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January 29, 2016

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

RE: Arizona Public Service Company 2016-2025 Ten-Year Transmission System Plan
Docket No. E-00000D-15-0001

In compliance with A.R.S. § 40-360.02, enclosed please find Arizona Public Service Company's ("APS") 2016-2025 Ten-Year Transmission System Plan (Ten-Year Plan) for major transmission facilities (Attachment A), which includes the internal planning criteria and system ratings as required by Arizona Corporation Commission ("ACC") Decision No. 63876 (July 25, 2001); the Renewable Transmission Action Plan (Attachment B) as required by ACC Decision No. 70635 (December 11, 2008), and the Technical Study on the Effects of DG/EE on Fifth Year Transmission (Attachment C) as required by ACC Decision No. 74785 (October 24, 2014).

The 2016-2025 Ten-Year Plan describes planned transmission lines of 115 kV or higher that APS may construct over the next 10 years. This Ten-Year Plan includes approximately 81 miles of new 500 kV transmission lines, 29 miles of new 230 kV transmission lines, and 7 new bulk transformers. The APS investment needed to construct these projects is currently estimated to be $197 million. These new transmission projects, coupled with additional distribution and sub-transmission investments, will support reliable power delivery in APS's service area, Arizona, and in the western United States.

If you have any questions, please contact me at (602)250-3341.

Sincerely,

Kerri C

Kerri A. Carnes

KC/kr

cc: Thomas Chenal
Thomas Broderick
Charles Hains
Toby Little

Attachment A

2016-2025 Ten-Year Transmission System Plan

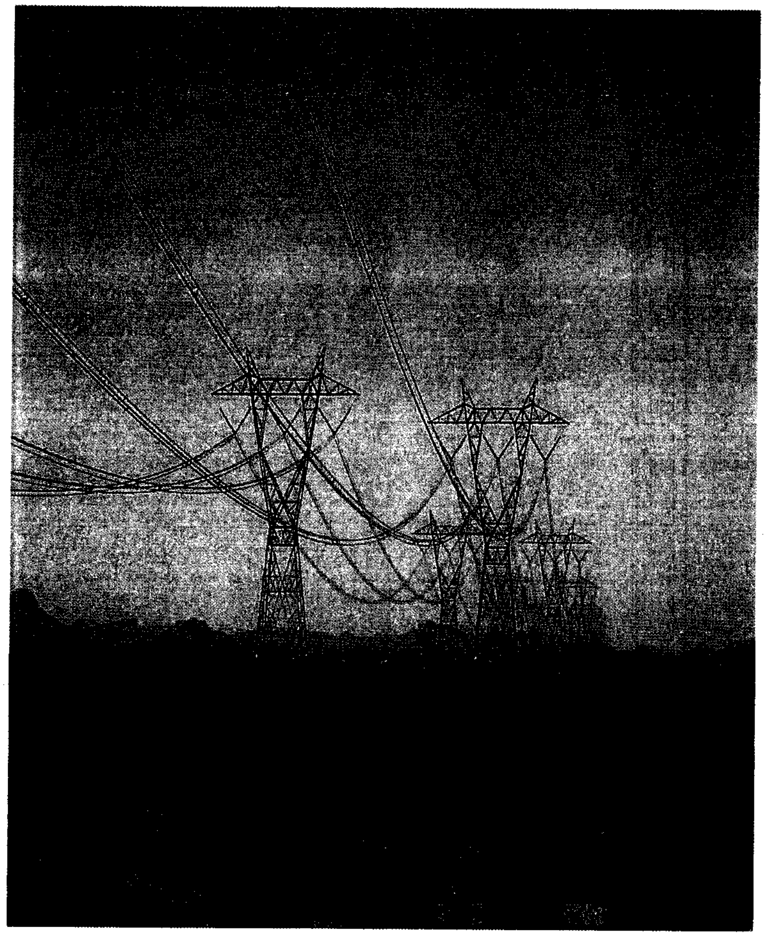
Transmission Planning Process and Guidelines

2015 System Rating Map

Technical Study Report

ARIZONA PUBLIC SERVICE COMPANY
2016–2025
TEN-YEAR TRANSMISSION SYSTEM PLAN

Prepared for the
Arizona Corporation Commission



January 2016

ARIZONA PUBLIC SERVICE COMPANY
2016 - 2025
TEN-YEAR TRANSMISSION SYSTEM PLAN

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ARIZONA PUBLIC SERVICE COMPANY
2016–2025
TEN-YEAR TRANSMISSION SYSTEM PLAN

GENERAL INFORMATION

Pursuant to A.R.S. § 40-360.02, Arizona Public Service Company ("APS") submits its 2016–2025 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 generally outline APS's internal planning for its high voltage ("HV") 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. APS also includes its Renewable Transmission Action Plan as an attachment to this filing. The Ten-Year Plan is conducted and filed annually with the Commission.

This 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 81 miles of 500kV transmission lines, 29 miles of 230kV transmission lines, and 7 transformers contained in the projects in this Ten-Year Plan. 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 $197 million.[1] Table 1 provides an overview of the projects included in this Ten-Year Plan.

Table 1: Ten Year Plan Project Breakdown

Description	Projects in Ten-Year Plan
500kV transmission lines	81 miles
230kV transmission lines	29 miles
Transformers	7
Total Investment	$197 million[1]

Consistent with the Commission's Sixth BTA (Decision No. 72031, December 10, 2010) this Ten-Year Plan includes information regarding planned transmission reconductor projects, substation transformer replacements, and reactive compensation projects. 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 to accommodate new generator interconnections. Table 2 shows a list of the planned substation transformer additions/replacements.

[1] This value is not comparable to the Capital Expenditures table presented in the "Liquidity and Capital Resources" section of APS's 10-K filing, which also includes other transmission costs for new subtransmission projects (69kV) and transmission upgrades and replacements.

Table 2: Equipment Additions/Replacements

Description	**Year**
Delaney 500/69kV Transformer	2016
Sun Valley 500/230kV Transformer	2016
Mazatzal 345/69kV Transformer	2017
North Gila 500/230kV Transformer	2021
Orchard 230/69kV Transformer	2021
Orchard 230/69kV Transformer #2	2021
Saguaro 230/69kV Transformer	2025

Some of the facilities reported in prior Ten-Year plan filings have been completed. Others have been canceled or deferred beyond the upcoming ten-year period and are therefore not included here. The projects that have "To Be Determined" ("TBD") in-service dates are projects that have been identified, but 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 Ten-Year plan is also provided. Additionally, a section is included that briefly describes projects still in the feasibility planning phase.

For convenience of the reader, APS has included planned transmission maps showing the electrical connections and in-service dates for all overhead transmission projects planned by APS for Arizona (p.9), the Phoenix Metropolitan Area (p.10), and the Yuma area (p.11). 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 routings are recommended by the Arizona Power Plant and Transmission Line Siting Committee and ultimately approved by the Commission when issuing a Certificate of Environmental Compatibility ("CEC") 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 where construction dates have been 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. Through membership and participation in these organizations, the needs of multiple entities, and the region as a whole, can be identified and studied, which maximizes the effectiveness and use of new projects. Regional organizations in 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.

The Commission's Sixth BTA ordered that utilities include the effects of distributed generation and energy efficiency programs on future transmission needs. APS's modeled load, located in the Technical Study Report section of this filing, addresses the requirements of the Commission's Sixth BTA.

The Commission's Seventh BTA suspended the requirement for performing Reliability Must Run (RMR) studies in every BTA and implemented criteria for restarting such studies. Since APS's last RMR, there have been no triggering events that would require restarting a RMR study for Phoenix and Yuma load pockets, which are the two major areas in APS's service territory where load cannot be served totally by imports over transmission lines. Also consistent with the Commission's Decision in the Seventh and Eighth BTAs, (Decision No. 73625, December 12, 2012 and Decision No. 74785, October 24, 2014), APS continues to monitor the reliability in Cochise County. In APS's service territory in Cochise County there have been two sustained outages[2] in the last two years. APS is finalizing plans for system additions in the area that will likely include new and upgraded transmission lines and new transformers. Should the plan be finalized prior to next January's filing, APS will file a supplement to this Ten-Year plan.

In the Eighth BTA decision, the Commission ordered utilities to describe the driving factors for each transmission project in the Ten-Year Plan. If the project's driving factor is due to load growth or reliability, the utility is required to provide a system load level range at which each transmission project is anticipated to be needed. In this Ten-Year Plan filing, APS has included a load level range in the "Purpose Section" of the Project's description page for any project that is load growth or reliability driven. Because projects that are designated TBD are only included for informational purposes, APS has not provided a load level range at this time for these projects. In that same Decision, the Commission also directed utilities to conduct or procure a study to more directly identify the effects of DG and EE installations and/or programs. This study is located in Attachment C of this filing.

The projects identified in this 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 contains tentative information only and is subject to change without notice at the discretion of APS (A.R.S. § 40-360.02(F)).

[2] APS's defines sustained outages as outages that last five minutes or longer.

CHANGES FROM 2015-2024 TEN-YEAR PLAN

The following is a list of projects that were removed or changed from APS's January 2015 Ten-Year Plan filing, along with a brief description of why the change was made:

- Bagdad 115kV line relocation has been completed. The project went in-service in September, 2015.
- Hassayampa – North Gila 500kV #2 line has been completed. The project went in-service in May, 2015.
- The first circuit of the Palm Valley – Trilby Wash 230kV line has been completed. The project went in-service in April, 2015. The in-service dates for the second circuit for this project and the TS2 230/69kV substation are TBD. The project description page reflects only these remaining portions of the project.
- The in-service date for the Ocotillo Modernization Project interconnection facilities has been rescheduled from 2017 to 2018 to coincide with the generation portion of the Ocotillo Modernization Project, which is scheduled for completion by summer 2019, rather than the original time of summer of 2018.
- The in-service date for the North Gila – Orchard 230kV project has been delayed from 2018 to 2021. The need for the transmission capacity to import additional resources is now forecasted to be in 2021 due to slower than anticipated growth in the area.
- The in-service date for the Morgan-Sun Valley 230kV project has been changed to TBD as the need date for this project remains beyond the ten year planning horizon.

NEW PROJECTS IN THE 2016-2025 TEN-YEAR PLAN

There are no new transmission projects planned within the 2016-2025 Ten-Year Plan that were not in the 2015-2024 Ten-Year Plan.

