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Arizona Corporation Commission
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January 28, 2016

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

RE: Southwest Transmission Cooperative, Inc. Ten Year Transmission Plan
Docket No. E-00000D-15-0001

In compliance with A.R.S. § 40-360.02, enclosed please find Southwest Transmission Cooperative, Inc. ("SWTC") Ten Year Plan for the period 2016 – 2025. It includes the Ten Year Plan Report and the Technical Study Report.

An original copy plus thirteen copies pursuant to A.R.S. Section 40-360-02, has been included for each Report.

Sincerely,

Boris Tumarin
Manager of Transmission Planning

Enc.

c/Corporate Records

Southwest Transmission
COOPERATIVE, INC
A Touchstone Energy® Cooperative

TEN-YEAR TRANSMISSION PLAN

2016 – 2025
Docket No. E00000D-15-0001

RECEIVED
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AZ CORP COMMISSION
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JANUARY 28, 2016

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR TRANSMISSION PLAN

2016 – 2025

Prepared for the

ARIZONA CORPORATION COMMISSION

Docket No. E-00000D-15-0001

TRANSMISSION PLANNING

JANUARY 28, 2016

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SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR TRANSMISSION PLAN

GENERAL INFORMATION

This Ten-Year Plan is submitted to the Arizona Corporation Commission ("Commission") to satisfy the requirements of section 40-360.02 of the Arizona Revised Statutes ("A.R.S."), relating to power plant and transmission line siting requirements. It outlines the plans of Southwest Transmission Cooperative, Inc. ("SWTC") to install electric facilities required to reliably meet the system load growth of its Distribution Cooperative Members ("Members") and other network customers or by reliability requirements applicable to SWTC's transmission system.

This report contains transmission projects that SWTC anticipates may be constructed over the next ten-year period. As noted in A.R.S. section 40-360.02.F, the plans contained in this report are tentative information only and are subject to change at any time at the discretion of SWTC. SWTC anticipates that any changes to this plan will likely to be due to changes in load forecasts, environmental constraints, economic considerations, other utilities' plans, regulatory and legal developments, as well as future regional and federal mandates. All transmission projects are subject to a peer-review by SWTC's Class A Operating Committee ("CAOC") prior to submittal to the SWTC Board for approval. Meetings of the CAOC are held quarterly, or as needed, and changes to these projects are reviewed as necessary to meet the Member needs. The CAOC reviews the Construction Work Plan ("CWP") that is then submitted to the SWTC Board for approval. Once the CWP is approved, the projects are considered by SWTC as "planned" projects. Conceptual projects, or those that have not been vetted by the CAOC for placement into a CWP, may be included in ten year plan filings but will be listed as conceptual projects with tentative or "to-be-determined" ("TBD") in-service dates. TBD as used in this document means that in addition to the project not being yet vetted by the CAOC, it can also mean that the project is still in negotiations with other entities.

This specific report is divided into two sections, as outlined in the Table of Contents on page 2. Section I describes planned transmission lines and projects SWTC may construct over the ten-year plan period, whose nominal voltage is equal to or greater than one hundred fifteen thousand volts ("115 kV").

Section II contains SWTC's internal planning criteria and facility ratings, pursuant to Commission Decision #63876, dated July 25, 2001.

A technical study report to satisfy the requirements of paragraph C.7 of A.R.S. Section 40-360.02 has been prepared as a stand-alone document and will be filed jointly with this document.

REGIONAL PLANNING

SWTC has been an active participant in regional and sub-regional transmission planning efforts within the Western Interconnection for many years. This participation has been through the Southwest Area Transmission ("SWAT"), membership in the Western Electricity Coordinating Council ("WECC") and WestConnect. SWTC is involved in the following subcommittees of SWAT, either through active participation or copy interest:

- Arizona Subcommittee ("SWAT-AZ")
- Short-circuit Work Group ("SCWG")

SWTC is an active participant within the following committees of WECC:

- Operating Committee ("OC")
- Planning Coordination Committee ("PCC")
- Technical Studies Subcommittee ("TSS")
- System Review Work Group ("SRWG").

In addition, SWTC continues to monitor the efforts of the WECC Transmission Expansion Planning Policy Committee ("TEPPC") which has been tasked with the development of 10- and 20-year transmission plans for the Western Interconnection.

SWTC continues its involvement in the regional transmission planning activities of WestConnect as a Coordinating Transmission Owner in the Transmission Owner with Load Serving Obligations Sector. WestConnect coordinates its efforts with other regional planning entities and inter-regionally within the Western Interconnection, to comply with the provisions of the Federal Energy Regulatory Commission ("FERC") Order No. 1000 "Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities" that was issued July 21, 2011.

WestConnect completed its initial abbreviated planning cycle on December 31, 2015, and will begin its first full 2-year planning cycle beginning January 1, 2016. WestConnect continues to work with Subregional Planning Groups, such as SWAT, on data collection and modeling processes.

The Planning Management Committee ("PMC") under the Planning Participation Agreement ("PPA") that was filed on November 17, 2014 is responsible for development of a Regional Transmission Study Plan, development of an annual budget for the Regional and Inter-regional planning processes, activities, and functions, development of planning models, identification of Regional transmission needs, submittal of projects to meet Regional transmission needs and identification of beneficiaries and cost allocation. The structure of the PMC includes three standing subcommittees: (1) the Planning Subcommittee, (2) the Cost Allocation Subcommittee and (3) the Legal Subcommittee. Within the Planning Subcommittee are two working groups, the Expansion Planning Working Group that will perform benefits analyses and such other functions as defined and directed by the PMC, and the Power Flow Working Group that will perform power flow, voltage, stability, short circuit and transient analyses and such other functions as defined and directed by the PMC.

At the WestConnect Annual Stakeholder Meeting, held November 19, 2015, the results of the first planning cycle were revealed. The Regional Transmission Needs Assessment did not identify any reliability issues in 2015. A Scenario Submittal Form was introduced for the upcoming cycle which will allow utilities to submit scenarios that they believe should be included in the next study cycle. A process is currently being developed to collect and prioritize all the scenario submittals for the 2016-2017 study cycle.

8th BTA REQUIREMENTS

On October 24, 2014, the Commission approved the 8th BTA Report with Decision #74785 that adopted staff's recommendations and the Commission ordered studies. The specific recommendations and orders applying to SWTC are listed below, along with SWTC's response:

Recommendation #7D:

The policy that Arizona utilities advise each interconnection applicant, at the time the applicant files for interconnection, of the need to contact the Commission for appropriate ACC filing requirements related to the Power Plant and Transmission Line Siting Committee.

SWTC Response:

SWTC has complied with this requirement since the policy was instituted by providing language to this effect in a document posted on its OASIS site and also by providing this Commission policy in writing to potential applicants filing for interconnection to the SWTC system.

Recommendation #7E:

The continued requirement for Arizona utilities to report relevant findings in future BTA's regarding compliance with transmission planning standards from NERC/WECC reliability audits that have been finalized with FERC.

SWTC Response:

In February 2015 SWTC completed a NERC/WECC reliability audit for the period February 10, 2012 through October 24, 2014. As a result of this audit, SWTC was found to be in 100% compliance with all NERC and WECC standards.

Recommendation #7F:

The policy that the Load Serving Entitles ("LSE") in Cochise and Santa Cruz Counties continue to monitor the reliability in Cochise and Santa Cruz Counties, respectively, and propose any modifications that they deem to be appropriate in future Ten Year Plans. Staff also recommends that the Commission continue to collect applicable outage data from the respective utilities in order to monitor any changes to Cochise County and Santa Cruz County system reliability in future BTA proceedings.

SWTC Response:

In the Section "Additional Projects Under Consideration," below, SWTC outlines its continuing efforts with Arizona Public Service Company ("APS") and Sulphur Springs Valley Electric Cooperative, Inc. ("SSVEC") to develop the joint Tombstone Junction project in Cochise County to effect reliability improvements among the utilities.

Recommendation #7G:

The requirements for Arizona utilities to include planned transmission reconductor projects, transformer capacity upgrade projects, and reactive power compensation facility additions at 115 kV and above in future ten year plans.

SWTC Response:

SWTC has no transmission reconductor projects or transformer capacity upgrade projects to report in this ten year plan. There are reactive power compensation facility additions at 115 kV and above that are planned for this ten-year plan filing, as per the following schedule:

Year	Substation	MVAR Quantity
2016	Bicknell	19.2
2016	Butterfield	14.4
2016	San Rafael	10.8 (8.4 moved from Kartchner)

Additional studies conducted in 2016, reflecting the recently approved 2015 load forecast or other circumstances that may tend to refine these values and/or suggest the need to adjust locations for reactive support to the SWTC system. Any modifications will be reported in the next ten-year plan filing.

Recommendation #8A:

Direct Arizona utilities to ensure the Commission-ordered Ten Year Snapshot study monitors transmission elements down to and including the 115 kV level for thermal loading and voltage violations.

SWTC Response:

SWTC will provide this information to the entity that will develop the Ten Year Snapshot study as per this recommendation.

Recommendation #8B:

Direct Arizona utilities to describe the driving factor(s) for each transmission project in the Ten Year Plan. For each load growth or reliability driven transmission project, direct Arizona utilities to report, in addition to each transmission project in-service date, a system load level range at which each transmission project is anticipated to be needed. This requirement should first occur with the ten year plans filed in January 2016.

SWTC Response:

SWTC performed an optimization study in May 2014 that identified the need for additional reactive resources to restore voltage for several N-1 and N-2 contingencies. In 2015, a portion of these reactive resources were installed, and the remaining are scheduled to be installed in 2016. The driving factors for each of these resources is Reliability and Voltage Support.

Year	Substation	MVAR Quantity	Driving Factor
2016	Bicknell	19.2	Reliability/Voltage Support
2016	Butterfield	14.4	Reliability/Voltage Support
2016	San Rafael	10.8	Reliability/Voltage Support

Recommendation #8D:

Direct Arizona utilities with retail load to report, as part of the Ninth BTA, the effects of DG and EE installations and/or programs on future transmission needs. Staff recommends the Commission direct utilities to conduct or procure a study to more directly identify the effects of DG and EE installations and/or programs.

SWTC Response:

Given that SWTC is a transmission only cooperative with no retail load to serve, this recommendation is not applicable to SWTC.

CHANGES FROM 2015 TEN-YEAR PLAN FILING

There are a few changes to the projects considered by SWTC for inclusion in this Ten-Year Plan filing over last year's ("2015-2024") Ten-Year Plan filing. Projects are categorized as "Planned Projects" or "Additional Projects Under Consideration" These are noted below:

PLANNED PROJECTS

Saguaro Bypass ED5 to Marana Tap (Joint project). In September 2015 Western Area Power Administration (WAPA) proposed disconnecting from Saguaro one of the two 115 kV lines to ED5 and the 115 kV line to Marana Tap. These lines would be connected together via jumpers prior to their crossing the Freeway West of I-10. This would resolve overload issues of the Saguaro to Marana path for several outages seen in previous studies. In addition, this connection temporarily alleviates the overload of the Coolidge to Valley Farms 115kV line for the Saguaro Category C outage identified by APS. Multiple configurations of the project were presented to SWTC, APS, and TEP at a range of $500,000 to $1,300,000. The driving factor for this project is reliability, and WAPA has plans to seek funding to complete this project prior to Summer 2016. SWTC supports WAPA's effort and may be involved in the financing.

