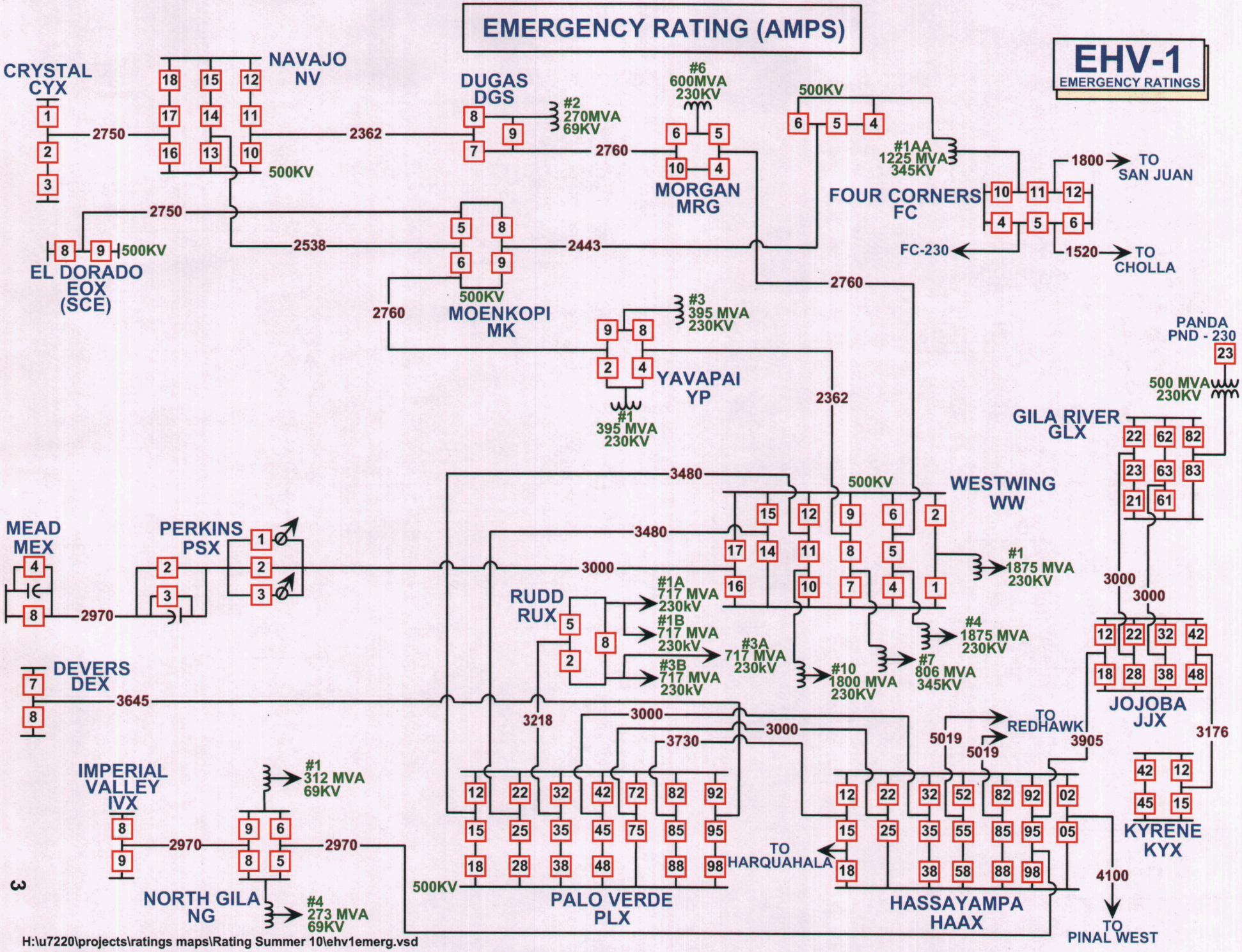
2


EMERGENCY RATING (AMPS)
EHV-1
EMERGENCY RATINGS
CRYSTAL
CYX
NAVAJO
NV
2750
2362
500KV
DUGAS
DGS
#2
270MVA
69KV
2760
#6
600MVA
230KV
MORGAN
MRG
500KV
#1AA
1225 MVA
345KV
FOUR CORNERS
FC
1800
TO
SAN JUAN
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2538
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230kV
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230kV
#4
1875 MVA
230KV
#10
1800 MVA
230KV
#7
806 MVA
345KV
3000
3000
JOJOBA
JJX
DEVERS
DEX
3645
3218
3000
3000
3730
TO
REDHAWK
5019
5019
3905
3176
IMPERIAL
VALLEY
IVX
#1
312 MVA
69KV
2970
2970
KYRENE
KYX
TO
HARQUAHALA
500KV
PALO VERDE
PLX
HASSAYAMPA
HAAX
4100
TO
PINAL WEST
NORTH GILA
NG
#4
273 MVA
69KV
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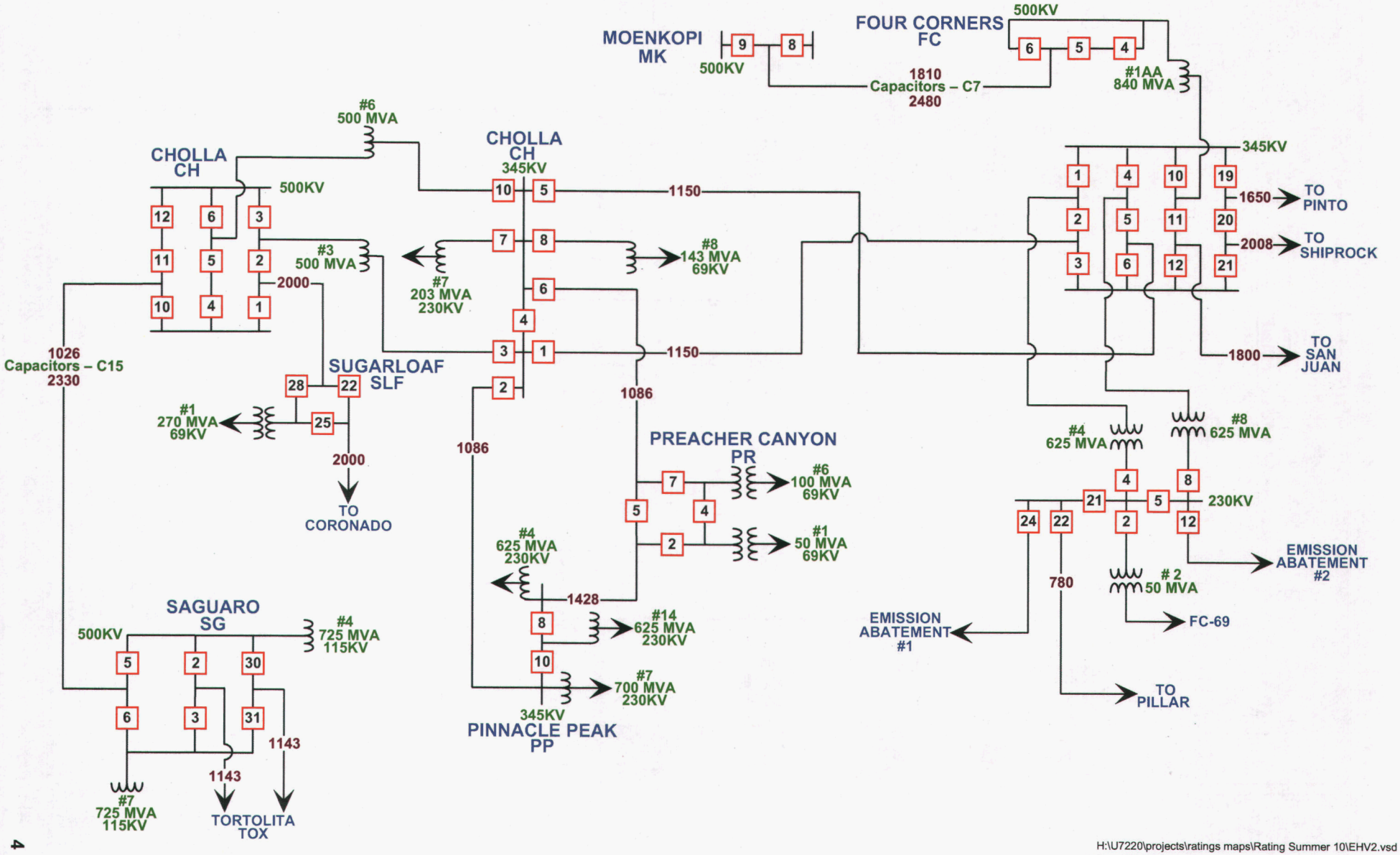
EHV-2



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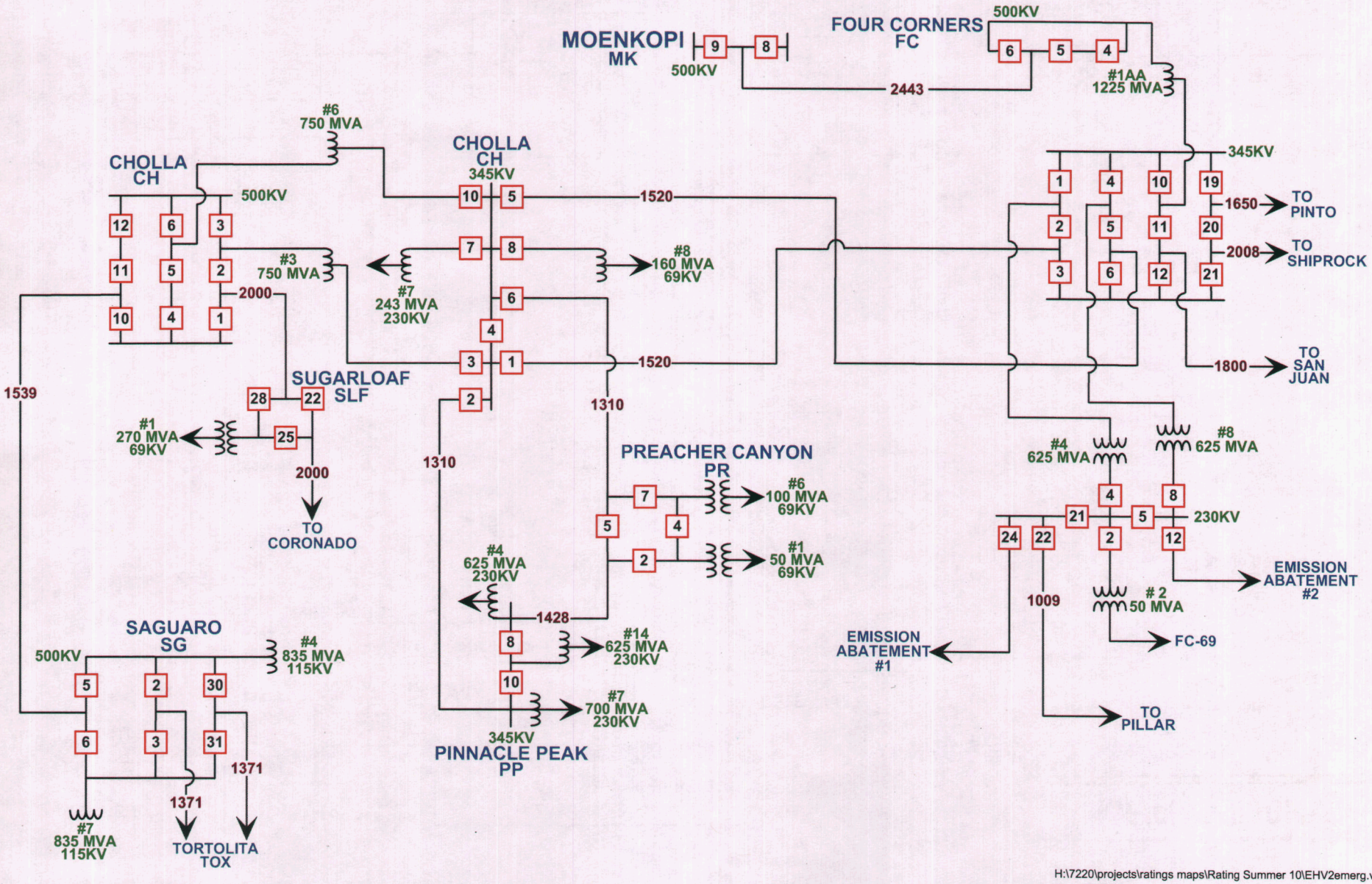
EMERGENCY RATING (AMPS)

EHV-2
EMERGENCY RATINGS



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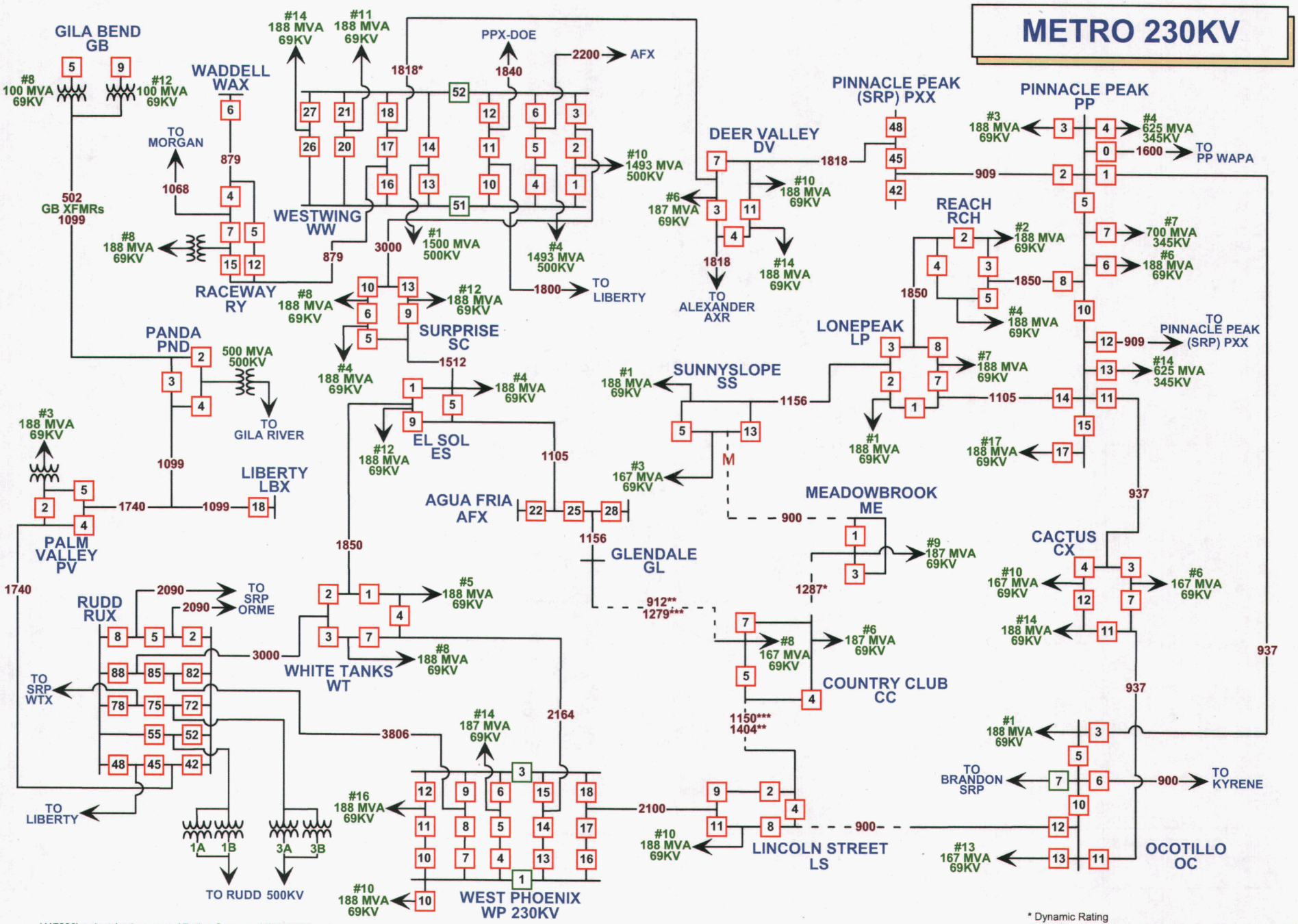

* Dynamic Rating
** No forced cooling on GT-CC, Cooling both ends LS-CC
*** Forced cooling on GT-CC, Cooling one end LS-CC

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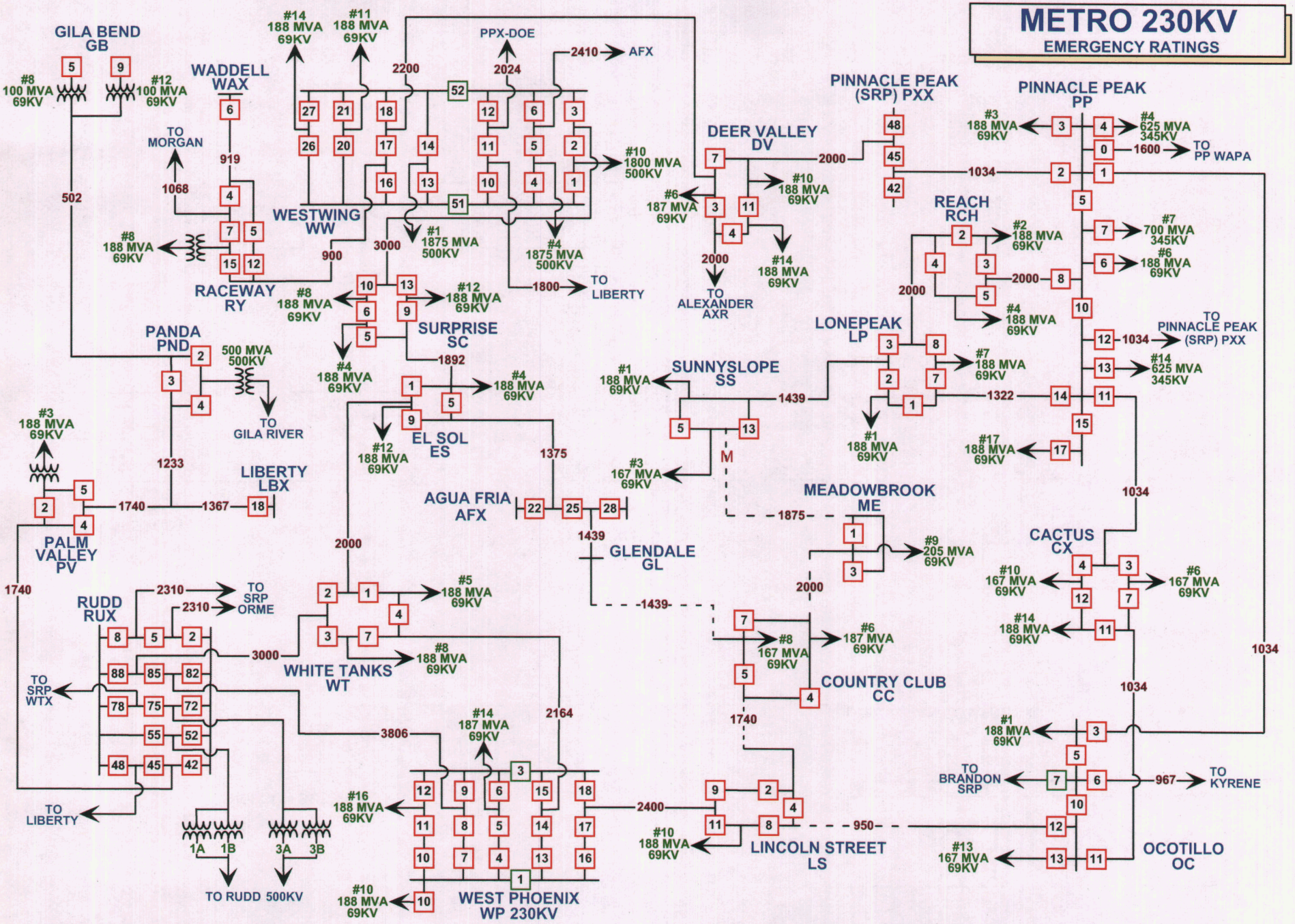