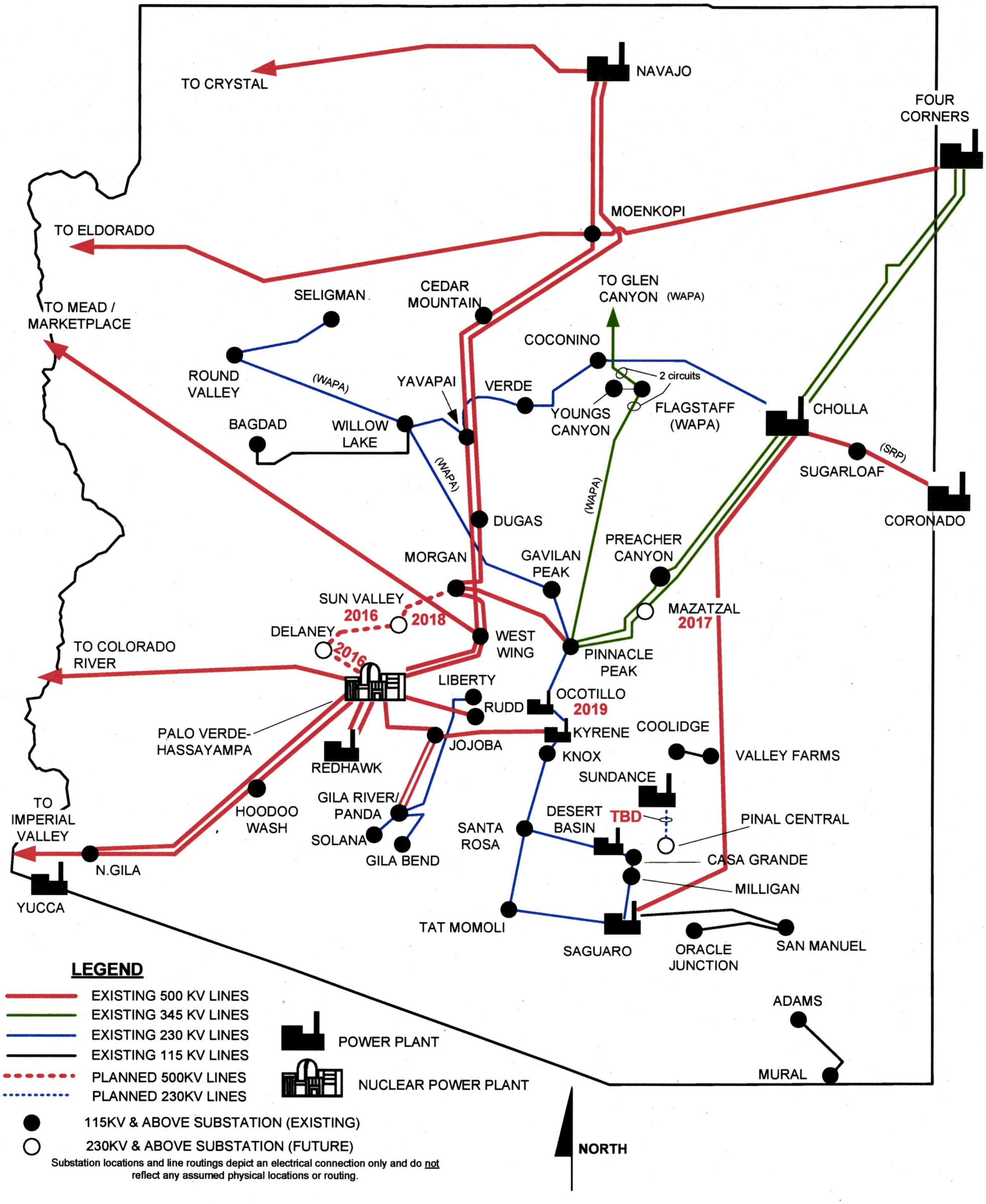
CONCEPTUAL PROJECTS IN THE FEASIBILITY PLANNING PHASE

Palo Verde/Gila Bend Area to Valley Transmission Capacity

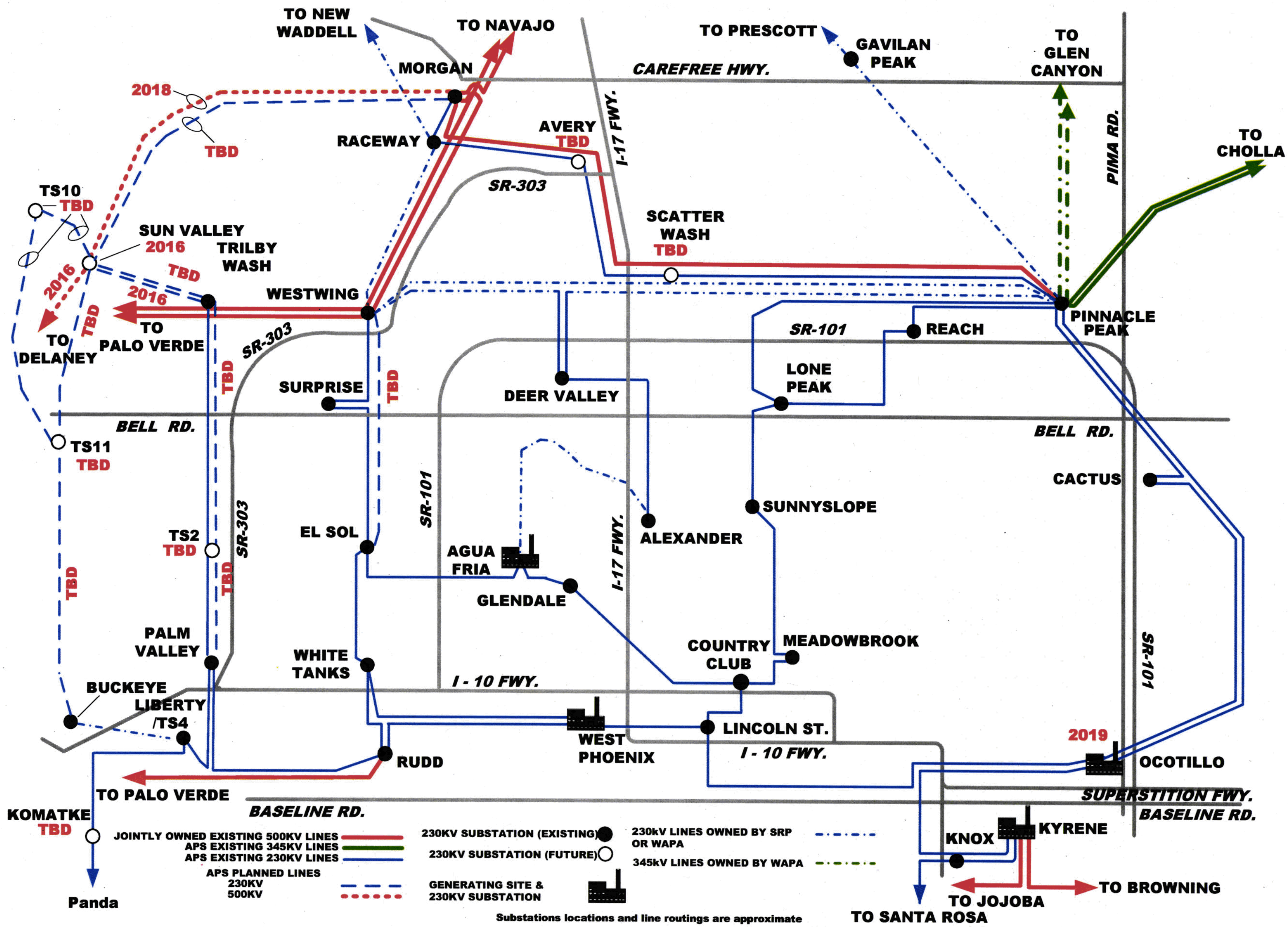
Additional transmission capacity will be studied from the Palo Verde/Gila Bend areas to the Phoenix load center. This transmission capacity is a robust component of the overall APS transmission and resource need. The areas around and west of Palo Verde as well as the Gila Bend area contain some of the best solar resources in the country. These areas also provide access to existing gas resources and, in the case of Palo Verde, potential new gas resources and market purchases.

PLANNED TRANSMISSION MAPS

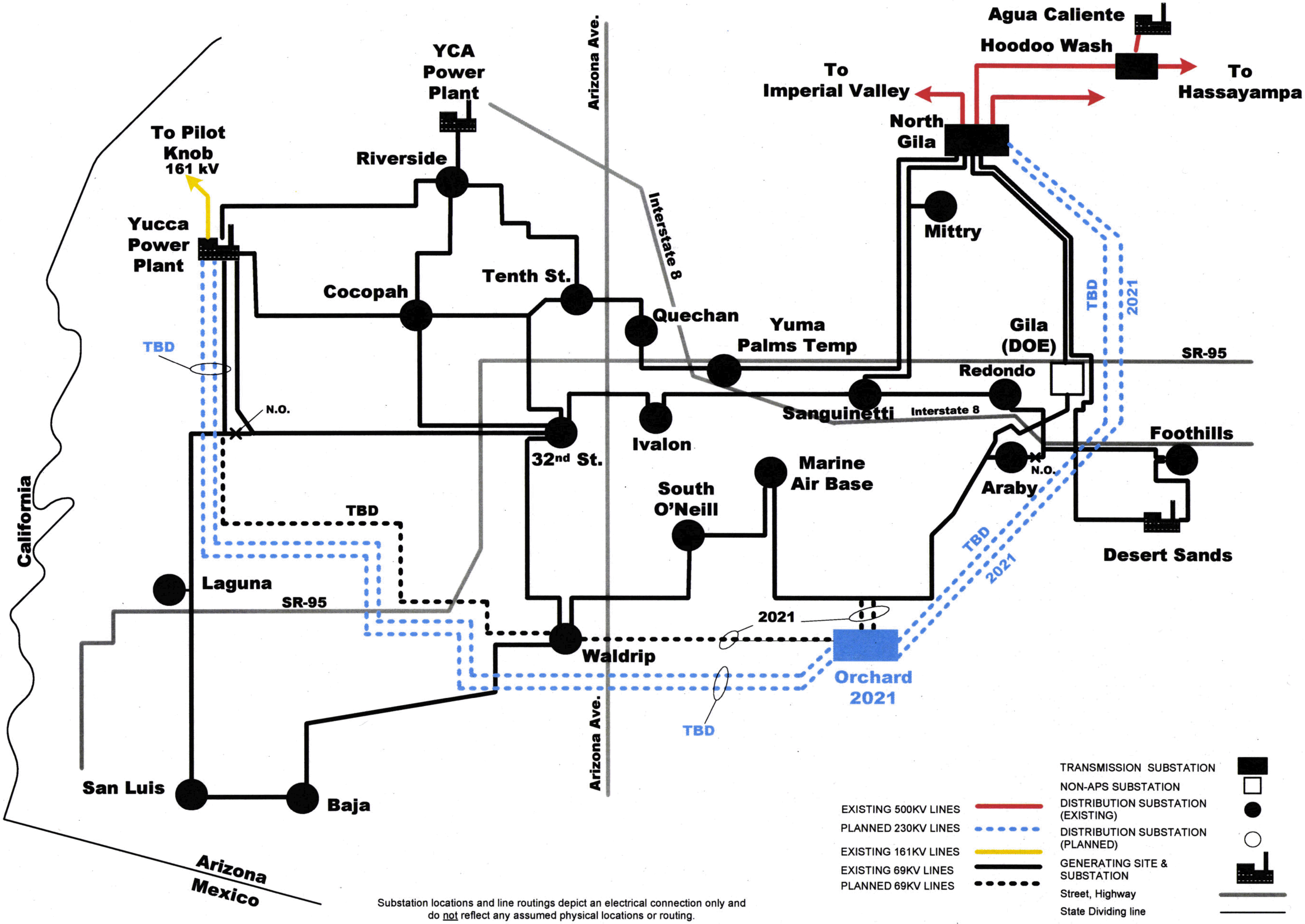
APS EHV & OUTER DIVISION 115/230 KV TRANSMISSION PLANS 2016 – 2025



PHOENIX METROPOLITAN AREA TRANSMISSION PLANS 2016-2025



Yuma Area Transmission Plans 2016-2025



Substation locations and line routings depict an electrical connection only and do not reflect any assumed physical locations or routing.

PROJECT DESCRIPTIONS

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

2016

Project Name	Delaney – Palo Verde 500kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	Central Arizona Water Conservation District (CAWCD)
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Palo Verde Switchyard
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Delaney Switchyard; Sec. 25, T2N, R8W
(f) Length	Approximately 15 miles
Routing	Generally leaving the Palo Verde Hub vicinity following the Palo Verde-Colorado River-Devers #1 and the Hassayampa-Harquahala 500kV lines to the Delaney Switchyard site in Sec. 25, T2N, R8W.
Purpose	Driving Factor(s): To increase 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. It will provide a new transmission source to help serve the areas in the western portions of the Phoenix Metropolitan area where there is currently no transmission infrastructure. This is a joint participation project with APS as the project manager.
Date	
(a) Construction Start	2011
(b) Estimated In-Service	2016
Permitting / Siting Status	*CEC 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. On May 19, 2015, in Decision No.75081, the Commission approved APS's application to extend the term of the CEC for the portion of line from the Delaney Switchyard to the Sun Valley Substation from August 17, 2015 to August 17, 2020 and to permit the use of monopoles in lieu of lattice towers in three locations.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

2016

Project Name	Delaney – Sun Valley 500kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	Central Arizona Water Conservation District (CAWCD)
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Delaney Switchyard; Sec. 25, T2N, R8W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Sun Valley substation to be in-service by 2016; Sec. 29, T4N, R4W
(f) Length	Approximately 28 miles
Routing	Generally follows the Palo Verde-Colorado River-Devers #1 line until crossing the CAP canal. Then easterly, generally following the north side of the CAP canal to the new Sun Valley substation.
Purpose	Driving Factor(s): To increase 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. It will provide a new transmission source to help serve the areas in the western portions of the Phoenix Metropolitan area where there is currently no transmission infrastructure. This is a joint participation project with APS as the project manager.
Date	
(a) Construction Start	2014
(b) Estimated In-Service	2016
Permitting / Siting Status	*CEC 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. On May 19, 2015, in Decision No. 75081, the Commission approved APS's application to extend the term of the CEC for the segment of line from the Delaney Switchyard to the Sun Valley Substation to August 17, 2020 and to authorize the use of monopoles in lieu of lattice towers in three locations.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

2016

Project Name	Sun Valley – Trilby Wash 230kV Line Circuit #1
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 2016; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Trilby Wash substation; 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	Driving Factor(s): To connect the new Sun Valley 500kV source into the Phoenix valley's 230kV system thereby providing more capability to import power into the Phoenix Metropolitan area. To provide new transmission infrastructure to serve the future growth in the western portions of the Phoenix Metropolitan area where there is currently no transmission infrastructure. The first circuit is scheduled to be in-service the summer of 2016 and the in-service date for the second circuit will be evaluated in future planning studies.
Date	
(a) Construction Start	2014
(b) Estimated In-Service	2016
Permitting / Siting Status	*CEC issued 5/5/05 (Case No. 127, Decision No. 67828, West Valley North 230kV Transmission Line project). On April 23, 2015, in Decision No. 75045, the Commission approved APS's application to extend the term of the CEC to May 5, 2020 for the first circuit and to May 5, 2030 for the second circuit.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

2017

Project Name	Mazatzal 345/69kV Substation
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	345kV AC
(b) Facility Rating	150 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 2017; 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	Driving Factor(s): To provide the electric source and support to the sub-transmission system in the area of Payson and the surrounding communities. This project will be needed when the load in the region consistently exceeds 35-40MW.
Date	
(a) Construction Start	2015
(b) Estimated In-Service	2017
Permitting / Siting Status	*CEC issued on 5/4/11 (Case No. 160, Decision No. 72302, Mazatzal Substation and 345kV Interconnection Project). On August 26, 2015, in Decision No. 75249, the Commission approved APS's application to extend the term of the CEC to 2021.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

2018

Project Name	Ocotillo Modernization Project Interconnection Facilities
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	Ocotillo GT3-7 Collection Yard
(d) Intermediate Points of Interconnection	None
(e) Point of Termination	Ocotillo 230kV Substation
(f) Length	Less than 1 mile
Routing	This project will include two onsite 230kV generation interconnection circuits for interconnection to the existing onsite Ocotillo 230kV Substation. One circuit will be routed along a portion of the northern boundary of the site, connecting from immediately north of GT7 to the substation. The second circuit will be routed along portions of the western and northern boundaries of the site, connecting immediately south of GT3 to the substation. In addition, the existing generation interconnection from existing GT2 will be rerouted, such that it will connect near GT7.
Purpose	Driving Factor(s): To interconnect new generators being constructed as part of the Ocotillo Modernization Project. These circuits will connect the new units to the existing Ocotillo 230kV Substation.
Date	
(a) Construction Start	2017
(b) Estimated In-Service	2018
Permitting / Siting Status	*CEC issued on 11/13/2014. (Case No. 169, Decision No. 74812, Ocotillo Modernization Project). Note – Ocotillo 230kV Generation Interconnections is now referred to as Ocotillo Modernization Project.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

2018

Project Name	Morgan – Sun Valley 500kV Line
Project Sponsor	Arizona Public Service Company
Other Participants	Central Arizona Water Conservation District (CAWCD)
Size	
(a) Voltage Class	500kV AC
(b) Facility Rating	3000 A
(c) Point of Origin	Sun Valley substation to be in-service in 2016; Sec. 29, T4N, R4W
(d) Intermediate Points of Interconnection	
(e) Point of Termination	Morgan substation; Sec. 33, T6N, R1E
(f) Length	Approximately 38 miles
Routing	Generally the line will head north-northeast out of the Sun Valley substation and then east to the Morgan substation.
Purpose	Driving Factor(s): To increase 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. This line is the final section of a new 500kV path from Palo Verde around the western and northern edges of the Phoenix area and terminates at Pinnacle Peak. This full path, Palo Verde-Delaney-Sun Valley-Morgan-Pinnacle Peak 500kV, 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, which provides support for multiple element contingencies. This project is 500/230kV double-circuit capable. This is a joint participation project with APS as the project manager.
Date	
(a) Construction Start	2016
(b) Estimated In-Service	2018
Permitting / Siting Status	*CEC issued on 3/17/09 (Case No. 138, Decision No. 70850, TS5-TS9 500/230kV Project). On May 19, 2015, in Decision 75092, the Commission approved APS's application to extend the term of the CEC to 2021 for the 500kV circuit and approved four corridor modifications.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