Tombstone Junction Project. This Cochise County project involves looping the SWTC Butterfield to San Rafael 230 kV line into a new Tombstone Junction Substation with a 230/69 kV transformation to the existing SSVEC Tombstone Junction Substation with a potential for additional system enhancements. APS and SWTC have studied variations of the project that has SWTC and APS interconnecting their respective systems in the vicinity which would further improve system reliability in Southeast Arizona. SWTC continues to meet with APS and SSVEC to discuss joint participation in the project. The driving factor for this project is reliability.

Valencia to CAP Black Mountain 115 kV line. This line segment was approved by the ACC Line Siting Committee on February 10, 2010 and by the Commission on April 14, 2010 (Case #152, Decision #71649) as part of the North Loop to Rattlesnake 115 kV Line Project. The project proposes a new 2.6 mile 115 kV line that will extend from the existing SWTC Valencia Substation to tie to the turning structure of the 115 kV CAP line that heads directly north 2 miles to the existing CAP Black Mountain Substation. This line project is being resurrected with CAP as a planned project. The driving factor for this project is reliability on both SWTC and CAP systems.

ADDITIONAL PROJECTS UNDER CONSIDERATION

SWTC continues to study the feasibility of additional projects for inclusion into future ten year plans that have been deferred from previous ten year plans for various reasons.

A brief description of each of these projects follows, for information purposes only. A driving factor is provided for each of these projects per BTA recommendation #8B. These projects are under consideration, but have not advanced far enough to have a projected in-service date.

SWTC will continue to hold discussions with potential project participants throughout 2016, and if refined project scopes have been established with agreements from project participants, and with approvals from governing boards, these projects may be reflected in next year's ten year plan.

Apache/Hayden to San Manuel 115 kV Line. This project has been presented in previous SWTC ten year plans, but was deferred from 2017 to beyond the ten-year plan horizon in last year's ten year plan filing. It was approved by the ACC Line Siting Committee on May 12, 2009 and by the Commission on July 9, 2009 (Case #142, Decision #71218). The project proposes the extension of a new 4.5 mile 115 kV line from the existing SWTC Apache to Hayden 115 kV line to the existing APS San Manuel Substation. The value to SWTC of this project depends on working out contact paths with APS connecting SWTC to Trico loads the from the east and north. This line project will require the agreement of APS and additional studies. The driving factor for this project is reliability.

Saguaro to Thornydale 115 kV Line. This line segment was approved by the ACC Line Siting Committee on October 7, 2009 and by the Commission on November 19, 2009 (Case #149, Decision #71420). The project proposed a new 15 mile 115 kV line between the existing APS Saguaro Substation and SWTC's existing Thornydale Substation which connects to TEP's 46 kV system. The existing peak load at Thornydale as modeled is 25.8 MW. This line project will require the agreement of APS and TEP, and potentially WAPA. The driving factor for this project is load growth and reliability. Several alternatives for this project are being considered by SWTC and the other utilities.

Potential for Overload of SWTC Greenlee 345/230 kV transformer. Under the current operating configuration, SWTC has identified outages of TEP's transmission system lines that would potentially overload SWTC's existing Greenlee transformer in peak load periods. SWTC is working with TEP to determine how to alleviate the situation. The driving factor for this strategy is reliability.

The following projects had previously been deferred by mutual agreement with the Central Arizona Project ("CAP").

> **Thornydale to Twin Peaks 115 kV Line. Thornydale to Twin Peaks 115 kV Line.** This line segment was approved by the ACC Line Siting Committee on February 10, 2010 and by the Commission on April 14, 2010 (Case #152, Decision #71649). The project proposes a new 8 mile 115 kV line between SWTC's Thornydale Substation and the CAP Twin Peaks Substation. This line project will require the agreement of CAP and is pending additional

studies. The driving factor for this project has been load growth and reliability, but alternatives to this project are being considered that may be more workable and cost effective.

CAP 115 kV Line Tap to SWTC Sandario Substation. This line segment was also approved by the ACC Line Siting Committee on February 10, 2010 and by the Commission on April 14, 2010 (Case #152, Decision #71649) as part of the North Loop to Rattlesnake 115 kV Line Project. The project proposes that a new 0.6 mile 115 kV line to be tapped off of the existing CAP Sandario to Brawley 115 kV line to tie to the existing SWTC Sandario Substation. This line project will require the agreement of CAP and is pending additional studies. The driving factor for this project is reliability.

Saguaro to Tucson 115 kV Line Loop-in To Marana. SWTC reported in last year's ten year filing that this project was being withdrawn. With the addition of the Saguaro Bypass Project described earlier, the advantages of the Marana Loop-In project will again be given consideration, and will be studied with neighboring utilities in the upcoming year in conjunction with the Saguaro Bypass project. The driving factor for this project is reliability.

PROJECT MAPS

The following maps are included to show the location of existing and future transmission projects and as presented include only the planned reactive power compensation projects of SWTC as outlined on page 8. There planned additions of AEPCO's Members are not included on these maps or reflected in this filing.

These maps have historically resided in the Technical Study Report, but will also be included in this document for ease of reference to the planned projects noted previously. The maps included in this report are:

FIGURE 1
SWTC NORTHERN AREA SYSTEM

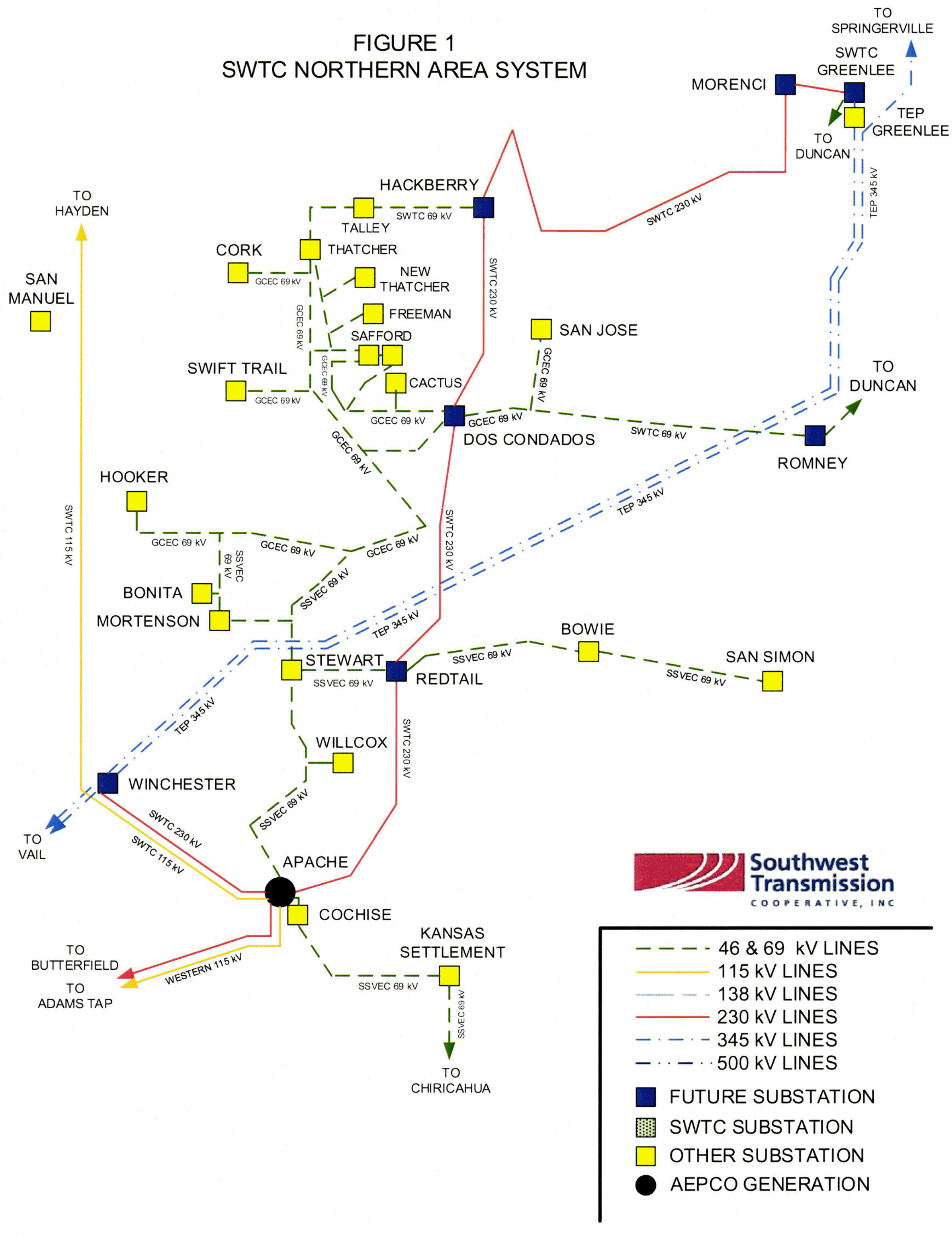


FIGURE 2
SWTC SOUTHERN AREA SYSTEM

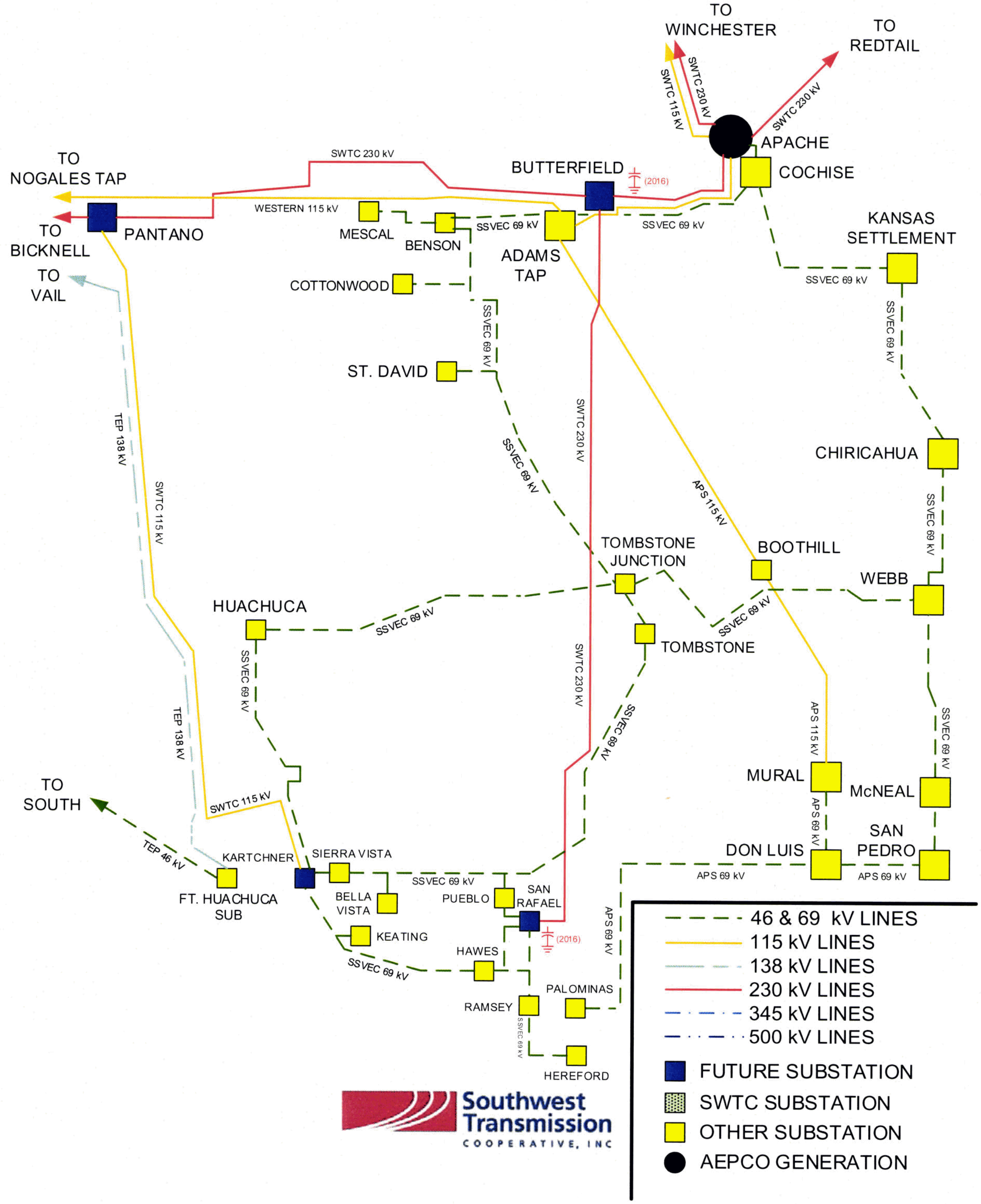


FIGURE 3
SWTC WESTERN AREA SYSTEM

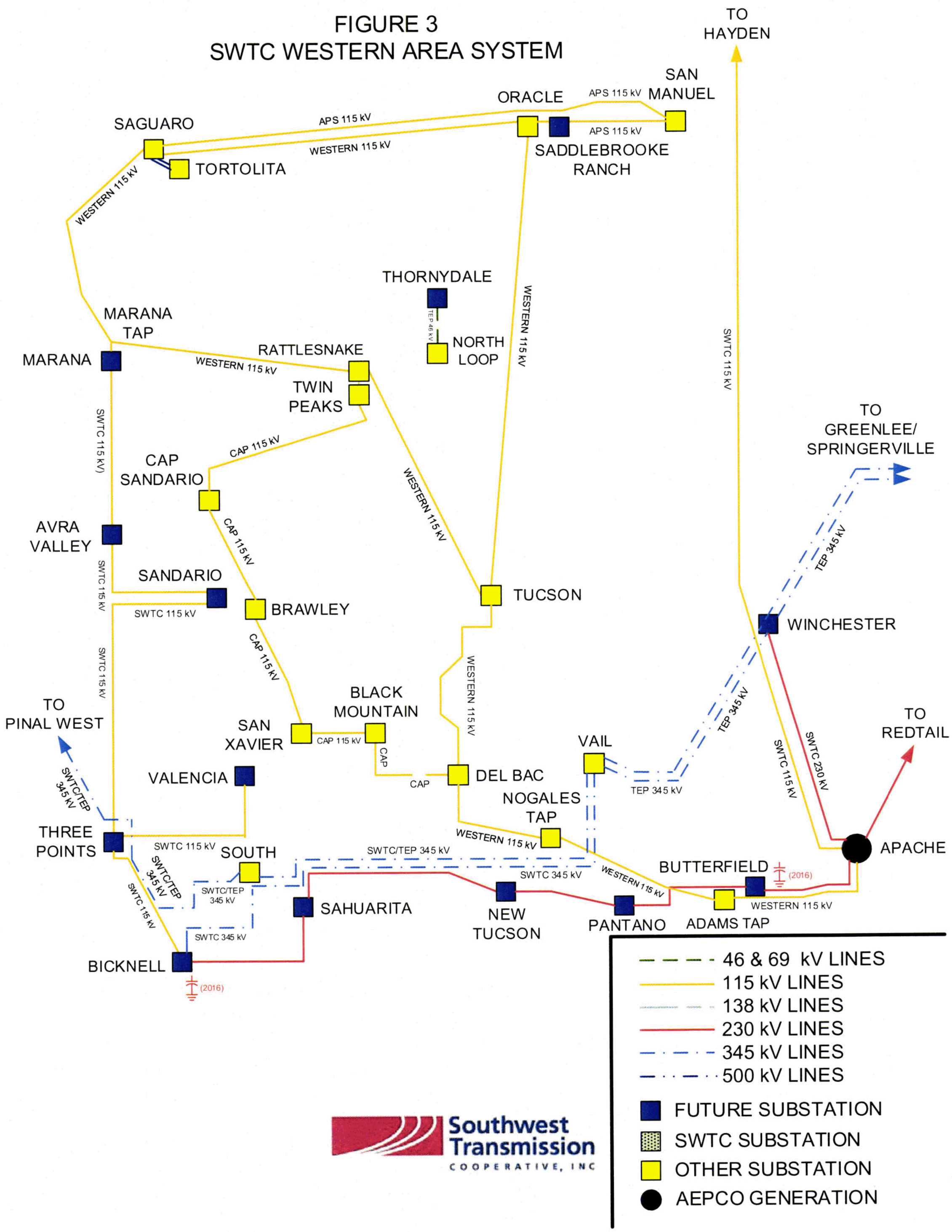


FIGURE 4
SWTC CALIFORNIA & NORTHWEST ARIZONA AREA SYSTEMS

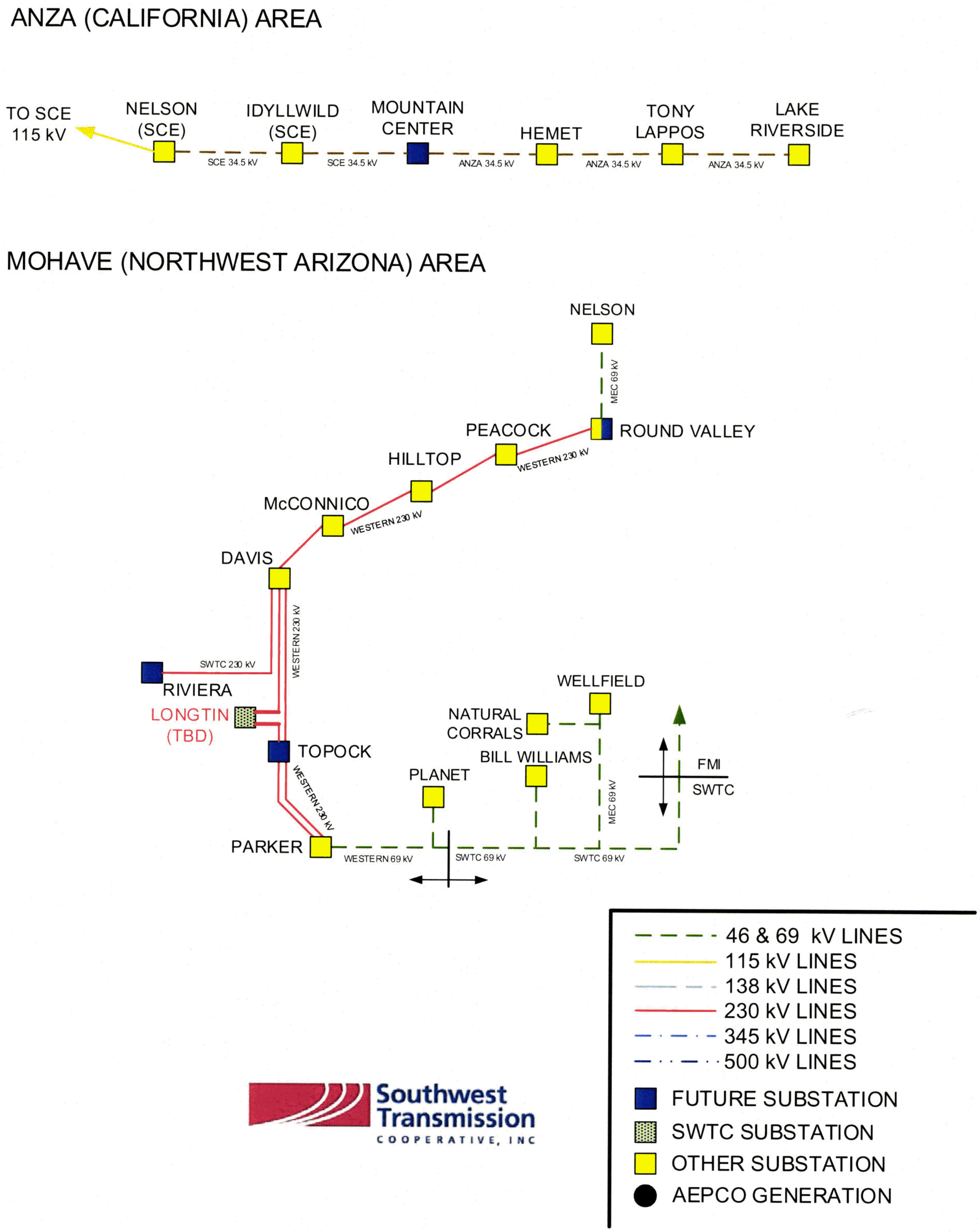


Figure 5 – Saguaro Bypass Project

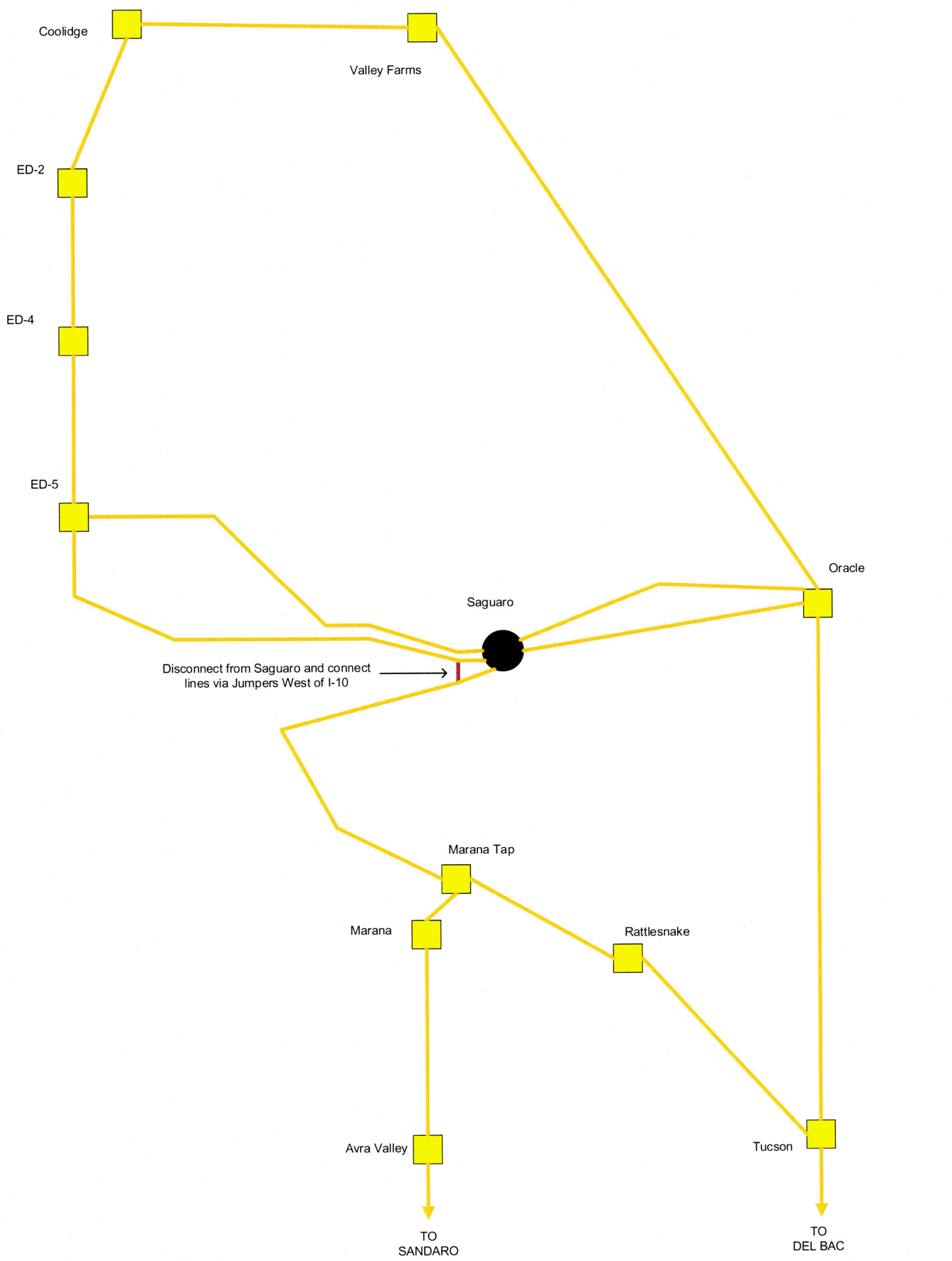


Figure 6 – Tombstone Junction Project

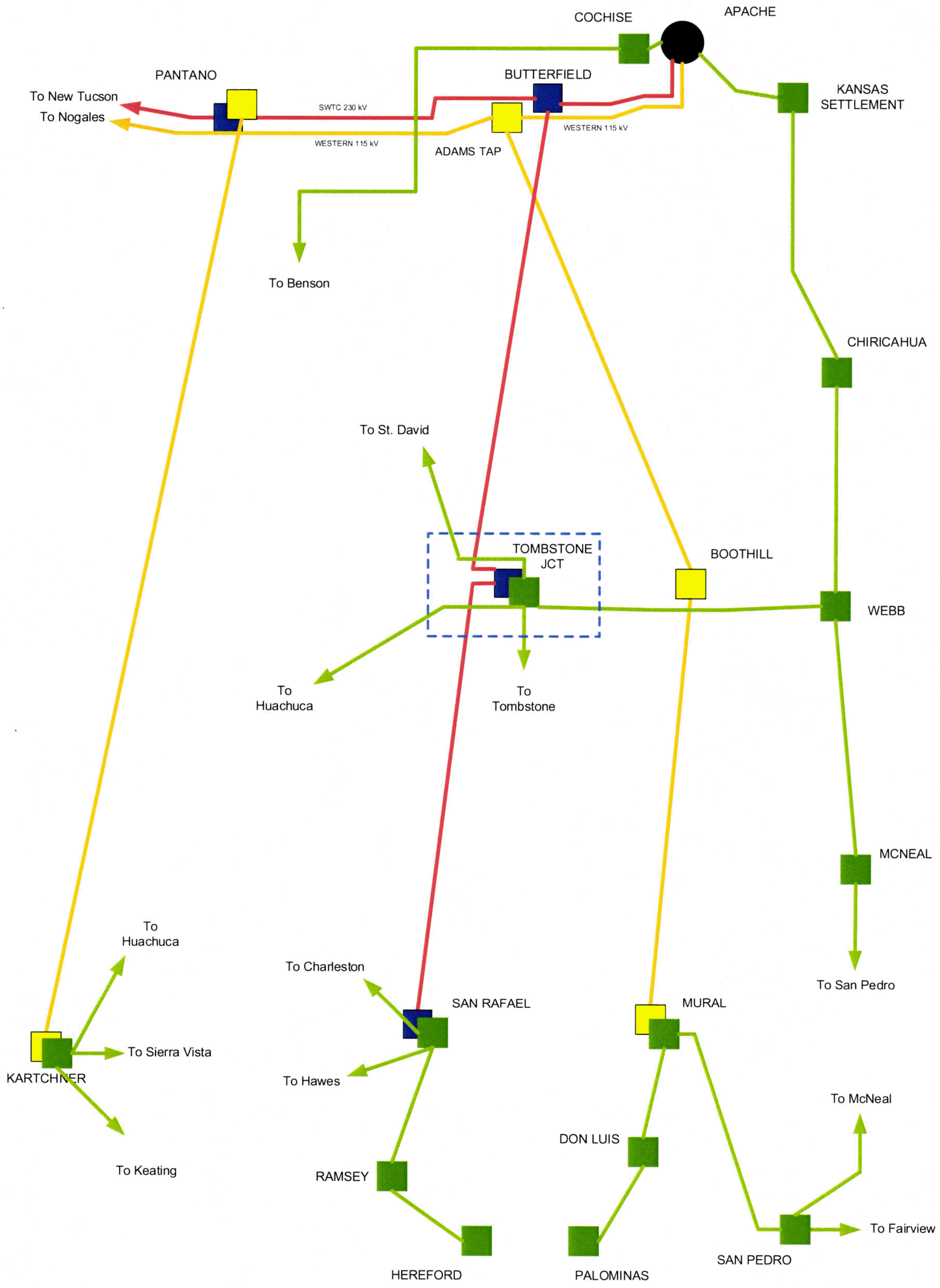
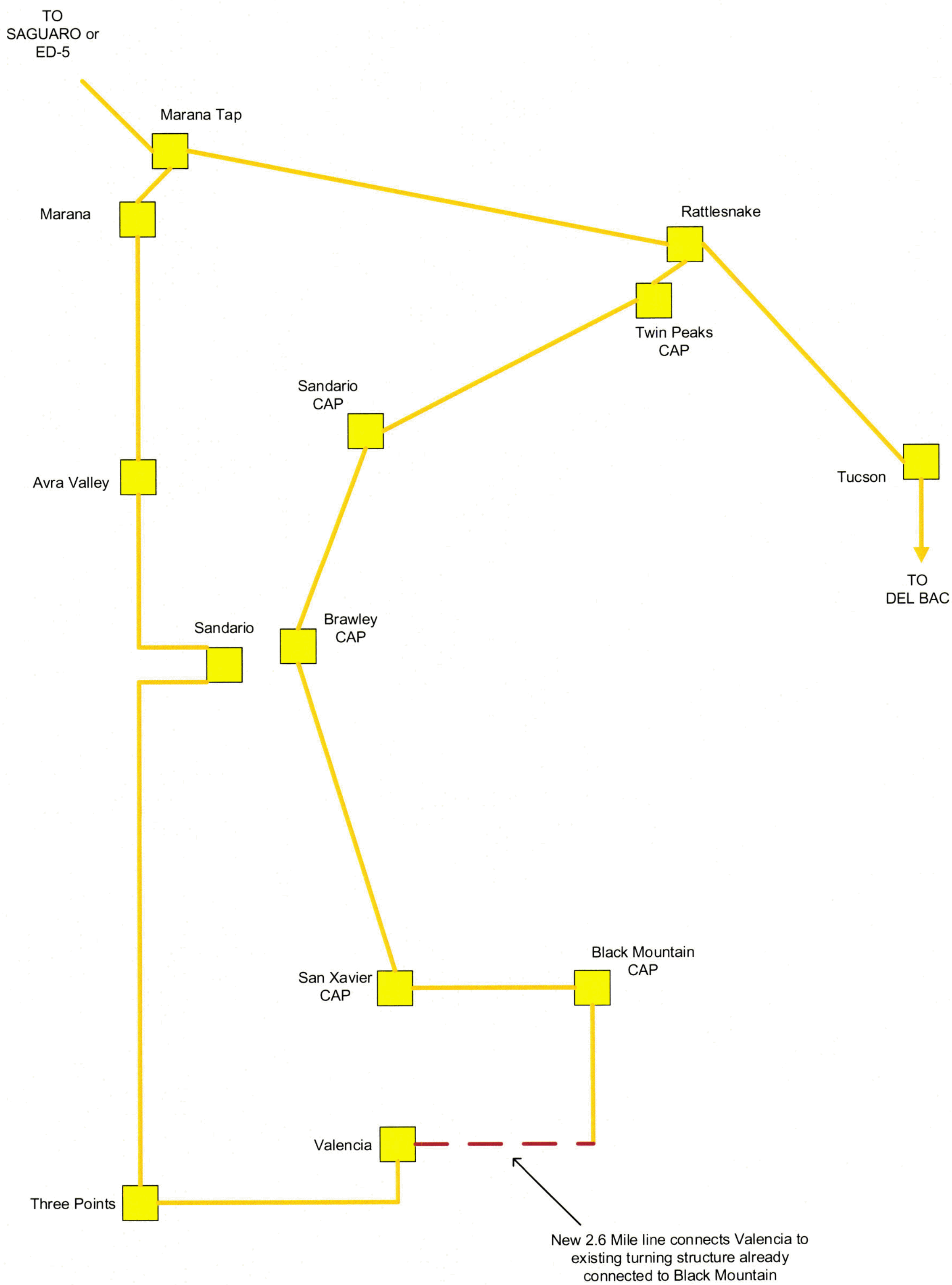


Figure 7 – Valencia to Black Mountain Project



SECTION I - PLANNED TRANSMISSION LINES

Reactive Power Compensation

Description:

There are reactive power compensation facility additions at 115 kV and above that are planned for this ten-year plan filing, as per the following schedule:

Year	Substation	MVAR Quantity
2016	Bicknell	19.2
2016	Butterfield	14.4
2016	San Rafael	10.8 (8.4 moved from Kartchner)

Project Type: Capacitor Installations

Project Location: Pima and Cochise Counties

Justification: Reliability

Estimated Cost: $1.4 Million

In Service Date: 2016

Tombstone Junction Project.

Description:

This Cochise County project involves looping the SWTC Butterfield to San Rafael 230 kV line into a new Tombstone Junction Substation with a 230/69 kV transformation to the existing SSVEC Tombstone Junction Substation with a potential for additional system enhancements. APS and SWTC have studied variations of the project that has SWTC and APS interconnecting their respective systems in the vicinity that would further improve system reliability in Southeast Arizona. SWTC continues to meet with APS and SSVEC to discuss joint participation in the project. The driving factor for this project is reliability.

Project Type: Multiple Transmission Elements

Project Location: Cochise County

Justification: Reliability

Estimated Cost: $5.6 Million

In Service Date: 2021

Valencia to CAP Black Mountain 115 kV line.

Description:

The project proposes a new 2.6 mile 115 kV line that will extend from the existing SWTC Valencia Substation to tie to the turning structure of the 115 kV CAP line that heads directly north 2 miles to the existing CAP Black Mountain Substation. This line project is being resurrected with CAP as a planned project. The driving factor for this project is reliability on both SWTC and CAP systems.