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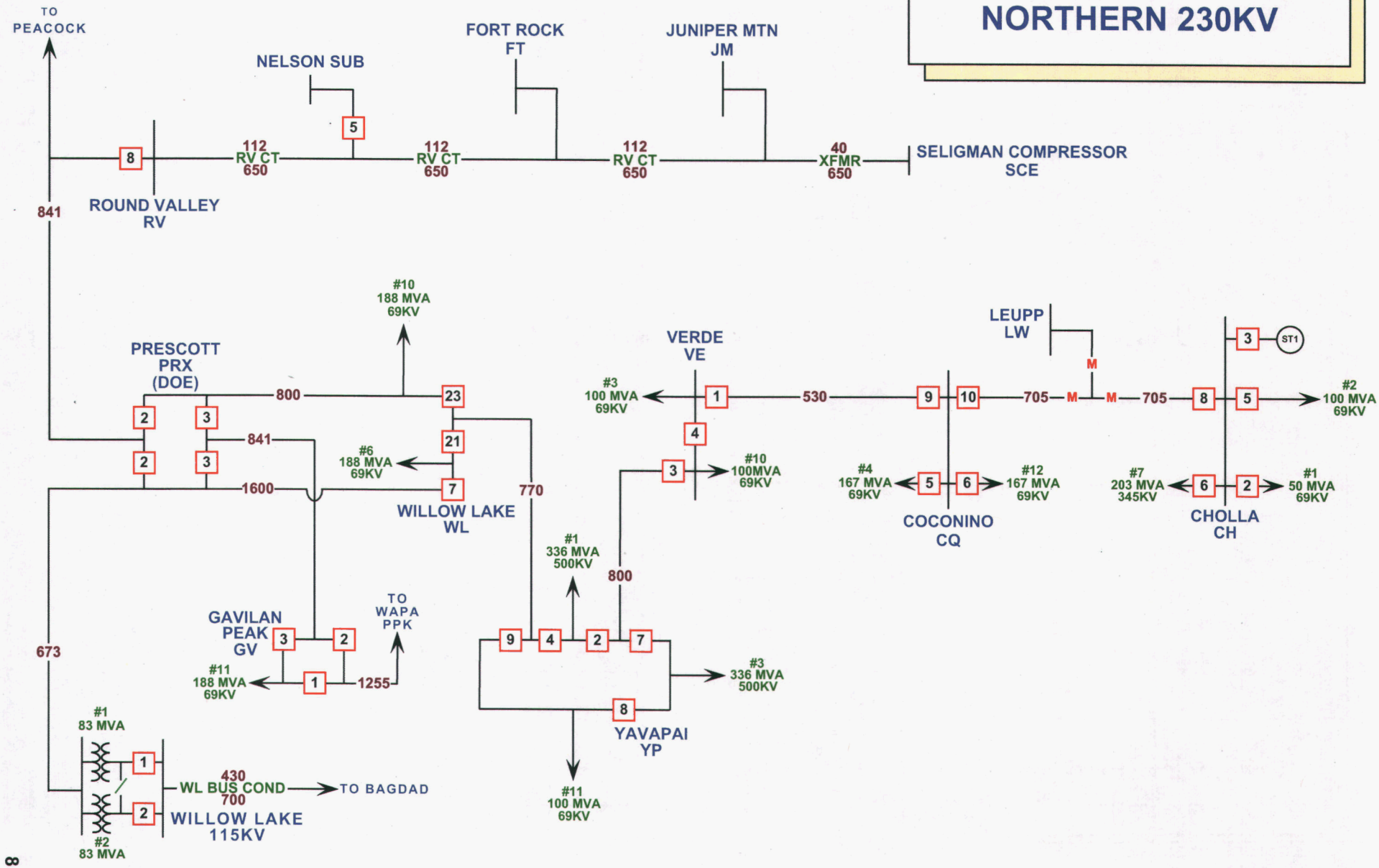
NORTHERN 230KV



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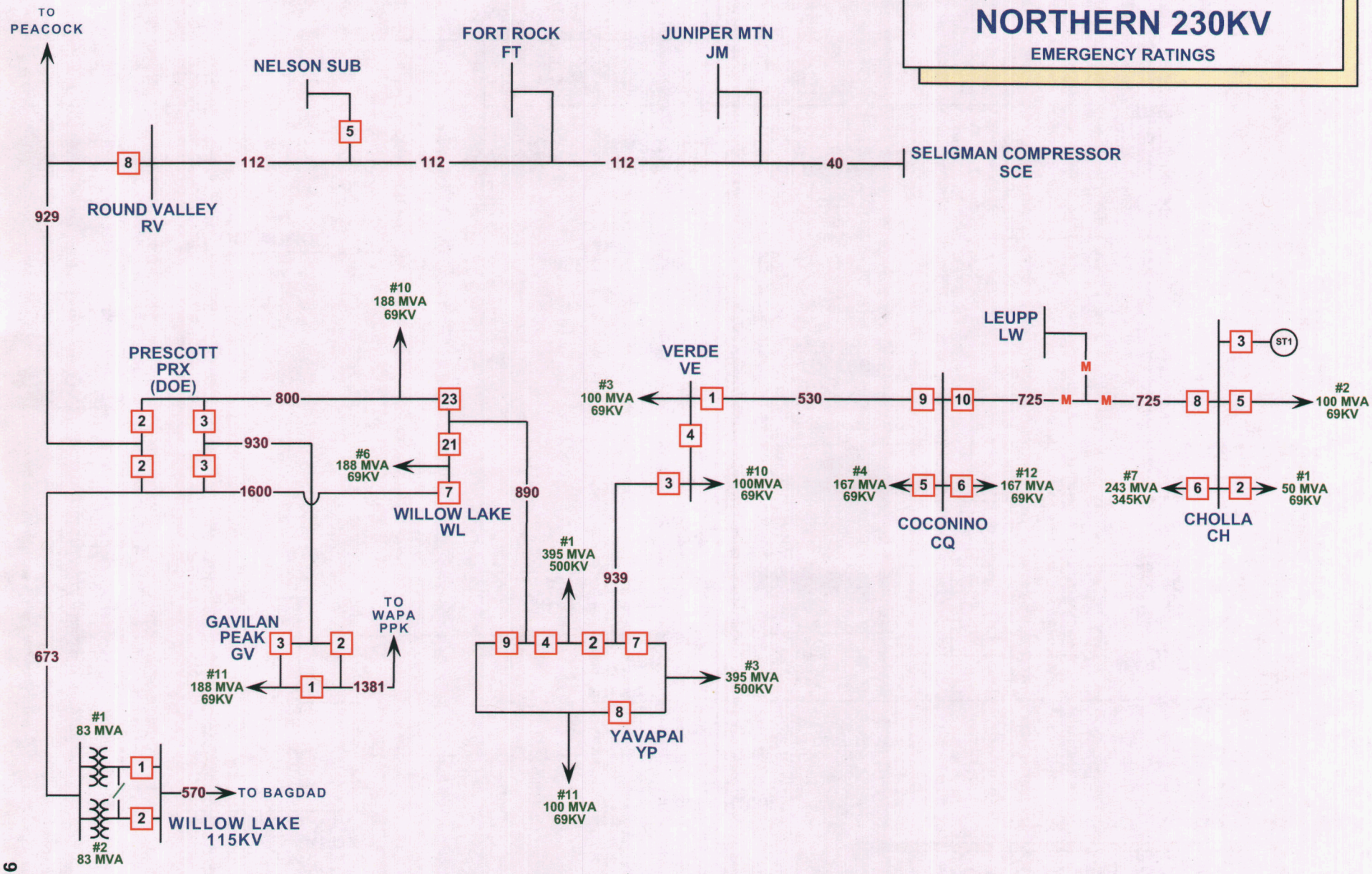
NORTHERN 230KV

EMERGENCY RATINGS



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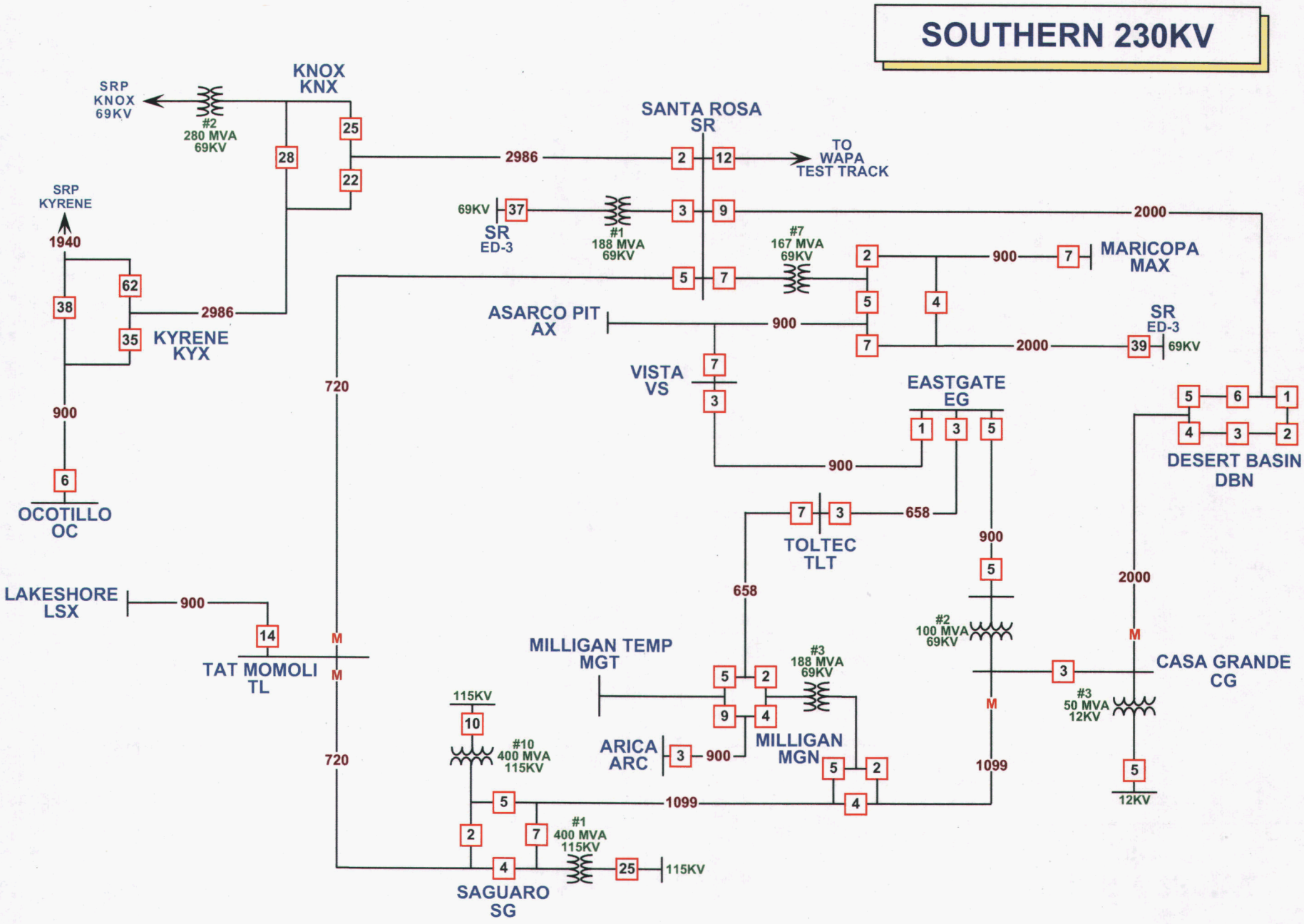

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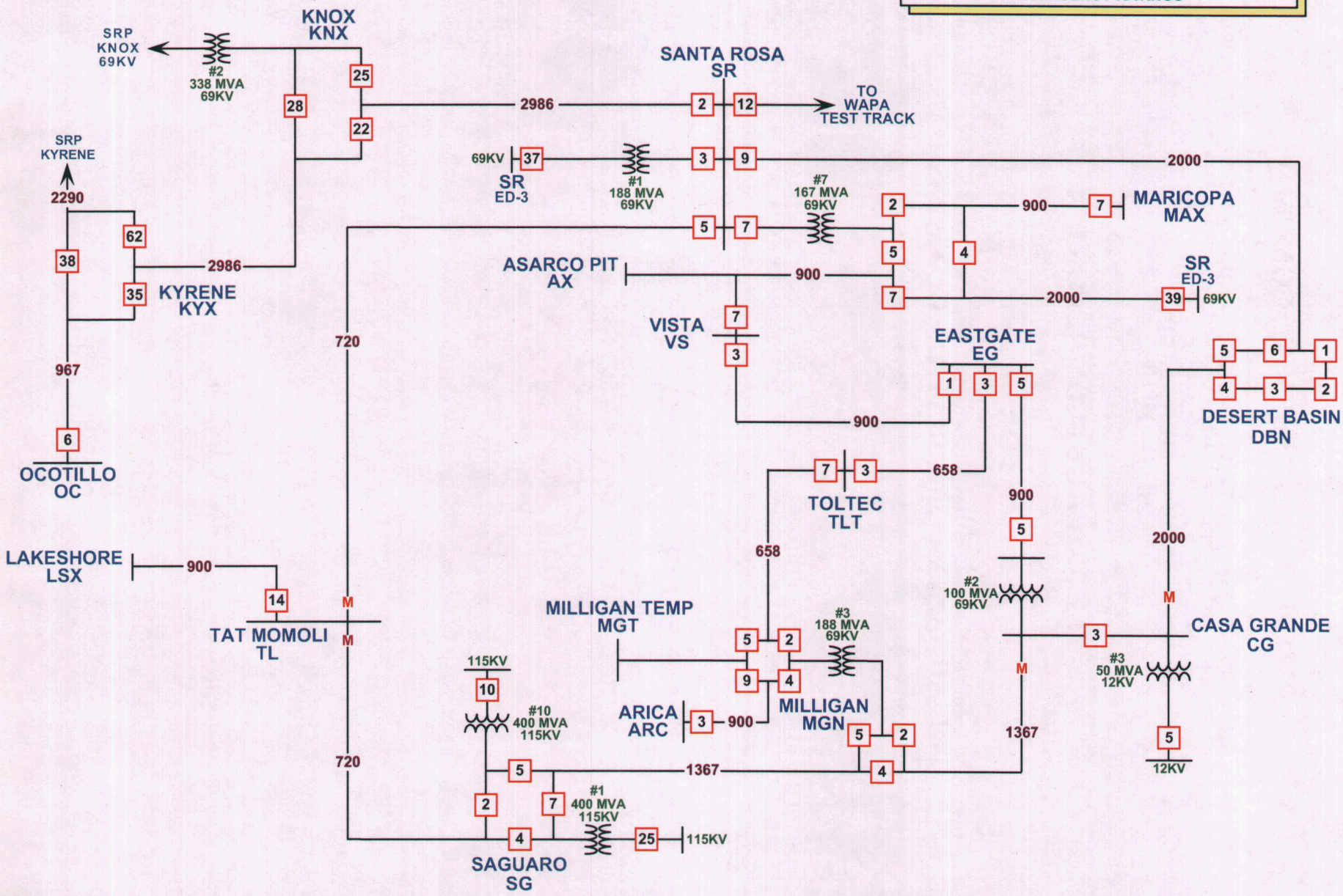
SOUTHERN 230KV
EMERGENCY RATINGS



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ARIZONA PUBLIC SERVICE COMPANY

TEN-YEAR TRANSMISSION SYSTEM PLAN

2011 – 2020

TECHNICAL STUDY REPORT

FOR

THE ARIZONA CORPORATION COMMISSION

JANUARY 2011

Executive Summary

Pursuant to North American Electric Reliability Corporation ("NERC") Standard TPL-001 "System Performance Under Normal (No Contingency) Conditions (Category A)", Arizona Public Service Company ("APS") performs annually a Category A analysis. The Category A analysis is performed for system conditions listed in Table I of the NERC/WECC Planning standards.

Results of the study indicate that, with the projects identified in APS's Ten-Year Transmission System Plan, APS is fully compliant with NERC Standard TPL-001.

Pursuant to NERC Standard TPL-002 "System Performance Following Loss of a Single Bulk Electric System Element (Category B)", APS performs annually a Category B contingency analysis. In Table I of the NERC/WECC planning standards, there are a total of four different Category B events that are to be studied each year to meet NERC Standard TPL-002.

A comprehensive list of contingencies was developed for the Category B contingency analysis and performed for the system conditions listed in Table I of the NERC/WECC Planning standards based on engineering judgment. APS believes that the selection of contingencies for inclusion in these studies, which is based on Category B of Table I of the NERC/WECC Planning standards, is acceptable to WECC. If requested by WECC, APS will implement measures to correct any deficiencies that have been identified by WECC.

Results of the study indicate that, with the projects identified in APS's Ten-Year Transmission System Plan, APS is fully compliant with NERC Standard TPL-002.

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ARIZONA PUBLIC SERVICE COMPANY
2011-2020
TEN-YEAR TRANSMISSION SYSTEM PLAN
TECHNICAL STUDY REPORT

I. Introduction

This technical study report is performed and filed annually with the Arizona Corporation Commission ("Commission") pursuant to ARS § 40-360.02 and Decision No. 63876 (July 25, 2001). This report summarizes the results of power flow analyses and stability analyses for the Arizona Public Service Company ("APS") transmission system.

Power flow analyses were conducted for every year within the ten year planning window (2011-2020) and performed for two scenarios: (i) assumption that all transmission system elements are in service and within continuous ratings (Category A); and (ii) assumption of an outage on a single element, with all remaining system elements remaining within emergency ratings (Category B). Voltage deviations for these scenarios must also be within established guidelines. These voltage deviation guidelines closely approximate post-transient Volt Ampere Reactive ("VAR") margin requirements of the Western Electricity Coordinating Council ("WECC"). More detail is provided in APS's Transmission Planning Process and Guidelines, which is also included in the annual APS Ten-Year Transmission System Plan ("Ten-Year Plan") filing.

The stability analyses were performed to simulate electrical disturbances on the transmission system and evaluate the system response. The desired result is that all generators will remain on line, no additional lines will open, and the system oscillations will damp out.

Results of the power flow and stability analyses aid in determining when and where new electrical facilities are needed because of reliability or security reasons. Additionally, some facilities are planned to address adequacy concerns. These include the interconnection of generation to the transmission system or efforts to increase import capability and/or export/scheduling capability to load-constrained or other areas.

II. Base Case Development

Power flow cases were created for each year of the 2011-2020 study time frame. These cases were developed from the latest available WECC heavy summer power flow cases.

The 2012 CATS-EHV heavy summer case was chosen as the first bulk seed case. This case was developed from a 2013 WECC heavy summer base case. The CATS-EHV case was then updated in a coordinated effort between Arizona utilities to include the sub-transmission and distribution models. This case was used as the seed case in the creation of the 2011-2016 power flow cases used for the power flow analyses performed for the 2011-2020 Ten-Year plan. Each intermediate case developed was updated with

the forecasted loads and any system additions/upgrades that are planned in the respective year.

The second and final seed case chosen was the 2020 Heavy Summer power flow case that was developed through the CATS-EHV sub-committee of SWAT. In a collaborative effort, the Arizona utilities used the jointly developed 2020 CATS-EHV case to develop a 2020 summer case that included the sub-transmission and distribution systems of the Arizona utilities. This seed case was used to develop the 2017-2020 power flow cases. Each intermediate case developed was updated with the forecasted loads and any system additions/upgrades that are planned in the respective year.

These cases represent the latest transmission and sub-transmission plans, load projections, and resource plans of utilities and independent power producers. By utilizing WECC base cases, all loads, resources, firm power transfers, and planned projects within the WECC system are represented. By using jointly developed seed cases the most accurate Arizona system is represented.

III. Power Flow Analyses

Base case and single contingency conditions are evaluated to determine system needs and timing. Various iterations of possible solutions lead to the final plans for transmission additions. The contingency analysis involves simulations for every non-radial 115kV or above line that APS owns, partially owns, or operates. Transformer as well as generator outages are also evaluated.

The APS system includes several reactive power resources that are used to maintain bus voltages within the limits defined by The Transmission Planning Process & Guidelines. These reactive power resources include shunt devices, series compensation, and tap changing transformers. The reactive power resources are adequate and meet the system performance.

APS does not have any existing or planned control devices. These devices exist outside the APS control area; however, they are not utilized or their operation is not necessary as a result of the contingencies in this study.

No planned outage of bulk electric equipment at APS occurs during the heavy summer peak time. Therefore it is not necessary to study planned outages since this Ten-Year Plan study focuses on the heavy summer peak time.

Results of the power flow studies are tabulated in a Security Needs Table and an Adequacy Needs Table, below. These tables identify 14 transmission projects that are included in this Ten-Year Plan filing. Some of the projects were classified as Adequacy Needs because of the uncertainty of generation location, project size, and transmission availability in the later years. As projects near the five-year planning time frame, they may be redefined as Security Needs projects. For the projects included in the Security Needs Table, selected maps of the power flow simulations are contained in Appendix B showing the pre-project scenario (outage and resulting violation) and the post-project scenario (outage and no criteria violations).