2021

Project Name	North Gila – Orchard 230kV Line Circuit #1
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	Orchard 230kV substation to be in-service by 2021; Sec. 20, T9S, R22W
(f) Length	Approximately 13 miles
Routing	Line will proceed south from the North Gila substation until County 6 ½ Street, where it will head east for approximately 1 mile. It will follow the existing WAPA utility right-of-way south to County 9 ½ Street, where it will proceed east for approximately 0.3 mile before heading south on Avenue 10E. Then the route will proceed southwest adjacent to the Union Pacific RR and then adjacent to the A Canal until it turns south along the Yuma Area Service Highway alignment. The route proceeds west along the County 13 ½ Street alignment to Avenue 5 ½E, where it will turn south to the Orchard Substation.
Purpose	Driving Factor(s): To increase ability to import resources into the Yuma load pocket. The project will also be used to improve reliability, serve the need for electric energy, and provide continuity of service for the greater Yuma area by adding a transmission source in a new area of the Yuma system. This project will be needed when the load in the Yuma area reaches 450-500MW, contingent upon the status of the Yucca Power Plant generation, which is internal to the load pocket. This project will have double-circuit capability with one circuit in-service in 2021 and the second circuit in-service TBD.
Date	
(a) Construction Start	2019
(b) Estimated In-Service	2021
Permitting / Siting Status	*CEC issued 2/2/12 (Case No. 163, Decision No. 72801). Note – North Gila to TS8 230KV Transmission Line is now referred to as North Gila – Orchard 230kV Line.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	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 2016; 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 38 miles
Routing	This line will be built as a second circuit with the Morgan-Sun Valley 500kV line, which generally heads north-northeast out of the Sun Valley substation and then east to the Morgan substation.
Purpose	Driving Factor(s): To provide a transmission source to serve future load that emerges in the currently undeveloped areas south and west of Lake Pleasant. The in-service date will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*CEC issued on 3/17/09 (Case No. 138, Decision No. 70850, TS5-TS9 500/230kV Project). On May 19, 2015, in Decision 75092, the Commission approved APS's application to extend the term of the CEC to 2030 for the 230kV circuit and approved corridor modifications in four areas.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	Scatter Wash 230/69kV Substation
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	188 MVA
(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	Driving Factor(s): To provide electric energy in the northern portions of the Phoenix Metropolitan area as well as increase the reliability for these areas. The in-service need date for this substation will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*CEC 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). On April 10, 2013, Decision No. 73824, the Commission approved APS's application to extend the term by 10 years to June 18, 2023 and to relocate the Scatter Wash substation to the north side of the approved corridor.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	Palm Valley – TS2 – Trilby Wash 230kV Circuit #2
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; 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	Driving Factor(s): To serve the need for electric energy in the western Phoenix Metropolitan area. The first circuit went in-service in 2015. The in-service need date for the TS2 substation and the second circuit will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	First circuit went in-service in 2015.
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*The Palm Valley-TS2 segment of the 230kV line was approved in the West Valley South 230kV Transmission Line project and a CEC was issued 12/22/03 (Case No. 122, Decision No. 66646). On 6/27/2013 (Decision No. 73937), the Commission approved APS's application to extend CEC term to 12/23/2018 for the first circuit of the Project and to 12/23/2028 for the second circuit and other facilities. The Trilby Wash-TS2 segment of the 230kV line was approved in the West Valley North 230kV Transmission Line project and a CEC was issued 5/5/2005 (Case No. 127, Decision No. 67828). On April 23, 2015, (Decision No.75045) the Commission approved APS's application to extend CEC term to May 5, 2020 for the first circuit and to May 5, 2030 for the second circuit and other modifications to the CEC.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	Avery 230/69kV Substation
Project Sponsor	Arizona Public Service Company
Other Participants	None
Size	
(a) Voltage Class	230kV AC
(b) Facility Rating	188 MVA
(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	Driving Factor(s): To provide electric energy in the northern portions of the Phoenix Metropolitan area as well as increase the reliability for these areas. The in-service need date for this substation will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*CEC issued on 6/18/03 (Case No. 120, Decision No. 65997, North Valley Project). On April 10, 2013, Decision No. 73824, the Commission approved APS's application to extend the term to June 18, 2023 and make other minor modifications unrelated to this substation.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	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; 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	Driving Factor(s): To serve increasing loads in Pinal County and throughout the APS system, and to improve reliability and continuity of service for the communities in the area. To increase the reliability of Sundance by providing a transmission line in a separate corridor than the existing lines that exit the plant. The project will be constructed as a 230kV double-circuit capable line, but initially operated as a single-circuit. The in-service need date for this substation will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*CEC 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. The Sundance – Faul 230 kV Line (construction was limited to inside the Sundance Property) was placed in-service in May 2010 as a portion of this project.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	Komatke 230/69kV Substation
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	Komatke 230/69 substation with an in-service TBD; Sec. 25, T2S, R4W
(f) Length	Less than 1 mile
Routing	The Komatke 230/69kV substation will be constructed adjacent to the Liberty (TS4)-Panda 230kV line.
Purpose	Driving Factor(s): To provide electric energy as well as increase the reliability for these areas. The in-service need date for this substation will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*CEC issued 10/16/00 (Case No. 102, Decision No. 62960) for the Gila River Transmission Project, including the interconnection of the 230kV substation. Note – Jojoba 230/69kV Substation is now referred to as Komatke 230/69kV Substation.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	Orchard – 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	Orchard 230kV substation to be in-service by 2021; Sec. 20, T9S, R22W
(f) Length	Approximately 19 miles
Routing	The line will proceed west from the Orchard substation along County 14th Street to the A Canal. Then the route will proceed southwest along the A Canal to Avenue 4E, where it will continue west along County 14 ½ Street to US 95. The line will proceed north along US 95 to the County 13 ½ Street alignment and proceed west along County 13 ½ and County 13th Street. At Avenue F the line will proceed north to Levee Road, where it will proceed north east until the 8th Street alignment. The line will proceed east along 8th Street until Calle Agua Salada Road, where it will proceed north to the Yucca Power Plant.
Purpose	Driving Factor(s): Double-circuit 230kV project to serve the need for electric energy, improve reliability, and continuity of service for the greater Yuma area. This project will provide a second electrical source to the future Orchard 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. The in-service need date for this line will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*CEC issued 2/2/12 (Case No. 163, Decision No. 72801, North Gila to TS8 to Yucca 230kV Transmission Line project). Note – TS8 to Yucca 230 kV Line is now referred to as Orchard – Yucca 230 KV Line.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	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 2016; 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	Driving Factor(s): 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. The in-service need date for this line will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*An application for a CEC has not yet been filed.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	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 2016; 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	Driving Factor(s): To 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 will result for this portion of Maricopa County. The in-service need date for this line will be continuously evaluated in planning studies to keep pace with system needs. 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 CEC has not yet been filed.*

Arizona Public Service Company
2016 – 2025
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	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	Driving Factor(s): To 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. The in-service need date for this line will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*CEC issued 7/26/73 (Case No. 9, Docket No. U-1345). Note that this CEC 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
2014 – 2023
Ten-Year Plan
Planned Transmission Description

To Be Determined

Project Name	Palo Verde – Saguaro 500kV Line
Project Sponsor	Arizona Public Service Company
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-Pinal West-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	Driving Factor(s): To increase the adequacy of the existing EHV transmission system and increase power delivery throughout the state. The in-service need date for this line will be continuously evaluated in planning studies to keep pace with system needs.
Date	
(a) Construction Start	To be determined
(b) Estimated In-Service	To be determined
Permitting / Siting Status	*CEC issued 1/23/76 (Case No. 24, Decision No. 46802).*

TRANSMISSION PLANNING PROCESS AND GUIDELINES

APS Transmission Planning
January 26, 2016

Ver 1.0

Table of Contents

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 (345 kV and 500 kV) and High Voltage transmission system (230 kV and 115 kV). In addition to these Guidelines, APS follows the Western Electricity Coordinating Council's (WECC) System Performance Criteria (TPL-001-WECC-CRT-02) in addition to NERC Table 1.

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), for any single contingency condition and for selected double contingency conditions as defined under TPL-001-WECC-CRT-02. In general, an adequately planned transmission system will:

- Provide an acceptable level of service that is cost-effective for normal, single and selected double contingency conditions.
- Maintain service to all firm loads for any single or selected double contingency outages; except for radial loads.
- Not result in overloaded equipment or unacceptable voltage conditions for single or selected double contingency outages.
- Not result in cascading for single or selected 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 on methodologies provided by the WECC RPEWG. 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's 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's and other network customers' local transmission and sub-transmission systems.
- Provide for interconnection to 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 Open Access Transmission Tariff (OATT) Attachment (E)). Finally, all EHV and HV substations will be CIP substations.

1. EHV Transmission Planning Process

APS's EHV transmission system, which consists of 500 kV and 345 kV, 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's annual planning process includes an assessment of APS's transmission capability to ensure that designated network resources can be accessed to reliably and economically serve all network loads. In addition, Reliability Must-Run (RMR) studies are selectively performed to ensure that proper balance between the transmission import capability and local generation requirements for an import limited load area are maintained.

2. 230 kV Transmission Planning Process

APS's 230 kV 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 230 kV system assesses the need for new 230/69 kV substations to support local sub-transmission and distribution system growth and the reliability performance of the existing 230 kV 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's 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 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, 115 kV and 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 Electric 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.
- Establishing new or modifying existing WECC Path Ratings through procedures.
- Compiling regional data banks, including the BCCS, 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. Technical Task Force and ad-hoc Work Groups

Many joint participant projects in the Desert Southwest rely on technical study groups for evaluating issues associated with their respective projects. These evaluations often include studies to address various types of issues associated with transfer capability, interconnections, reliability and security. APS actively participates in many of these groups such as the Western Arizona Transmission System Task Force, Four Corners Technical Task Force and the Eastern Arizona Transmission System Task Force.

3. 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.

4. WestConnect

APS and the other WestConnect members executed the WestConnect Project Agreement for Subregional Transmission Planning in May 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.

5. 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's system peak load in the following manner:

- Determine base generation available and schedule these units at maximum output.
- Determine resources purchased from other utilities, IPPs, or power marketing agencies.
- Determine APS' spinning reserve requirements.

- Schedule intermediate generation (oil/gas steam units) such that the spinning reserve requirements, in section (c) above, are met.
- 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 also examined in the context of common mode and common corridor outages. Normal system voltages, voltage deviations, and voltage extreme limitations are based upon operating experience resulting in acceptable voltage levels to the customer. 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 also examined in the context of common mode and common corridor outages.

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, non-simultaneous ratings are determined using methodologies consistent with WECC Path Rating Procedures as defined in the *WECC Project Coordination and Path Rating Processes* manual and NERC Standard MOD-029-1. In addition, simultaneous relationships are identified that can either be mitigated through use of nomograms, operating procedures or other methods.

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. Flexible AC Transmission System (FACTS)

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. Examples include DSTATCOM for powerfactor correction and the DVR for dynamic voltage regulation for distribution loads.

10. Economic Evaluation

In general, an economic evaluation of alternative plans consists of a cumulative net 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 69 kV 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

Nominal EHV design voltages are 500 kV, 345 kV, 230 kV, and 115 kV. Nominal EHV operating voltages are 535 kV, 348 kV, 239 kV, and 119 kV, with exceptions to certain buses.

4. Sources of Databases

APS currently relies on WECC cases and internal data listings as their depository of EHV and HV system data and models. WECC has chosen to pursue a relational database (i.e. Base Case Coordination System) to maintain data and models for its members in addition to using WECC base cases. APS will begin to use the BCCS as the system becomes available.

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. Currently, APS has TCULs on only its 500 kV autotransformers except for a few transformers. Other than operator control, the TCUL transformers do not automatically regulate voltages.

6. Phase Shifters

For pre-disturbances scenarios, phase shifters may be used to hold flows depending on the objectives of the study. For post-disturbance scenarios, the phase shifters are assumed to not hold flows and are not automatically regulated.

7. Conductor Sizes

APS uses several types of standard phase conductors depending on the design, voltage class and application for new transmission lines. Table 1 lists the current standard conductor sizes for the various voltage levels used for new facilities.

Table 1. Standard conductor sizes.

Class	Conductor
525 kV	3x1780 kcm ACSR Chukar 2x2156 kcm ACSR Bluebird
345 kV	2x795 kcm ACSR Tern
230 kV	1x2156 kcm ACSS Bluebird 1x1272 kcm ACSR Bittern 1x795 kcm ACSR Tern
115 kV	(same as 230 kV construction)
69 kV	1x795 kcm ACSS Tern 1x795 kcm AA Arbutus 1x336 kcm ACSR Linnet

8. 69 kV System Modeling

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

9. Substation Transformers

- 500 kV and 345 kV 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.

TCULs are typically used on the 525 kV transformers generally with a range of plus or minus 10% of nominal voltage. Primary voltages will be 525 kV or 345 kV, and secondary voltages will be 230 kV or 69 kV and tertiary voltages will be 34.5 kV, 14.4 kV or 12.47 kV.

- 230 kV Substations

For high-density load areas, both 230/69 kV and 69/12.5 kV transformers can be utilized. 230/69 kV transformers will be rated at 113/150/188 MVA with a 65°C temperature rise, unless otherwise specified. 69/12.5 kV 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 Air (ONAF) rating without sustaining any loss of service life. For a single contingency outage (loss of one transformer) the remaining new transformer or transformers may be loaded up to 25% above their top ONAF 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. No-load tap setting adjustment capabilities on 230/69 kV transformers will be ±5% from the nominal voltage setting (230/69 kV) at 2½% increments.

10. Switchyard Arrangements

- 500 kV and 345 kV Substations

Existing 345 kV 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 500 kV switchyards and the necessity of having adequate reliability, all 500 kV 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.

- 230 kV Substations

  Future 230/69 kV 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 230/69 kV substations should accommodate up to four 230 kV line terminations and up to three 230/69 kV 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 230/69 kV Metropolitan Phoenix Area substations, with provision for initial development to be a ring bus. Any two 230/69 kV 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 are planned according to the needs of their associated transmission projects and are typically a customized design. Benefits resulting from the installation of series capacitors include but are not limited to improved transient stability, voltage regulating capability and reactive capability. A new series capacitor installation will currently include MOV protection that mitigates fault current levels through the series capacitor for internal faults. A bank will typically bypass for internal faults because there is no benefit to requiring that the bank remain in service when the line is tripped. Depending on the required impedances and ampacity level, new series capacitor banks may be either one to three segment units. The bank ratings should be based upon line's ultimate uses. At a minimum bank should be upgradable to higher ampacity needs in the future. Most 500 kV banks in APS system have a continuous rating of either 1750 A or 2200 A. ANSI standard require that the 30 minutes emergency rating be 135% of the continuous.

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. EHV reactors are used to adjust pre-disturbance voltages if controlled through a breaker, circuit switcher or motor operated disconnect switch. APS currently does not automatically control its EHV or HV reactors or capacitors.

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 or path rating studies. Existing WECC or regional path ratings and facilities ratings will not be violated pre- or facility ratings post-disturbance.

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. Alternately, no fictitious generation sources may be used to stress paths.

C. Transient Stability Studies

1. Fault Simulation

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

- Three-phase-to-ground faults with normal clearing.
- Single-line-to-ground faults with a stuck circuit breaker in one phase with delayed clearing.

2. Margin

- Generation margin may be applied for the contingencies primarily affected by generation.
- 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 if part of a proposed or existing remedial action scheme.

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 three phase faults. Fault damping levels will be determined from studies that account for the effect of generator amortisseur windings and the SSR filters. Fault damping will be applied on the buses listed in Table 2 for three phase faults on the nearest EHV or HV bus. If the model does not provide the ancillary signals for applying and removing damping values then a brake can be applied to the terminal bus of the affected generator.

Table 2. Damping levels for three phase faults.

Fault location	Affected units	Percent Damping
Palo Verde 500 kV	1-3	7.25%
Four Corners 500 & 345 kV	4&5	10%
Coronado 500 kV	1&2	12.5%
Cholla 500 kV	2-4	10%

6. Series Capacitor Switching

For APS designed banks, a MOV/by-pass model is employed in transient stability analysis.

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

Unless previously calculated as part of APSs requirement for MOD-032, the transmission line zero sequence impedance (Z_0) is assumed to be equal to three times the positive sequence impedance (Z_1). If a new transmission impedance is required, APS utilizes the CAPE line constant program for determining sequence values.

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.

5. Series Capacitor Switching

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

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)

- Voltage Levels

a. General

Nominal Voltage Level	Continuous Voltage Limits
525 kV	+/- 5%
345 kV	+/- 5%
230 kV	+/- 5%
115 kV	+/- 5%
69 kV	+/- 5%
Palo Verde	525-525 kV

- Facility Loading Limits

a. Transmission Lines

EHV transmission line loading cannot exceed 100% of the continuous rating, which is based upon established conductor temperature limit or sag limitation as defined by APS latest estimates for NERC Standard FAC-008-3.

b. 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.

c. Transformers

For all transformers pre-disturbance flows cannot exceed APS established continuous ratings using methodologies used in reporting ratings under NERC Standard FAC-008-3.

d. Series Capacitors

Series Capacitors cannot exceed 100% of continuous rating as determined using methodologies used in reporting ratings under NERC Standard FAC-008-3.

- Interchange of VARS

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

- Distribution of Flow

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

2. Single and selected Double Contingency Outages

- Voltage Levels

Maximum voltage deviation on APS's major buses cannot exceed 5% for single contingencies and 10% for selected double contingencies. APS uses the following formulae to calculate voltage deviations for post-disturbance conditions.

$$\%Deviation = 100x(\frac{Vpre - Vpost}{Vpre})$$

- Facilities Loading Limits

a. 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.

b. 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.

c. Transformers

For all transformers post-disturbance flows cannot exceed APS established emergency ratings using methodologies used in reporting ratings under NERC Standard FAC-008-3.

d. Series Capacitors

Series Capacitors cannot exceed 100% of emergency rating as determined using methodologies used in reporting ratings under NERC Standard FAC-008-3.

- Generator Units

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

- Impact on Interconnected System

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

B. Transient Stability Studies

Transient stability studies are primarily performed on the 500 kV and 345 kV systems but may be performed on lower voltage systems depending on the study objectives.