Project Type: Transmission Line

Project Location: Pima County

Justification: Reliability

Estimated Cost: $3.1 Million

In Service Date: 2018

SECTION II - INTERNAL PLANNING CRITERIA AND FACILITY RATINGS

SWTC's current internal planning criteria and facility ratings have been documented in its "Facility Ratings Methodology and Establish and Communicate Facility Ratings (FAC-008-1 and FAC-009-1)," dated February 11, 2009, and revised June 30, 2014, to meet requirements of the North American Reliability Corporation ("NERC") Planning Standards. Portions of the document are reprinted below, which identify the assumptions and methodologies used by SWTC to determine electrical facility ratings and also describe the electrical load limits for SWTC on the various power system transmission lines, power transformers, and other facility equipment under normal and emergency operating conditions.

1.0 Introduction

In accordance with North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) standards, this document sets forth the methodology to cover facilities solely owned by Southwest Transmission Cooperative, Inc. (SWTC). This document's purpose is to ensure that Facility Ratings used in the reliable planning and operation of the Bulk Electric System (BES) are determined based on technically sound principles. As industry standards change over the years, SWTC will modify its rating methodology to comport with accepted industry practice. In particular, this document covers the methodologies used to establish the electrical ratings of transmission facilities owned by SWTC, which are currently in commercial service. This document is intended to comply with the requirements of NERC Reliability Standard FAC-008-3.

2.0 Statement of Limitations

This document is limited to addressing operating conditions under normal and emergency situations and is not intended to address electrical faults, abnormal operations, failures of covered equipment or establish settings for protective devices. Additionally, the document does not make any assumptions as to the design criteria of legacy equipment and facilities.

2.1 The facilities addressed in this document include transmission conductors, transformers, relay protective devices, terminal equipment and compensation devices.

2.2 This methodology addresses Normal and Emergency ratings for the facilities that comprise SWTC's BES.

2.3 This Facility Ratings Methodology considers the ratings provided by equipment manufacturers, The Institute of Electrical and Electronics Engineers, Inc., (IEEE) and American National Standards Institute (ANSI) standards, ambient conditions for solar input, temperature and wind speed, design criteria, operating limitations, and other assumptions, as applicable.

2.4 The ratings for all of SWTC BES facilities, including but not limited to lines, transformers, and shunt compensation devices shall respect the most limiting applicable Equipment Rating of the individual equipment that comprises that facility.

2.5 In cases where a facility is jointly owned, the operator of the facility determines the rating and shares the rating with the other joint owners. SWTC is a joint owner in two transmission lines: The Vail to Westwing 345 kV line, which it co-owns with Tucson Electric Power (TEP) (project operator), and the Hassayampa to Pinal West 500 kV line, which it co-owns with Electrical District 2 (ED2), Electrical District 3 (ED3), Electrical District 4 (ED4), Salt River Project (SRP) (project operator) and TEP. SWTC is also a co-owner with TEP (project operator) in the Pinal West 500/345 kV transformer. Information on co-owned facilities is included in Appendices A and B.

2.6 In cases where a facility is owned in segments (such as a transmission line owned by one party with the breaker being owned by a different party), each owner will determine the rating for their segment and coordinate with the others to determine the most limiting segment. The rating for the most limiting segment will be used for the entire facility.

3.0 Facility Rating Methodologies for Transmission Facilities

The following sections describe the rating methodology for SWTC facilities.

3.1 Generation Facilities

SWTC does not own generation facilities. However, generation facilities, including step-up transformers, which are owned by Arizona Electric Power Cooperative, Inc. (AEPCO), are modeled in the SWTC power flow base case models according to AEPCO's facility ratings methodology.

3.2 Overhead Conductors

In 2014, SWTC updated its overhead conductor rating methodology based upon the parameters outlined in Table 2 below. The calculations for normal operating conditions use the design criteria of 75°C, and the emergency operating conditions use a conductor design temperature rating of 100°C. SWTC incorporates the calculations used in the IEEE Standard 738 "IEEE Standard for Calculating the

Current-Temperature of Bare Overhead Conductors," in its analysis of determining the current-temperature relationship of its conductors, given the parameters noted in Table 2.[1]

The ratings can be found in Table 1 below. The conductor ratings apply to the entire line, including the last span of the line entering a substation. The limiting factors of each transmission line are discussed in the next Section and a spreadsheet of SWTC's transmission line ratings can be found in Appendix A "SWTC Transmission Line Ratings." Appendix F "GE PSLF Power Flow Model" also shows the transmission line ratings based on their limiting factors as noted in Appendix A.

The updated conductor ratings have also been done to calculate year-round 15-minute, 30-minute and 4-hour emergency ratings, using an Excel based program to produce a loading guide for each conductor, based on the IEEE Standard 738. The same parameters noted in Table 2 below were used to calculate these emergency ratings.

The 15-minute and 30-minute emergency ratings will be utilized by System Operations in their Dispatch Center where contingency overloads can be mitigated within 15 to 30 minutes.

The values for the 4-hour emergency ratings for all conductors below are based on 130% of the normal ratings. It should be noted that the 15- and 30-minute emergency ratings for the smaller conductors, #2 CU to 636 ACSR, are the same as the 4-hour emergency ratings. For conductor sizes 795 AAC and up, all four values of ratings are shown: normal, 15-minute, 30-minute and 4-hour. The 15-minute ratings are 140% of normal and the 30 minute ratings are 135% of normal.

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[1] Information on SWTC Conductor Ratings also found in the following reference documents:
System Operating Limits Methodology for the Operations Horizon, Version 6.1
Establish and Communicate System Operating Limits, Version 3.0

TABLE 1: Conductor Thermal Ratings			
At 75 Deg. Celsius Operating Temperature			
Based on 4 ft. per second Wind Velocity			
and 40 deg. Celsius Air Temperature			
15-Minute, 30-Minute and 4-Hour Ratings are same for smaller conductors to 636 ACSR			
15-Minute, 30-Minute and 4-Hour Ratings listed below for conductors 795 AAC & Up			
ACSR/AAC Conductor		Copper Conductor	
SIZE	AMPS	SIZE	AMPS
	(Normal/Emergency)		(Normal/Emergency)
1/0 – 105.7 ACSR	239/311	#2 – 3 Strand	235/306
2/0 – 133.0 ACSR	274/356	#2 – 7 Strand	228/296
3/0 – 167.7 ACSR	314/408	4/0 – 211.6 MCM	476/619
4/0 – 211.6 ACSR	361/469	350 MCM	653/849
266.8 ACSR	451/586		
336.4 ACSR	522/679		
397.5 ACSR	580/754		
477 AAC	631/820		
477.0 ACSR	652/848		
556.0 ACSR	718/933		
636.0 ACSR	781/1015		
795.0 AAC	870/1218/1175/1131		
795.0 ACSR	899/1259/1214/1169		
954.0 AAC	974/1364/1315/1266		
954.0 ACSR	989/1385/1335/1286		
2 – 954 ACSR	1978/2769/2670/2571		
1033.5 ACSR	1040/1456/1404/1352		
1192.5 ACSR	1135/1589/1532/1476		
1272.0 AAC	1164/1630/1571/1513		
1272.0 ACSR	1182/1655/1596/1537		
1351.5 ACSR	1228/1719/1658/1596		
1590.0 ACSR	1359/1903/1835/1767		
2167.0 ACSR	1624/2274/2192/2111		

The parameters upon which the conductor ratings are based are found in Table 2 below:

TABLE 2: Conductor Rating Parameters		
Parameters Common to All Locations/Conductors		
Parameter	**Continuous Rating**	**Emergency Rating**
Wind Direction	70° to Line	70° to Line
Emissivity	0.7	0.7
Absorptivity	0.8	0.8
Date	July 1	July 1
Time	4 PM	4 PM
Latitude and Longitude	32.5° North	32.5° North
Elevation	2500 Ft	2500 Ft
Solar Input	Clear	Clear
Allowable Cond. Temp (ACSR)	75°C	100°C or sag limit
Wind Speed	4 ft/s	4 ft/s
Ambient Temperature	40°C	40°C

The following items are pertinent with regard to the current conductor rating method:

a. The thermal ratings from Table 1, used by SWTC to rate its transmission lines, are considered to be conservative. The emergency ratings are set at 130% of the normal rating based on ratings developed for each transmission line according to IEEE Standard 738. If through internal studies it is determined that a line will become stability limited, (at a value lower than the thermal limit) its rating will be based on its particular stability limit.

b. The weather parameters for development of the existing conductor thermal ratings are based on the values for wind direction, absorptivity, and wind speed as noted in Table 2 above. The conductor ratings are based on a 75°C operating temperature with a 4 ft. per second wind speed and a 40°C air temperature. Emergency ratings, as shown in Appendix A, are based on a 100°C operating temperature with a 4 ft. per second wind speed and a 40°C air temperature. SWTC can exceed its normal ratings for up to 30 minutes. Where a transmission line, or line section, is constructed or upgraded with more than one size conductor, the overall line rating is determined by the rating of the most limiting sized conductor. If other equipment (switches, series capacitors, etc) in series with the transmission conductor is more limiting, the lowest limitation defines the transmission line rating.

c. Rigid Bus and Strain Bus design are determined by the Rural Utilities Service (RUS) Design Guide for Rural Substations Bulletin 1724E-300 (Bulletin) and NESC as a minimum. The design involves many factors, which are spelled out in the Bulletin. For new 115 kV substations, SWTC uses a standard schedule 40 aluminum pipe conductor size of 3"and for new 230 kV substations, SWTC uses an aluminum pipe conductor size of 4". There is currently no case on the SWTC system where the rigid bus or strain bus is a limiting factor for any of SWTC's transmission line ratings. The ratings of the Aluminum rigid bus or pipe conductor are based on IEEE Standard 605-1998 "IEEE Guide for Design of Substation Rigid-Bus Structures, using an emissivity of 0.5, with Sun, at a 40°C temperature rise above 40°C Ambient for normal operating conditions, and a 60°C temperature rise above 40°C Ambient for emergency operating conditions.

3.2.1 Transmission Line Ratings

Appendix A contains a summary table for the transmission line ratings followed by tables that show the individual rating of components that make up each transmission line. Currently, there are not operating limitations in effect as of the date of this revision. Any such limitations will be posted on the SWTC OASIS. Specific items that are marked "N/A" mean that the facility in question is a legacy facility for which no specific data exists or the facility belongs to another entity that has not provided the requested information. The summary table allows for the finding of the most limiting factor of a transmission line, as well as the next most limiting factor.

SWTC ensures that its transmission line ratings are aligned with current design tolerances based on the National Electric Safety Code (NESC) and likewise ensures that actual field conditions do not create conditions that will cause the facilities to be non-compliant with the NESC clearance requirements.

Based on historical, conservative design practices, SWTC has incorporated additional design margin to compensate for minor variations between design conditions and actual field conditions. In addition, SWTC verifies its "as-built" conditions by scheduled field visits. Each line segment part of the BES is monitored on an annual basis. SWTC's current maintenance practices include an annual inspection on concrete and steel structures and a semi-annual inspection on wood structures. Inspections are performed by a journeyman hot stick lineman inspector who has been trained and provided the information to identify problems of a structural nature as well as phase to ground clearance issues. The inspector will note changes in field conditions such as new structures, tree growth, etc. In addition, the inspector has been trained in the use of measuring devices to determine pole integrity and phase to ground clearances. The inspection is a visual inspection designed to monitor the integrity, reliability, and compliance with NESC standards checking minimum conductor sag distances at key points throughout the system. Findings are documented, reported, and addressed as issues arise. In addition to on-ground line inspections, SWTC also performs regular aerial bucket or climbing inspections in high risk areas outlined in SWTC's Transmission Vegetation Management Plan (TVMP).