Table 1: Security Needs Table

Transmission Project	In Service Year	Critical Outage	Limiting Element/Condition	Map
Scatter Wash 230kV substation	2013	Adobe-Deer Valley 69kV line	Overloads Deer Valley-Rose Garden 69kV line	B1-B2
Trilby Wash (TS1) 230kV substation	2014	Westwing 230/69kV Transformer	Overloads remaining Westwing 230/69kV Transformer	B3-B4
		McMicken-Westwing 69kV line	Overloads McMicken-Surprise 69kV line	B5-B6
Youngs Canyon (Flagstaff) 345/69kV interconnection	2012	230/69kV transformers at Coconino	Voltage deviations on the sub-transmission system in the area resulting in load shedding	B7-B8
Mazatzal 345kV substation	2014	Preacher Canyon – Tonto 69kV line	Voltage deviations on the sub-transmission system in the area resulting in load shedding	B9
		Preacher Canyon - Owens 69kV line	Voltage deviations on the sub-transmission system in the area resulting in load shedding	B10-B11

Table 2: Adequacy Needs Table

Transmission Project	In Service Year	System Benefits
Palo Verde-Delany	2013	Increases the export scheduling capability from the Palo Verde ("PV") area to provide access to both solar and gas resources. The project is also to provide for the interconnection of 3 solar generation projects into the Delany switchyard.
Desert Basin-Pinal Central 230kV line and Pinal Central-Sundance 230kV line	2014	Increases the reliability of the Sundance generating facility and provides an APS transmission path for delivery of the full output of the Sundance generating facility. Provides another transmission path in the regional system, thereby increasing the system reliability and capacity in order to continue to serve the growing electrical demand in an economical and reliable manner.
Hassayampa to North Gila 500kV #2 line.	2014	Increases import capability for the Yuma area and export/scheduling capability from the PV area to provide access to both solar and gas resources. Increases transmission system reliability and ability to deliver power from these resources. Increases transmission system reliability.
North Gila-TS8 230kV line.	2014	Increases transmission system reliability and ability to distribute and deliver power within the Yuma area.
Delany-Sun Valley 500kV line & Sun Valley-Trilby Wash 230kV line	2014	Increases the import capability for the Phoenix Metropolitan area and export/scheduling capability from the PV area to provide access to both solar and gas resources. Increases the system reliability by providing a new transmission source to help serve the growing areas in the western portions of the Phoenix Metropolitan area.
Palm Valley-TS2-Trilby Wash 230kV line	2015	Provides a second 230kV source for Trilby Wash so that it is not served as a radial substation, thereby increasing the local system reliability. Also, connecting the Sun Valley-Trilby Wash 230kV line to Palm Valley also increases the reliability of the high voltage transmission system on the western side of the Phoenix Metropolitan area.
Sun Valley-Morgan 500kV line.	2016	Increases import capability for the Phoenix Metropolitan area and export/scheduling capability from the PV area which includes both solar and gas resources. Increases transmission system reliability and ability to deliver power from these resources. Provides a second 500kV source for the Sun Valley substation. Provides support for multiple Category C and D transmission contingencies.
Loop-in of Saguaro-Casa Grande 230kV line into TS12 230kV substation	2016	Provides a transmission source to serve the new load developing in the local area that does not have any electrical facilities existing in the area.

IV. Stability Analyses

A stability simulation for simulated three-phase faults was performed for 2012 and 2020 for every non-radial 115kV, 230kV, 345kV or 500kV line that APS owns (totally or partially) or operates. It has been APS's experience that stability concerns do not manifest on the sub-transmission system, which is primarily designed to deliver power to load. Therefore, no simulations were performed at voltage levels less than 115kV, except at generator substation. Additionally, every new proposed generation plant will be required to perform stability evaluations prior to receiving permission to interconnect to the transmission system.

Existing and planned protection systems are utilized in the study, including any backup or redundant system, and represent fault clearing times, the operation of the protection system, and the resulting removal of the facility that would occur as a result of the simulated event. Each simulation modeled a 3-phase bus fault, appropriate series capacitor flashing and reinsertion, fault removal, and transmission line removal. System performance was evaluated by monitoring representative generator rotor angles, bus voltages and system frequency. Plots of these system parameters are included in Appendices C and D. The stability simulations performed to date indicate that no stability problems limit the transmission system.

V. Category A & B Contingency Study Results

A high level overview of the results for the Category A and Category B contingences is shown in Table 3. From this table, it is shown that each of the Category A and Category B contingencies meets the NERC/WECC Planning Standards.

Table 3: Overview of Category A & B Standard Results

		1-5 year Time Frame		6-10 year Time Frame	
	NERC Planning Standards Category A	Case Years Studied	Standards Met?	Case Years Studied	Standards Met?
1	All Facilities in Service	2011 through 2015	Yes	2016 through 2020	Yes
		1-5 year Time Frame		6-10 year Time Frame	
	NERC Planning Standards Category B	Case Years Studied	Standards Met?	Case Years Studied	Standards Met?
1	3-Phase Fault with Normal Clearing – Generator	2011 through 2015	Yes	2016 through 2020	Yes
2	3-Phase Fault with Normal Clearing – Transmission Circuit	2011 through 2015	Yes	2016 through 2020	Yes
3	3-Phase Fault with Normal Clearing – Transformer	2011 through 2015	Yes	2016 through 2020	Yes
4	Loss of an Element without a Fault	2011 through 2015	Yes	2016 through 2020	Yes

Table 3 is a high level summary that shows, with the projects listed in Tables 1 & 2, the APS system meets the criteria listed in NERC Standards TPL-001 and TPL-002. The transient stability plots are detailed in Appendices C & D. Due to the size of the power flow thermal and voltage steady state analysis the detailed results are not included. However, they are available upon request by WECC or any other authorized stakeholder.

APPENDIX A

Representative Contingency List

(2016 used as an example year)

2016 Single Contingency List (Category B)

Outage Number	Type	Contingency	Circuit #
line_1	Line	CHOLLA 500.0 to SAGUARO 500.0	Circuit 1
line_2	Line	FOURCORN 500.0 to MOENKOPI 500.0	Circuit 1
line_3	Line	NAVAJO 500.0 to MOENKOPI 500.0	Circuit 1
line_4	Line	CHOLLA 345.0 to PNPKAPS 345.0	Circuit 1
line_5	Line	CHOLLA 345.0 to PRECHCYN 345.0	Circuit 1
line_6	Line	FOURCORN 345.0 to CHOLLA 345.0	Circuit 1
line_7	Line	FOURCORN 345.0 to CHOLLA 345.0	Circuit 2
line_8	Line	BUCKEYE 230.0 to LIBERTY 230.0	Circuit 1
line_9	Line	CACTUS 230.0 to OCOTILLO 230.0	Circuit 1
line_10	Line	CACTUS 230.0 to PPAPS N 230.0	Circuit 1
line_11	Line	CTRYCLUB 230.0 to LINCSTRT 230.0	Circuit 1
line_12	Line	CTRYCLUB 230.0 to GRNDTRML 230.0	Circuit 1
line_13	Line	DEERVALY 230.0 to ALEXANDR 230.0	Circuit 1
line_14	Line	DEERVALY 230.0 to PINPKSRP 230.0	Circuit 1
line_15	Line	EL SOL 230.0 to AGUAFRIA 230.0	Circuit 1
line_16	Line	GLENDALE 230.0 to GRNDTRML 230.0	Circuit 1
line_17	Line	GLENDALE 230.0 to AGUAFRIA 230.0	Circuit 1
line_18	Line	LEUPP 230.0 to COCONINO 230.0	Circuit 1
line_19	Line	LINCSTRT 230.0 to OCOTILLO 230.0	Circuit 1
line_20	Line	LINCSTRT 230.0 to WPHXAPSN 230.0	Circuit 1
line_21	Line	LONEPEAK 230.0 to PPAPS E 230.0	Circuit 1
line_22	Line	LONEPEAK 230.0 to SUNYSLOP 230.0	Circuit 1
line_23	Line	MEADOWBK 230.0 to CTRYCLUB 230.0	Circuit 1
line_24	Line	MEADOWBK 230.0 to SUNYSLOP 230.0	Circuit 1
line_25	Line	REACH 230.0 to LONEPEAK 230.0	Circuit 1
line_26	Line	REACH 230.0 to PPAPS C 230.0	Circuit 1
line_27	Line	PPAPS N 230.0 to OCOTILLO 230.0	Circuit 1
line_28	Line	PPAPS N 230.0 to PINPKSRP 230.0	Circuit 1
line_29	Line	PPAPS N 230.0 to PINPKSRP 230.0	Circuit 2
line_30	Line	PPAPS W 230.0 to PINPK 230.0	Circuit 1
line_31	Line	SAGUARO 230.0 to TATMOMLI 230.0	Circuit 1
line_32	Line	SNTAROSA 230.0 to TATMOMLI 230.0	Circuit 1
line_33	Line	SNTAROSA 230.0 to TESTTRAK 230.0	Circuit 1
line_34	Line	SURPRISE 230.0 to EL SOL 230.0	Circuit 1
line_35	Line	SURPRISE 230.0 to WESTWNGW 230.0	Circuit 1
line_36	Line	WESTWNGW 230.0 to PINPK 230.0	Circuit 1
line_37	Line	WHTNKAPS 230.0 to EL SOL 230.0	Circuit 1
line_38	Line	WHTNKAPS 230.0 to RUDD 230.0	Circuit 1
line_39	Line	WPHXAPSS 230.0 to WPHXAPSN 230.0	Circuit 1
line_40	Line	PPAPS W 230.0 to PPAPS C 230.0	Circuit 1
line_41	Line	PPAPS C 230.0 to PPAPS E 230.0	Circuit 1
line_42	Line	PPAPS N 230.0 to PPAPS E 230.0	Circuit 1
line_43	Line	WPHXAPSS 230.0 to RUDD 230.0	Circuit 1
line_44	Line	YAVAPAI 230.0 to VERDE N 230.0	Circuit 1
line_45	Line	YAVAPAI 230.0 to WILOWLKE 230.0	Circuit 1
line_46	Line	KYR-NEW 230.0 to OCOTILLO 230.0	Circuit 1
line_47	Line	KYR-NEW 230.0 to KNOX 230.0	Circuit 1
line_48	Line	GILARIVR 230.0 to GILABEND 230.0	Circuit 1

line_49	Line	WPHXAPSN 230.0 to WHTNKAPS 230.0	Circuit 1
line_50	Line	FORTROCK 230.0 to ROUNDVLY 230.0	Circuit 1
line_51	Line	FORTROCK 230.0 to JUNIPRMT 230.0	Circuit 1
line_52	Line	WILOWLKW 230.0 to PRESCOTT 230.0	Circuit 1
line_53	Line	WILOWLKW 230.0 to WILOWLKE 230.0	Circuit 1
line_54	Line	JUNIPRMT 230.0 to SELIGMAN 230.0	Circuit 1
line_55	Line	CORONADO 500.0 to SILVERKG 500.0	Circuit 1
line_56	Line	PALOVRDE 500.0 to WESTWING 500.0	Circuit 1
line_57	Line	PALOVRDE 500.0 to WESTWING 500.0	Circuit 2
line_58	Line	PALOVRDE 500.0 to RUDD 500.0	Circuit 1
line_59	Line	PERK PS2 500.0 to PERKINPS 500.0	Circuit 1
line_60	Line	HASSYAMP 500.0 to REDHAWK 500.0	Circuit 1
line_61	Line	HASSYAMP 500.0 to REDHAWK 500.0	Circuit 2
line_62	Line	HASSYAMP 500.0 to PALOVRDE 500.0	Circuit 1
line_63	Line	HASSYAMP 500.0 to PALOVRDE 500.0	Circuit 2
line_64	Line	HASSYAMP 500.0 to PALOVRDE 500.0	Circuit 3
line_65	Line	HASSYAMP 500.0 to PINAL_W 500.0	Circuit 1
line_66	Line	HASSYAMP 500.0 to ARLINTON 500.0	Circuit 1
line_67	Line	HASSYAMP 500.0 to MESQUITE 500.0	Circuit 1
line_68	Line	AGUAFRIA 230.0 to WESTWNGW 230.0	Circuit 1
line_69	Line	AGUAFRIA 230.0 to ALEXANDR 230.0	Circuit 1
line_70	Line	AGUAFRIA 230.0 to WHITETNK 230.0	Circuit 1
line_71	Line	BRANDOW 230.0 to KYRENE 230.0	Circuit 1
line_72	Line	BRANDOW 230.0 to PAPAGOBT 230.0	Circuit 1
line_73	Line	BRANDOW 230.0 to WARD 230.0	Circuit 1
line_74	Line	BRANDOW 230.0 to WARD 230.0	Circuit 2
line_75	Line	CORBELL 230.0 to KYRENE 230.0	Circuit 1
line_76	Line	KYRENE 230.0 to KYR-NEW 230.0	Circuit 1
line_77	Line	KYRENE 230.0 to SCHRADER 230.0	Circuit 1
line_78	Line	ORME 230.0 to RUDD 230.0	Circuit 1
line_79	Line	PAPAGOBT 230.0 to PINPKSRP 230.0	Circuit 1
line_80	Line	ROGERS 230.0 to THUNDRST 230.0	Circuit 1
line_81	Line	ROGERS 230.0 to ROGSWAPA 230.0	Circuit 1
line_82	Line	ROGERS 230.0 to ROGSWAPA 230.0	Circuit 2
line_83	Line	SANTAN 230.0 to CORBELL 230.0	Circuit 1
line_84	Line	SANTAN 230.0 to THUNDRST 230.0	Circuit 1
line_85	Line	SCHRADER 230.0 to SANTAN 230.0	Circuit 1
line_86	Line	THUNDRST 230.0 to GOLDFELD 230.0	Circuit 1
line_87	Line	THUNDRST 230.0 to GOLDFELD 230.0	Circuit 2
line_88	Line	KNOX 230.0 to SNTAROSA 230.0	Circuit 1
line_89	Line	BROWNING 230.0 to SANTAN 230.0	Circuit 1
line_90	Line	RUDD 230.0 to WHITETNK 230.0	Circuit 1
line_91	Line	RUDD 230.0 to LIBERTY 230.0	Circuit 1
line_92	Line	COPPERVR 230.0 to FRISCO 230.0	Circuit 1
line_93	Line	APACHE 230.0 to BUTERFLD 230.0	Circuit 1
line_94	Line	APACHE 230.0 to RED TAIL 230.0	Circuit 1
line_95	Line	APACHE 230.0 to WINCHSTR 230.0	Circuit 1
line_96	Line	BUTERFLD 230.0 to SAN RAF 230.0	Circuit 1
line_97	Line	MORENCI 230.0 to GREEN-AE 230.0	Circuit 1
line_98	Line	RED TAIL 230.0 to DOSCONDO 230.0	Circuit 1

line_99	Line	SAHUARIT 230.0 to BICKNELL 230.0	Circuit 1
line_100	Line	MEAD N 230.0 to HVRA3A4 230.0	Circuit 1
line_101	Line	MEAD S 230.0 to MEAD N 230.0	Circuit 1
line_102	Line	DAVIS 230.0 to RIVIERA 230.0	Circuit 1
line_103	Line	DAVIS 230.0 to MEAD N 230.0	Circuit 1
line_104	Line	DAVIS 230.0 to TOPOCK 230.0	Circuit 2
line_105	Line	HOVRA5A6 230.0 to MEAD S 230.0	Circuit 1
line_106	Line	HOVRA7-9 230.0 to MEAD S 230.0	Circuit 1
line_107	Line	MEAD 500.0 to PERKINS 500.0	Circuit 1
line_108	Line	PARKER 230.0 to EAGLEYE 230.0	Circuit 1
line_109	Line	PARKER 230.0 to BLK MESA 230.0	Circuit 1
line_110	Line	PARKER 230.0 to HAVASU 230.0	Circuit 1
line_111	Line	PARKER 230.0 to HARCUVAR 230.0	Circuit 1
line_112	Line	COOLIDGE 230.0 to SUN ARIZ 230.0	Circuit 1
line_113	Line	COOLIDGE 230.0 to SUN ARIZ 230.0	Circuit 2
line_114	Line	LIBERTY 230.0 to WESTWNGW 230.0	Circuit 1
line_115	Line	LIBERTY 230.0 to LONE BUT 230.0	Circuit 1
line_116	Line	LIBERTY 230.0 to PHXWAPA 230.0	Circuit 1
line_117	Line	LIBERTY 345.0 to PEACOCK 345.0	Circuit 1
line_118	Line	LONE BUT 230.0 to TESTTRAK 230.0	Circuit 1
line_119	Line	LONE BUT 230.0 to SUN ARIZ 230.0	Circuit 1
line_120	Line	MCCONICO 230.0 to DAVIS 230.0	Circuit 1
line_121	Line	MCCONICO 230.0 to GRIFFITH 230.0	Circuit 1
line_122	Line	MCCONICO 230.0 to HARRIS 230.0	Circuit 1
line_123	Line	PHXWAPA 230.0 to LONE BUT 230.0	Circuit 1
line_124	Line	PINPK 230.0 to PINPKSRP 230.0	Circuit 1
line_125	Line	PINPK 230.0 to PINPKSRP 230.0	Circuit 2
line_126	Line	TESTTRAK 230.0 to CASAGRND 230.0	Circuit 1
line_127	Line	HILLTOP 230.0 to MCCONICO 230.0	Circuit 1
line_128	Line	N.HAVASU 230.0 to PARKER 230.0	Circuit 1
line_129	Line	N.HAVASU 230.0 to TOPOCK 230.0	Circuit 1
line_130	Line	HOVRN7N8 230.0 to MEAD S 230.0	Circuit 1
line_131	Line	HOVRN5N6 230.0 to MEAD S 230.0	Circuit 1
line_132	Line	HOVRN3N4 230.0 to MEAD S 230.0	Circuit 1
line_133	Line	HOVRN1N2 230.0 to MEAD S 230.0	Circuit 1
line_134	Line	HOVRA1A2 230.0 to MEAD S 230.0	Circuit 1
line_135	Line	HARCUVAR 230.0 to HARCU AZ 230.0	Circuit 1
line_136	Line	HARCUVAR 230.0 to HASSYTAP 230.0	Circuit 1
line_137	Line	SPKHILTP 230.0 to COOLIDGE 230.0	Circuit 1
line_138	Line	GRIFFITH 230.0 to PEACOCK 230.0	Circuit 1
line_139	Line	PEACOCK 230.0 to HILLTOP 230.0	Circuit 1
line_140	Line	PEACOCK 345.0 to MEAD 345.0	Circuit 1
line_141	Line	TOPOCK 230.0 to BLK MESA 230.0	Circuit 1
line_142	Line	TOPOCK 230.0 to SOPOINT 230.0	Circuit 1
line_143	Line	TOPOCK 230.0 to SOPOINT 230.0	Circuit 2
line_144	Line	HASSYTAP 230.0 to HASSY AZ 230.0	Circuit 1
line_145	Line	HASSYTAP 230.0 to LIBERTY 230.0	Circuit 1
line_146	Line	RNDVLYTP 230.0 to ROUNDVLY 230.0	Circuit 1
line_147	Line	RNDVLYTP 230.0 to PEACOCK 230.0	Circuit 1
line_148	Line	ROGSWAPA 230.0 to PINPK 230.0	Circuit 1

line_149	Line	ROGSWAPA 230.0 to PINPK 230.0	Circuit 2
line_150	Line	ROGSWAPA 230.0 to SPKHILTP 230.0	Circuit 1
line_151	Line	FLAGSTAF 345.0 to GLENCANY 345.0	Circuit 1
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line_154	Line	FLAGSTAF 345.0 to PINPKBRB 345.0	Circuit 2
line_155	Line	GLEN PS 230.0 to NAVAJO 230.0	Circuit 1
line_156	Line	KAYENTA 230.0 to SHIPROCK 230.0	Circuit 1
line_157	Line	KAYENTA 230.0 to LNGHOUSE 230.0	Circuit 1
line_158	Line	SHIPROCK 345.0 to FOURCORN 345.0	Circuit 1
line_159	Line	NAVAJO 230.0 to LNGHOUSE 230.0	Circuit 1
line_160	Line	TS4 230.0 to PLMVLY 230.0	Circuit 1
line_161	Line	RUDD 230.0 to PLMVLY 230.0	Circuit 1
line_162	Line	LIBERTY 230.0 to TS4 230.0	Circuit 1
line_163	Line	BUTERFLD 230.0 to SLOAN 0.0	Circuit 1
line_164	Line	DOSCONDO 230.0 to HACKBERY 230.0	Circuit 1
line_165	Line	HACKBERY 230.0 to MORENCI 230.0	Circuit 1
line_166	Line	ORME 230.0 to RUDD 230.0	Circuit 2
line_167	Line	ABEL 500.0 to BROWNING 500.0	Circuit 1
line_168	Line	DAVIS 230.0 to ZORB 230.0	Circuit 1
line_169	Line	ZORB 230.0 to TOPOCK 230.0	Circuit 1
line_170	Line	FOURCORN 500.0 to FCW 500.0	Circuit 1
line_171	Line	MOENKOPI 500.0 to RME 500.0	Circuit 1
line_172	Line	NAVAJO 500.0 to RME 500.0	Circuit 1
line_173	Line	DRPP 500.0 to FCW 500.0	Circuit 1
line_174	Line	DRPP 500.0 to FCW 500.0	Circuit 2
line_175	Line	RME 500.0 to FCW 500.0	Circuit 1
line_176	Line	NAVAJO 500.0 to DUGAS 500.0	Circuit 1
line_177	Line	MORGAN 500.0 to WESTWING 500.0	Circuit 1
line_178	Line	MORGAN 500.0 to PNPKAPS 500.0	Circuit 1
line_179	Line	SGRLF 500.0 to CHOLLA 500.0	Circuit 1
line_180	Line	DUGAS 500.0 to MORGAN 500.0	Circuit 1
line_181	Line	AVERY 230.0 to RACEWAY 230.0	Circuit 1
line_182	Line	AVERY 230.0 to TS6 230.0	Circuit 1
line_183	Line	TS6 230.0 to PPAPS W 230.0	Circuit 1
line_184	Line	SNVLY 230.0 to TRLBY 230.0	Circuit 1
line_185	Line	SNVLY 230.0 to TRLBY 230.0	Circuit 2
line_186	Line	CORONADO 500.0 to SGRLF 500.0	Circuit 1
line_187	Line	PD-MORNC 230.0 to FRISCO 230.0	Circuit 1
line_188	Line	CHOLLA 230.0 to LEUPP 230.0	Circuit 1
line_189	Line	SNVLY 230.0 to HASSY AZ 230.0	Circuit 1
line_190	Line	MEAD S 230.0 to EQUEST 230.0	Circuit 1
line_191	Line	MEAD N 230.0 to EQUEST 230.0	Circuit 2
line_192	Line	MEAD N 230.0 to NEWPORT 230.0	Circuit 1
line_193	Line	MEAD N 230.0 to EASTSIDE 230.0	Circuit 1
line_194	Line	MOENKOPI 500.0 to MARKETPL 500.0	Circuit 1
line_195	Line	NAVAJO 500.0 to CRYSTAL 500.0	Circuit 1
line_196	Line	FOURCORN 345.0 to RIOPUERC 345.0	
line_197	Line	FOURCORN 345.0 to SAN_JUAN 345.0	Circuit 1
line_198	Line	FOURCORN 345.0 to WESTMESA 345.0	Circuit 1