1. Fault Simulation

Three-phase and single-line-to-ground faults initiated disturbances will be simulated according to the guidelines described in NERC Table 1 as well as WECC Regional Criteria TPL-001-WECC-CRT-2. Normal clearing times for different voltage levels are given Table 3 for new facilities. Fault damping will be applied when applicable at fault inception. Breaker failure operation on the 500 kV system has a minimum clearing time of 10 cycles.

Table 3. Normal clearing times for new facilities.

Voltage level	Normal clearing times
500 & 345 kV	4 cycle
230 kV	5 cycle
115 kV	5 cycle
≤69 kV	7 cycle

2. Series Capacitor Switching

All of APS's designed and installed series capacitor units are protected from internal faults using MOV and by-pass elements. For transient stability analysis, models are used to represent the mitigation provided by the MOV components or through by-passing of the series capacitors.

3. System Stability

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

- All machines in the system remain synchronized as demonstrated by the relative rotor angles.
- Positive system damping exists as demonstrated by the damping of relative rotor angles and the damping of voltage magnitude swings. For N-1 and N-2 disturbances, APS follows the voltage and frequency performance guidelines as described in NERC's Table 1 and WECC Regional Criteria TPL-001-WECC-CRT-2.
- Cascading does not occur for any category contingency.

4. Re-closing

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

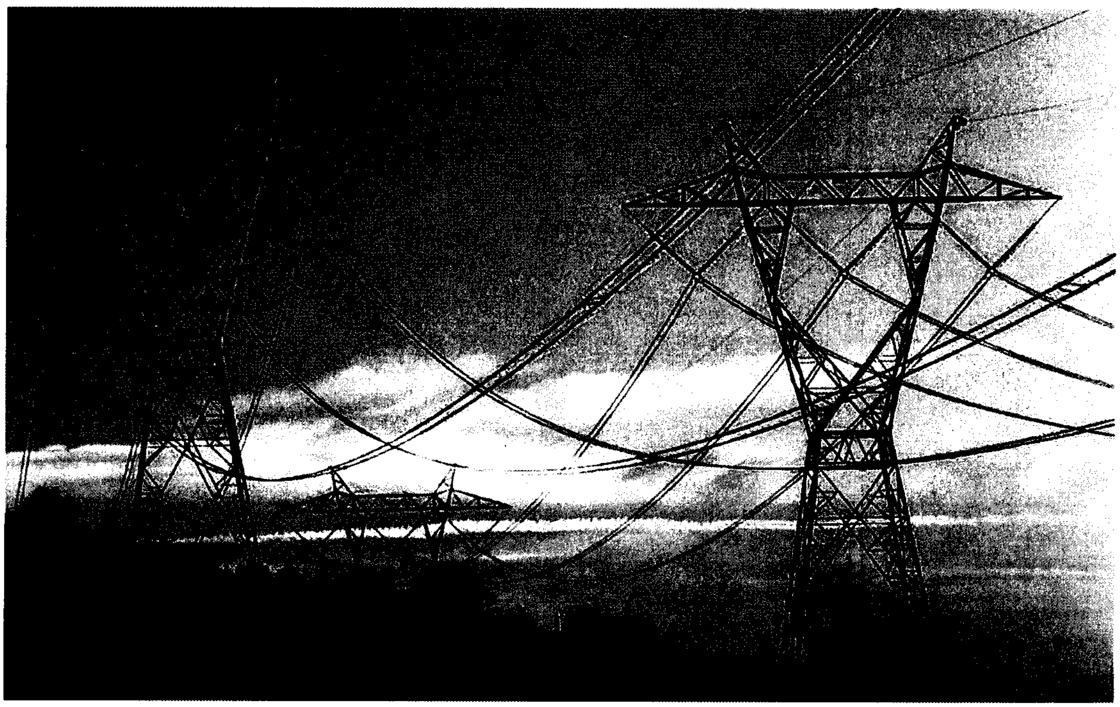
5. Short Circuit Studies

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

6. 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.

2015 SYSTEM RATING MAPS



PREPARED BY

Erik Rios
Joe Medina
November 2015

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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

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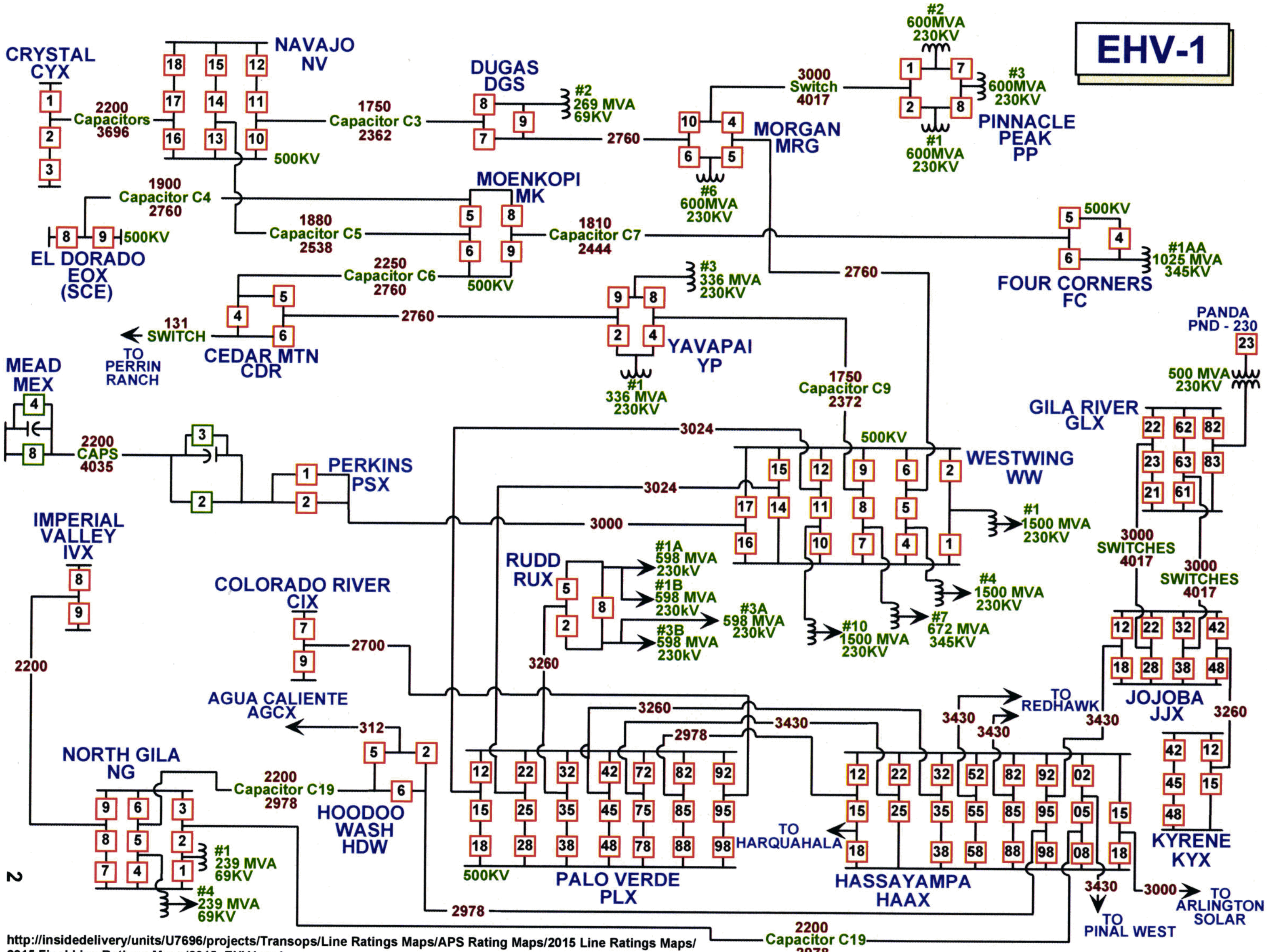

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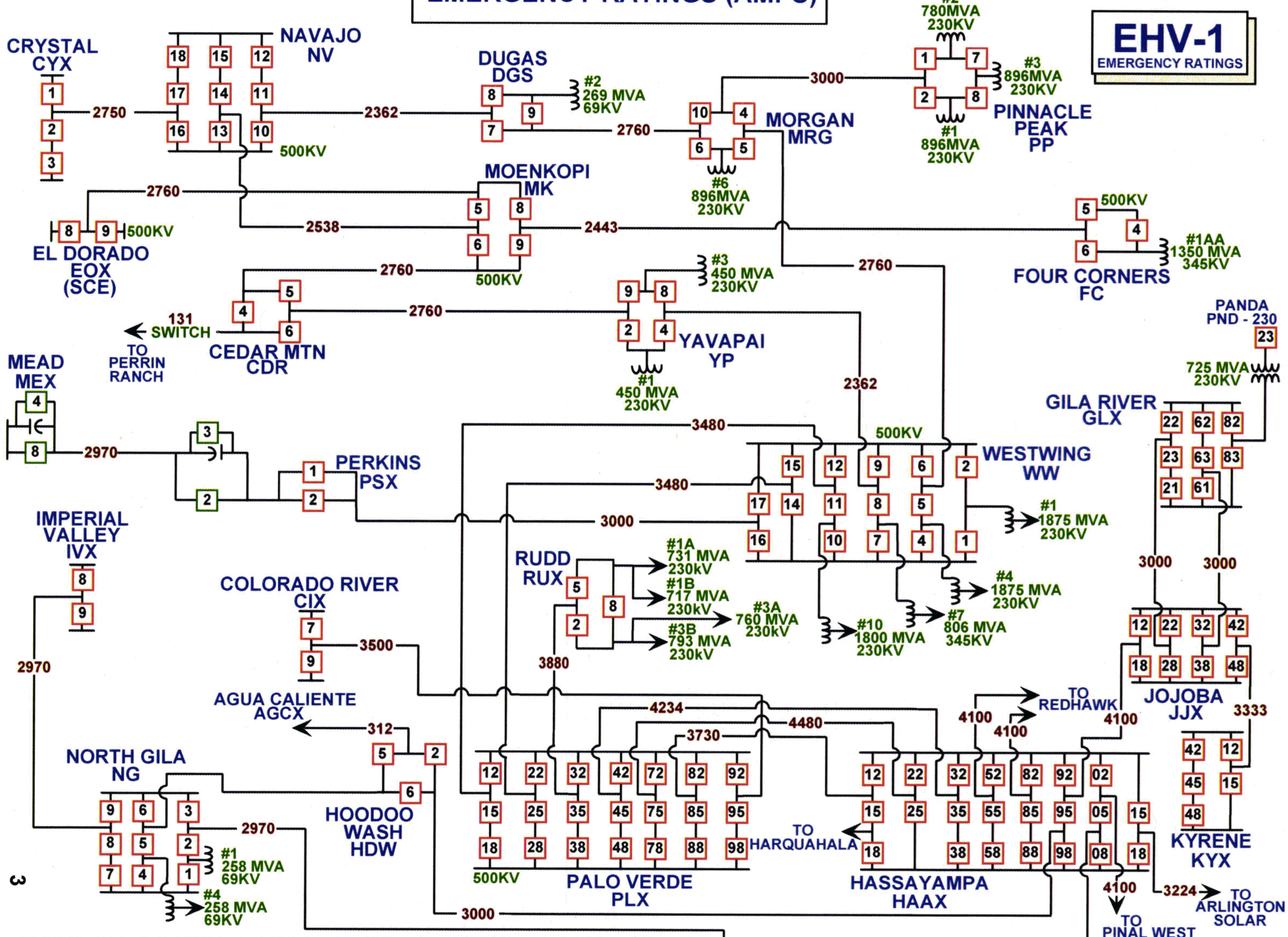
Rev. 11/19/15

EMERGENCY RATINGS (AMPS)



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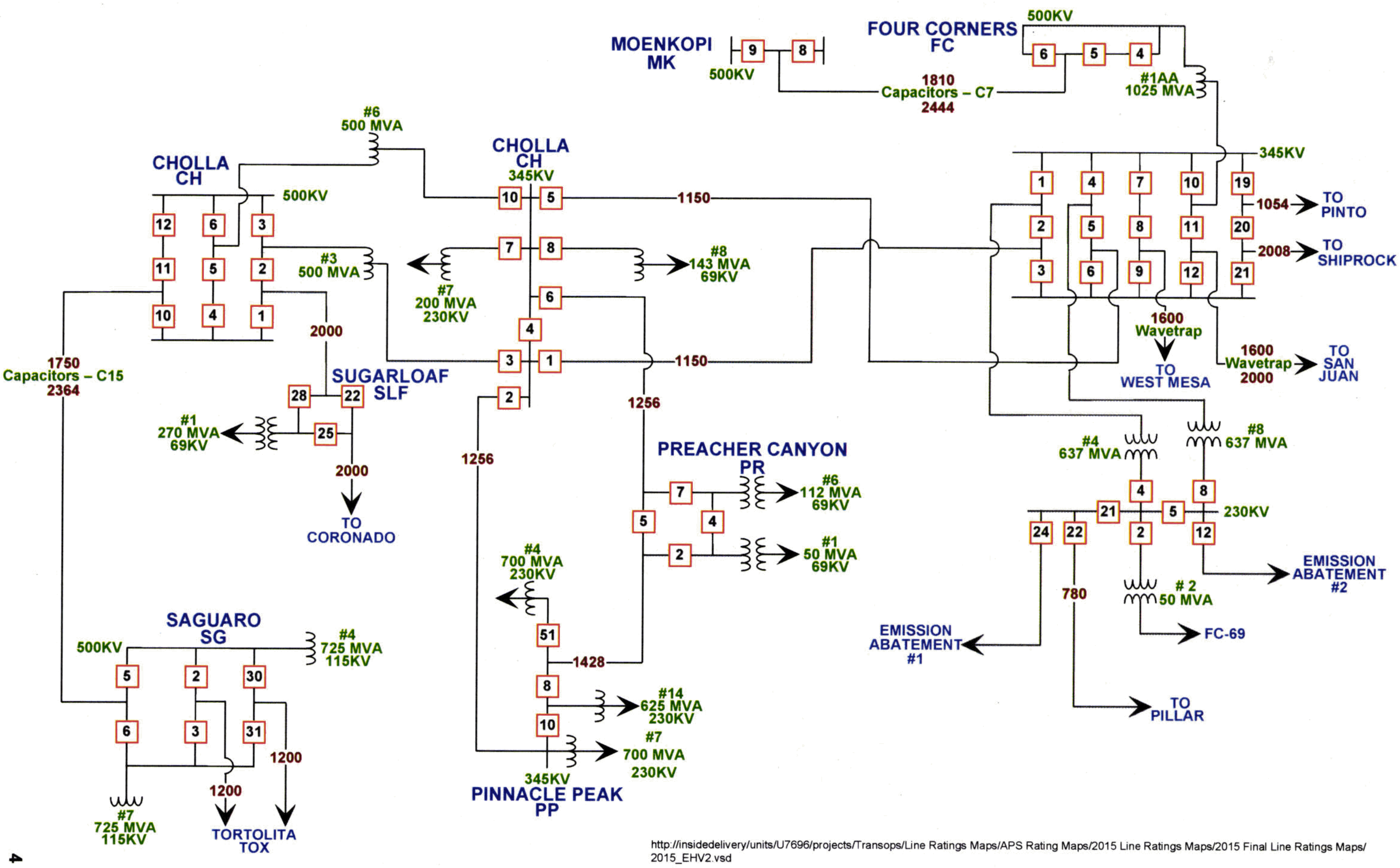
Rev. 11/19/15