3.3 Transformers

SWTC owns the following types of power transformers:

a. Load serving transformers with LTC
   - Conventional
   - Auto

b. Tie Autotransformers

The Normal and Emergency Ratings for terminal equipment are determined as follows:

Equipment	Normal Rating	Emergency Rating ½ Hour Maximum Overload
SWTC Transformers	100% Manufacturer's highest Nameplate Rating @ 55°C or 65°C rise	125% of Manufacturer's Nameplate Rating @ 55°C or 65°C rise

During All Lines In Service (ALIS) operation the loading of the transformer should not exceed the normal rating. During system contingencies the loading of the transformer should not exceed its Emergency Rating, which is set at 125% of the normal rating based on ratings developed for each transformer according to IEEE Std. C57.91-1995 "Guide for Loading Mineral-Oil-Immersed Transformers." SWTC can exceed its normal ratings for up to 30 minutes. In addition, SWTC follows the recommendations of PRC-023 which limits the ability of automatic protection equipment to de-energize transformers. This allows time to permit operator intervention and helps avoid potential system cascading. Under special circumstances, SWTC may wish to evaluate other sources in regard to manufacturer's specifications, such as the latest applicable versions of IEEE Standard C57.15.12.00-2010 "IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers," and IEEE Std. C57.119-2001 "IEEE Recommended Practice for Performing Temperature Rise Tests on Oil-Immersed Power Transformers at Loads Beyond Nameplate Ratings." Appendix B contains a summary table of SWTC transformer data including the ratings as discussed in this Section.

Some transformers on the SWTC system are owned by other entities or co-owned by SWTC and other entities. Appendix B lists these specific transformers and notes the operating agent responsible for the transformer ratings.

3.4 Relay Protective Devices

None of SWTC BES facilities have ratings that are limited by protection or monitoring devices. SWTCs relays will not trip (trip on Zone 3) due to normal or emergency load current (See PRC-023-1 Transmission Relay Loadability). New facilities and protection schemes are reviewed by SWTC to ensure that loadability requirements are met.

3.5 Terminal Equipment (switches, breakers, etc)

Power Circuit Breakers will be rated according to the manufacturer's nameplate ampacity at the nominal applied voltage. Normal and Emergency Ratings will be identical. This is in accordance with IEEE C37.010-1999 (R2005) "IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis," and IEEE C37.06 "IEEE Standard for Switchgear – AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities."

Power Circuit Switchers will be rated according to the manufacturer's nameplate ampacity at the nominal applied voltage. Normal and Emergency Ratings will be identical.

Air Disconnect Switches will be rated according to the manufacturer's nameplate ampacity at the nominal applied voltage. Normal and Emergency Ratings will be identical. This is in accordance with IEEE C37.30 "IEEE Standard Requirements for High-Voltage Switches" and IEEE C37.37a-1996 "IEEE Standard Loading Guide for AC High-Voltage Air Switches Under Emergency Conditions."

Current Transformers as installed on the SWTC system are primarily Bushing Current Transformers that are supplied with power transformers and circuit breakers. These will be rated according to the corresponding unit's nameplate in accordance with IEEE C57.13-2008 "IEEE Standard Requirements for Instrument Transformers." A thermal rating factor will be applied to the normal and emergency ratings as provided by the manufacturer or developed based on industry practice. Normal and Emergency Ratings will be identical. Under certain circumstances, SWTC may wish to evaluate other sources in regard to manufacturer's specifications, such as increasing a thermal rating factor for a legacy bushing current transformer.

For example, SWTC uses a Westinghouse "Memorandum on Thermal Current Characteristics of Current Transformers used with Power Circuit Breakers and Power Transformers," dated June 26, 1969, to develop ratings for legacy bushing current transformers at the Pantano and Marana Substations.

There are very few free-standing current transformers on the SWTC system, but they are also rated according to the corresponding unit's nameplate in according with IEEE C57.13-2008.

The Normal and Emergency Ratings for terminal equipment are determined as follows:

Equipment	Normal Rating	Emergency Rating
Power Circuit breakers	100% of Manufacturer's Nameplate Rating	100% of Manufacturer's Nameplate Rating
Power Circuit switchers	100% of Manufacturer's Nameplate Rating	100% of Manufacturer's Nameplate Rating
Air Disconnect switches	100% of Manufacturer's Nameplate Rating	100% of Manufacturer's Nameplate Rating
Current transformers	100% of Manufacturer's Nameplate Rating	100% of Manufacturer's Nameplate Rating

Additional applicable IEEE standards will be consulted as deemed necessary regarding the rating of its terminal equipment. Appendix C "SWTC Power Circuit Breaker & Circuit Switcher Ratings," and Appendix D "Substation Switch Ratings," contains the summary table for SWTC terminal equipment ratings.

3.6 Compensation Devices

a. Shunt compensations
Shunt capacitors will be rated according to the manufacturer's nameplate ampacity and in accordance with IEEE 18-2012 "IEEE Standard for Shunt Power Capacitors." Appendix E "Shunt Capacitor Ratings" contains a summary table for SWTC shunt capacitor ratings. The normal and emergency ratings for shunt compensation devices will be identical as follows:

Equipment	Normal Rating	Emergency Rating
Shunt Capacitors	100% of Manufacturer's Nameplate Rating	100% of Manufacturer's Nameplate Rating

b. Series compensation
SWTC has no series compensation devices on its system.

4.0 Internal Planning Criteria for Facility Ratings

The factors used to determine equipment ratings were outlined above. They represent criteria that is accepted within the utility industry, NERC, WECC, and the Federal Energy Regulatory Commission (FERC).

The following is SWTC's internal transmission reliability planning criteria as published in its FERC FORM #715 filing:

1) Nominal Operating Limit

- Transmission lines should not be loaded greater than 100% of the thermal rating of the conductors.
- Transformers, circuit breakers, current transformers, and other equipment should not be loaded above their continuous nameplate rating.
- Transmission system voltages should not fall below 0.95 per unit (p.u.) of nominal rating nor rise above 1.05 p.u. of nominal rating.
- For long range planning system studies, an appropriate power factor for the planning period will be used.
- For operating system studies, an appropriate power factor for the operating planning period will be used.

2) Emergency Operating Limit

- Transmission lines should not be loaded greater than the specified emergency rating of the conductors. (See Appendix A)
- Transformers should not be loaded greater than the specified emergency rating of the transformers. (See Appendix B)
- Circuit breakers, current transformers, and other equipment should not be loaded above their continuous nameplate rating, except as permitted under applicable standards. (See Appendices C, D, and E)
- Transmission system voltages should not fall below 0.90 p.u. of nominal rating nor rise above 1.10 p.u. of nominal rating.
- For long range planning system studies, an appropriate power factor for the planning period will be used.
- For operating system studies, an appropriate power factor for the operating planning period will be used.

5.0 Establishment and Communication of Facility Ratings

SWTC establishes the facility ratings for its BES in accordance with the facility rating methodologies described above. SWTC submits its most up-to-date ratings as part of the WECC base case preparation process on a periodic basis as required by WECC. Appendix E "GE PSLF Powerflow Model" contains a table for typical SWTC power flow modeling data.

SWTC shall communicate its Facility Ratings Methodology for its solely and jointly owned Facilities that are existing Facilities, new Facilities, modifications to existing Facilities and re-ratings of existing Facilities to Peak RC, its Reliability Coordinator, its Planning Coordinator, and to other Transmission Owners, Operators, or Planners within 21 calendar days of a receipt of a request. If any of the aforementioned entities provides documented comments on its technical review of the SWTC Facility Ratings Methodology, SWTC shall provide a response to the commenting entity within 45 calendar days of a receipt of those comments, indicating whether a change will be made to the Facility

Ratings Methodology and, if no change will be made, the reason why.

Within 30 calendar days (or a later date if specified by a requestor) for any requested Facility with a Thermal Rating that limits the use of Facilities under a requestor's authority by causing any of the following: 1) An Interconnection Reliability Operating Limit, 2) A limitation of Total Transfer Capability, 3) An impediment to generator deliverability, or 4) An impediment to service to a major load center, SWTC shall identify the existing next most limiting equipment of the Facility and the Thermal Rating for that most limiting equipment.

When SWTC has determined that updated ratings are applicable, it will communicate those ratings as part of the WECC base case preparation process, by email or by telephone, as appropriate. SWTC shall keep all superseded portions of its Facility Ratings Methodology for 12 months beyond the date of the change in that methodology and shall keep all documented comments on the Facility Ratings Methodology and associated responses for three calendar years, in accordance with NERC Standard FAC-008-3.

The following table of SWTC Transmission Line Ratings is found in Appendix A of SWTC's Facility Ratings Methodology:

SWTC Transmission Line Rating Limits

Station A From	Station B To	Voltage KV	Normal Limit Amps	Emergency Limit Amps	Normal Limit MVA	Emergency Limit MVA	Limiting Equipment
HASSAYAMPA	PINAL WEST	500	3000	3000	2598	2598	Breaker Out for Maintenance
PINAL WEST	HASSAYAMPA	500	3000	3000	2598	2598	
GREEN-SW	GREENLEE	345	1978	2571	1182	1537	Conductor
GREENLEE	GREEN-SW	345	1978	2571	1182	1537	Conductor
BICKNELL	VAIL	345	1600	1600	956	956	Station Motor-Operated Switch
VAIL	BICKNELL	345	1600	1600	956	956	
PINAL WEST	VAIL	345	1548	1858	925	1110	Station Terminal Equipment
VAIL	PINAL WEST	345	1548	1858	925	1110	
PINAL WEST	WESTWING	345	1548	1858	925	1110	Station Terminal Equipment
WESTWING	PINAL WEST	345	1548	1858	925	1110	
DOSCONDO	HACKBERRY	230	1164	1513	464	603	Conductor
HACKBERRY	DOSCONDO	230	1164	1513	464	603	Conductor
HACKBERRY	MORENCI	230	1164	1513	464	603	Conductor
MORENCI	HACKBERRY	230	1164	1513	464	603	Conductor
GREEN-SW	MORENCI	230	1182	1537	471	612	Conductor
MORENCI	GREEN-SW	230	1182	1537	471	612	Conductor
MORENCI	PD-MORNC	230	989	1286	394	512	Conductor
PD-MORNC	MORENCI	230	989	1286	394	512	Conductor
APACHE	BUTERFLD	230	899	1072	358	427	Conductor
BUTERFLD	APACHE	230	899	1072	358	427	Conductor
APACHE	RED TAIL	230	1182	1537	471	612	Conductor
RED TAIL	APACHE	230	1182	1537	471	612	Conductor
APACHE	WINCHESTER	230	1182	1537	471	612	Conductor
WINCHESTER	APACHE	230	1182	1537	471	612	Conductor
BUTERFLD	PANTANO	230	899	1169	358	466	Conductor
PANTANO	BUTERFLD	230	899	1169	358	466	Conductor
BUTERFLD	SAN RAF	230	989	1286	394	512	Conductor
PANTANO	NEWTUCSN	230	899	1169	358	466	Conductor
NEWTUCSN	PANTANO	230	899	1169	358	466	Conductor
NEWTUCSN	SAHUARITA	230	899	1169	358	466	Conductor
SAHUARITA	NEWTUCSN	230	899	1169	358	466	Conductor
SAHUARITA	BICKNELL	230	899	1169	358	466	Conductor
BICKNELL	SAHUARITA	230	899	1169	358	466	Conductor
RED TAIL	DOSCONDO	230	1182	1537	471	612	Conductor
DOSCONDO	RED TAIL	230	1182	1537	471	612	Conductor
DAVIS	RIVIERA	230	1182	1200	471	478	Conductor/ Disconnect Switch
APACHE	HAYDENAZ	115	631	740	126	147	Conductor
HAYDENAZ	APACHE	115	631	740	126	147	Conductor
MARANA	MARANATP	115	718	800	143	159	Disconnect Switch
MARANATP	MARANA	115	718	800	143	159	
MARANA	AVRA	115	870	1131	173	225	Conductor
AVRA	MARANA	115	870	1131	173	225	Conductor
AVRA	SANDARIO	115	870	1131	173	225	Conductor
SANDARIO	AVRA	115	870	1131	173	225	Conductor
SANDARIO	THREEPNT	115	361	469	72	93	Conductor
THREEPNT	SANDARIO	115	361	469	72	93	Conductor
BICKNELL	THREEPNT	115	652	848	130	169	Conductor
THREEPNT	BICKNELL	115	652	848	130	169	Conductor
THREEPNT	VALENCIA	115	652	848	130	169	Conductor
PANTANO	KARTCHNR	115	652	848	130	169	Conductor