line_199	Line	FOURCORN 230.0 to PILLAR 230.0	Circuit 1
line_200	Line	HENDRSON 230.0 to MEAD N 230.0	Circuit 1
line_201	Line	H ALLEN 500.0 to MEAD 500.0	Circuit 1
line_202	Line	BC TAP 230.0 to MEAD N 230.0	Circuit 1
line_203	Line	DAVIS 230.0 to MCCULLGH 230.0	Circuit 1
line_204	Line	MEAD N 230.0 to DECATUR 230.0	Circuit 1
line_205	Line	MEAD S 230.0 to PAHRUMP 230.0	Circuit 1
line_206	Line	MEAD S 230.0 to GREENWAY 230.0	Circuit 1
line_207	Line	MEAD S 230.0 to MCCULLGH 230.0	Circuit 1
line_208	Line	MEAD S 230.0 to MCCULLGH 230.0	Circuit 2
line_209	Line	MEAD 500.0 to MARKETPL 500.0	Circuit 1
line_210	Line	PINTO PS 345.0 to FOURCORN 345.0	Circuit 1
line_211	Line	SIGURDPS 230.0 to GLENCANY 230.0	Circuit 1
line_212	Line	SHIPROCK 345.0 to SAN_JUAN 345.0	Circuit 1
line_213	Line	HASSYAMP 500.0 to N.GILA 500.0	Circuit 1
line_214	Line	MOENKOPI 500.0 to ELDORDO 500.0	Circuit 1
line_215	Line	PALOVRDE 500.0 to DEVERS 500.0	Circuit 1
line_216	Line	MEAD S 230.0 to ELDORDO 230.0	Circuit 1
line_217	Line	MEAD S 230.0 to ELDORDO 230.0	Circuit 2
line_218	Line	PARKER 230.0 to GENE 230.0	Circuit 1
line_219	Line	CAMINO 230.0 to MEAD S 230.0	Circuit E
line_220	Line	CAMINO 230.0 to MEAD S 230.0	CircuitW
line_221	Line	MEAD N 230.0 to ARDEN 230.0	Circuit 1
line_222	Line	MEAD S 230.0 to DIAMOND 230.0	Circuit 1
line_223	Line	MEAD S 230.0 to DIAMOND 230.0	Circuit 2
line_224	Line	HARQUAHA 500.0 to DEVERS 500.0	Circuit 1
line_225	Line	MEAD N 230.0 to SINATRA 230.0	Circuit 1
line_226	Line	EQUEST N 500.0 to MEAD 500.0	Circuit 1
line_227	Line	SNVLY 500.0 to MORGAN 500.0	Circuit 1
line_228	Line	DELANY 500.0 to SNVLY 500.0	Circuit 1
line_229	Line	PRECHCYN 345.0 to MAZATZAL 345.0	Circuit 1
line_230	Line	MAZATZAL 345.0 to PNPKAPS 345.0	Circuit 1
line_231	Line	JOJOBA 230.0 to GILARIVR 230.0	Circuit 1
line_232	Line	JOJOBA 230.0 to TS4 230.0	Circuit 1
line_233	Line	TRLBY 230.0 to TS2 230.0	Circuit 1
line_234	Line	TS2 230.0 to PLMVLY 230.0	Circuit 1
line_235	Line	MORENCI 230.0 to PD-MORNC 230.0	Circuit 1
line_236	Line	PANTANO 230.0 to NEWTUCSN 230.0	Circuit 1
line_237	Line	NEWTUCSN 230.0 to SAHUARIT 230.0	Circuit 1
line_238	Line	BOWIE 500.0 to PINAL_C 500.0	Circuit 1
line_239	Line	BOWIE 500.0 to ARROYO 500.0	Circuit 1
line_240	Line	MOENKOPI 500.0 to YAVAPAI 500.0	Circuit 1
line_241	Line	YAVAPAI 500.0 to WESTWING 500.0	Circuit 1
line_242	Line	DELANY 500.0 to HARQUAHA 500.0	Circuit 1
line_243	Line	DEERVALY 230.0 to WESTWNGE 230.0	Circuit 1
line_244	Line	WESTWNGW 230.0 to WESTWNGE 230.0	Circuit 1
line_245	Line	RACEWAY 230.0 to WESTWNGE 230.0	Circuit 1
line_246	Line	WESTWNGE 230.0 to EL SOL 230.0	Circuit 1
line_247	Line	HASSYAMP 500.0 to DELANY 500.0	Circuit 1
line_248	Line	PERKINS 500.0 to PERKINPS 500.0	Circuit 1

line_249	Line	PAPAGOBT 230.0 to KYR-NEW 230.0	Circuit 1
line_250	Line	PINAL_C 500.0 to TORTOLIT 500.0	Circuit 1
line_251	Line	SAGUARO 500.0 to TORTOLIT 500.0	Circuit 1
line_252	Line	SAGUARO 500.0 to TORTOLIT 500.0	Circuit 2
line_253	Line	BICKNELL 345.0 to VAIL 345.0	Circuit 1
line_254	Line	GREEN-AE 345.0 to GREENLEE 345.0	Circuit 1
line_255	Line	GREENLEE 345.0 to COPPERVR 345.0	Circuit 1
line_256	Line	GREENLEE 345.0 to WILLOW 345.0	Circuit 1
line_257	Line	GREENLEE 345.0 to WINCHSTR 345.0	Circuit 1
line_258	Line	HIDALGO 345.0 to GREENLEE 345.0	Circuit 1
line_259	Line	MCKINLEY 345.0 to SPRINGR 345.0	Circuit 1
line_260	Line	MCKINLEY 345.0 to SPRINGR 345.0	Circuit 2
line_261	Line	PINALWES 345.0 to SOUTH 345.0	Circuit 1
line_262	Line	SAN_JUAN 345.0 to MCKINLEY 345.0	Circuit 1
line_263	Line	SAN_JUAN 345.0 to MCKINLEY 345.0	Circuit 2
line_264	Line	SOUTH 345.0 to GATEWAY 345.0	Circuit 1
line_265	Line	SOUTH 345.0 to GATEWAY 345.0	Circuit 2
line_266	Line	SPRINGR 345.0 to CORONADO 345.0	Circuit 1
line_267	Line	SPRINGR 345.0 to GREENLEE 345.0	Circuit 1
line_268	Line	SPRINGR 345.0 to LUNA 345.0	Circuit 1
line_269	Line	SPRINGR 345.0 to VAIL2 345.0	Circuit 1
line_270	Line	TORTOLIT 345.0 to NLOOP345 345.0	Circuit 1
line_271	Line	VAIL 345.0 to SOUTH 345.0	Circuit 1
line_272	Line	WESTWING 345.0 to PINALWES 345.0	Circuit 1
line_273	Line	WESTWING 345.0 to SOUTH 345.0	Circuit 1
line_274	Line	WHTHILLS 345.0 to MEAD 345.0	Circuit 1
line_275	Line	WHTHILLS 345.0 to PEACOCK 345.0	Circuit 1
line_276	Line	WILLOW 345.0 to BOWIE 345.0	Circuit 1
line_277	Line	WILLOW 345.0 to BOWIE 345.0	Circuit 2
line_278	Line	WINCHSTR 345.0 to VAIL 345.0	Circuit 1
line_279	Line	WINCHSTR 345.0 to WILLOW 345.0	Circuit 1
line_280	Line	FRANCONI 230.0 to GRIFFITH 230.0	Circuit 1
line_281	Line	FRANCONI 230.0 to N.HAVASU 230.0	Circuit 1
line_282	Line	MCCONICO 230.0 to MERC230 230.0	Circuit 1
line_283	Line	WHTHILLS 230.0 to MERC230 230.0	Circuit 1
line_284	Line	RACEWAY 230.0 to RACEWYWA 230.0	Circuit 1
line_285	Line	PRSCOTWA 230.0 to PRESCOTT 230.0	Circuit 1
line_286	Line	PRSCOTWA 230.0 to RNDVLYTP 230.0	Circuit 1
line_287	Line	GAVLINWA 230.0 to GAVILNPK 230.0	Circuit 1
line_288	Line	GAVLINWA 230.0 to PINPK 230.0	Circuit 1
line_289	Line	GAVLINWA 230.0 to PRSCOTWA 230.0	Circuit 1
line_290	Line	N.WADDEL 230.0 to RACEWYWA 230.0	Circuit 1
line_291	Line	HASSYAMP 500.0 to N.GILA 500.0	Circuit 2
line_292	Line	ANDERSON 230.0 to KYR-NEW 230.0	Circuit 1
line_293	Line	SILVERKG 230.0 to GOLDFELD 230.0	Circuit 1
line_294	Line	ABEL 230.0 to DINOSAUR 230.0	Circuit 1
line_295	Line	RACEWYWA 230.0 to WESTWNGE 230.0	Circuit 1
line_296	Line	CASGRAPS 230.0 to MILLIGAN 230.0	Circuit 1
line_297	Line	TS12 230.0 to SAGUARO 230.0	Circuit 1
line_298	Line	MILLIGAN 230.0 to TS12 230.0	Circuit 1

line_299	Line	VERDE S 230.0 to VERDE N 230.0	Circuit 1
line_300	Line	VERDE S 230.0 to COCONINO 230.0	Circuit 1
line_301	Line	GILA 230.0 to NGL-E 230.0	Circuit 1
line_302	Line	GILA 230.0 to NGL-W 230.0	Circuit 1
line_303	Line	SLRC 230.0 to GILA 230.0	Circuit 2
line_304	Line	SLRC 230.0 to GILA 230.0	Circuit 1
line_305	Line	GLENDALE 230.0 to GLENDALW 230.0	Circuit 1
line_306	Line	GLENDALW 230.0 to AGUAFRIA 230.0	Circuit 1
line_307	Line	BUCKEYE2 230.0 to LIBERTY 230.0	Circuit 1
line_308	Line	EAGLEYE 230.0 to BUCKEYE2 230.0	Circuit 1
line_309	Line	BUCKEYE 230.0 to BUCKEYE2 230.0	Circuit 1
line_310	Line	CORONADO 500.0 to CHOLLA 500.0	Circuit 1
line_311	Line	PERKINPS 500.0 to WESTWING 500.0	Circuit 1
line_312	Line	BUCK230 230.0 to J.HINDS 230.0	Circuit 1
line_313	Line	PALOVRDE 500.0 to DELANY 500.0	Circuit 1
line_314	Line	HASSYAMP 500.0 to HARQUAHA 500.0	Circuit 1
line_315	Line	SNTAROSA 230.0 to DBG 230.0	Circuit 1
line_316	Line	DBG 230.0 to CASGRAPS 230.0	Circuit 1
line_317	Line	KYRENE 500.0 to BROWNING 500.0	Circuit 1
line_318	Line	PERKINPS 500.0 to PERK PS1 500.0	Circuit 1
line_319	Line	BROWNING 500.0 to SILVERKG 500.0	Circuit 1
line_320	Line	PINAL_C 500.0 to ABEL 500.0	Circuit 1
line_321	Line	PINAL_C 500.0 to SNTAROSA 500.0	Circuit 1
line_322	Line	PINAL_W 500.0 to SNTAROSA 500.0	Circuit 1
line_323	Line	JOJOBA 500.0 to GILARIVR 500.0	Circuit 1
line_324	Line	JOJOBA 500.0 to GILARIVR 500.0	Circuit 2
line_325	Line	JOJOBA 500.0 to KYRENE 500.0	Circuit 1
line_326	Line	HASSYAMP 500.0 to JOJOBA 500.0	Circuit 1
line_327	Line	ORME 230.0 to ANDERSON 230.0	Circuit 1
line_328	Line	ORME 230.0 to ANDERSON 230.0	Circuit 2
line_329	Line	PINPKSRP 230.0 to BRANDOW 230.0	Circuit 1
line_330	Line	PINPKSRP 230.0 to BRANDOW 230.0	Circuit 2
line_331	Line	SANTAN 230.0 to RS-24 230.0	Circuit 1
line_332	Line	SCHRADER 230.0 to RS-24 230.0	Circuit 1
line_333	Line	ABEL 230.0 to RS-24 230.0	Circuit 1
line_334	Line	ABEL 230.0 to RS-24 230.0	Circuit 2
line_335	Line	ABEL 230.0 to SANTAN 230.0	Circuit 1
line_336	Line	BROWNING 230.0 to DINOSAUR 230.0	Circuit 1
line_337	Line	BROWNING 230.0 to RANDOLPH 230.0	Circuit 1
line_338	Line	ABEL 230.0 to RANDOLPH 230.0	Circuit 1
line_339	Line	PINAL_C 230.0 to DBG 230.0	Circuit 1
line_340	Line	PINAL_C 230.0 to RANDOLPH 230.0	Circuit 1
line_341	Line	SUN ARIZ 230.0 to PINAL_C 230.0	Circuit 1
line_342	Line	N.GILA 230.0 to TS8 230.0	Circuit 1
tran_343	Tran	CHOLLA 500.00 to CHOLLA 345.0	Circuit 1
tran_344	Tran	CHOLLA 500.00 to CHOLLA 345.0	Circuit 2
tran_345	Tran	FOURCORN 500.00 to FOURCORN 345.0	Circuit 1
tran_346	Tran	WESTWING 500.00 to WESTWNGW 230.0	Circuit 1
tran_347	Tran	WESTWING 500.00 to WESTWNGW 230.0	Circuit 2
tran_348	Tran	GILARIVR 500.00 to GILARIVR 230.0	Circuit 1

tran_349	Tran	FOURCORN 345.00 to FOURCORN 230.0	Circuit 1
tran_350	Tran	FOURCORN 345.00 to FOURCORN 230.0	Circuit 2
tran_351	Tran	PNPKAPS 345.00 to PPAPS C 230.0	Circuit 1
tran_352	Tran	PNPKAPS 345.00 to PPAPS N 230.0	Circuit 2
tran_353	Tran	PNPKAPS 345.00 to PPAPS E 230.0	Circuit 3
tran_354	Tran	KYRENE 500.00 to KYRENE 230.0	Circuit 7
tran_355	Tran	PERKINS 500.00 to PERK PS1 500.0	Circuit 1
tran_356	Tran	PERKINS 500.00 to PERK PS2 500.0	Circuit 1
tran_357	Tran	SILVERKG 500.00 to SILVERKG 230.0	Circuit 1
tran_358	Tran	BROWNING 500.00 to BROWNING 230.0	Circuit 1
tran_359	Tran	BROWNING 500.00 to BROWNING 230.0	Circuit 2
tran_360	Tran	RUDD 500.00 to RUDD 230.0	Circuit 1
tran_361	Tran	RUDD 500.00 to RUDD 230.0	Circuit 2
tran_362	Tran	RUDD 500.00 to RUDD 230.0	Circuit 3
tran_363	Tran	MESQUITE 500.00 to MESQUITE 230.0	Circuit 1
tran_364	Tran	COPPERVR 345.00 to COPPERVR 230.0	Circuit 1
tran_365	Tran	BICKNELL 345.00 to BICKNELL 230.0	Circuit 1
tran_366	Tran	GREEN-AE 345.00 to GREEN-AE 230.0	Circuit 1
tran_367	Tran	MEAD 345.00 to MEAD N 230.0	Circuit 1
tran_368	Tran	MEAD 500.00 to MEAD N 230.0	Circuit 1
tran_369	Tran	LIBERTY 345.00 to LIBTYPHS 230.0	Circuit 1
tran_370	Tran	LIBTYPHS 230.00 to LIBERTY 230.0	Circuit 1
tran_371	Tran	PEACOCK 345.00 to PEACOCK 230.0	Circuit 1
tran_372	Tran	GLEN PS 230.00 to GLENCANY 230.0	Circuit 1
tran_373	Tran	GLENCANY 345.00 to GLENCANY 230.0	Circuit 1
tran_374	Tran	GLENCANY 345.00 to GLENCANY 230.0	Circuit 2
tran_375	Tran	PINPKBRB 345.00 to PINPK 230.0	Circuit 1
tran_376	Tran	PINPKBRB 345.00 to PINPK 230.0	Circuit 2
tran_377	Tran	PINPKBRB 345.00 to PINPK 230.0	Circuit 3
tran_378	Tran	SHIPROCK 345.00 to SHIPROCK 230.0	Circuit 1
tran_379	Tran	RUDD 500.00 to RUDD 230.0	Circuit 4
tran_380	Tran	SNVLY 500.00 to SNVLY 230.0	Circuit 1
tran_381	Tran	SNVLY 500.00 to SNVLY 230.0	Circuit 2
tran_382	Tran	MORGAN 500.00 to RACEWAY 230.0	Circuit 1
tran_383	Tran	MORGAN 500.00 to RACEWAY 230.0	Circuit 2
tran_384	Tran	PNPKAPS 500.00 to PPAPS N 230.0	Circuit 1
tran_385	Tran	PNPKAPS 500.00 to PPAPS E 230.0	Circuit 1
tran_386	Tran	MEAD 500.00 to MEAD N 230.0	Circuit 2
tran_387	Tran	CHOLLA 345.00 to CHOLLA 230.0	Circuit 1
tran_388	Tran	CHOLLA 345.00 to CHOLLA 230.0	Circuit 2
tran_389	Tran	MEAD S 230.00 to MEAD 287.0	Circuit 1
tran_390	Tran	SHIP PS 230.00 to SHIPROCK 230.0	Circuit 1
tran_391	Tran	ARROYO 500.00 to ARROYO 345.0	Circuit 1
tran_392	Tran	ARROYO 500.00 to ARROYO 345.0	Circuit 2
tran_393	Tran	WESTWING 500.00 to WESTWNGE 230.0	Circuit 1
tran_394	Tran	YAVAPAI 500.00 to YAVAPAI 230.0	Circuit 1
tran_395	Tran	YAVAPAI 500.00 to YAVAPAI 230.0	Circuit 2
tran_396	Tran	CORONADO 500.00 to CORONADO 345.0	Circuit 1
tran_397	Tran	CORONADO 500.00 to CORONADO 345.0	Circuit 2
tran_398	Tran	PINAL_W 500.00 to PINALWES 345.0	Circuit 1