EHV-2



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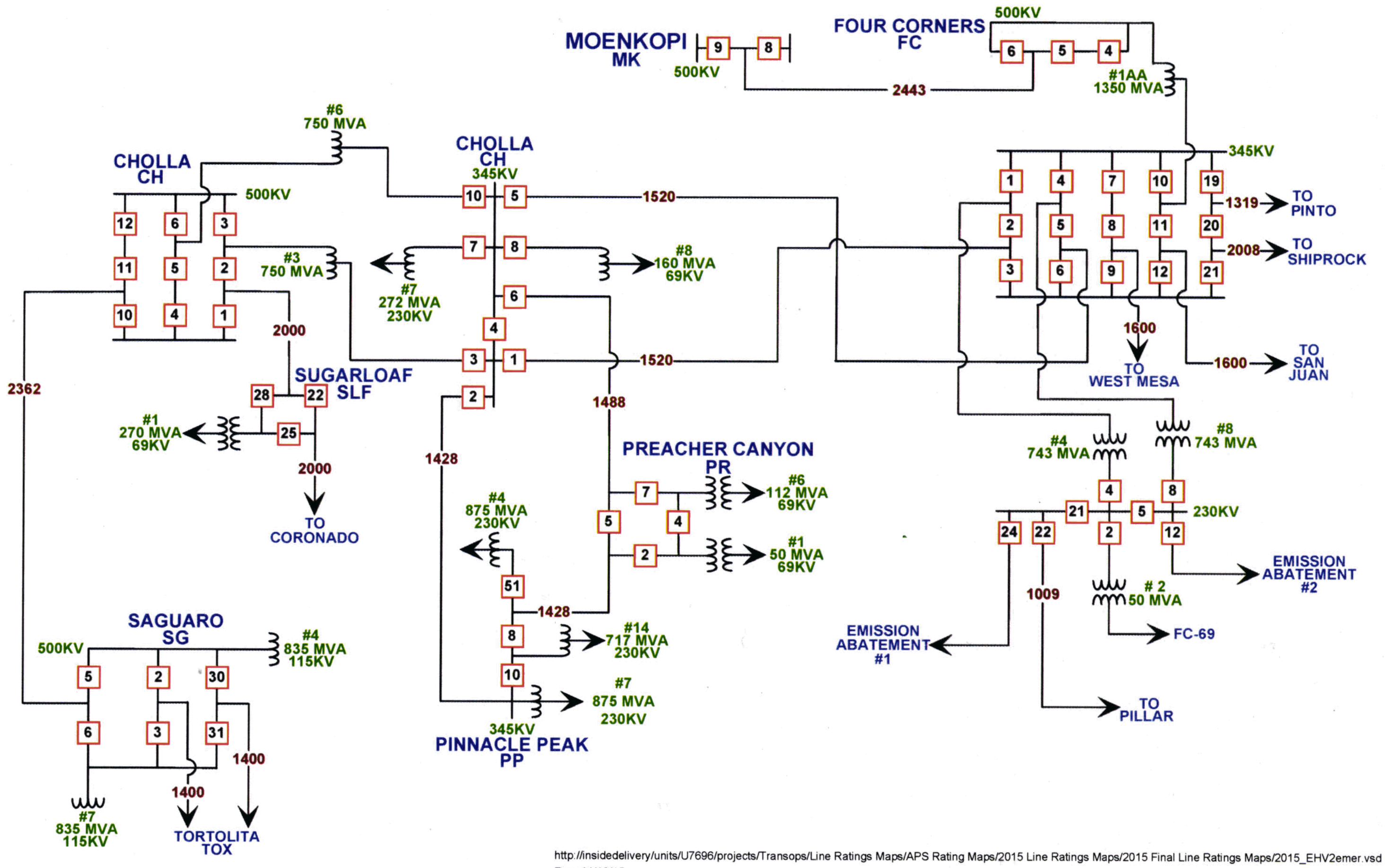
EMERGENCY RATING (AMPS)

EHV-2
EMERGENCY RATINGS



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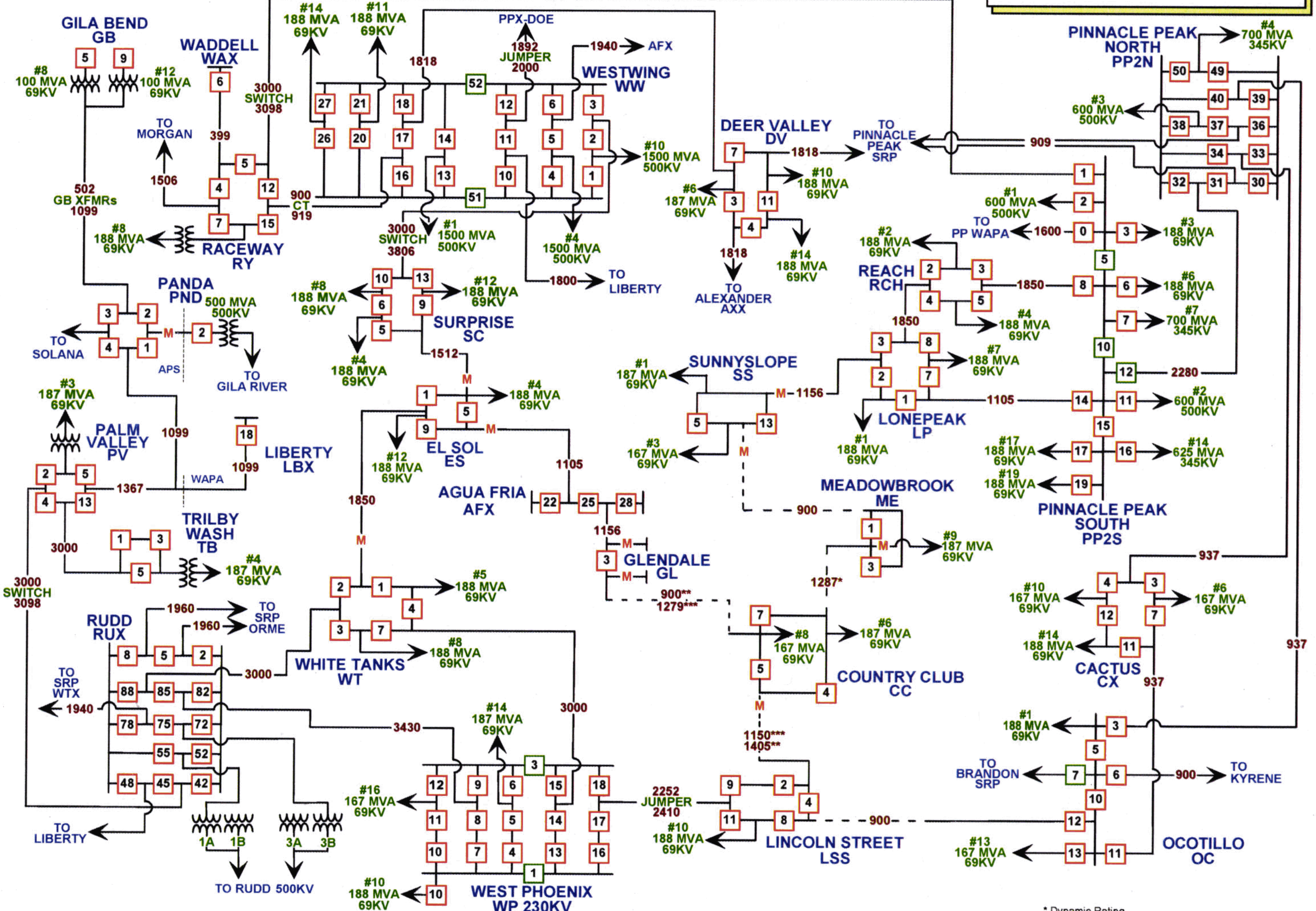
Rev. 11/19/15

METRO 230KV



* 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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Rev. 11/19/15

METRO 230KV
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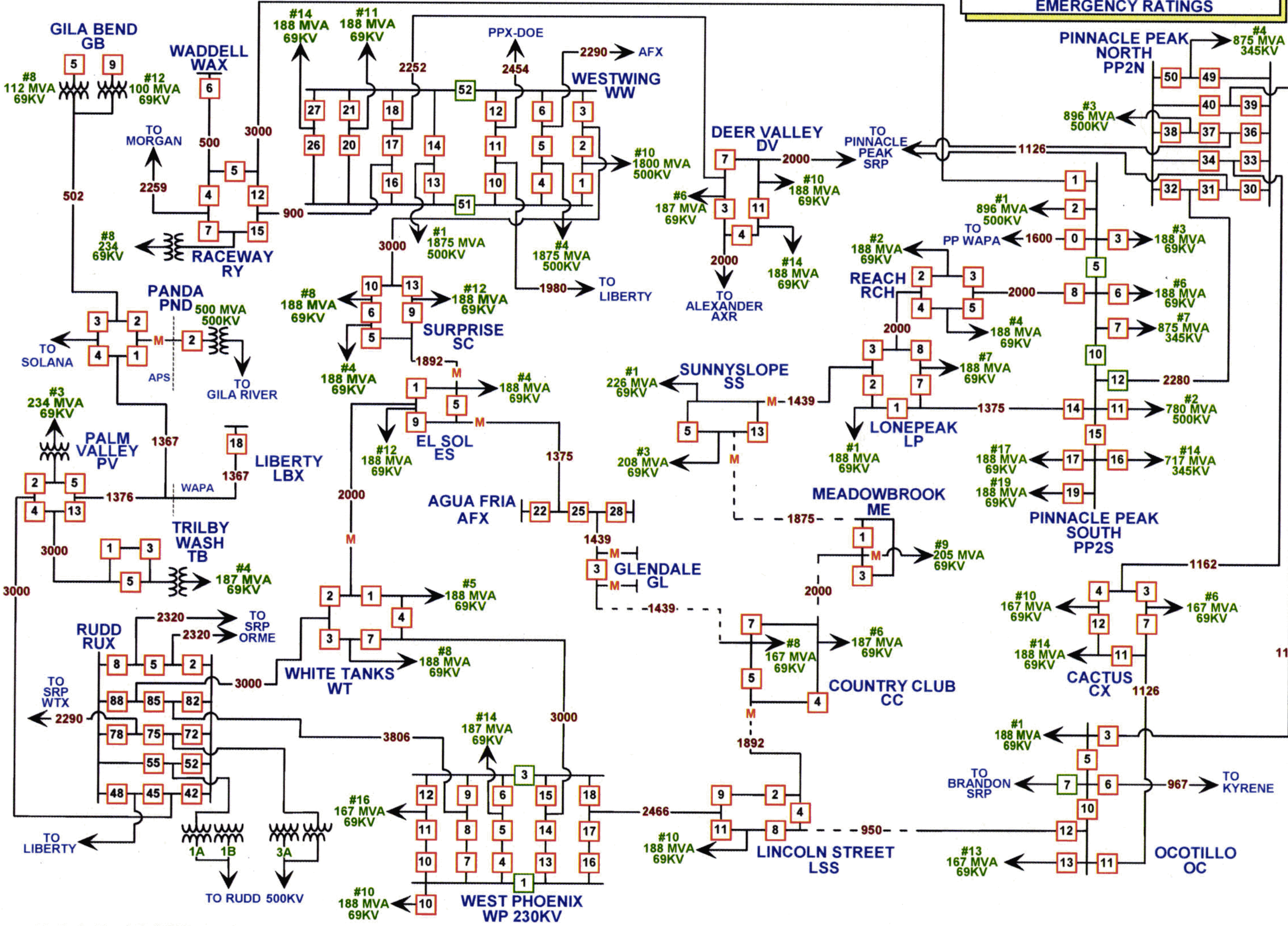

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Rev. 11/19/15

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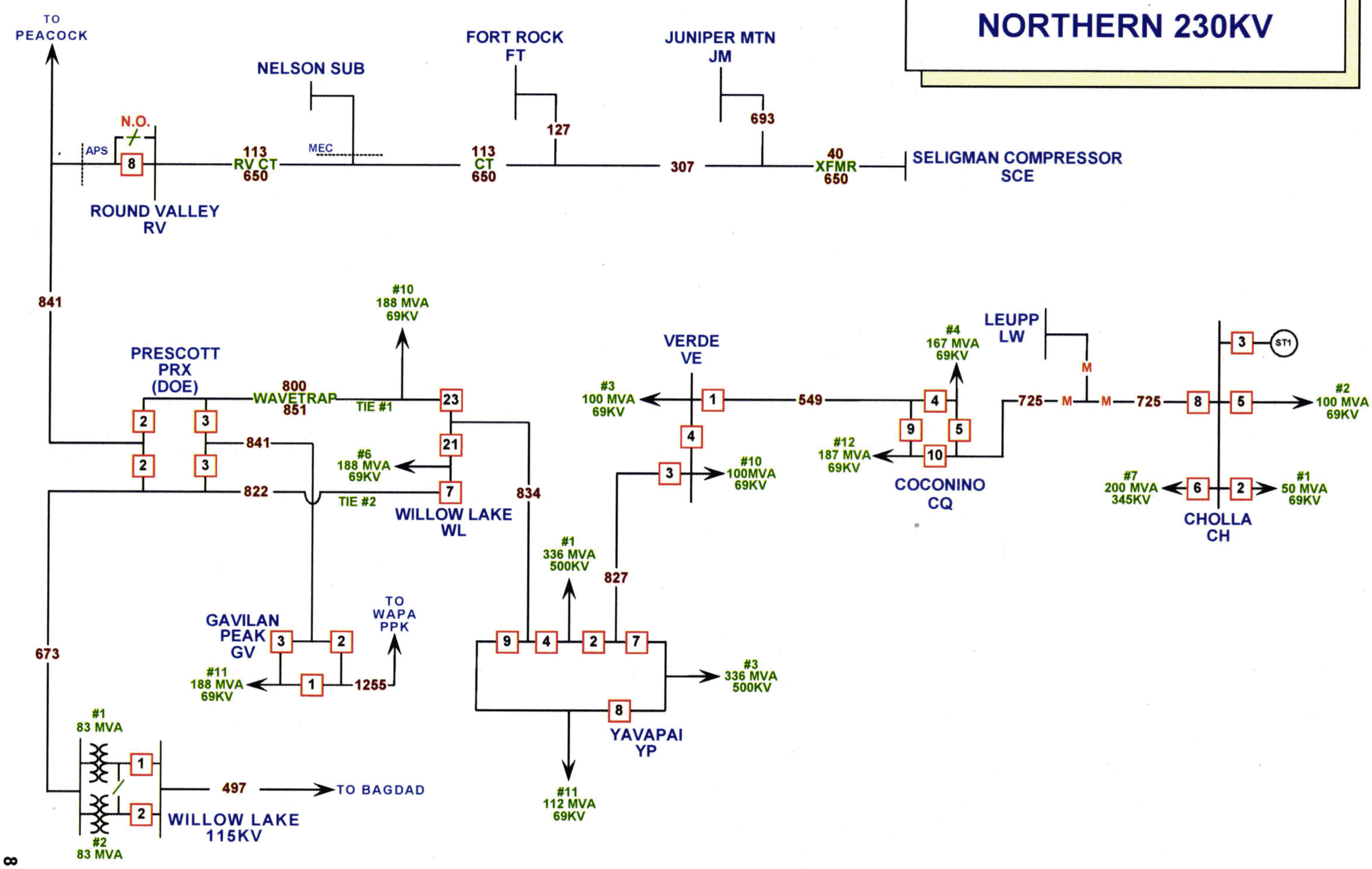