Notes:

1) SRP is the operating agent for the Hassayampa to Pinal West 500 kV line and has determined its line ratings. SWTC owns 7.305% of this line.
2) TEP is the operating agent for Pinal West to Vail and Pinal West to Westwing 345 kV lines and have determined their line ratings. SWTC owns 24% of these lines.
3) Dos Condados to Hackberry and Hackberry to Morenci 230 kV Lines limited by 1272 AAC conductor.
4) Davis to Riviera 230 kV Line limited by 1272 ACSR conductor Normal Conditions and limited by 1200A disconnect switch Emergency Conditions.
5) Apache to Hayden 115 kV Line limited by 477 AAC conductor at Apache (SWTC Rating) and Hayden (SRP Rating).
6) Marana to Avra and Avra to Sandario 115 kV Lines limited by 795 AAC conductor at Avra.

Southwest Transmission
COOPERATIVE, INC
A Touchstone Energy® Cooperative

TECHNICAL STUDY REPORT

2016 – 2025

Docket No. E00000D-15-0001

JANUARY 28, 2016

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR PLAN

2016 – 2025

TECHNICAL STUDY REPORT

SUBMITTED TO THE ARIZONA CORPORATION COMMISSION IN FULFILLMENT OF A.R.S. §40-360.02 ¶C.7

Docket No. E-00000D-15-0001

TRANSMISSION PLANNING
JANUARY 28, 2016

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SOUTHWEST TRANSMISSION COOPERATIVE, INC.
TEN-YEAR PLAN
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TECHNICAL STUDY REPORT

INTRODUCTION

This technical report is submitted to the Arizona Corporation Commission ("Commission") pursuant to the Arizona Revised Statutes ("ARS") §40-360.02 ¶C.7, and Decision No. 63876, dated July 25, 2001, regarding the Biennial Transmission Assessment prepared by Commission Utilities Division Staff.

Each year, SWTC performs an annual assessment of its interconnected transmission system in accordance with the North American Reliability Corporation ("NERC") Transmission Planning Standards ("TPL"). Power flow analyses used for this report were performed in accordance with the NERC criteria for Planning Standard TPL-001-4, and are contained in the SWTC 2015 Transmission Planning Assessment Report that details study results for the years 2016 through 2025. As required by the Standards, the SWTC transmission system was analyzed within the near-term planning horizon (2016-2020) and the long-term planning horizon (2020-2025). Heavy summer and light winter conditions were analyzed for all years of the 2016-2025 planning horizon, but only the years 2016, 2020 and 2025 will be discussed in this report. The diagrams and plots in this report will only represent Heavy Summer conditions for 2016, 2020 and 2025. Diagrams and plots for Light Winter conditions as well as other years are available upon request.

As has been done in previous years, the transmission planning assessment performed by SWTC did not consider the Sunzia Southwest Transmission Project or the Southline Transmission Project. These projects are still undergoing study through the Western Electricity Coordinating Council ("WECC") Three-Phase Rating Process. Consideration was made as to whether or not to include these projects in the bases cases for study, as they may potentially have an impact upon the SWTC system, but for the present it was decided not include to them until a degree of certainty is achieved regarding completion of the projects.

The ten year plan document that this report accompanies, contains a discussion of a number of projects that are being considered as future projects. These are not yet ready to put into the ten year plan, but are important because of the ability these projects will have to enhance load serving capability, system reliability, increased transfer capability and voltage support to the SWTC transmission system. These projects were studied as part of SWTC's annual transmission assessment and the initial results are included in this report. Discussions with potential project participants will continue to occur throughout 2016 and if refined project scopes have been established with agreements from project participants, and with approvals from governing boards, these projects may be reflected in next year's ten year plan.

The analyses performed for this study have been done with the 2015 SWTC load forecast and the results show that under a variety of outage conditions, the system will perform well with no violations of the NERC criteria.

SWTC's current and planned transmission system maps are included in Appendix A. The contingency list used for the TPL Assessment is included in Appendix B. Selective power flow one-line diagrams, showing the entire SWTC system under various heavy summer outage conditions, for the years 2016, 2020 and 2025, are included in Appendix C. As part of SWTC's TPL

Assessment, selective outages of the SWTC transmission system were evaluated. However, only a few of the High Voltage ("HV") and Extra-High Voltage ("EHV") P1, P2, P3, P4, P6, and P7 outage simulations for the years 2016, 2020, and 2025 are included in this report. A single P7 or common corridor outage simulation for each year are also included, since that is the only common corridor on the SWTC system. Contingency simulations for radial transmission lines have been excluded from this listing.

Post-transient studies for reactive margin for the interconnected SWTC transmission system for heavy summer for the years 2016, 2020 and 2025 are presented in this report. Q-V plots can be found in Appendix D.

Dynamic stability evaluations for heavy summer conditions for the years 2016 and 2020 only are presented in this report. These can be found in Appendix E.

At this time, there are no planned third-party generation interconnections to the SWTC transmission system.

POWER FLOW ANALYSES

Power flow studies were performed using General Electric's Positive Sequence Load Flow ("PSLF") program. The power flow base cases were created for the 2016-2025 study period, using the latest Arizona seed cases that have been developed from Western Electricity Coordinating Council ("WECC") approved base cases. The cases used for this report are listed below:

- 2016HS Case (Created from SouthWest Area Transmission Arizona Subcommitee Study Group ("SWAT-AZ") 2016 Summer Seasonal Study case that was originally developed from the WECC 2015hs4a approved operating base case) – Load Flow and Stability
- 2016LW Case (Created from SASG 2016 Winter Seasonal Study case that was original developed from the WECC 2015lwa approved operating base case) – Load Flow and Stability
- 2020HS Case (Created from the coordinated SWAT-AZ 2020HS seed case that was originally developed from the WECC 2020hs2 approved base case) – Load Flow and Stability
- 2025HS Case (Created from coordinated SWAT-AZ 2024HS seed case that was originally developed from the WECC 2024hsTEPa approved base case) – Load Flow and Stability
- 2025LW Case (Created from SASG 2016 Winter Seasonal Study case that was original developed from the WECC 2015lwa approved operating base case) – Load Flow and Stability

The Heavy Summer ("HS") base cases represent the non-coincident peak summer load of the Member Cooperatives and the Light Winter ("LW") base cases represent approximately 70% of the SWTC non-coincident peak winter load of the Member Cooperatives.

These base cases were based on the 2015 load forecast of SWTC, using the medium economic forecast. Base case, single, and double contingency conditions were evaluated using PSLF to determine system impacts and timing of transmission facilities needed to mitigate those system impacts.

ON-GOING BTA REQUIREMENTS

The Eighth Biennial Transmission Assessment (BTA) was approved on October 24, 2014 by the Commission as Decision #74785. Recommendation #7G of this BTA states the following:

Staff recommends that the Commission support "The requirements for Arizona utilities to include planned transmission reconductor projects, transformer capacity upgrade projects and reactive power compensation facility additions at 115 kV and above in future 10-year plan filings."

There are no transmission reconductor projects or capacity upgrade projects in this ten year plan filing.

Reactive power compensation facility additions at 115 kV and above for this ten year plan filing, are planned according to the following schedule:

Year	Substation	MVAR Quantity
2016	Bicknell	19.2
2016	Butterfield	14.4
2016	San Rafael	10.8

Additional studies conducted during 2016, due to the 2015 load forecast or other unforeseen circumstances may tend to refine these values and/or suggest the need to adjust locations for reactive support to the SWTC system. These will be reported in the next ten year plan filing.

SPECIFIC ASSUMPTIONS FOR STUDY

Multiple power flow cases were used to assess the future transmission system adequacy. In each of the planning scenarios, the load flow and stability models that were used, originated from WECC approved base cases as discussed earlier.

Each of the different cases were assembled to match the forecasted heavy summer and light winter scenarios and include the lower voltage distribution networks (below 100 kV within the SWTC system). Generation dispatch levels were varied as a means to acess the sensitivity of each case. It should be noted that the Anza Electric Cooperative, Inc. ("AEC") load is not located in the southeast Arizona area and is represented as a transfer.

The cases prepared for these studies contain a power factor for the Member Systems that is approximately 0.98 per unit.

Specific study scenarios for the years 2016, 2020 and 2025 were conducted with the addition of the some of the proposed projects that are listed in the Section entitled "Additional Projects under Consideration" of the Ten Year Plan Report that accompanies this technical study report. These projects have a high likelihood of being advanced for approval and construction sometime between 2016 and 2020. These scenarios were conducted for heavy summer conditions for 2016, 2020, and 2025, with the addition of studies for 2016 and 2025 light winter. As stated earlier, only the heavy summer conditions have been provided in this Report.

2016 Scenario has the following project represented:

- A new connection with WAPA Substation ED5 which bypasses Saguaro Substation

2020 and 2025 Scenarios have the following projects represented in each base year:

- All projects from the 2016 scenario plus:
- A new Tombstone Junction Substation with a 230/69 kV transformation to the existing SSVEC Tombstone Junction 69 kV Substation.
- Existing APS Boothill Substation with a 115/69 kV transformation to feed a 69 kV line to the existing SSVEC Tombstone Junction 69 kV Substation.
- A Capacitor Bank transferred from Morenci Substation To Dos Condados Substation.
- New 115 kV line between SWTC's Valencia Substation and CAP's Black Mountain Substation.

The Tombstone Junction Project is currently under study by the entities that would be impacted by this project in Southeast Arizona and results of this study effort will be reported in the next ten year plan filing.

The initial study results for the scenarios listed above are included below for the detailed near and long term assessments. However, power flow diagrams and plots of contingencies associated with these scenarios are not included with this report, due to the ongoing studies being conducted by other entities, but are available upon request.

NEARTERM ASSESSMENT (2016-2020)

2016 Heavy Summer Conditions

The 2016HS SWTC base case developed from the SASG 2016 Summer Seasonal Study case was used as the base model for this projected timeframe. The load levels within the case were adjusted to represent the non-coincidental loads of the Member Systems totaling 657.4 MW served by SWTC transmission (not including system losses).