tran_399	Tran	TORTOLIT 500.00 to TORTOLIT 345.0	Circuit 1
tran_400	Tran	WESTWING 500.00 to WESTWING 345.0	Circuit 1
tran_401	Tran	WHTHILLS 345.00 to WHTHILLS 230.0	Circuit 1
tran_402	Tran	WINCHSTR 345.00 to WINCHSTR 230.0	Circuit 1
tran_403	Tran	BOWIE 500.00 to BOWIE 345.0	Circuit 1
tran_404	Tran	BOWIE 500.00 to BOWIE 345.0	Circuit 2
tran_405	Tran	GREEN-AE 345.00 to GREEN-AE 230.0	Circuit 2
tran_406	Tran	NGL-E 230.00 to N.GILA 500.0	Circuit 1
tran_407	Tran	NGL-W 230.00 to N.GILA 500.0	Circuit 1
tran_408	Tran	ABEL 500.00 to ABEL 230.0	Circuit 1
tran_409	Tran	COPPERVR 345.00 to COPPERVR 230.0	Circuit 2
tran_410	Tran	KYRENE 500.00 to KYR-NEW 230.0	Circuit 6
tran_411	Tran	KYRENE 500.00 to KYRENE 230.0	Circuit 8
tran_412	Tran	ABEL 500.00 to ABEL 230.0	Circuit 2
tran_413	Tran	PINAL_C 500.00 to PINAL_C 230.0	Circuit 1
tran_414	Tran	PINAL_C 500.00 to PINAL_C 230.0	Circuit 2
tran_415	Tran	SNTAROSA 500.00 to SNTAROSA 230.0	Circuit 1
tran_416	Tran	N.GILA 500.00 to N.GILA 230.0	Circuit 1
tran_417	Tran	PNPKAPS 500.00 to PPAPS W 230.0	Circuit 1
gen_418	Gen	CORONAD1 22.0	Unit 1
gen_419	Gen	CORONAD2 22.0	Unit 1
gen_420	Gen	NAVAJO 1 26.0	Unit 1
gen_421	Gen	NAVAJO 2 26.0	Unit 1
gen_422	Gen	NAVAJO 3 26.0	Unit 1
gen_423	Gen	SANTAN 1 13.8	Unit 1
gen_424	Gen	ARL-CT1 18.0	Unit 1
gen_425	Gen	ARL-CT2 18.0	Unit 1
gen_426	Gen	ARL-ST1 18.0	Unit 1
gen_427	Gen	HGC-CT1 16.0	Unit 1
gen_428	Gen	HGC-ST1 13.8	Unit 1
gen_429	Gen	HGC-CT2 16.0	Unit 1
gen_430	Gen	HGC-ST2 13.8	Unit 1
gen_431	Gen	HGC-CT3 16.0	Unit 1
gen_432	Gen	HGC-ST3 13.8	Unit 1
gen_433	Gen	MES-CT1 18.0	Unit 1
gen_434	Gen	MES-CT2 18.0	Unit 1
gen_435	Gen	MES-ST1 18.0	Unit 1
gen_436	Gen	MES-CT3 18.0	Unit 1
gen_437	Gen	MES-CT4 18.0	Unit 1
gen_438	Gen	MES-ST2 18.0	Unit 1
gen_439	Gen	CHOLLA 13.8	Unit 1
gen_440	Gen	CHOLLA2 22.0	Unit 1
gen_441	Gen	CHOLLA3 22.0	Unit 1
gen_442	Gen	CHOLLA4 22.0	Unit 1
gen_443	Gen	FCNGEN 1 20.0	Unit 1
gen_444	Gen	FCNGEN 2 20.0	Unit 1
gen_445	Gen	FCNGEN 3 20.0	Unit 1
gen_446	Gen	FCNGN4CC 22.0	Unit 4
gen_447	Gen	FCNGN5CC 22.0	Unit 5
gen_448	Gen	OCOTGT2 13.8	Unit 1

gen_449	Gen	PALOVRD1 24.0	Unit 1
gen_450	Gen	PALOVRD2 24.0	Unit 1
gen_451	Gen	PALOVRD3 24.0	Unit 1
gen_452	Gen	SAGUARO1 15.5	Unit 1
gen_453	Gen	SAGUARO2 15.5	Unit 1
gen_454	Gen	WPHX CC1 13.8	Unit 1
gen_455	Gen	WPHX CC2 13.8	Unit 1
gen_456	Gen	WPHX CC3 13.8	Unit 1
gen_457	Gen	WPCC5CT1 15.0	Unit 1
gen_458	Gen	WPCC5CT2 15.0	Unit 1
gen_459	Gen	WPCC5ST1 16.5	Unit 1
gen_460	Gen	WPCC4CT1 13.8	Unit 1
gen_461	Gen	RED-CT1 18.0	Unit 1
gen_462	Gen	RED-CT2 18.0	Unit 1
gen_463	Gen	GIL-CT1 18.0	Unit 1
gen_464	Gen	GIL-CT2 18.0	Unit 1
gen_465	Gen	GIL-ST1 18.0	Unit 1
gen_466	Gen	GIL-CT3 18.0	Unit 1
gen_467	Gen	GIL-CT4 18.0	Unit 1
gen_468	Gen	GIL-ST2 18.0	Unit 1
gen_469	Gen	GIL-CT5 18.0	Unit 1
gen_470	Gen	GIL-CT6 18.0	Unit 1
gen_471	Gen	GIL-ST3 18.0	Unit 1
gen_472	Gen	GIL-CT7 18.0	Unit 1
gen_473	Gen	GIL-CT8 18.0	Unit 1
gen_474	Gen	GIL-ST4 18.0	Unit 1
gen_475	Gen	APACHST2 20.0	Unit 1
gen_476	Gen	APACHST3 20.0	Unit 1
gen_477	Gen	RED-CT3 18.0	Unit 1
gen_478	Gen	RED-CT4 18.0	Unit 1
gen_479	Gen	RED-ST1 18.0	Unit 1
gen_480	Gen	RED-ST2 18.0	Unit 1
gen_481	Gen	SANTN 5S 18.0	Unit 1
gen_482	Gen	SANTN 5A 18.0	Unit 1
gen_483	Gen	SANTN 6A 18.0	Unit 1
gen_484	Gen	SANTN 6S 13.8	Unit 1
gen_485	Gen	HOOVERA3 16.5	Unit 1
gen_486	Gen	HOOVERA4 16.5	Unit 1
gen_487	Gen	HOOVERA5 16.5	Unit 1
gen_488	Gen	HOOVERA6 16.5	Unit 1
gen_489	Gen	HOOVERA7 16.5	Unit 1
gen_490	Gen	HOVRA1A2 16.5	Unit A1
gen_491	Gen	HOVRA1A2 16.5	Unit A2
gen_492	Gen	HOVRN1N2 16.5	Unit N1
gen_493	Gen	HOVRN1N2 16.5	Unit N2
gen_494	Gen	HOVRN3N4 16.5	Unit N3
gen_495	Gen	HOVRN3N4 16.5	Unit N4
gen_496	Gen	HOVRN5N6 16.5	Unit N5
gen_497	Gen	HOVRN5N6 16.5	Unit N6
gen_498	Gen	HOVRN7N8 16.5	Unit N7

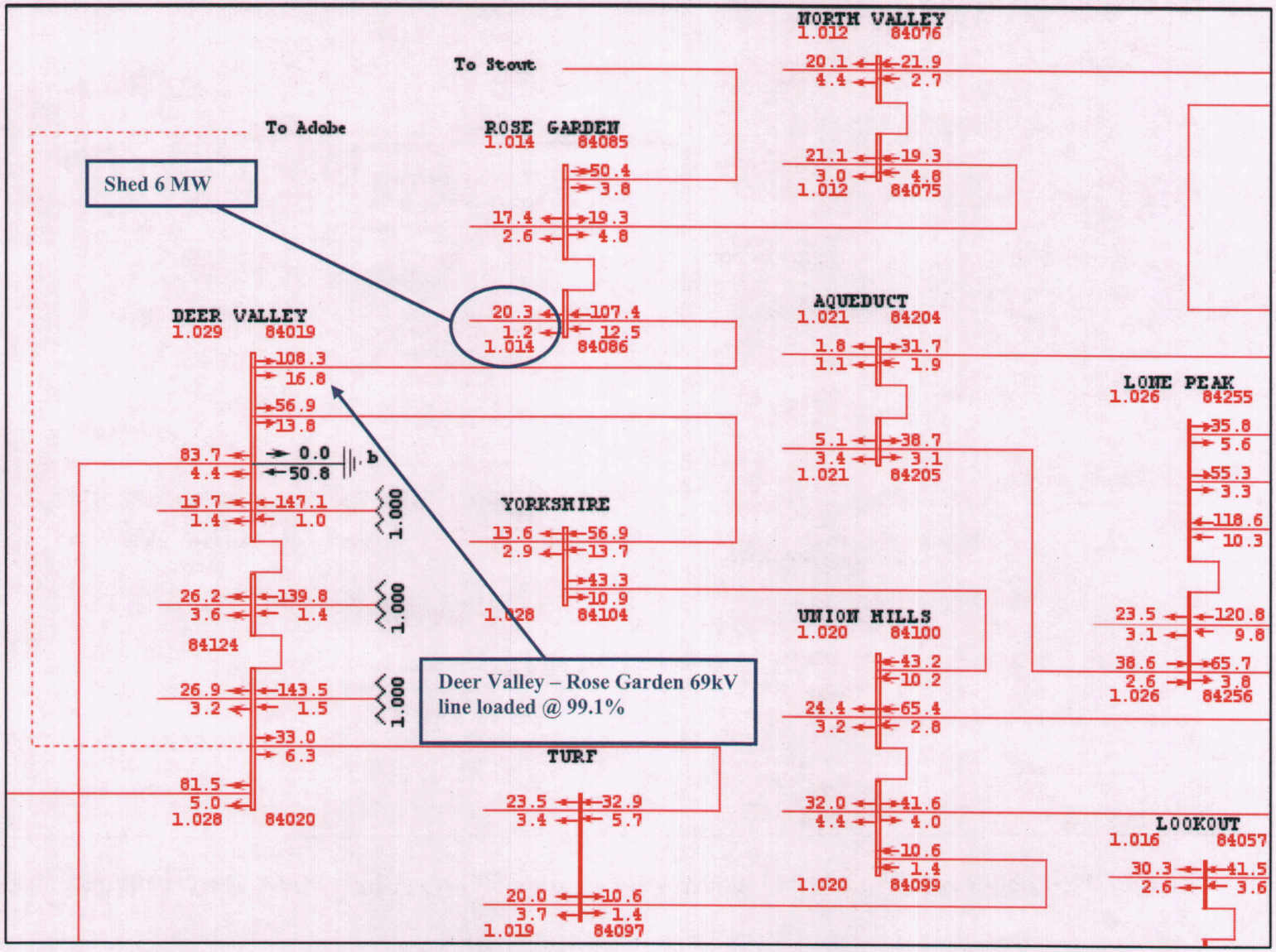
gen_499	Gen	HOVRN7N8 16.5	Unit N8
gen_500	Gen	GLENC1-2 13.8	Unit 1
gen_501	Gen	GLENC1-2 13.8	Unit 2
gen_502	Gen	GLENC3-4 13.8	Unit 3
gen_503	Gen	GLENC3-4 13.8	Unit 4
gen_504	Gen	GLENC5-6 13.8	Unit 5
gen_505	Gen	GLENC5-6 13.8	Unit 6
gen_506	Gen	GLENC7-8 13.8	Unit 7
gen_507	Gen	GLENC7-8 13.8	Unit 8
gen_508	Gen	SOPOINT1 16.0	Unit 1
gen_509	Gen	SOPOINT2 16.0	Unit 2
gen_510	Gen	SOPOINT3 16.0	Unit 3
gen_511	Gen	GRIFFTH1 18.0	Unit 1
gen_512	Gen	GRIFFTH2 18.0	Unit 2
gen_513	Gen	GRIFFTH3 18.0	Unit 3
gen_514	Gen	BLYENG1 16.0	Unit 1
gen_515	Gen	BLYENG2 16.0	Unit 1
gen_516	Gen	BLYENG3 16.0	Unit 1
gen_517	Gen	HAVASU12 13.2	Unit 1
gen_518	Gen	HAVASU12 13.2	Unit 2
gen_519	Gen	DBG-CT1 18.0	Unit 1
gen_520	Gen	DBG-CT2 18.0	Unit 1
gen_521	Gen	DBG-ST1 18.0	Unit 1
gen_522	Gen	DRPP G1 24.0	Unit 1
gen_523	Gen	DRPP G2 24.0	Unit 1
gen_524	Gen	BOWIE_G1 18.0	Unit 1
gen_525	Gen	BOWIE_G2 18.0	Unit 1
gen_526	Gen	BOWIE_G3 18.0	Unit 1
gen_527	Gen	BOWIE_G4 18.0	Unit 1
gen_528	Gen	BOWIE_S1 18.0	Unit 1
gen_529	Gen	BOWIE_S2 18.0	Unit 1
gen_530	Gen	DMPCCT#1 13.8	Unit 1
gen_531	Gen	SPR GEN1 19.0	Unit 1
gen_532	Gen	SPR GEN2 19.0	Unit 1
gen_533	Gen	SPR GEN3 21.0	Unit 1
gen_534	Gen	SPR GEN4 21.0	Unit 1
gen_535	Gen	SUNDTGE1 13.8	Unit 1
gen_536	Gen	SUNDTGE2 13.8	Unit 1
gen_537	Gen	SUNDTGE3 13.8	Unit 1
gen_538	Gen	SUNDTGE4 18.0	Unit 1
gen_539	Gen	OCOTGT1 13.8	Unit 1
gen_540	Gen	WPHX GT1 13.8	Unit 1
gen_541	Gen	WPHX ST4 12.5	Unit 1
gen_542	Gen	OCOTST2 13.8	Unit 1
gen_543	Gen	OCOTST1 13.8	Unit 1
gen_544	Gen	WPHX GT2 13.8	Unit 1
gen_545	Gen	WPHX ST6 12.5	Unit 1
gen_546	Gen	FAIRVW11 12.5	Unit 1
gen_547	Gen	CHILDS 2.3	Unit 1
gen_548	Gen	IRVING 2.3	Unit 1

gen_549	Gen	ABITIBI 13.8	Unit 1
gen_550	Gen	YUCCAGEN 13.8	Unit 1
gen_551	Gen	YUCCACT1 13.2	Unit 1
gen_552	Gen	YUCCACT2 13.2	Unit 1
gen_553	Gen	YUCCACT3 13.8	Unit 1
gen_554	Gen	YUCCACT4 13.8	Unit 1
gen_555	Gen	RVERSIDE 69.0	Unit 1
gen_556	Gen	YUCCACT5 13.8	Unit 1
gen_557	Gen	YUCCACT6 13.8	Unit 1
gen_558	Gen	SLRC-ST1 21.0	Unit 1
gen_559	Gen	SLRC-CT2 18.0	Unit 1
gen_560	Gen	SLRC-CT1 18.0	Unit 1
gen_561	Gen	SANTAN 2 13.8	Unit 1
gen_562	Gen	SANTN 5B 18.0	Unit 1
gen_563	Gen	SANTAN 4 13.8	Unit 1
gen_564	Gen	CROSSHYD 69.0	Unit 1
gen_565	Gen	AGUAFR 3 18.0	Unit 1
gen_566	Gen	AGUAFR 1 13.8	Unit 1
gen_567	Gen	AGUAFR 2 13.8	Unit 2
gen_568	Gen	ABEL G1 13.8	Unit 1
gen_569	Gen	ABEL G2 13.8	Unit 1
gen_570	Gen	ABEL G3 13.8	Unit 1
gen_571	Gen	ABEL G4 13.8	Unit 1
gen_572	Gen	ABEL G5 13.8	Unit 1
gen_573	Gen	ABEL G6 13.8	Unit 1
gen_574	Gen	ABEL G7 13.8	Unit 1
gen_575	Gen	ABEL G8 13.8	Unit 1
gen_576	Gen	ABEL G9 13.8	Unit 1
gen_577	Gen	KYREN 7S 13.8	Unit 1
gen_578	Gen	KYREN 7A 18.0	Unit 1
gen_579	Gen	SANTAN 3 13.8	Unit 1

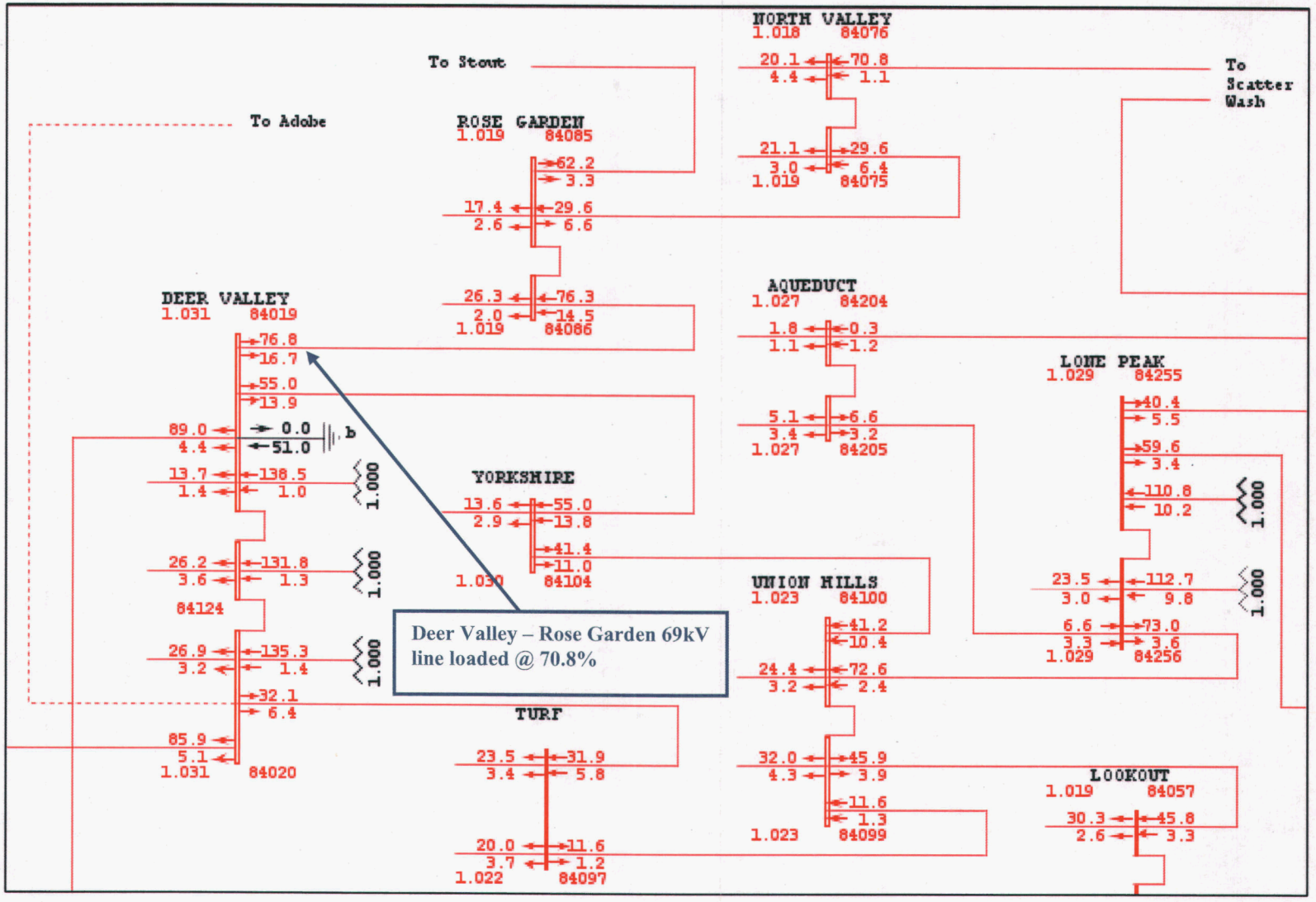
APPENDIX B

Power Flow Map

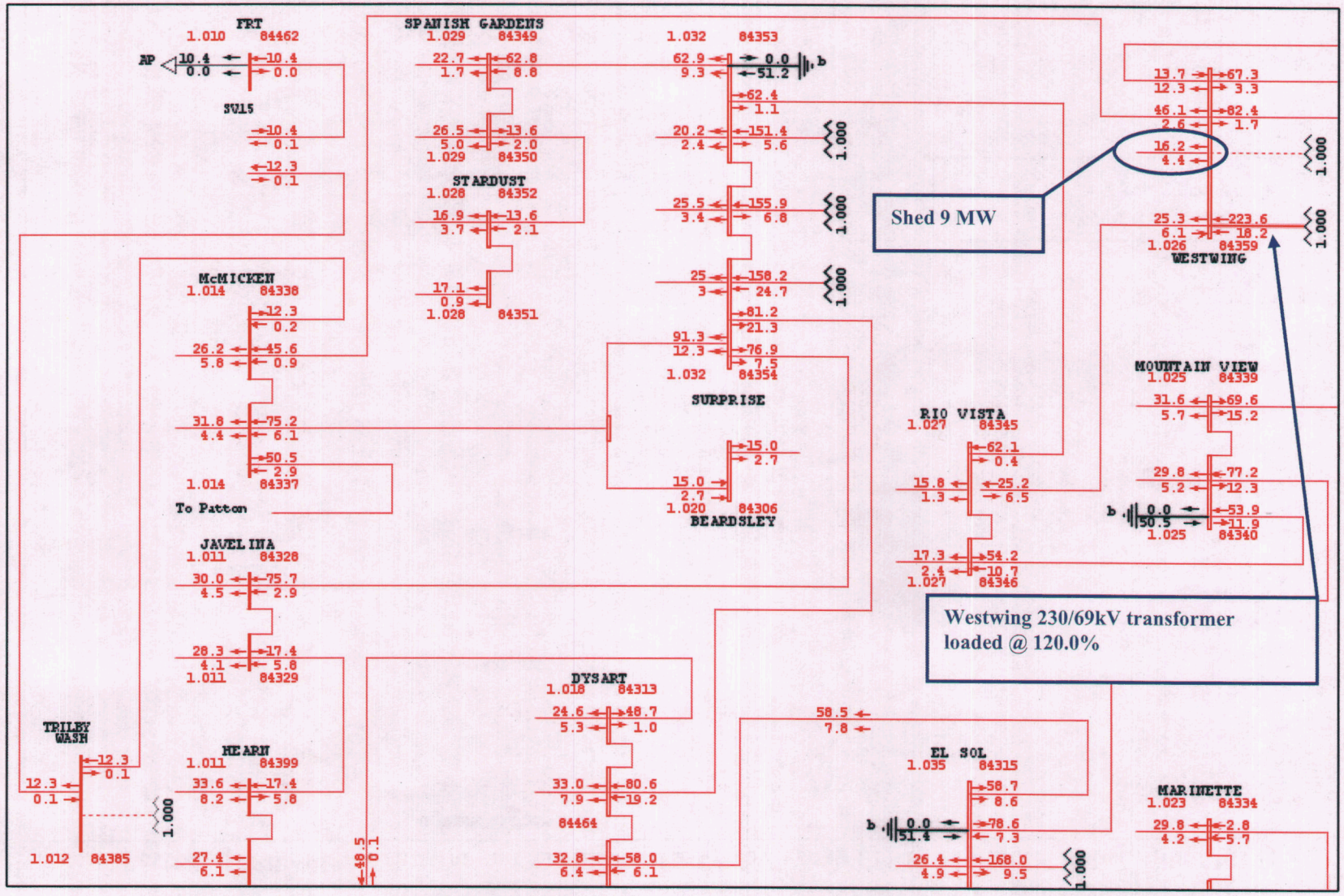
Adobe – Deer Valley 69kV Outage <u>without</u> Scatter Wash (TS6) 230/69kV Substation (2013)