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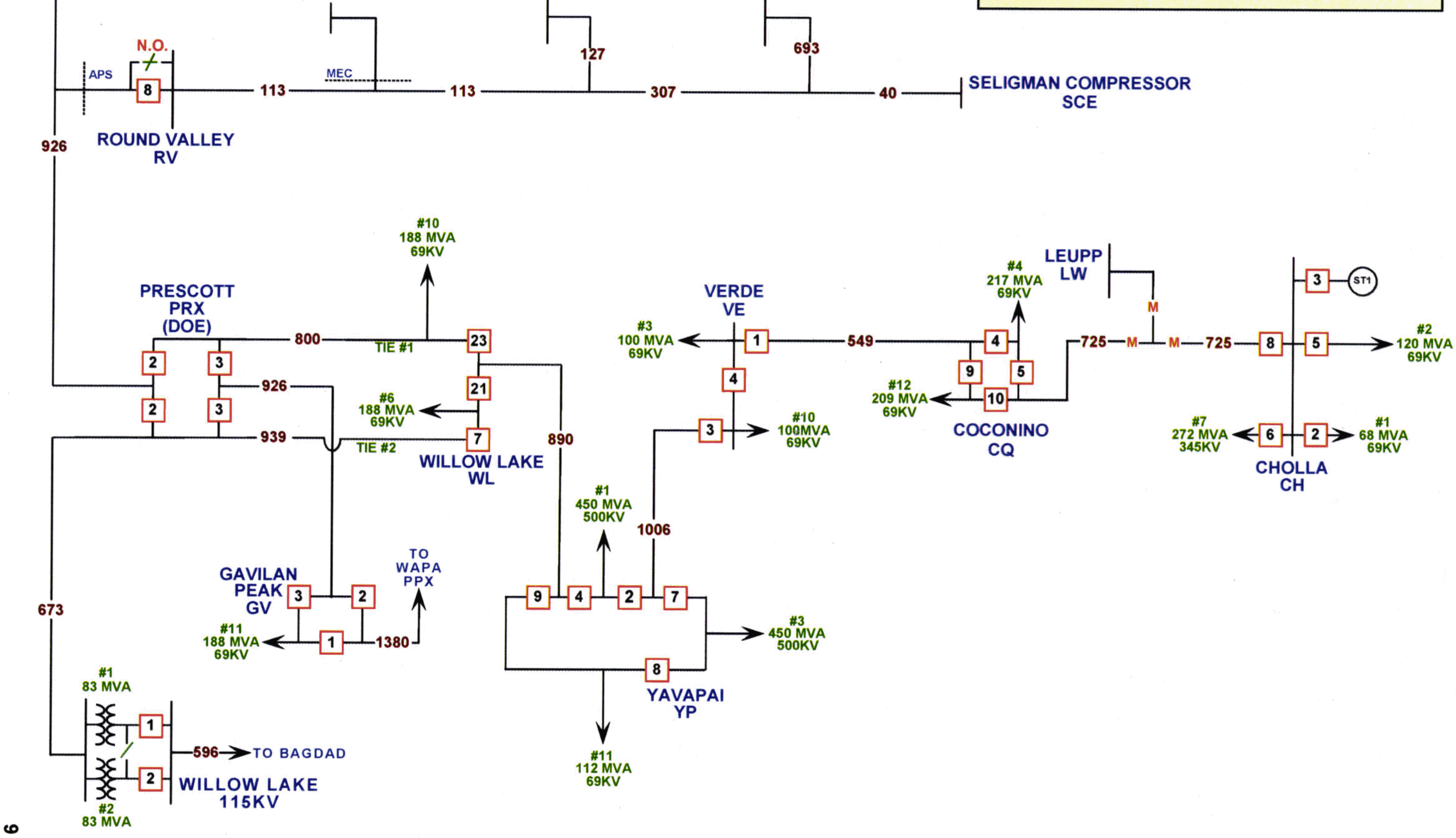

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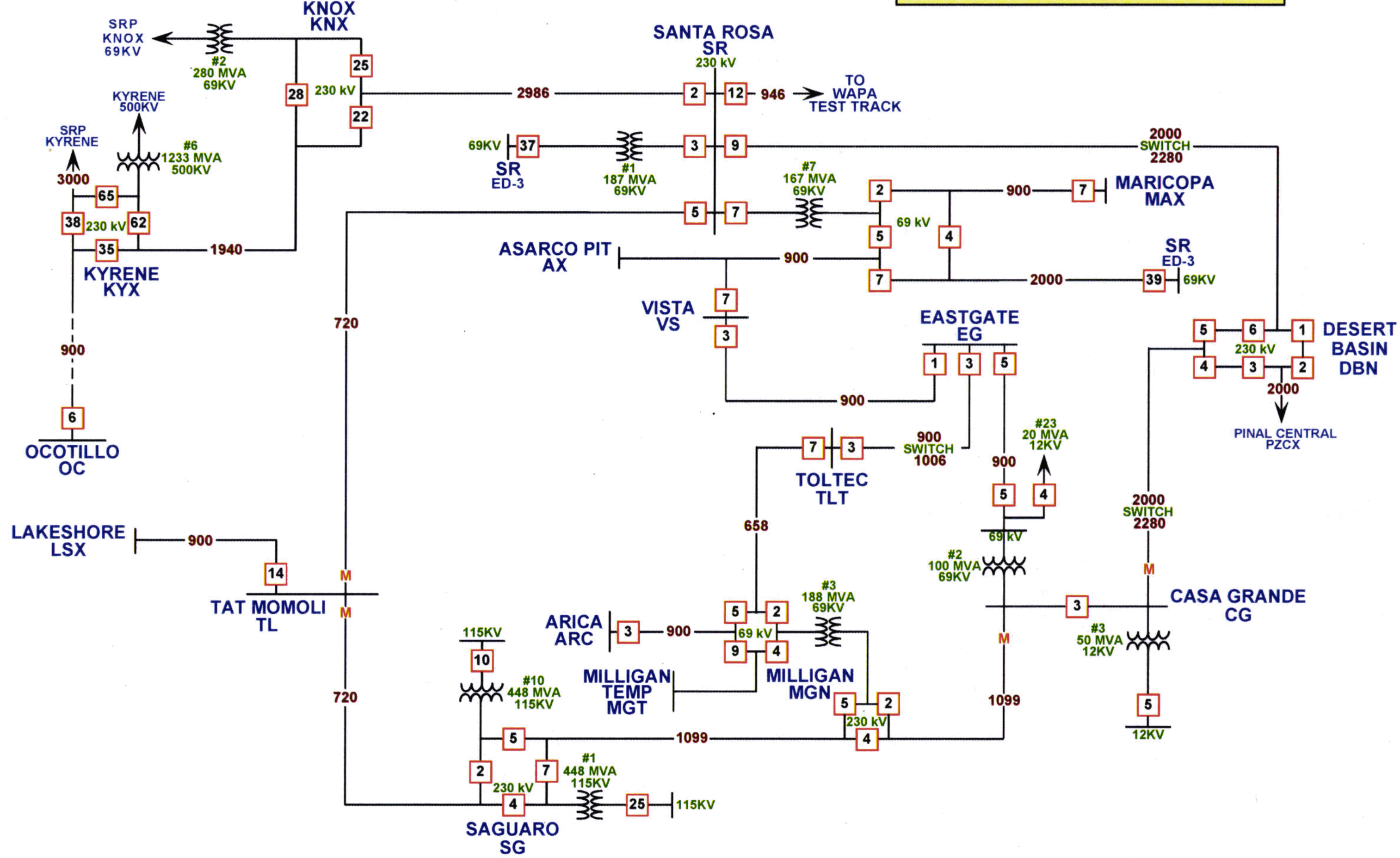
Rev. 11/19/15

SOUTHERN 230KV



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SOUTHERN 230KV
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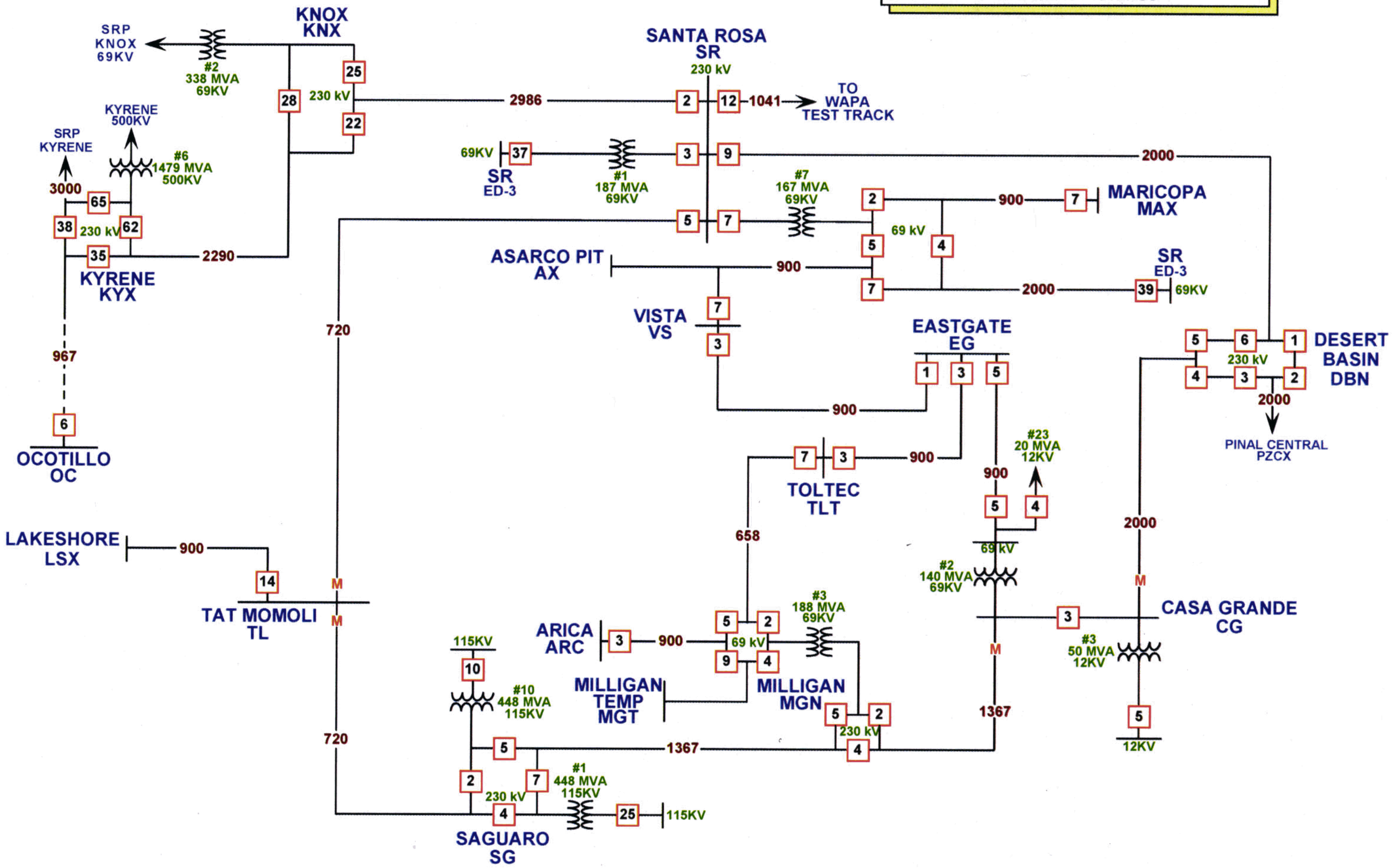


ARIZONA PUBLIC SERVICE COMPANY

TEN-YEAR TRANSMISSION SYSTEM PLAN

2016 – 2025

TECHNICAL STUDY REPORT

FOR

THE ARIZONA CORPORATION COMMISSION

JANUARY 2016

Executive Summary

This technical study report is performed 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 in accordance with requirements and system performance described in North American Electric Reliability Corporation ("NERC") Standard TPL-001-4 "Transmission System Planning Performance Requirements." APS performs annually P0 and P1 analysis on ten cases representing planning years one through ten. This plan represents years 2016 through 2025. A comprehensive list of contingencies was developed for the P1 contingency analysis base on criteria found in TPL-001-4 Table 1.

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-001-4 and APS's transmission system is planned to reliably meet the needs of our customers.

Table of Contents

ARIZONA PUBLIC SERVICE COMPANY
2016-2025
TEN-YEAR TRANSMISSION SYSTEM PLAN
TECHNICAL STUDY REPORT

1 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 (2016-2025) and performed for two scenarios: (i) assumption that all transmission system elements are in service and within continuous ratings (P0); and (ii) assumption of an outage on a single element, with all remaining system elements remaining within emergency ratings (P1). 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 exhibit positive damping.

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 transmission-constrained or other areas.

2 Base Case Development

Power flow cases were created for each year of the 2016-2025 study time frame. These cases were developed from the latest available WECC heavy summer power flow cases.

The 2015 heavy summer operating case was chosen as the first seed case. This case was developed from a 2015 WECC heavy summer base case, and then updated in a coordinated effort between Arizona utilities, as well as the Imperial Irrigation District (IID), to include the sub-transmission models. This case was used as the seed case in the creation of the 2016-2019 power flow cases used for the power flow analyses performed for the 2016-2025 Ten-Year Plan. Each intermediate case developed was updated, by APS and SRP, with the forecasted loads and any system additions/upgrades that are planned in the respective year.

The second seed case chosen was the 2020 heavy summer power flow case that was developed through the SWAT-Arizona (SWAT-AZ) sub-committee. In a collaborative effort, the Arizona utilities used the 2020 case to develop a 2020 summer case that included the sub-transmission systems of the Arizona utilities and IID. This seed case was used to develop the 2021-2023 power flow cases. Each intermediate case developed was updated, by APS and SRP, with the forecasted loads and any system additions/upgrades that are planned in the respective year.

The third and final seed case chosen was the 2024 heavy summer power flow case that was also developed through the SWAT-AZ sub-committee. In a collaborative effort, the Arizona utilities used the 2024 case to develop a 2024 summer case that included the sub-transmission systems of the Arizona utilities and IID. This seed case was used to develop the 2025 power flow case. The 2025 intermediate case developed was updated, by APS and SRP, with the forecasted loads and any system additions/upgrades that are planned in the respective year.

The forecasted loads modeled within all the power flow base cases include the effects of distributed renewable generation as well as energy efficiency programs. In addition, the forecasted loads are based on the most recent data at the time the cases were constructed.

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 and IID system are represented.

3 Power Flow Analyses

APS performs analysis on base case and single contingency conditions to assess APS's system and neighboring systems. This analysis will determine any needs and timing for transmission additions and assess the impact of those additions on APS's system and neighboring systems. Various iterations of possible solutions lead to the final plans for transmission additions. The current APS planning practice is to include contingency analysis of system elements; lines, transformers, shunt devices, and generators; in the following regions:

- Arizona greater than 100kV including all generation - WECC model Area 14
  - APS, SRP, SWTC, TEP, WALC, Others[1]
- APS's 69kV sub-transmission
- El Paso Electric 100kV and above - WECC model Area 11
- Imperial Irrigation District's system greater than 60kV - WECC model Area 21 or Area 8[2]
- Los Angeles Department of Water and Power greater than 90kV - WECC model Area 26

[1] Some local Load Serving Entities, such as local Electrical Districts, are also included in the expanded Arizona system model.

[2] Area 21 is IID's model included in WECC base cases. Area 8 is the more detailed version of IID's system model.

- Public Service Company of New Mexico 100kV and above - WECC model Area 10
- San Diego Gas & Electric greater than 90kV - WECC model Area 22
- Southern California Edison greater than 90kV - WECC model Area 24
- Southern Nevada (NV Energy) 100kV and above – WECC model Area 18
- Utah (Rocky Mountain Power) 100kV and above – WECC model Area 65 (PACE)
- WACM[3] 100kV and above - WECC model Area 73
- Mexico-CFE (Comision Federal Electricidad) greater than 90kV – WECC model Area 20

Due to the increase in monitored areas and the number of contingencies, the comprehensive lists of contingencies are not included in this report. However, they are available upon request by WECC or any other authorized stakeholder.

The APS system includes several reactive power resources that are used to maintain bus voltages within the limits defined by APS's Transmission Planning Process & Guidelines. These reactive power resources include shunt devices, series compensation, and tap changing transformers. APS also uses the reactive capabilities of its generators to assist in controlling system voltages. The reactive power resources are adequate and meet the system performance criteria.