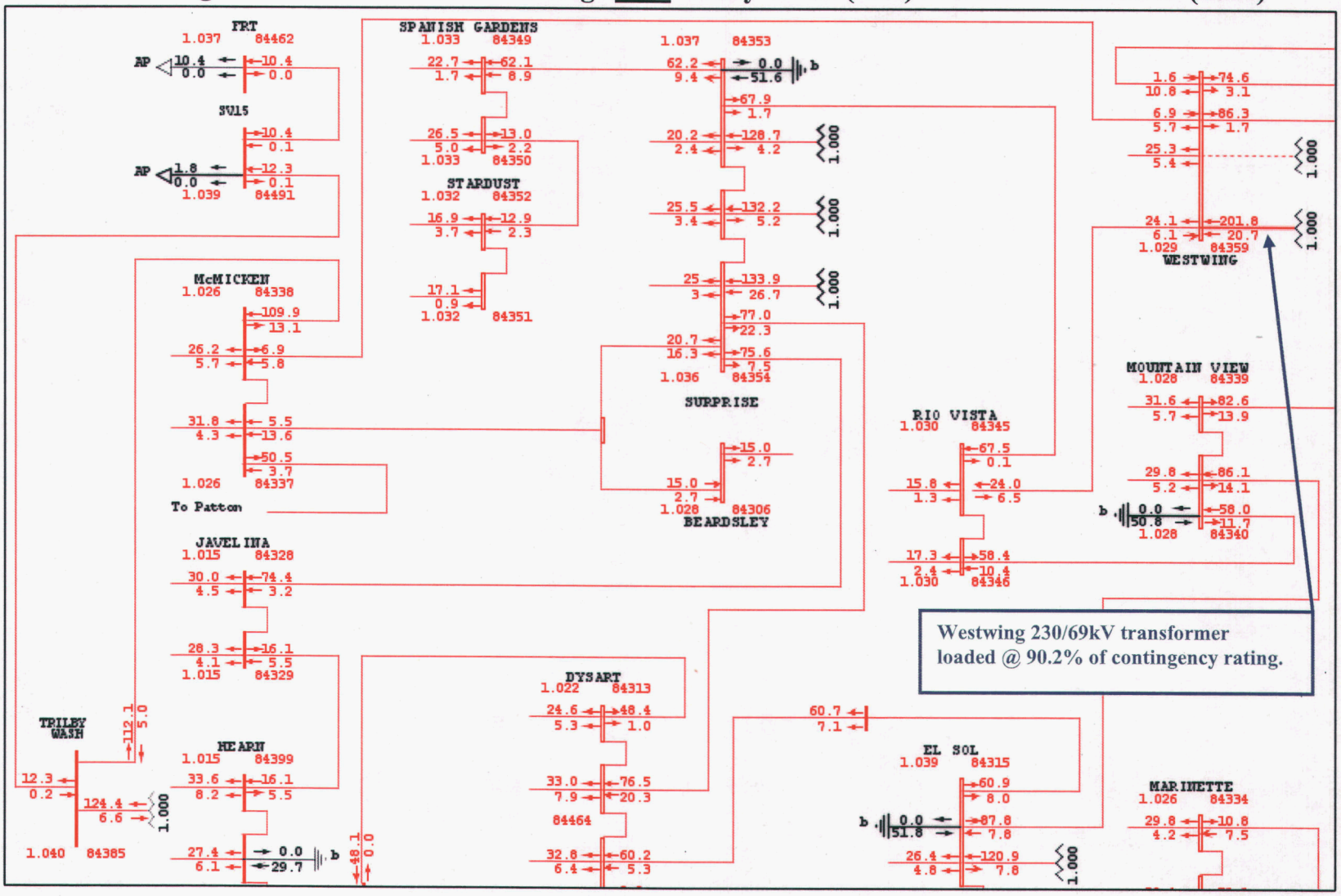
Adobe – Deer Valley 69kV Outage with Scatter Wash (TS6) 230/69kV Substation (2013)



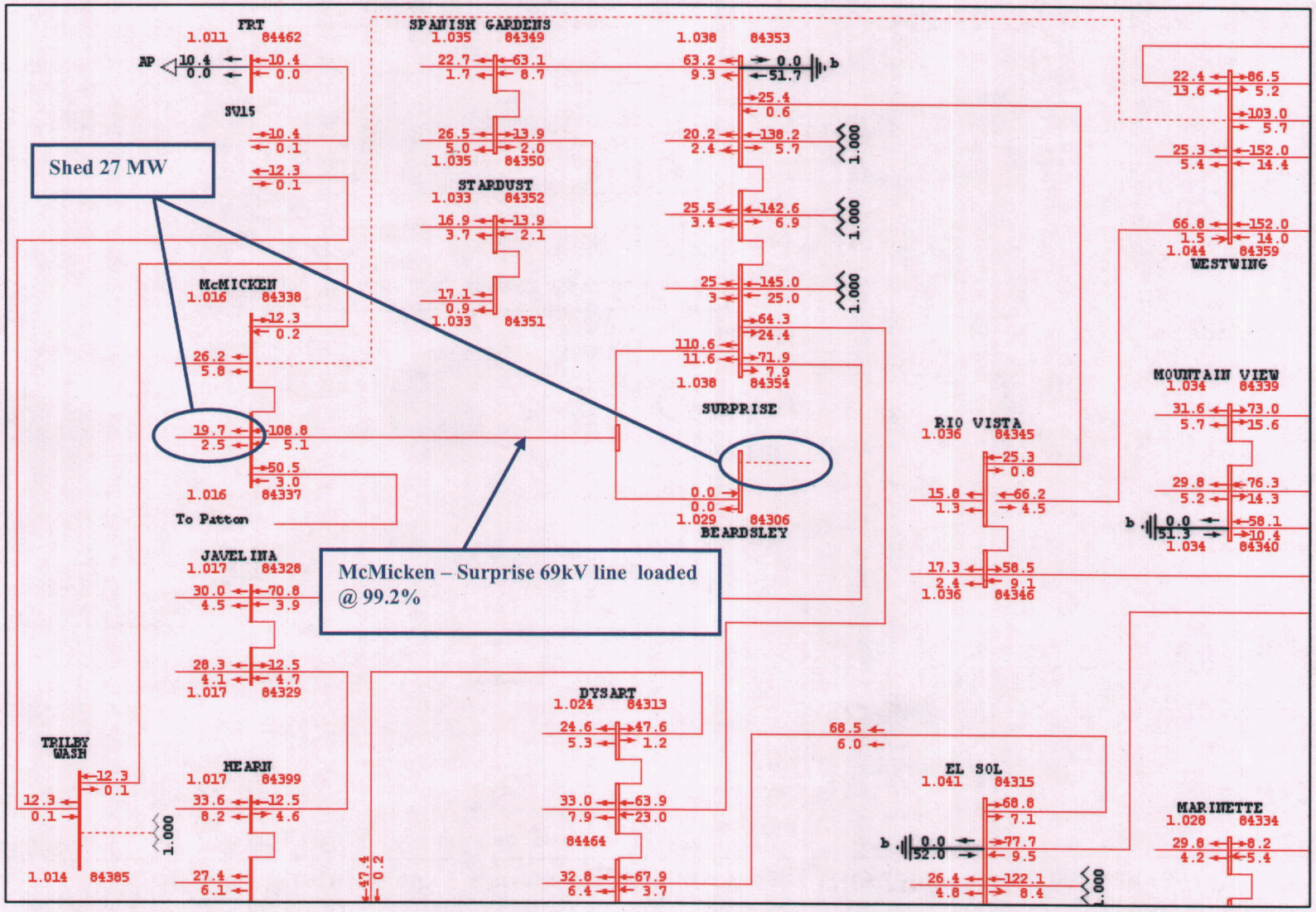
Westwing 230/69kV Transformer Outage without Trilby Wash (TS1) 230/69kV Substation (2014)



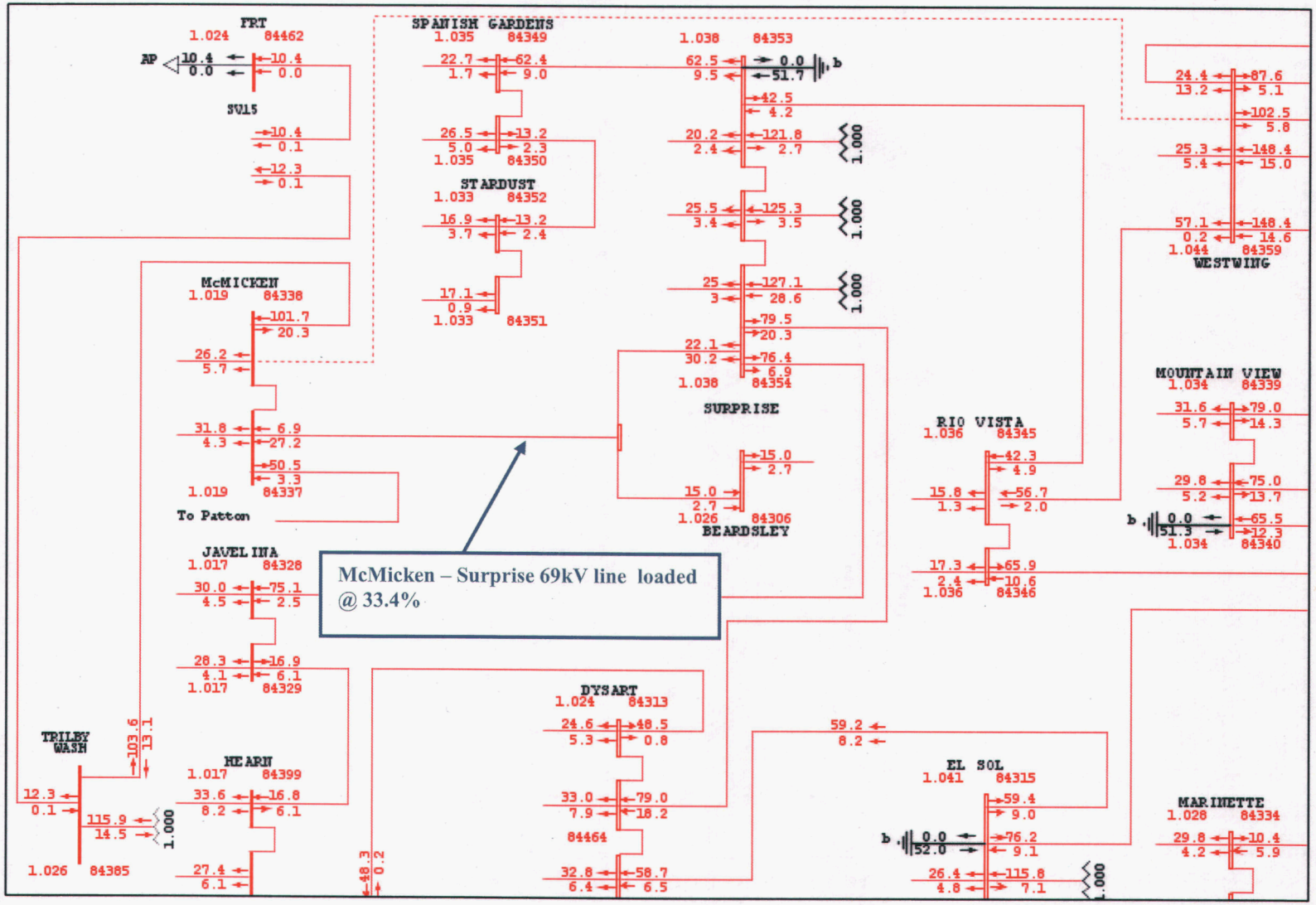
Westwing 230/69kV Transformer Outage with Trilby Wash (TS1) 230/69kV Substation (2014)



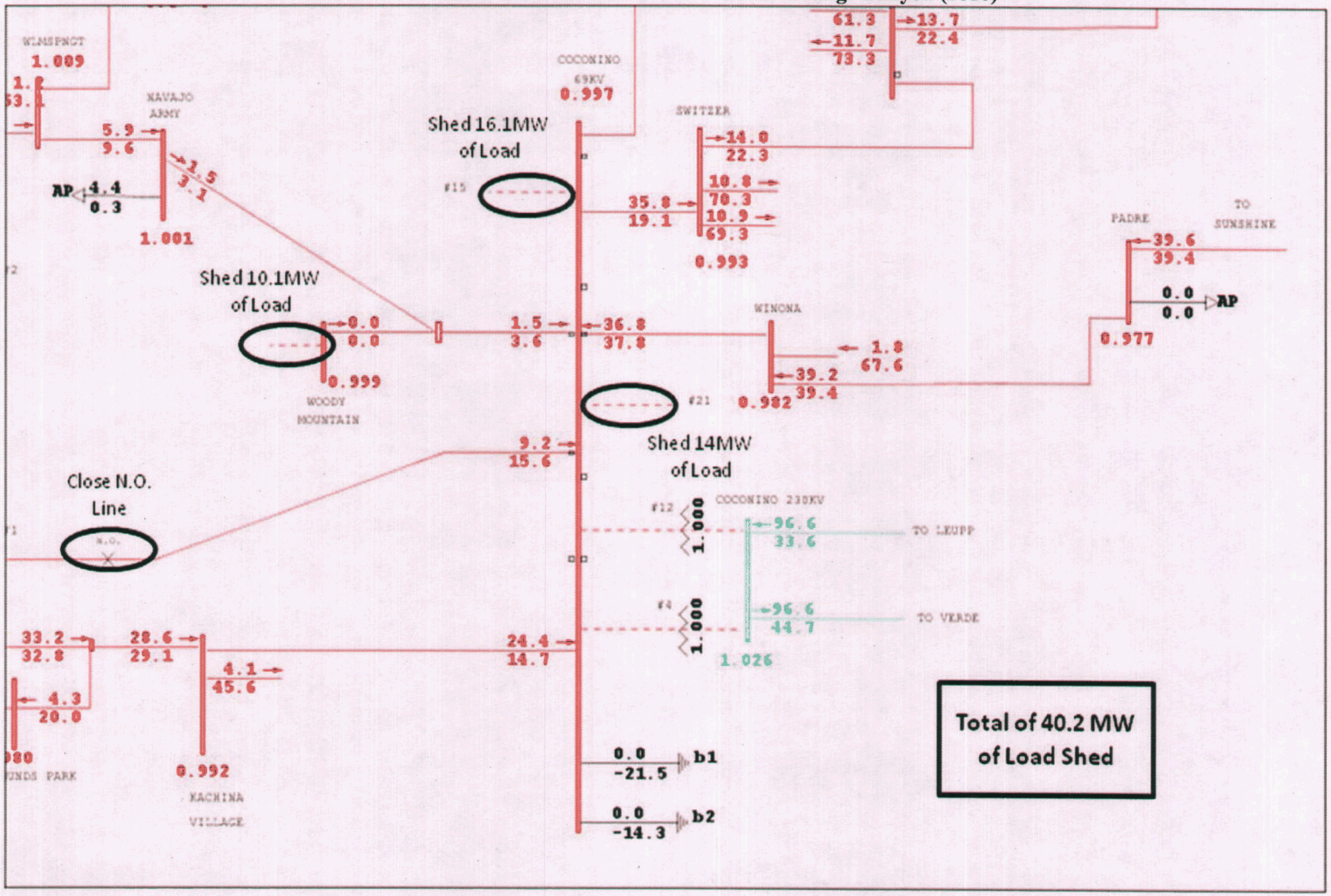
McMicken - Westwing 69kV Outage without Trilby Wash (TS1) 230/69kV Substation (2014)



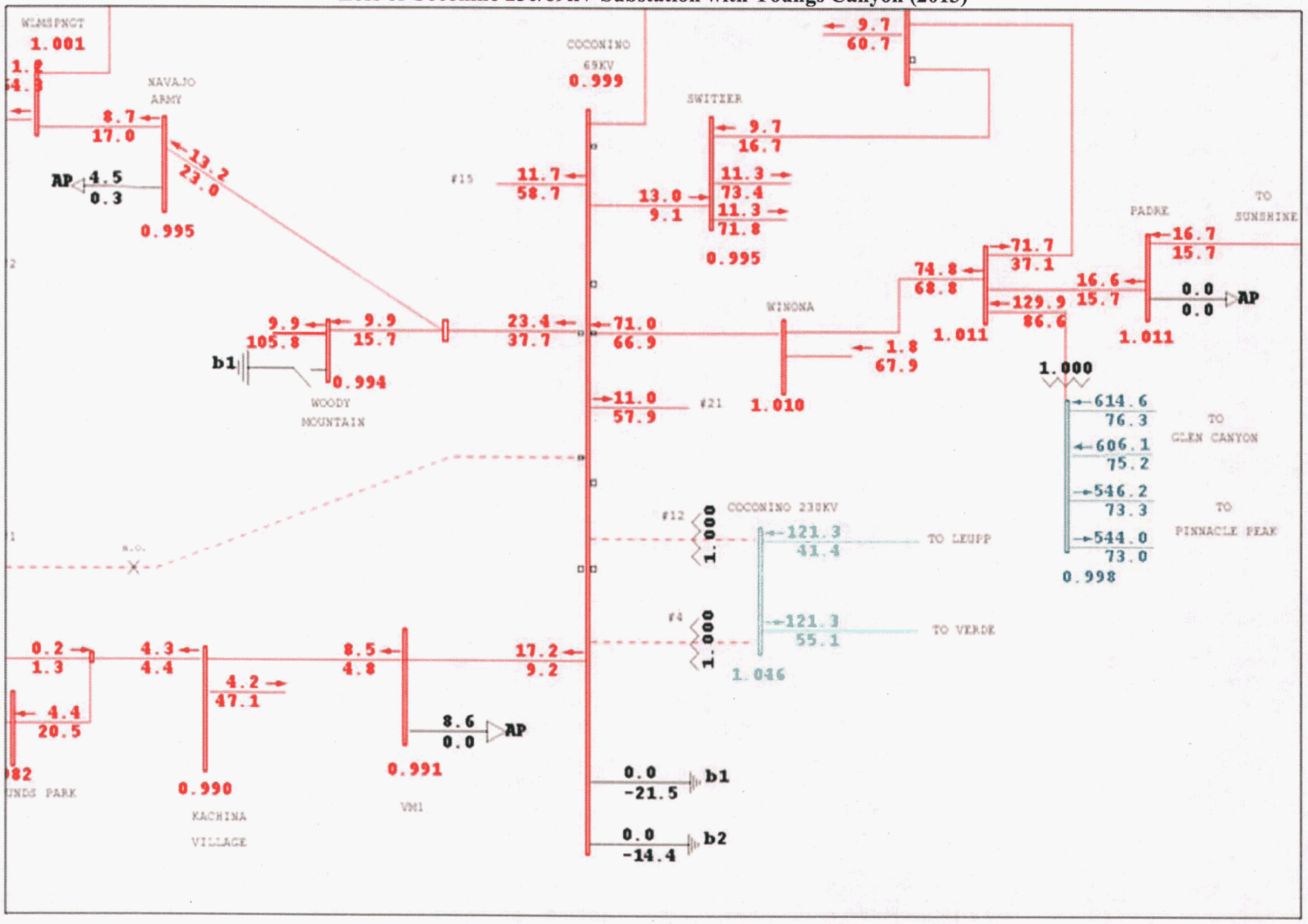
McMicken - Westwing 69kV Outage with Trilby Wash (TS1) 230/69kV Substation (2014)