APS does not have any additional existing or planned voltage or power flow control devices except those noted in the preceding paragraph. These devices, such as phase-shifting transformers, 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, in the steady state analysis it is not necessary to study planned outages since this Ten-Year Plan study focuses on the heavy summer peak time. In the transient stability analysis the 2017 spring case used does include some base load generators off-line due to lower load levels and maintenance schedules.

The transmission projects included in APS's Ten-Year plan are tabulated in a Security Needs Table, Table 1, and an Adequacy Needs Table, Table 2, as shown below. These tables identify 7 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). A summary of the power flow results is shown in Table 3.

[3] Western Area Power Administration – Colorado Missouri

Table 1: Security Needs Table

Transmission Project	In Service Year	Critical Outage	Limiting Element/Condition	Map
Mazatzal 345/69kV Substation	2017	Preacher Canyon – Owens– Tonto 69kV line	Voltage deviations on the sub-transmission system in the area resulting in load shedding. Also overloads the Childs-Irving-Strawberry 69kV line.	B4-B5

Table 2: Adequacy Needs Table

Transmission Project	In Service Year	System Benefits
Palo Verde-Delaney 500kV Line	2016	Increases the export scheduling capability from the PV area to provide access to both solar and gas resources. The project also provides for the interconnection of solar generation projects into the Delaney switchyard.
Delaney-Sun Valley 500kV Line	2016	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. Along with the Sun Valley-Trilby Wash 230kV line, provides a new transmission source for power in the far north and west sides of the Phoenix Metropolitan transmission system.
Sun Valley-Trilby Wash 230kV Line	2016	Provides a second 230kV source for Trilby Wash so that it is not served as a radial substation, thereby increasing the local system reliability. With the 500kV source at Sun Valley, the project provides a new source for power in the far north and west sides of the Phoenix Metropolitan transmission system.
Ocotillo Modernization Project 230kV Interconnection Lines	2018	APS plans to modernize the Ocotillo Power Plant by retiring two 1960's-era steam generators and replacing them with five (5) quick-start natural Gas Turbines (GTs), and constructing associated 230kV transmission generation interconnections. The new generators will increase reliability in the Phoenix load center and upgrade Ocotillo's generation capabilities with advanced, high-efficiency technology.
Morgan- Sun Valley 500kV Line	2018	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 transmission corridor contingencies.
North Gila-Orchard 230kV Line	2021	To distribute and deliver power within the Yuma area which increases the ability to import power and the reliability of the Yuma 69kV system.

4 Stability Analyses

A stability simulation for three-phase faults was performed for both the 2017 summer and spring cases for every non-radial BES element 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, with the possible exception of generators or generator step up transformers at the generator substation. Additionally, every new proposed generation plant is required to perform stability evaluations prior to receiving permission to interconnect to the transmission system. Due to the increase in the number of contingencies, the comprehensive lists of contingencies are not included in this report. However, they are available upon request by WECC or any other authorized stakeholder.

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 element removal. System performance was evaluated by monitoring representative generator rotor angles, bus voltages and system frequency. Plots of these system parameters are available to authorized stakeholders upon request. The stability simulations performed to date indicate that no stability problems limit the transmission system.

5 Category P0 and P1 Contingency Study Results

A high level overview of the results for the Category P0 and P1 contingences is shown in Table 3 below. From this table, it is shown that each of the Category P0 and P1 contingencies meets the NERC/WECC Planning Standards.

Table 3: Overview of Category P0 & P1 Standard Results

		1-5 year Time Frame		6-10 year Time Frame	
NERC Planning Standards Category P0		Case Years Studied	Standards Met?	Case Years Studied	Standards Met?
1	All Facilities in Service	2016 through 2020	Yes	2021 through 2025	Yes
		1-5 year Time Frame		6-10 year Time Frame	
NERC Planning Standards Category P1		Case Years Studied	Standards Met?	Case Years Studied	Standards Met?
1	Loss of an Element without a Fault	2016 through 2020	Yes	2021 through 2025	Yes
2	3-Phase Fault with Normal Clearing – Generator	2017 summer and 2017 spring	Yes		
3	3-Phase Fault with Normal Clearing – Transmission Circuit	2017 summer and 2017 spring	Yes		
4	3-Phase Fault with Normal Clearing – Transformer	2017 summer and 2017 spring	Yes		
5	3-Phase Fault with Normal Clearing – Shunt Device	2017 summer and 2017 spring	Yes		

Table 3 is a high level summary that shows, with the projects listed in Tables 1 & 2, the APS system meets the performance criteria listed in NERC Standards TPL-001-4. The detailed results of the transient stability, thermal power flow, and voltage steady state analyses, are not included. However, they are available upon request by WECC or any other authorized stakeholder.

APPENDIX A

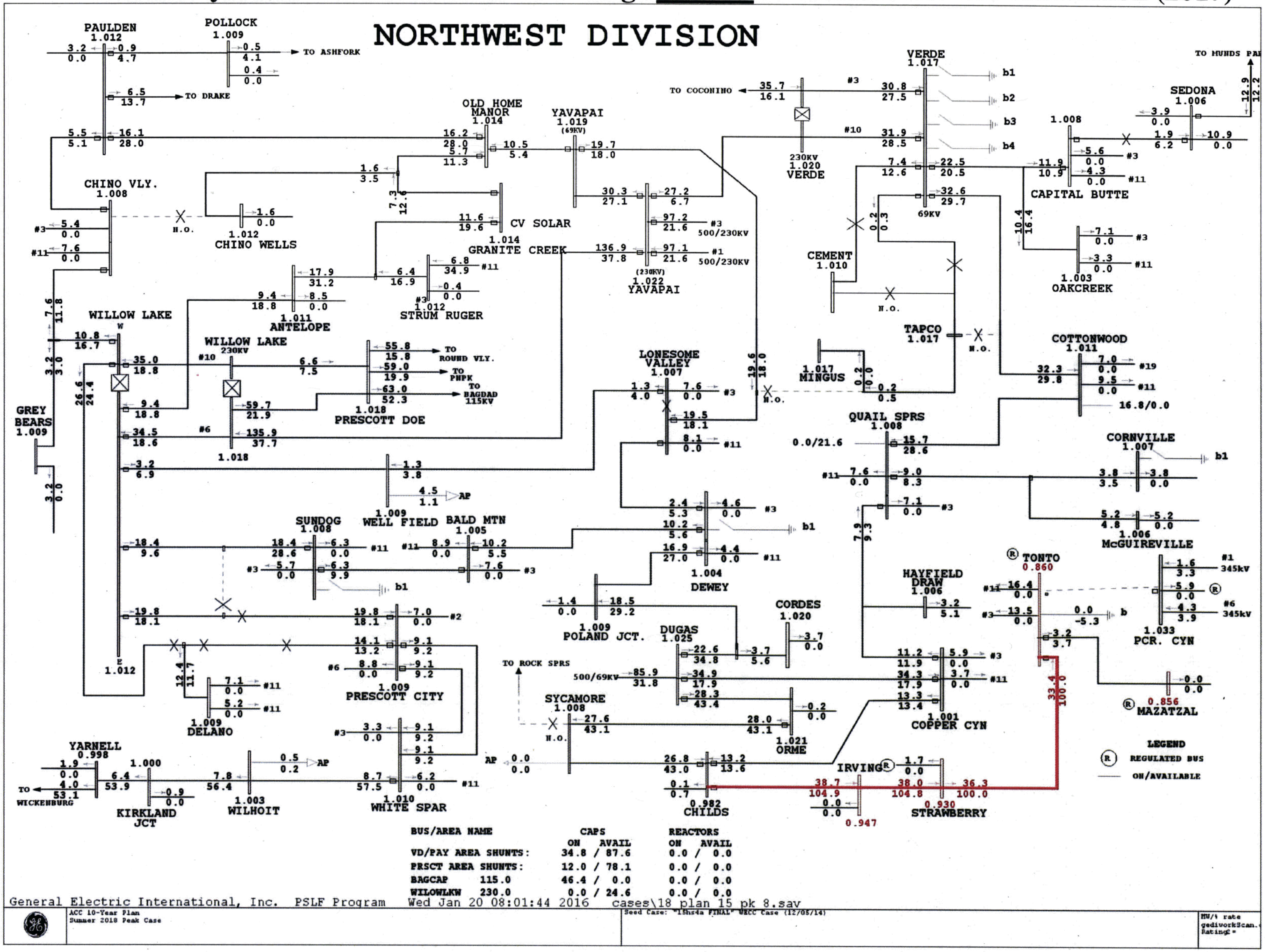
Steady-State Contingency Lists

Available upon request for authorized stakeholders

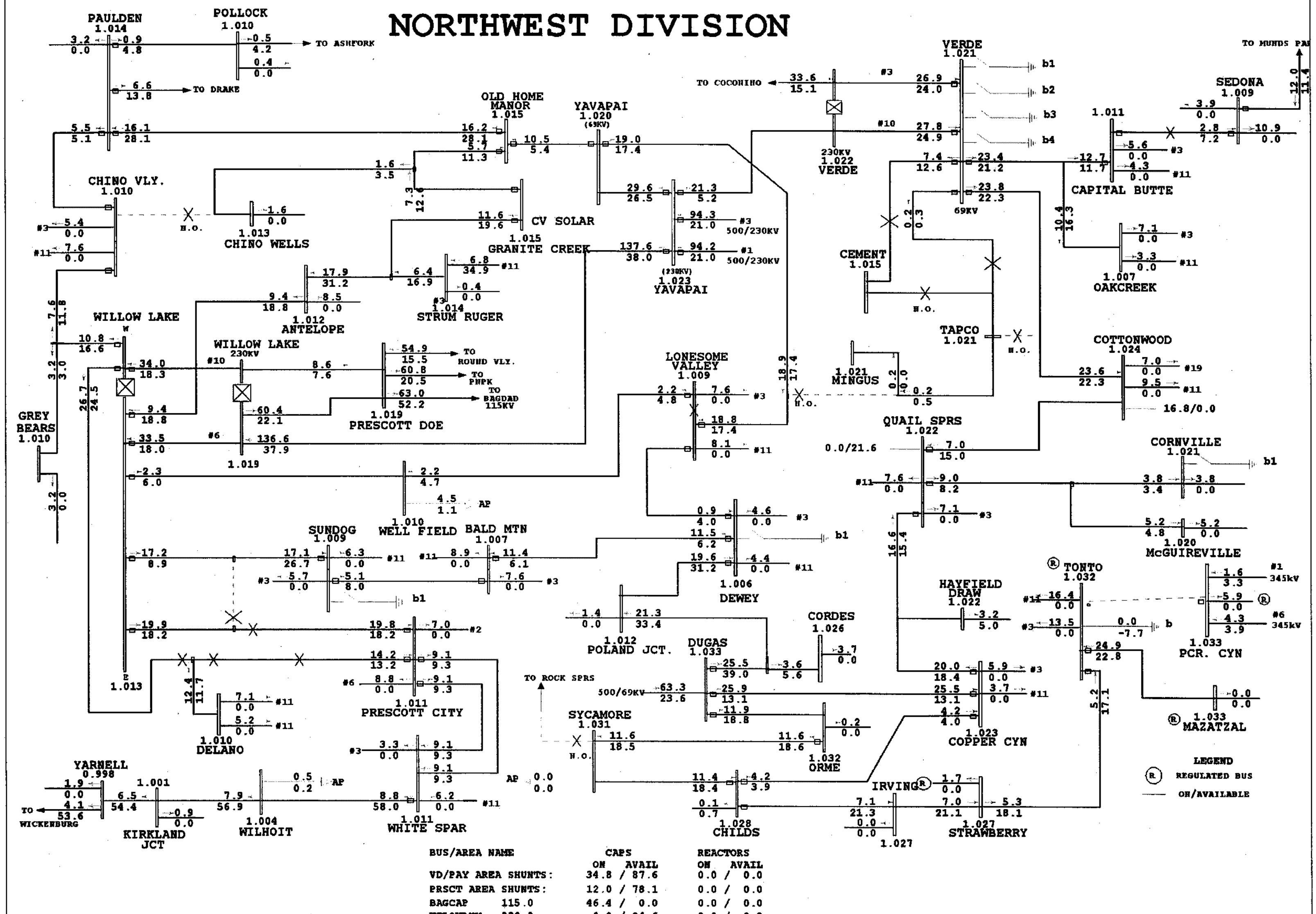
APPENDIX B

Power Flow Maps for Security Needs Project

Preacher Canyon – Owens – Tonto 69kV Outage without Mazatzal 345/69kV Substation (2017)



Preacher Canyon – Owens 69kV Outage with Mazatzal 345/69kV Substation (2017)



BUS/AREA NAME		CAPS ON / AVAIL	REACTORS ON / AVAIL
VD/PAY AREA SHUNTS:		34.8 / 87.6	0.0 / 0.0
PRSCT AREA SHUNTS:		12.0 / 78.1	0.0 / 0.0
BAGCAP	115.0	46.4 / 0.0	0.0 / 0.0
WILOWLKW	230.0	0.0 / 24.6	0.0 / 0.0

General Electric International, Inc. PSLF Program Wed Jan 20 08:06:22 2016 cases\18 plan 15 pk 8.sav

ACC 10-Year Plan
Summer 2018 Peak Case

Seed Case: "15hs4a FINAL" WECC Case (12/05/14)

APPENDIX C

2017 Summer Transient Stability Contingency List

Plots provided upon request for authorized stakeholders

APPENDIX D

2017 Spring Transient Stability Contingency List

Plots provided upon request for authorized stakeholders

Attachment B

Renewable Transmission Action Plan

Arizona Public Service Company
Renewable Transmission Action Plan
January 2016

In the Fifth Biennial Transmission Assessment ("BTA") Decision, (Decision No. 70635, December 11, 2008), the Arizona Corporation Commission ("ACC" or "Commission") ordered Arizona Public Service Company ("APS" or "Company") to file a document identifying their top potential Renewable Transmission Projects ("RTPs") that would support the growth of renewable resources in Arizona. As such, on January 29, 2010, APS filed with the Commission its top potential RTPs, which were identified in collaboration with Southwest Area Transmission planning group ("SWAT") and its subgroups, other utilities and stakeholders. In its filing, APS included a Renewable Transmission Action Plan ("RTAP"), which included the method used to identify RTPs, project approval and financing of the RTPs.

On January 6, 2011, the Commission approved APS's RTAP (Decision No. 72057, January 6, 2011[1]), which allows APS to pursue the development steps indicated in the APS RTAP. The Decision, in part, ordered:

> *IT IS FURTHER ORDERED that the timing of the next Renewable Transmission Action Plan filing shall be in parallel with the 2012 Biennial Transmission Assessment process.*
>
> *IT IS FURTHER ORDERED that Arizona Public Service Company shall, in any future Renewable Transmission Action Plans filed with the Commission, identify Renewable Transmission Projects, which include the acquisition of transmission capacity, such as, but not limited to, (i) new transmission line(s), (ii) upgrade(s) of existing line(s), or (iii) the development of transmission project(s) previously identified by the utility (whether conceptual, planned, committed and/or existing), all of which provide either:*
>
> 1. *Additional direct transmission infrastructure providing access to areas within the state of Arizona that have renewable energy resources, as defined by the Commission's Renewable Energy Standard Rules (A.A.C. R14-2-1801, et seq.), or are likely to have renewable energy resources; or*
> 2. *Additional transmission facilities that enable renewable resources to be delivered to load centers.*

Renewable expansion in the APS service territory (solar) has been trending toward the development of smaller scale renewable projects. APS has received many interconnection requests for these smaller solar projects, which interconnect directly into the local distribution system (69kV or below) rather than APS's high voltage transmission system. Additionally, APS has received only a few transmission system interconnection requests within the last two years.