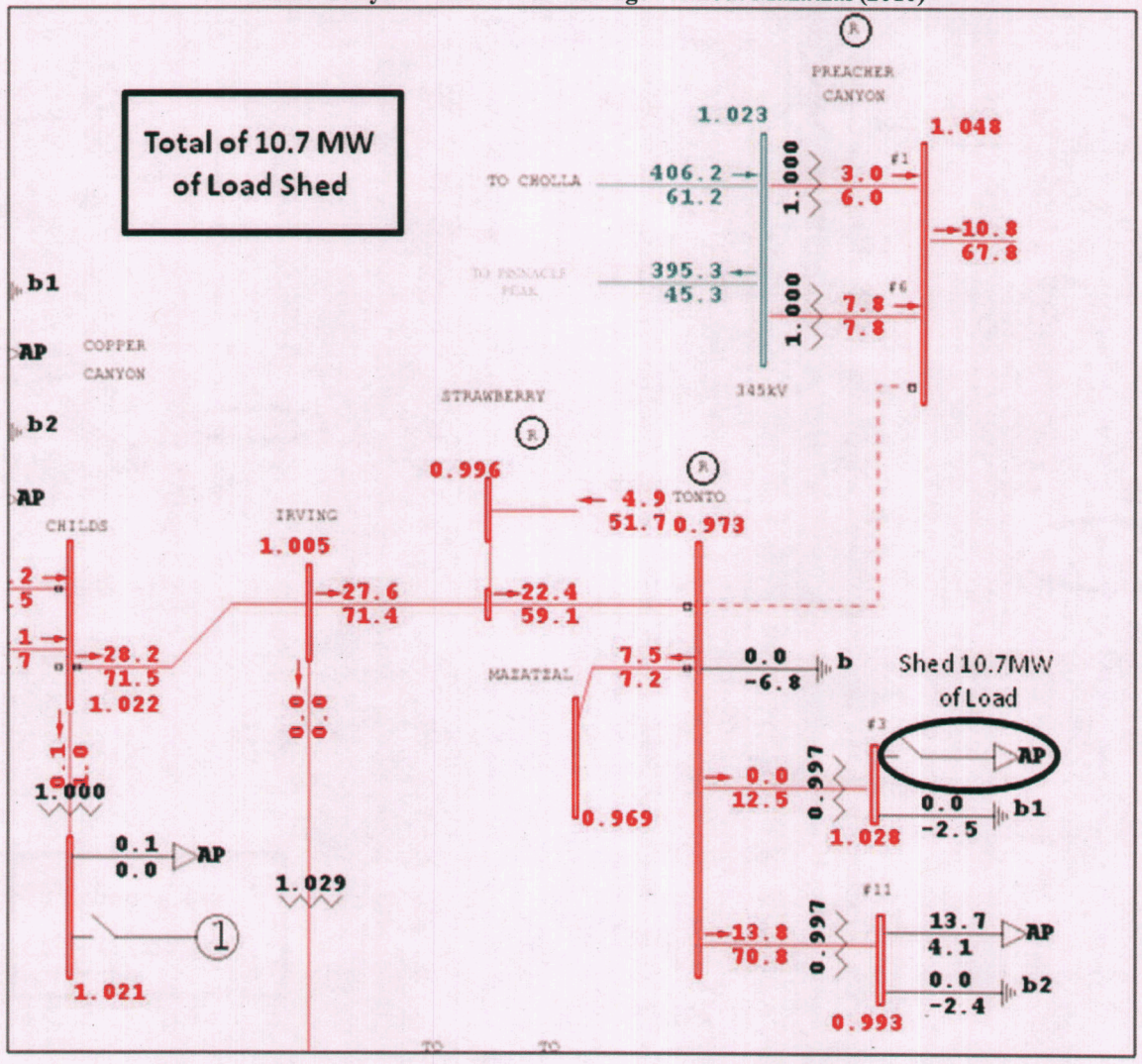
Loss of Coconino 230/69kV Substation Without Youngs Canyon (2010)



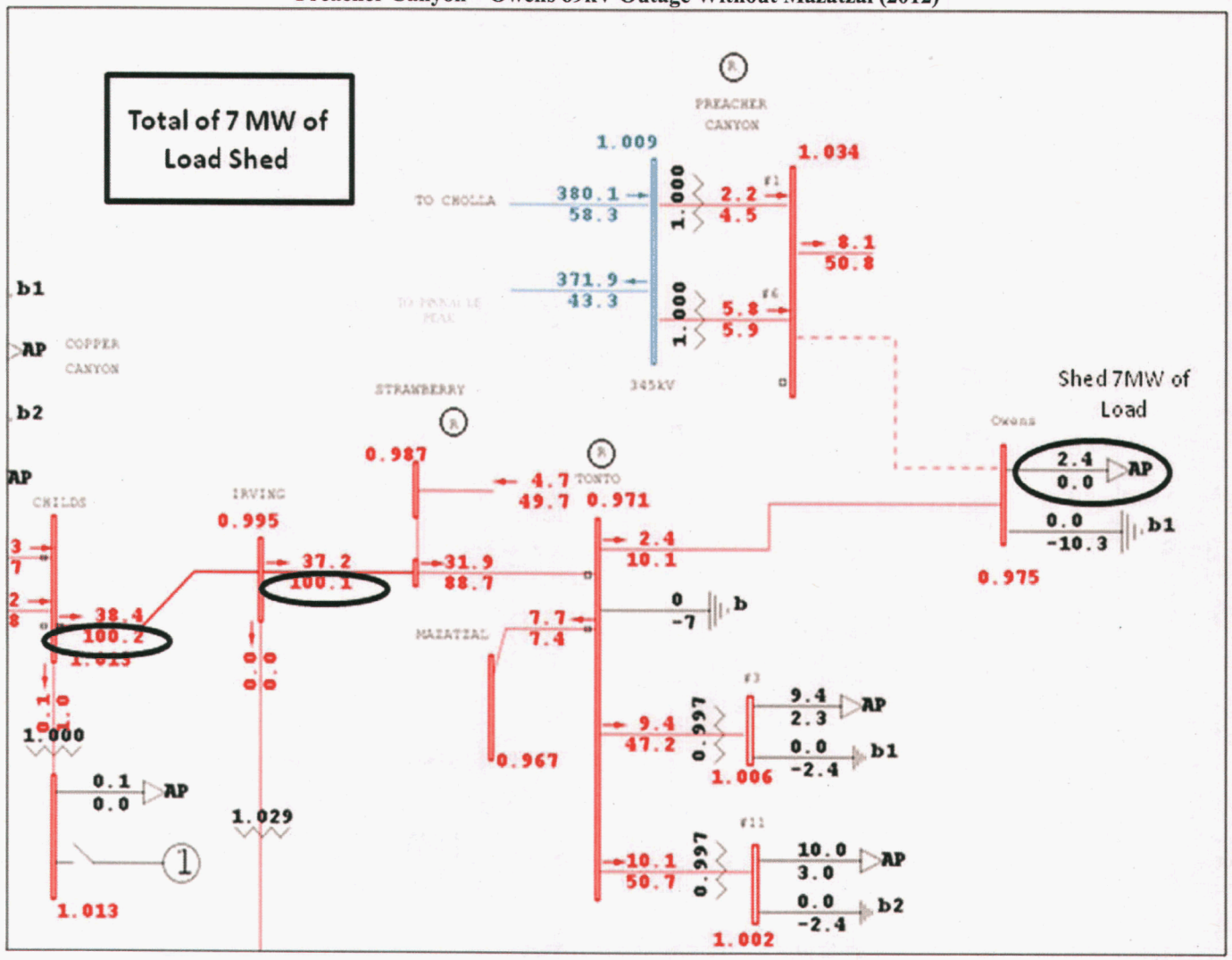
Loss of Coconino 230/69kV Substation with Youngs Canyon (2013)



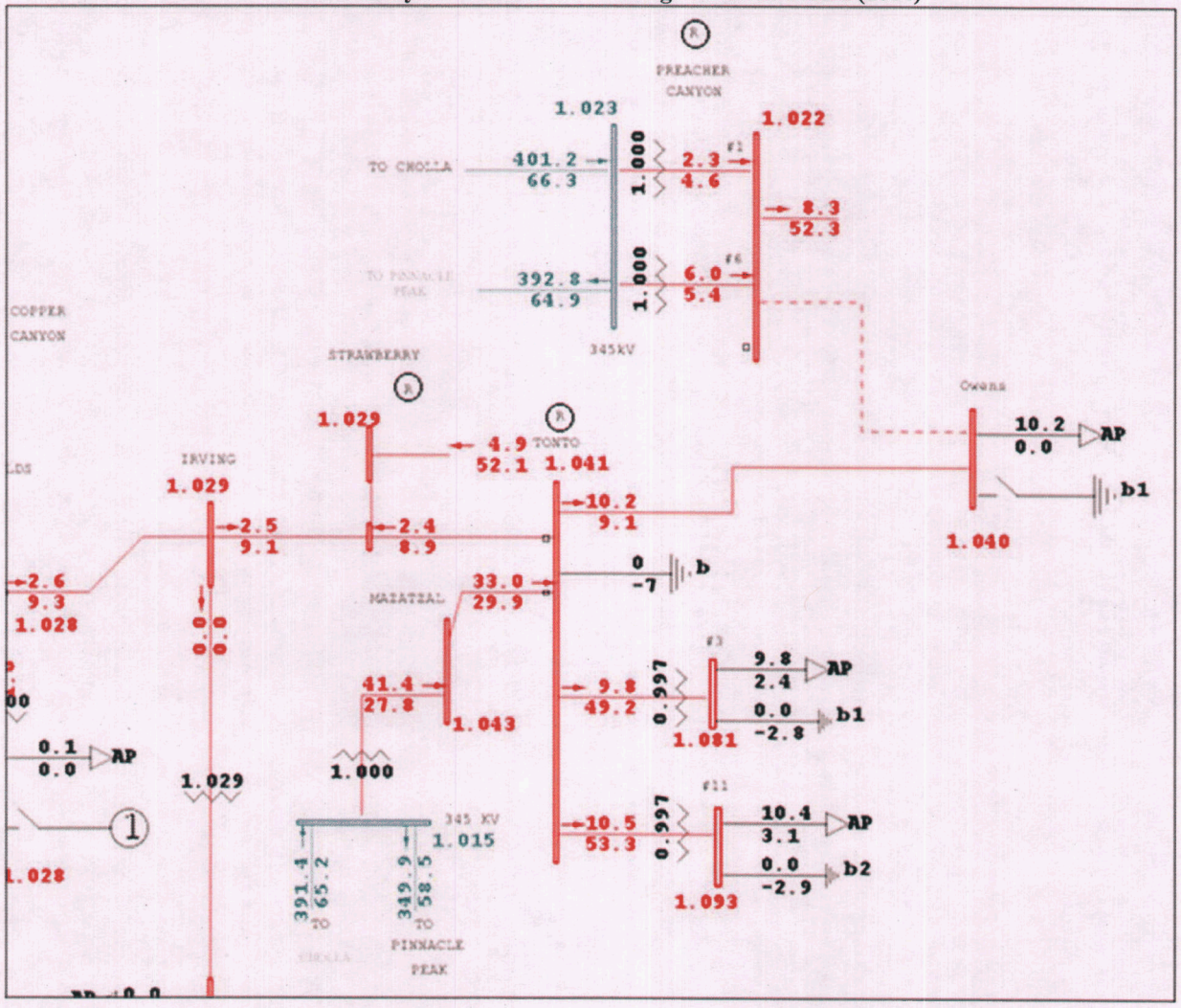
Preacher Canyon – Tonto 69kV Outage Without Mazatzal (2010)



Preacher Canyon – Owens 69kV Outage Without Mazatzal (2012)



Preacher Canyon – Owens 69kV Outage with Mazatazal (2014)



APPENDIX C

2012
Stability Plots

Table of Contents

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
CHOLLA	PNPKAPS	345	46
CHOLLA	PRECHCYN	345	47
CHOLLA	SAGUARO	500	48
CHOLLA	SGRLF	500	49
COCONINO	LEUPP	230	50
COCONINO	VERDE S	230	51
COOLIDGE	SPKHILTP	230	52
COOLIDGE	SUN ARIZ	230	53
COOLIDGE	SUN ARIZ	230	54
CORBELL	KYRENE	230	55
CORBELL	SANTAN	230	56
CORONADO	CHOLLA	500	57
CORONADO	SGRLF	500	58
CORONADO	SILVERKG	500	59
CORONADO	SPRINGR	345	60
CRYSTAL	NAVAJO	500	61
CTRYCLUB	GRNDTRML	230	62
CTRYCLUB	LINCSTRT	230	63
CTRYCLUB	MEADOWBK	230	64
DBG	CASGRAPS	230	65
DBG	PINAL C	203	66
DBG	SNTAROSA	230	67
DEERVALY	ALEXANDR	230	68
DEERVALY	PINPKSRP	230	69
DEERVALY	WESTWNGE	230	70
DEVERS	HARQUAHA	500	71
DEVERS	PALOVRDE	500	72
DINOSAUR	ABEL	230	73
DINOSAUR	BROWNING	230	74
DUGAS	MORGAN	500	75
DUGAS	NAVAJO	500	76
EAGLEYE	BUCKEYE2	230	77
EAGLEYE	PARKER	230	78
EL SOL	AGUAFRIA	230	79
EL SOL	SURPRISE	230	80
EL SOL	WESTWNGE	230	81
EL SOL	WHTNKAPS	230	82
FLAGSTAF	GLENCANY	345	83
FLAGSTAF	GLENCANY	345	84
FLAGSTAF	PINPKBRB	345	85
FLAGSTAF	PINPKBRB	345	86
FOURCORN	CHOLLA	345	87
FOURCORN	CHOLLA	345	88
FOURCORN	FCW	500	89
FOURCORN	MOENKOPI	500	90

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
GAVILNPK	GAVLINWA	230	91
GAVLINWA	GAVILNPK	230	92
GAVLINWA	PINPK	230	93
GAVLINWA	PRSCOTWA	230	94
GILARIVR	JOJOBA	230	95
GILARIVR	JOJOBA	500	96
GILARIVR	JOJOBA	500	97
GILA	NGL-E	230	98
GILA	NGL-W	230	99
GILA	SLRC	230	100
GILA	TS8	230	101
GLENCANY	FLAGSTAF	345	102
GLENCANY	FLAGSTAF	345	103
GLENDALE	AGUAFRIA	230	104
GLENDALE	GLENDALW	230	105
GLENDALE	GRNDTRML	230	106
GLENDALW	AGUAFRIA	230	107
GLENDALW	GLENDALE	230	108
GOLDFELD	SILVERKG	230	109
GOLDFELD	THUNDRST	230	110
GOLDFELD	THUNDRST	230	111
GRNDTRML	CTRYCLUB	230	112
GRNDTRML	GLENDALE	230	113
HARQUAHA	DELANY	500	114
HARQUAHA	DEVERS	500	115
HARQUAHA	HASSYAMP	500	116
HASSYAMP	ARLINTON	500	117
HASSYAMP	DELANY	500	118
HASSYAMP	HARQUAHA	500	119
HASSYAMP	JOJOBA	500	120
HASSYAMP	MESQUITE	500	121
HASSYAMP	N.GILA	500	122
HASSYAMP	N.GILA	500	123
HASSYAMP	PALOVRDE	500	124
HASSYAMP	PALOVRDE	500	125
HASSYAMP	PALOVRDE	500	126
HASSYAMP	PINAL W	500	127
HASSYAMP	REDHAWK	500	128
HASSYAMP	REDHAWK	500	129
HASSYTAP	LIBERTY	230	130
HASSY AZ	SNVLY	230	131
JOJOBA	GILARIVR	230	132
JOJOBA	GILARIVR	500	133
JOJOBA	GILARIVR	500	134
JOJOBA	HASSYAMP	500	135

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
JOJOBA	KYRENE	500	136
JOJOBA	TS4	230	137
KNOX	KYR-NEW	230	138
KNOX	SNTAROSA	230	139
KYR-NEW	ANDERSON	230	140
KYR-NEW	KNOX	230	141
KYR-NEW	KYRENE	230	142
KYR-NEW	OCOTILLO	230	143
KYR-NEW	PAPAGOBT	230	144
KYRENE	BRANDOW	230	145
KYRENE	BROWNING	500	146
KYRENE	CORBELL	230	147
KYRENE	JOJOBA	500	148
KYRENE	KYR-NEW	230	149
KYRENE	SCHRADER	230	150
LEUPP	CHOLLA	230	151
LEUPP	COCONINO	230	152
LIBERTY	BUCKEYE2	230	153
LIBERTY	BUCKEYE	230	154
LIBERTY	HASSYTAP	230	155
LIBERTY	LONE BUT	230	156
LIBERTY	PEACOCK	345	157
LIBERTY	PHXWAPA	230	158
LIBERTY	RUDD	230	159
LIBERTY	TS4	230	160
LIBERTY	WESTWNGW	230	161
LINCSTRT	CTRYCLUB	230	162
LINCSTRT	OCOTILLO	230	163
LINCSTRT	WPHXAPSN	230	164
LONEPEAK	PPAPS E	230	165
LONEPEAK	REACH	230	166
LONEPEAK	SUNYSLOP	230	167
LONE BUT	LIBERTY	230	168
LONE BUT	PHXWAPA	230	169
LONE BUT	SUN ARIZ	230	170
LONE BUT	TESTTRAK	230	171
MARKETPL	MOENKOPI	500	172
MAZATZAL	PNPKAPS	345	173
MAZATZAL	PRECHCYN	345	174
MEADOWBK	CTRYCLUB	230	175
MEADOWBK	SUNYSLOP	230	176
MESQUITE	HASSYAMP	500	177
MILLIGAN	CASGRAPS	230	178
MILLIGAN	TS12	230	179
MOENKOPI	ELDORDO	500	180
MOENKOPI	FOURCORN	500	181

Simulation			Page
From Bus (Fault Location)	To Bus	kV	
PINAL W	HASSYAMP	500	228
PINAL W	SNTAROSA	500	229
PINPKBRB	FLAGSTAF	345	230
PINPKBRB	FLAGSTAF	345	231
PINPKSRP	BRANDOW	230	232
PINPKSRP	BRANDOW	230	233
PINPKSRP	DEERVALY	230	234
PINPKSRP	PAPAGOBT	230	235
PINPKSRP	PINPK	230	236
PINPKSRP	PINPK	230	237
PINPKSRP	PPAPS N	230	238
PINPKSRP	PPAPS N	230	239
PINPK	GAVLINWA	230	240
PINPK	PINPKSRP	230	241
PINPK	PINPKSRP	230	242
PINPK	PPAPS W	230	243
PINPK	ROGSWAPA	230	244
PINPK	ROGSWAPA	230	245
PINPK	WESTWNGW	230	246
PLMVLY	RUDD	230	247
PLMVLY	TS2	230	248
PLMVLY	TS4	230	249
PNPKAPS	CHOLLA	345	250
PNPKAPS	MAZATZAL	345	251
PNPKAPS	MORGAN	500	252
PPAPS C	PPAPS E	230	253
PPAPS C	PPAPS W	230	254
PPAPS C	REACH	230	255
PPAPS E	LONEPEAK	230	256
PPAPS E	PPAPS C	230	257
PPAPS E	PPAPS N	230	258
PPAPS N	CACTUS	230	259
PPAPS N	OCOTILLO	230	260
PPAPS N	PINPKSRP	230	261
PPAPS N	PINPKSRP	230	262
PPAPS N	PPAPS E	230	263
PPAPS W	PINPK	230	264
PPAPS W	PPAPS C	230	265
PPAPS W	TS6	230	266
PRECHCYN	CHOLLA	345	267
PRECHCYN	MAZATZAL	345	268
PRESCOTT	PRSCOTWA	230	269
PRESCOTT	WILOWLKW	230	270
PRSCOTWA	GAVLINWA	230	271
PRSCOTWA	PRESCOTT	230	272
PRSCOTWA	RNDVLYTP	230	273

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
RACEWAY	AVERY	230	274
RACEWAY	RACEWYWA	230	275
RACEWAY	WESTWNGE	230	276
RACEWYWA	N.WADDEL	230	277
RACEWYWA	RACEWAY	230	278
RACEWYWA	WESTWNGE	230	279
RANDOLPH	ABEL	230	280
RANDOLPH	BROWNING	230	281
RANDOLPH	PINAL C	230	282
REACH	LONEPEAK	230	283
REACH	PPAPS C	230	284
REDHAWK	HASSYAMP	500	285
REDHAWK	HASSYAMP	500	286
RME	MOENKOPI	500	287
RME	NAVAJO	500	288
RNDVLYTP	PEACOCK	230	289
RNDVLYTP	PRSCOTWA	230	290
RNDVLYTP	ROUNDVLY	230	291
ROGERS	ROGSWAPA	230	292
ROGERS	ROGSWAPA	230	293
ROGERS	THUNDRST	230	294
ROGSWAPA	PINPK	230	295
ROGSWAPA	PINPK	230	296
ROGSWAPA	ROGERS	230	297
ROGSWAPA	ROGERS	230	298
ROGSWAPA	SPKHILTP	230	299
RS-24	ABEL	230	300
RS-24	ABEL	230	301
RS-24	SANTAN	230	302
RS-24	SCHRADER	230	303
RUDD	LIBERTY	230	304
RUDD	ORME	230	305
RUDD	ORME	230	306
RUDD	PALOVRDE	500	307
RUDD	PLMVLY	230	308
RUDD	WHITETNK	230	309
RUDD	WHTNKAPS	230	310
RUDD	WPHXAPSS	230	311
SAGUARO	CHOLLA	500	312
SAGUARO	TATMOMLI	230	313
SAGUARO	TORTOLIT	500	314
SAGUARO	TORTOLIT	500	315
SAGUARO	TS12	230	316
SANTAN	ABEL	230	317
SANTAN	BROWNING	230	318
SANTAN	CORBELL	230	319

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
SANTAN	RS-24	230	320
SANTAN	SCHRADER	230	321
SANTAN	THUNDRST	230	322
SCHRADER	KYRENE	230	323
SCHRADER	RS-24	230	324
SCHRADER	SANTAN	230	325
SGRLF	CHOLLA	500	326
SGRLF	CORONADO	500	327
SILVERKG	BROWNING	500	328
SILVERKG	CORONADO	500	329
SILVERKG	GOLDFELD	230	330
SLRC	GILA	230	331
SLRC	TS8	230	332
SNTAROSA	DBG	230	333
SNTAROSA	KNOX	230	334
SNTAROSA	PINAL C	500	335
SNTAROSA	PINAL W	500	336
SNTAROSA	TATMOMLI	230	337
SNTAROSA	TESTTRAK	230	338
SOUTH	WESTWING	345	339
SPKHILTP	COOLIDGE	230	340
SPKHILTP	ROGSWAPA	230	341
SUNYSLOP	LONEPEAK	230	342
SUNYSLOP	MEADOWBK	230	343
SUN ARIZ	COOLIDGE	230	344
SUN ARIZ	COOLIDGE	230	345
SUN ARIZ	LONE BUT	230	346
SUN ARIZ	PINAL C	230	347
SURPRISE	EL SOL	230	348
SURPRISE	WESTWNGW	230	349
TATMOMLI	SAGUARO	230	350
TATMOMLI	SNTAROSA	230	351
TESTTRAK	CASAGRND	230	352
TESTTRAK	LONE BUT	230	353
TESTTRAK	SNTAROSA	230	354
THUNDRST	GOLDFELD	230	355
THUNDRST	GOLDFELD	230	356
THUNDRST	ROGERS	230	357
THUNDRST	SANTAN	230	358
TS12	MILLIGAN	230	359
TS12	SAGUARO	230	360
TS4	JOJOBA	230	361
TS4	LIBERTY	230	362
TS4	PLMVLY	230	363
TS6	AVERY	230	364
TS6	PPAPS W	230	365

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
TS8	GILA	230	366
TS8	SLRC	230	367
VERDE N	VERDE S	230	368
VERDE N	YAVAPAI	230	369
VERDE S	COCONINO	230	370
VERDE S	VERDE N	230	371
WARD	BRANDOW	230	372
WARD	BRANDOW	230	373
WESTWING	MORGAN	500	374
WESTWING	PALOVRDE	500	375
WESTWING	PALOVRDE	500	376
WESTWING	PERKINPS	500	377
WESTWING	PINALWES	345	378
WESTWING	SOUTH	345	379
WESTWING	YAVAPAI	500	380
WESTWNGE	DEERVALY	230	381
WESTWNGE	EL SOL	230	382
WESTWNGE	RACEWAY	230	383
WESTWNGE	RACEWYWA	230	384
WESTWNGE	WESTWNGW	230	385
WESTWNGW	AGUAFRIA	230	386
WESTWNGW	LIBERTY	230	387
WESTWNGW	PINPK	230	388
WESTWNGW	SURPRISE	230	389
WESTWNGW	WESTWNGE	230	390
WHITETNK	AGUAFRIA	230	391
WHITETNK	RUDD	230	392
WHTNKAPS	EL SOL	230	393
WHTNKAPS	RUDD	230	394
WHTNKAPS	WPHXAPSN	230	395
WILOWLKE	WILOWLKW	230	396
WILOWLKE	YAVAPAI	230	397
WILOWLKW	PRESCOTT	230	398
WILOWLKW	WILOWLKE	230	399
WPHXAPSN	LINCSTRT	230	400
WPHXAPSN	WHTNKAPS	230	401
WPHXAPSN	WPHXAPSS	230	402
WPHXAPSS	RUDD	230	403
WPHXAPSS	WPHXAPSN	230	404
YAVAPAI	MOENKOPI	500	405
YAVAPAI	VERDE N	230	406
YAVAPAI	WESTWING	500	407
YAVAPAI	WILOWLKE	230	408

Simulation **Page**

Transformer Outages (Fault on High Side)

Substation	High Side Voltage	Low Side Voltage	Transformer #	
BROWNING	500	230	1	409
BROWNING	500	230	2	410
CHOLLA	345	230	1	411
CHOLLA	345	230	2	412
CHOLLA	500	345	1	413
CHOLLA	500	345	2	414
CORONADO	500	345	1	415
CORONADO	500	345	2	416
FOURCORN	345	230	1	417
FOURCORN	500	345	1	418
GILARIVR	500	230	1	419
GLENCANY	345	230	1	420
KYRENE	500	230	6	421
KYRENE	500	230	7	422
KYRENE	500	230	8	423
LIBERTY	345	230	1	424
LIBTYPHS	230	230	1	425
MORGAN	500	230	1	426
PINAL C	500	230	1	427
PINAL C	500	230	2	428
PINAL W	500	345	1	429
PINPKBRB	345	230	1	430
PINPKBRB	345	230	1	431
PINPKBRB	345	230	3	432
PNPKAPS	345	230	1	433
PNPKAPS	345	230	2	434
PNPKAPS	345	230	3	435
PNPKAPS	500	230	E	436
PNPKAPS	500	230	N	437
PNPKAPS	500	230	W	438
RUDD	500	230	1	439
RUDD	500	230	2	440
RUDD	500	230	3	441
RUDD	500	230	4	442
SILVERKG	500	230	1	443
WESTWING	500	230	1	444
WESTWING	500	230	2	445
WESTWING	500	345	1	446
YAVAPAI	500	230	2	447

Plots provided upon request

APPENDIX D

2020
Stability Plots

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From Bus (Fault Location)	**To Bus**	**kV**	
CHOLLA	PRECHCYN	345	46
CHOLLA	SAGUARO	500	47
CHOLLA	SGRLF	500	48
CHOLLA	SILVERKG	500	49
COCONINO	LEUPP	230	50
COCONINO	VERDE S	230	51
COOLIDGE	SPKHILTP	230	52
COOLIDGE	SUN ARIZ	230	53
CORBELL	KYRENE	230	54
CORBELL	SANTAN	230	55
CORONADO	CHOLLA	500	56
CORONADO	SGRLF	500	57
CORONADO	SILVERKG	500	58
CORONADO	SPRINGR	345	59
CRYSTAL	NAVAJO	500	60
CTRYCLUB	GRNDTRML	230	61
CTRYCLUB	LINCSTRT	230	62
CTRYCLUB	MEADOWBK	230	63
DBG	CASGRAPS	230	64
DBG	SNTAROSA	230	65
DEERVALY	ALEXANDR	230	66
DEERVALY	PINPKSRP	230	67
DEERVALY	WESTWNGE	230	68
DELANY	SNVLY	500	69
DEVERS	HARQUAHA	500	70
DEVERS	PALOVRDE	500	71
DINOSAUR	BROWNING	230	72
DUGAS	NAVAJO	500	73
DUGAS	RACEWAY	500	74
EAGLEYE	LIBERTY	230	75
EAGLEYE	PARKER	230	76
ELDORDO	MOENKOPI	500	77
EL SOL	AGUAFRIA	230	78
EL SOL	SURPRISE	230	79
EL SOL	WESTWNGW	230	80
EL SOL	WHTNKAPS	230	81
FLAGSTAF	GLENCANY	345	82
FLAGSTAF	GLENCANY	345	83
FLAGSTAF	PINPKBRB	345	84
FLAGSTAF	PINPKBRB	345	85
FOURCORN	CHOLLA	345	86
FOURCORN	CHOLLA	345	87
FOURCORN	MOENKOPI	500	88
GAVILNPK	GAVLINWA	230	89
GAVLINWA	GAVILNPK	230	90

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
GAVLINWA	PINPK	230	91
GAVLINWA	PRSCOTWA	230	92
GILABEND	GILARIVR	230	93
GILARIVR	GILABEND	230	94
GILARIVR	JOJOBA	230	95
GILARIVR	JOJOBA	500	96
GILARIVR	JOJOBA	500	97
GLENCANY	FLAGSTAF	345	98
GLENCANY	FLAGSTAF	345	99
GLENDALE	GLENDALW	230	100
GLENDALE	GRNDTRML	230	101
GLENDALW	AGUAFRIA	230	102
GLENDALW	GLENDALE	230	103
GOLDFELD	SILVERKG	230	104
GOLDFELD	THUNDRST	230	105
GOLDFELD	THUNDRST	230	106
GRNDTRML	CTRYCLUB	230	107
GRNDTRML	GLENDALE	230	108
HARQUAHA	DEVERS	500	109
HARQUAHA	HASSYAMP	500	110
HASSYAMP	ARLINTON	500	111
HASSYAMP	HARQUAHA	500	112
HASSYAMP	JOJOBA	500	113
HASSYAMP	KYRENE	500	114
HASSYAMP	MESQUITE	500	115
HASSYAMP	N.GILA	500	116
HASSYAMP	N.GILA	500	117
HASSYAMP	PALOVRDE	500	118
HASSYAMP	PALOVRDE	500	119
HASSYAMP	PALOVRDE	500	120
HASSYAMP	PINAL W	500	121
HASSYAMP	REDHAWK	500	122
JOJOBA	GILARIVR	230	123
JOJOBA	GILARIVR	500	124
JOJOBA	GILARIVR	500	125
JOJOBA	HASSYAMP	500	126
JOJOBA	KYRENE	500	127
JOJOBA	TS4	230	128
KNOX	KYR-NEW	230	129
KNOX	SNTAROSA	230	130
KYRENE	BRANDOW	230	131
KYRENE	BROWNING	500	132
KYRENE	CORBELL	230	133
KYRENE	HASSYAMP	500	134
KYRENE	JOJOBA	500	135

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
N.GILA	HASSYAMP	500	181
N.HAVASU	PARKER	230	182
N.HAVASU	TOPOCK	230	183
N.WADDEL	RACEWYWA	230	184
NAVAJO	CRYSTAL	500	185
NAVAJO	DUGAS	500	186
NAVAJO	MOENKOPI	500	187
NAVAJO	RACEWAY	500	188
NAVAJO	RME	500	189
OCOTILLO	CACTUS	230	190
OCOTILLO	KYR-NEW	230	191
OCOTILLO	LINCSTRT	230	192
OCOTILLO	PNPKAPS	230	193
ORME	ANDERSON	230	194
ORME	ANDERSON	230	195
ORME	LIBERTY	230	196
ORME	RUDD	230	197
ORME	RUDD	230	198
PALOVRDE	DELANY	500	199
PALOVRDE	DEVERS	500	200
PALOVRDE	HASSYAMP	500	201
PALOVRDE	HASSYAMP	500	202
PALOVRDE	HASSYAMP	500	203
PALOVRDE	RUDD	500	204
PALOVRDE	SNVLY	500	205
PALOVRDE	WESTWING	500	206
PALOVRDE	WESTWING	500	207
PAPAGOBT	BRANDOW	230	208
PAPAGOBT	KYR-NEW	230	209
PAPAGOBT	PINPKSRP	230	210
PEACOCK	LIBERTY	345	211
PEACOCK	MEAD	345	212
PHXWAPA	LIBERTY	230	213
PINALWES	SOUTH	345	214
PINALWES	WESTWING	345	215
PINAL S	ABEL	500	216
PINAL S	SNTAROSA	500	217
PINAL S	TORTOLIT	500	218
PINAL W	HASSYAMP	500	219
PINAL W	SNTAROSA	500	220
PINPK	GAVLINWA	230	221
PINPK	PINPKSRP	230	222
PINPK	PINPKSRP	230	223
PINPK	PNPKAPS	230	224
PINPK	ROGSWAPA	230	225

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
PINPK	ROGSWAPA	230	226
PINPK	WESTWNGW	230	227
PINPKBRB	FLAGSTAF	345	228
PINPKBRB	FLAGSTAF	345	229
PINPKSRP	BRANDOW	230	230
PINPKSRP	BRANDOW	230	231
PINPKSRP	DEERVALY	230	232
PINPKSRP	PAPAGOBT	230	233
PINPKSRP	PINPK	230	234
PINPKSRP	PINPK	230	235
PINPKSRP	PNPKAPS	230	236
PLMVLY	RUDD	230	237
PLMVLY	TS2	230	238
PLMVLY	TS4	230	239
PNPKAPS	AVERY	230	240
PNPKAPS	CACTUS	230	241
PNPKAPS	CHOLLA	345	242
PNPKAPS	LONEPEAK	230	243
PNPKAPS	MAZATZAL	345	244
PNPKAPS	OCOTILLO	230	245
PNPKAPS	PINPKSRP	230	246
PNPKAPS	PINPKSRP	230	247
PNPKAPS	PINPK	230	248
PNPKAPS	PRECHCYN	345	249
PNPKAPS	RACEWAY	500	250
PNPKAPS	REACH	230	251
PNPKAPS	TS6	230	252
PRECHCYN	CHOLLA	345	253
PRECHCYN	MAZATZAL	345	254
PRECHCYN	PNPKAPS	345	255
PRESCOTT	PRSCOTWA	230	256
PRESCOTT	WILOWLKW	230	257
PRSCOTWA	GAVLINWA	230	258
PRSCOTWA	PRESCOTT	230	259
PRSCOTWA	RNDVLYTP	230	260
RACEWAY	AVERY	230	261
RACEWAY	DUGAS	500	262
RACEWAY	NAVAJO	500	263
RACEWAY	PNPKAPS	500	264
RACEWAY	RACEWYWA	230	265
RACEWAY	SNVLY	500	266
RACEWAY	WESTWING	500	267
RACEWYWA	N.WADDEL	230	268
RACEWYWA	RACEWAY	230	269
RACEWYWA	WESTWNGE	230	270

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
REACH	LONEPEAK	230	271
REACH	PNPKAPS	230	272
REDHAWK	HASSYAMP	500	273
REDHAWK	HASSYAMP	500	274
RME	MOENKOPI	500	275
RME	NAVAJO	500	276
ROGERS	ROGSWAPA	230	277
ROGERS	ROGSWAPA	230	278
ROGERS	THUNDRST	230	279
ROGSWAPA	PINPK	230	280
ROGSWAPA	PINPK	230	281
ROGSWAPA	ROGERS	230	282
ROGSWAPA	ROGERS	230	283
ROGSWAPA	SPKHILTP	230	284
RUDD	LIBERTY	230	285
RUDD	LIBERTY	230	286
RUDD	ORME	230	287
RUDD	ORME	230	288
RUDD	PALOVRDE	500	289
RUDD	PLMVLY	230	290
RUDD	WHITETNK	230	291
RUDD	WHTNKAPS	230	292
RUDD	WPHXAPSS	230	293
SAGUARO	CASGRAPS	230	294
SAGUARO	CHOLLA	500	295
SAGUARO	MILLIGAN	230	296
SAGUARO	SILVERKG	500	297
SAGUARO	TATMOMLI	230	298
SAGUARO	TORTLIT2	500	299
SAGUARO	TORTOLIT	500	300
SAGUARO	TORTOLIT	500	301
SANTAN	BROWNING	230	302
SANTAN	CORBELL	230	303
SANTAN	SCHRADER	230	304
SANTAN	THUNDRST	230	305
SAN RAF	BUTERFLD	230	306
SCHRADER	KYRENE	230	307
SCHRADER	SANTAN	230	308
SGRLF	CHOLLA	500	309
SGRLF	CORONADO	500	310
SILVERKG	BROWNING	500	311
SILVERKG	CORONADO	500	312
SILVERKG	GOLDFELD	230	313
SILVERKG	SAGUARO	500	314
SNTAROSA	ABEL	500	315

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
SNTAROSA	BROWNING	500	316
SNTAROSA	DBG	230	317
SNTAROSA	KNOX	230	318
SNTAROSA	PINAL S	500	319
SNTAROSA	PINAL W	500	320
SNTAROSA	TATMOMLI	230	321
SNTAROSA	TESTTRAK	230	322
SNVLY	DELANY	500	323
SNVLY	PALOVRDE	500	324
SNVLY	RACEWAY	500	325
SNVLY	TRLBY	230	326
SUNYSLOP	LONEPEAK	230	327
SUNYSLOP	MEADOWBK	230	328
SUN ARIZ	COOLIDGE	230	329
SUN ARIZ	COOLIDGE	230	330
SUN ARIZ	LONE BUT	230	331
SURPRISE	EL SOL	230	332
SURPRISE	WESTWNGW	230	333
TATMOMLI	SAGUARO	230	334
TATMOMLI	SNTAROSA	230	335
TESTTRAK	CASAGRND	230	336
TESTTRAK	LONE BUT	230	337
TESTTRAK	SNTAROSA	230	338
THUNDRST	GOLDFELD	230	339
THUNDRST	GOLDFELD	230	340
THUNDRST	ROGERS	230	341
THUNDRST	SANTAN	230	342
TORTLIT2	SAGUARO	500	343
TORTOLIT	PINAL S	500	344
TORTOLIT	SAGUARO	500	345
TORTOLIT	SAGUARO	500	346
TRLBY	SNVLY	230	347
TRLBY	TS2	230	348
TS2	PLMVLY	230	349
TS2	TRLBY	230	350
TS4	JOJOBA	230	351
TS4	LIBERTY	230	352
TS4	PLMVLY	230	353
TS6	AVERY	230	354
TS6	PNPKAPS	230	355
WARD	BRANDOW	230	356
WARD	BRANDOW	230	357
WESTMESA	FOURCORN	345	358
WESTWING	MEAD	500	359
WESTWING	PALOVRDE	500	360

Simulation			Page
From Bus (Fault Location)	**To Bus**	**kV**	
WESTWING	PALOVRDE	500	361
WESTWING	PINALWES	345	362
WESTWING	RACEWAY	500	363
WESTWING	SOUTH	345	364
WESTWING	YAVAPAI	500	365
WESTWNGE	DEERVALY	230	366
WESTWNGE	RACEWYWA	230	367
WESTWNGE	WESTWNGW	230	368
WESTWNGW	AGUAFRIA	230	369
WESTWNGW	AGUAFRIA	230	370
WESTWNGW	EL SOL	230	371
WESTWNGW	LIBERTY	230	372
WESTWNGW	PINPK	230	373
WESTWNGW	SURPRISE	230	374
WESTWNGW	WESTWNGE	230	375
WHITETNK	AGUAFRIA	230	376
WHITETNK	RUDD	230	377
WHTNKAPS	EL SOL	230	378
WHTNKAPS	RUDD	230	379
WHTNKAPS	WPHXAPSN	230	380
WILOWLKE	WILOWLKW	230	381
WILOWLKE	YAVAPAI	230	382
WILOWLKW	PRESCOTT	230	383
WILOWLKW	WILOWLKE	230	384
WPHXAPSN	LINCSTRT	230	385
WPHXAPSN	WHTNKAPS	230	386
WPHXAPSN	WPHXAPSS	230	387
WPHXAPSS	RUDD	230	388
WPHXAPSS	WPHXAPSN	230	389
YAVAPAI	MOENKOPI	500	390
YAVAPAI	WESTWING	500	391
YAVAPAI	WILOWLKE	230	392

Simulation				Page
Transformer Outages (Fault on High Side)				
Substation	High Side Voltage	Low Side Voltage	Transformer #	
BROWNING	500	230	1	393
CHOLLA	345	230	1	394
CHOLLA	345	230	2	395
CHOLLA	500	345	1	396
CHOLLA	500	345	2	397
CORONADO	500	345	1	398
CORONADO	500	345	2	399
FOURCORN	345	230	1	400
FOURCORN	345	230	2	401
FOURCORN	500	345	1	402
GILARIVR	500	230	1	403
GOLDFELD	230	115	1	404
KYRENE	500	230	6	405
KYRENE	500	230	7	406
KYRENE	500	230	8	407
LIBERTY	345	230	1	408
LIBTYPHS	230	230	1	409
PINAL W	500	345	1	410
PINPKBRB	345	230	1	411
PINPKBRB	345	230	2	412
PINPKBRB	345	230	3	413
PNPKAPS	345	230	1	414
PNPKAPS	345	230	2	415
PNPKAPS	345	230	3	416
PNPKAPS	500	230	1	417
PNPKAPS	500	230	2	418
PNPKAPS	500	230	3	419
PRESCOTT	230	115	1	420
PRESCOTT	230	115	2	421
RACEWAY	500	230	1	422
RACEWAY	500	230	2	423
RUDD	500	230	1	424
RUDD	500	230	2	425
RUDD	500	230	3	426
RUDD	500	230	4	427
SAGUARO	230	115	1	428

Simulation **Page**

Transformer Outages (Fault on High Side)

Substation	High Side Voltage	Low Side Voltage	Transformer #	
SAGUARO	500	115	1	429
SILVERKG	230	115	1	430
SILVERKG	500	230	1	431
SNTAROSA	500	230	1	432
SNVLY	500	230	1	433
WESTWING	500	230	1	434
WESTWING	500	230	2	435
WESTWING	500	230	3	436
WESTWING	500	345	1	437
YAVAPAI	500	230	1	438
YAVAPAI	500	230	2	439

Plots provided upon request