The APS 2016-2025 Ten-Year Transmission System Plan does not show a need for additional RTPs beyond what the Commission previously approved in Decision No. 72057. As a result, in this RTAP, APS is not proposing new RTPs. APS will explore new renewable transmission opportunities when appropriate.

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[1] *Commission Decision No. 72057 found that APS's 2010 RTAP process and Plan is appropriate and consistent with the Commissions' Fifth Biennial Transmission Assessment final order.*

Arizona Public Service Company
Renewable Transmission Action Plan
January 2016

One of the filed RTP projects, Hassayampa-North Gila 500kV line #2 has been completed and placed into service. The project went in service in May, 2015.

The RTPs that APS filed in its original RTAP continue to be viable and will be developed as reliability and resource needs arise. The following section describes the remaining RTPs (approved by the Commission in Decision No. 72057), the expected cost for each, and the current status of each RTP.

1. Proposed development plan for a Delaney to Palo Verde 500kV project

Description: This project is one section of the Palo Verde to Sun Valley 500kV transmission line project that APS will need to import various generation resources to the Phoenix area load center. It is an integral piece to APS's 500kV infrastructure backbone in the greater Phoenix area. It also is an important component to the Delany to Colorado River (DCR)[2] transmission project as the project establishes the Delaney switchyard. The Delaney switchyard has been identified as the starting point for the DCR transmission project, which would provide a connection to the Southern California markets, and has the potential to enable additional renewable energy to be exported from Arizona to California.

Expected Cost: APS estimates the Company's portion of the project to cost approximately $51 million.

Current Status: APS acquired a Certificate of Environmental Compatibility ("CEC") for the project (Decision No. 68063, August 17, 2005). APS has almost completed the construction of the project. It is expected that the project will be placed in service prior to May, 2016.

2. Proposed development plan for a Palo Verde to Liberty and Gila Bend to Liberty projects

Description: The Palo Verde to Liberty and Gila Bend to Liberty are conceptual 500kV transmission line projects from the Palo Verde hub and from the Gila Bend/Gila River area to a new substation near the existing Liberty substation located in the west valley.

Current Status: The APS 2015 Ten-Year Plan Study does not currently show a need for these projects and, as a result, no further progress on the development plan has been made. This is primarily due to the previous downturn in the economy and a slowdown of renewable energy development in the area. APS will revisit these projects when appropriate.

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[2] *The Devers II project is now called Delaney to Colorado River (DCR).*

Attachment C

Technical Study on the Effects of Distributed Generation/Energy Efficiency on Fifth Year Transmission Plan

Technical Study

Effects of Distributed Generation and Energy Efficiency on Future Transmission Needs

ARIZONA PUBLIC SERVICE COMPANY

January 29, 2016

9th BTA (Docket No. E-00000D-15-0001)

Executive Summary

In Decision No. 74785 (October 24, 2014), the Eighth Biennial Transmission Assessment (Eighth BTA), the Commission ordered Arizona utilities with retail load to study the effects of Distributed Generation (DG) and Energy Efficiency (EE) on their future planned transmission systems in their fifth planning year – 2020 Heavy Summer model ("the Study").

Arizona Public Service (APS) and Salt River Project (SRP) collaborated on a study plan (Effects of DG/EE Study Plan) and coordinated it through the Southwest Area Transmission (SWAT) sub-regional planning group. SRP and APS coordinated DG and EE loads for each of their respective areas to match the scenarios as outlined in the study plan.

- The first case is the base case or typical system peak planning load which includes the effects of DG and EE in the load. The forecasted APS load is 7,361 MW.
- The second case is the base case with the projected increases in DG and EE over the next 5 years backed out of the load forecast. The projected increases of DG and EE from 2016 to 2020 are 703 MW; 145 MW for DG and 558 MW for EE. The total APS load studied for this scenario is 8,064 MW.

ES 1: Summary of Loads (MW) represented in each scenario.

Case	Scenario	Load (MW)	EE (MW)	DG (MW)	Utility Solar (MW)	Total Load (MW)
1	Base	8064	-558	-145	On	7361
2	EE/DG	8064	0	0	On	8064

The Study indicates that DG and EE have no effect on APS's Bulk Electric System (BES) as currently planned in 2020. If all of APS's current planning assumptions are found to be true over the next five years, including predictions about local growth and customer behavior, this analysis indicates that there may be some impact at the subtransmission level with delayed or non-implemented DG and EE. This impact would require advancing the in-service date of one 230/69kV substation an unknown number of years to alleviate overloads on existing 230/69kV transformers.

Table of Contents

1. Introduction

In Decision No. 74785 (October 24, 2014), the Eighth Biennial Transmission Assessment (Eighth BTA), the Commission ordered Arizona utilities with retail load to study the effects of Distributed Generation (DG) and Energy Efficiency (EE) installations and/or programs on their future planned transmission systems. The Decision states:

> The technical study should be performed on the fifth year transmission plan by disaggregating the utilities load forecasts from effects of DG and EE and performing contingency analysis with and without the disaggregate DG and EE. The technical study should at a minimum discuss DG and EE forecasting methodologies and transmission loading impacts. The study should monitor transmission down to and including the 115kV level. . . Alternative methodologies or study approaches will be acceptable on condition that the study results satisfy the minimum requirements [above].[1]

2. Study Requirements and Assumptions

2.1. Study Requirements

To fulfill this requirement in the Eighth BTA, the Study looks at two load scenarios, outlined in Table 1 below. The first case includes the forecasted load including the effects of DG and EE, per the typical planning process. The second case includes the forecasted load excluding the effects of projected increases in DG and EE between 2016 and 2020. This scenario is equivalent to "disaggregating the utilities load forecasts from effects of DG and EE." [2]

Table 1 - Summary of Cases

Case	Scenario	Load	EE	DG	Utility Solar
1	Base	Peak	On	On	On
2	EE/DG	Peak	Pre 2016 only	Pre 2016 only	On

The Study monitored the loading impacts to the transmission system and performed reliability analysis similar to how APS analyzes it in the ten year planning process. For the two cases, Bulk Electric System (BES) facilities (>100kV) are examined to ensure there are no thermal criteria

[1] Decision No. 74785 at pgs. 9-10, lns. 22-27 and 1-2.
[2] Decision No. 74785 at pg. 9, ln. 23.

violations with all lines in-service and for all single contingencies. Voltage limits and voltage deviation criteria are also monitored.

2.2. Base Case Assumptions

The 2020 heavy summer case was a "seed case" coordinated through the Southwest Area Transmission Arizona (SWAT-AZ) subcommittee. The case was reviewed and updated by all the Arizona utilities and the Imperial Irrigation District (IID). Salt River Project (SRP) and Arizona Public Service (APS) coordinated the base cases with the appropriate loads to meet the Study Requirements outlined above in Table 1.

- For APS, all of the MW contributions of DG and EE were assumed to be in the metro Phoenix load areas, because that is where DG and EE are most prevalent. Since the Study uses the metro Phoenix load areas, this assumption may have the effect of overestimating the amount of DG and EE on the system and may cause an overstatement of the impact it may have on the transmission plans.
- Identified large industrial loads were not scaled during the process of creating the scenario cases.
- Power schedules in the case were adjusted between California and Arizona to account for the increased load.

3. Distributed Generation and Energy Efficiency Forecasting Methodology Description

While DG and EE have impacts on APS's system load, EE was the primary contributor to impacts found the Study. Estimates were developed to determine what each program's role was at the time of the system peak in 2020. APS's 2020 system peak forecast excluding the effects of DG and EE is 8,064 MW;[3] the 703 MW difference is comprised of 79% EE and 21% DG. The values of EE and DG can be seen below.

3.1. Energy Efficiency Impact

To forecast the EE program impact (net of demand response curtailment) on system peak in 2020, several steps were taken. First, efficiency measures in 2016 – 2020 were forecasted by assuming continued compliance with the EE Rules and Commission Orders, consistent with A.A.C. R14-2-2405 and outlined in APS's 2015 Demand Side Management Implementation

[3] Whereas an official estimate of geographic peaks has not been performed on the 2020 system peak, historically metro has accounted for approximately 70% of the system peak (2015 results were 70.4%, 2014: 70.7%). All expectations are for that trend not to change.

Plan.[4] Then, when the EE amounts were determined, as defined above, they were assessed to establish the programs overall impact coincident to APS's system peak.

(a) Existing EE impact at peak hour (defined as EE installed on or before 2015): **~670MW**
(b) Projected increases in EE at peak hour 2016 – 2020.

Table 2: Energy Efficiency Forecast 2016-2020[5]

	2016	2017	2018	2019	2020
EE installed 2016+ impact to peak	109 MW	225 MW	335 MW	444 MW	558 MW

Note: Values are cumulative

3.2. Distributed Generation Impact

The DG impact to load from installed DG systems in 2016 – 2020 was estimated using the average monthly volume of applications that APS received in 2015. That rate was then applied to each month of the forecast period until 2020 to forecast the total amount of DG installed on the network. From this, the impacts to the 2020 system coincident peaks from DG can be determined.

To determine the base system peak loading in the fifth year, 2020, following load values are determined:

(a) Existing DG impact at peak hour (defined as DG installed on or before 2015): **~130MW**
(b) Forecasted incremental DG at peak hour 2016 – 2020.

Table 3: Distributed Generation Forecast 2016-2020

	2016	2017	2018	2019	2020
DG installed 2016+ impact to peak	29 MW	58 MW	87 MW	116 MW	145 MW

Note: Values are cumulative

[4] Details on the program used in the determination of the EE impact are defined in APS's 2015 Demand Side Management Implementation Plan in Docket E-01345A-15-0095.

[5] Data in above items represent a smoothed EE 2020 compliance target. Changes to represent annual or incremental compliance would be minimal, but can fluctuate annual impacts by 10MW to 15MW.

The load values for each case in Table 1 are listed below.

Table 4: Summary of Loads (MW) represented in each case.

Case	Scenario	Load (MW)	EE (MW)	DG (MW)	Utility Solar (MW)	Total Load (MW)
1	Base	8064	-558	-145	On	7361
2	EE/DG	8064	0	0	On	8064

4. Conclusion

The Study indicates that DG and EE have no effect on APS's Bulk Electric System as currently planned in 2020. If all of APS's current planning assumptions are found to be true over the next five years, including predictions about local growth and customer behavior, this analysis indicates that there may be some impact at the subtransmission level. This impact may require advancing the in-service date of one 230/69kV substation an unknown number of years to alleviate overloads on existing 230/69kV transformers. The 230/69kV substations are continuously evaluated in planning studies to keep pace with system needs.

Appendix A

Power flow loading changes

(Loading values are per unit)

All Lines in Service

FROM NO.	FROM NAME	FROM KV	TO NO.	TO NAME	TO KV	CK ID	RATING NUMBER USED	RATING VALUE USED	RATING UNIT	BASE CASE	5PM CASE
14207	DEERVALY	230	84019	DEERVALE	69	1	1	188	MVA	0.898	1.016
14207	DEERVALY	230	84020	DEERVALW	69	1	1	188	MVA	0.884	1.
14207	DEERVALY	230	84124	DEERVALC	69	2	1	187	MVA	0.862	0.976
14243	GAVILNPK	230	84247	GAVILNPK	69	1	1	188	MVA	0.878	0.998
14259	WESTWNGE	230	84359	WESTWING	69	2	1	187	MVA	0.891	0.988
14259	WESTWNGE	230	84359	WESTWING	69	1	1	188	MVA	0.886	0.983

Contingency - LINE Buckeye 230kV to Liberty 230kV

FROM NO.	FROM NAME	FROM KV	TO NO.	TO NAME	TO KV	CK ID	RATING NUMBER USED	RATING VALUE USED	RATING UNIT	BASE CASE	5PM CASE
14207	DEERVALY	230	84019	DEERVALE	69	1	2	188	MVA	0.9	1.019
14207	DEERVALY	230	84020	DEERVALW	69	1	2	188	MVA	0.886	1.003
14207	DEERVALY	230	84124	DEERVALC	69	2	2	187	MVA	0.864	0.978
14243	GAVILNPK	230	84247	GAVILNPK	69	1	2	188	MVA	0.88	1.
14259	WESTWNGE	230	84359	WESTWING	69	2	2	187	MVA	0.893	0.991
14259	WESTWNGE	230	84359	WESTWING	69	1	2	188	MVA	0.888	0.986

Contingency - LINE Deer Valley 230kV to Alexander 230kV

FROM NO.	FROM NAME	FROM KV	TO NO.	TO NAME	TO KV	CK ID	RATING NUMBER USED	RATING VALUE USED	RATING UNIT	BASE CASE	5PM CASE
14207	DEERVALY	230	84019	DEERVALE	69	1	2	188	MVA	0.976	1.09
14207	DEERVALY	230	84020	DEERVALW	69	1	2	188	MVA	0.961	1.072
14207	DEERVALY	230	84124	DEERVALC	69	2	2	187	MVA	0.937	1.046
14243	GAVILNPK	230	84247	GAVILNPK	69	1	2	188	MVA	0.877	0.997
14259	WESTWNGE	230	84359	WESTWING	69	2	2	187	MVA	0.914	1.01
14259	WESTWNGE	230	84359	WESTWING	69	1	2	188	MVA	0.909	1.005

Contingency - LINE Deer Valley 230kV to West Wing East 230kV

FROM NO.	FROM NAME	FROM KV	TO NO.	TO NAME	TO KV	CK ID	RATING NUMBER USED	RATING VALUE USED	RATING UNIT	BASE CASE	5PM CASE
14243	GAVILNPK	230	84247	GAVILNPK	69	1	2	188	MVA	0.878	0.999
14259	WESTWNGE	230	84359	WESTWING	69	2	2	187	MVA	1.046	1.151
14259	WESTWNGE	230	84359	WESTWING	69	1	2	188	MVA	1.04	1.145

Contingency - LINE Reach 230kV to Pinnacle Peak Center 230kV

FROM NO.	FROM NAME	FROM KV	TO NO.	TO NAME	TO KV	CK ID	RATING NUMBER USED	RATING VALUE USED	RATING UNIT	BASE CASE	5PM CASE
14207	DEERVALY	230	84019	DEERVALE	69	1	2	188	MVA	0.912	1.036
14207	DEERVALY	230	84020	DEERVALW	69	1	2	188	MVA	0.897	1.019
14207	DEERVALY	230	84124	DEERVALC	69	2	2	187	MVA	0.875	0.994
14243	GAVILNPK	230	84247	GAVILNPK	69	1	2	188	MVA	0.884	1.008
14260	PPAPS C	230	84267	PINNPK E	69	1	2	188	MVA	0.908	1.105
14259	WESTWNGE	230	84359	WESTWING	69	2	2	187	MVA	0.894	0.994
14259	WESTWNGE	230	84359	WESTWING	69	1	2	188	MVA	0.89	0.989

Contingency - TRANSFORMER Pinnacle Peak 345kV to Pinnacle Peak Center 230kV

FROM NO.	FROM NAME	FROM KV	TO NO.	TO NAME	TO KV	CK ID	RATING NUMBER USED	RATING VALUE USED	RATING UNIT	BASE CASE	5PM CASE
14207	DEERVALY	230	84019	DEERVALE	69	1	2	188	MVA	0.927	1.057
14207	DEERVALY	230	84020	DEERVALW	69	1	2	188	MVA	0.912	1.04
14207	DEERVALY	230	84124	DEERVALC	69	2	2	187	MVA	0.89	1.015
14243	GAVILNPK	230	84247	GAVILNPK	69	1	2	188	MVA	0.912	1.046
14221	PPAPS W	230	84268	PINNPK W	69	1	2	187	MVA	0.875	1.032
14259	WESTWNGE	230	84359	WESTWING	69	2	2	187	MVA	0.899	1.002
14259	WESTWNGE	230	84359	WESTWING	69	1	2	188	MVA	0.894	0.996