The system additions planned for this base year are:

- Butterfield 14.4 MVAR Capacitor Bank
- Bicknell 19.2 MVAR Capacitor Bank
- San Rafael 10.8 MVAR Capacitor Bank

2016HS Category P0 Analysis:

With all lines and facilities in service, the SWTC system for 2016 heavy summer conditions, meets the requirements and measures of the TPL Standards and does not require any further plans to meet Category P0 criteria.

2016HS Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:

- Under three P1 outages, there are five (5) buses with voltages in excess of 1.05 per unit.

Voltage Deviations:

- None

Thermal Overloads

- None

There were no non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

The five buses with voltages in excess of 1.05 per unit do not belong to SWTC, nor do the outaged elements that caused the voltages to be in excess of 1.05 per unit belong to SWTC. These are the Vail2 345 kV bus, the Adams 115 kV bus, the Adams Tap 115 kV bus, the Mural 115 kV bus, and the Boothill 115 kV bus. The Vail2 345 kV bus is owned by TEP and would need to be mitigated by TEP. The Adams and Adams Tap 115 kV buses are owned by WAPA and would need to be mitigated by WAPA. The Mural, and Boothill 115 kV buses are owned by APS and would need to be mitigated by APS.

No mitigation plans are needed for Category P1 voltage deviations on the SWTC system.

The one element exhibiting thermal overload issues is the SWTC Greeenlee 345/230 kV transformer, which occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, or loss of the FMI PD-Morenci to Frisco 230 kV line or loss of the FMI Copper Verde to Frisco 230 kV line. The overload of the Greenlee 345/230 kV transformer will be mitigated by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

2016HS Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

There were no non-solved cases found on the system under the Category P2 criterion.

Mitigation Plans

No mitigation plans are needed for Category P2 voltage violations voltage deviations and thermal overloads on the SWTC system.

2016HS Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2016HS Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2016HS Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2016HS Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:

- Under one P6 outages, there are nine (9) buses with voltages less than 0.90 per unit.

Voltage Deviations:

- Under one P6 outages, there are nine (9) buses with voltage deviations greater than 10%

Thermal Overloads

- Under various P6 outages, there are three (3) transmission elements that exceeded their emergency rating.

There were three (3) non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

The nine buses exhibiting voltages less than 0.90 per unit are the Morenci 230 kV, Dos Condados 230 kV, Redtail 230 kV, Hackberry 230 kV, Greenlee-SW 230kV, Copper Verde 345 kV, Copper Verde 230 kV, Frisco 230 kV, PD-Morenci 230 kV.

Low voltages at the SWTC Morenci 230 kV, Dos Condados 230 kV, Redtail 230 kV, Hackberry 230 kV, Greenlee-SW 230kV, FMI Copper Verde 345 kV, Copper Verde 230 kV, Frisco 230 kV and PD-Morenci 230 kV buses occur for loss of the FMI Greenlee to Copper Verde 345 kV transmission line, along with the loss of the SWTC Apache to Redtail 230 kV line. Mitigation will be accomplished either by adding more capacitor banks to the system or by shedding load. FMI, as the owner, would have responsibility for mitigating low voltages at the Copper Verde, Frisco and PD-Morenci buses.

The nine buses exhibiting voltage deviations greater than 10% are the Dos Condados 230 kV, Greenlee-SW 230 kV, Morenci 230 kV, Redtail 230 kV, Hackberry 230 kV, Copper Verde 345 kV, Copper Verde 230 kV, Frisco 230 kV, PD-Morenci 230 kV.

Voltage deviations at the SWTC Dos Condados 230 kV, Greenlee-SW 230 kV, Morenci 230 kV, Redtail 230 kV, Hackberry 230 kV, FMI Copper Verde 345 kV, Copper Verde 230 kV, Frisco 230 kV and PD-Morenci 230 kV buses occur for loss of the Apache to Redtail 230 kV line, along with loss of the FMI Greenlee to Copper Verde 345 kV transmission line. Mitigation will be accomplished either adding new capacitor banks to the system or by shedding load. FMI, as the owner, would have responsibility for mitigating voltage deviations at the Copper Verde, Frisco and PD-Morenci buses.

The three overloaded elements are the Saguaro East to Marana Tap 115 kV line, the Three Points to Sandario Tap 115 kV line, and the Greenlee 345/230 kV transformer.

The overloads of the Western Saguaro East to Marana Tap 115 kV line occur for loss of the SWTC Bicknell 345/230 kV transformer, along with loss of the SWTC Pantano to New Tucson 230 kV line. These overloads are limited by disconnect switches at Marana Tap, which are owned by Western and could also be limited by jumpers at Saguaro, which are owned by APS. These limiting elements will be bypassed in the spring of 2016 when WAPA installs the proposed Saguaro Bypass to Marana project. As needed currently, SWTC would implement load shedding to reduce overloads of its Marana Tap to Marana 115 kV line.

The overload of the SWTC Three Points to Sandario 115 kV line also occurs for loss of the SWTC Bicknell 345/230 kV transformer, along with loss of either the SWTC Pantano to New Tucson 230 kV line or the SWTC New Tucson to Sahuarita 230 kV line. Mitigation will be accomplished either by upgrading the line or by shedding load.

The overload of the SWTC Greenlee 345/230 kV transformer occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, along with any other element. Mitigation will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

One of the three non-solved cases involves loss of the FMI Greenlee to Copper Verde 345 kV line along with loss of the SWTC Greenlee 345/230 kV transformer. Mitigation will be accomplished by shedding load.

In order to mitigate one of the remaining non-solved cases, which involve the loss of the SWTC Apache to Butterfield 230 kV line, along with loss of the SWTC Bicknell 345/230 kV transformer, it will be necessary to shed load, to bring post contingency voltages and thermal loading within the Category P6 criterion.

The last of the non-solved cases is the loss of Common Right-of-Way (ROW) #1 which involves loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Morenci to Greenlee 230 kV line. Mitigation will be accomplished by shedding load.

2016HS Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

2016 Heavy Summer Scenario Results

2016HS Scenario Category P0 Analysis:

CATEGORY P0 CRITERIA VIOLATIONS AND MITIGATION PLANS

With all lines and facilities in service, the SWTC system Saguaro Bypass scenario for 2016 heavy summer conditions, meets the requirements and measures of the TPL Standards and does not require any further plans to meet Category P0 criteria.

2016HS Scenario Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:

- Under two P1 outages, there are five (5) buses with voltages in excess of 1.05 per unit.

Voltage Deviations:

- None

Thermal Overloads

- Under P1 outages, there is one (1) transmission elements that exceeded their emergency rating.

There were no non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

The five buses with voltages in excess of 1.05 per unit do not belong to SWTC, nor do the outaged elements that caused the voltages to be in excess of 1.05 per unit belong to SWTC. These are the Vail2 345 kV bus, the Adams 115 kV bus, the Adams Tap 115 kV bus, the Mural 115 kV bus, and the Boothill 115 kV bus. The Vail2 345 kV bus is owned by TEP and would need to be mitigated by TEP. The Adams, Adams Tap 115 kV buses are owned by WAPA and would need to be mitigated by WAPA. The Mural and Boothill 115 kV buses are owned by APS and would need to be mitigated by APS.

No mitigation plans are needed for Category P1 voltage deviations on the SWTC system.

The one element exhibiting thermal overload issues is the SWTC Greeenlee 345/230 kV transformer, which occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, or loss of the FMI PD-Morenci to Frisco 230 kV line, or loss of the FMI Copper Verde to Frisco 230 kV line. The overload of the Greenlee 345/230 kV transformer will be mitigated by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

2016HS Scenario Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

There were no non-solved cases found on the system under the Category P2 criterion.

Mitigation Plans

No mitigation plans are needed for Category P2 voltage violations voltage deviations and thermal overloads on the SWTC system.

2016HS Scenario Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2016HS Scenario Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2016HS Scenario Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2016HS Scenario Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads

- Under various P6 outages, there are two (2) transmission elements that exceeded their emergency rating.

There were five (5) non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

The three overloaded elements are the Three Points to Sandario Tap 115 kV line, the Greenlee 345/230 kV transformer, and the Bicknell 345/230kV transformer.

The overload of the SWTC Three Points to Sandario 115 kV line occurs for loss of the SWTC Bicknell 345/230 kV transformer, along with loss of the SWTC New Tucson to Sahuarita 230 kV line. Mitigation will be accomplished either by upgrading the line or by shedding load.

The overload of the SWTC Greenlee 345/230 kV transformer occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, by itself or, along with any other element. Overload also occurs for loss of the Copper Verde to Frisco 230 kV line or the PD-Morenci to Frisco 230 kV line. Mitigation will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

The overload of the SWTC Bicknell 345/230 kV transformer occurs for loss of the SWTC Apache to Butterfield 230 kV line, along with loss of the Western Saguaro East to Marana Tap 115 kV line. Mitigation will be accomplished either by the addition of a 2nd Bicknell 345/230 kV transformer or by shedding load.

Two of the five non-solved cases involves loss of the SWTC Greenlee 345/230 kV transformer along with loss of the FMI Greenlee to Copper Verde 345 kV line or the loss of the Apache to Red Tail 230 kV line. Mitigation will be accomplished by shedding load.

In order to mitigate two of the remaining non-solved cases, which involve the loss of the SWTC Bicknell 345/230 kV transformer, along with loss of the SWTC Apache to Butterfield 230 kV line or the loss of the Pantano to New Tucson 230kV line, it will be necessary to add a 2nd Bicknell 345/230 kV transformer or shed load to bring post contingency voltages and thermal loading within the Category P6 criterion.

The last of the non-solved cases is the loss of Common ROW #1 which involves loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Morenci to Greenlee 230 kV line. Mitigation will be accomplished by shedding load.

2016HS Scenario Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

2016 Light Winter Results

2016 Light Winter Conditions

The 2016LW SWTC base case developed from the WECC approved 2015lwa.sav base case, and coordinated through SASG for the 2016 winter seasonal studies, was used as the base model for this projected timeframe. The load levels within the case were adjusted to represent approximately 75% of the peak non-coincidental winter peak loads of the Member systems totaling 265.5 MW served by the SWTC transmission system (not including system losses). Apache station generation dispatch is at 264 MW.

The system additions planned for this base year are the same as those shown for the 2016 Heavy Summer case.

2016LW Category P0 Analysis:

With all lines and facilities in service, the SWTC system for 2016 light winter conditions, meets the requirements and measures of the TPL Standards and does not require any further plans to meet Category P0 criteria.

2016LW Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

There were no non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

No mitigation plans are needed for category P1 voltage violations, voltage deviations, or thermal overloads on the SWTC system.

2016LW Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

There were no non-solved cases found on the system under the Category P2 criterion.

Mitigation Plans

No mitigation plans are needed for Category P2 voltage violations voltage deviations and thermal overloads on the SWTC system.

2016LW Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2016LW Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2016LW Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2016LW Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:
- Under one P6 outage, there are four (4) Buses with a voltage less than 0.90 per unit.

Voltage Deviations:
- Under one P6 outage, there are four (4) Buses with a voltage deviation greater than 10%.

Thermal Overloads:

- Under one P6 outage, there is one (1) transmission element that exceeded its emergency ratings.

There were two (2) non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

Of the four buses with voltages less than 0.90 per unit, none belong to SWTC. These are the Copper Verde 345 kV bus, the Copper Verde 230 kV bus, the Frisco 230kV bus, and the PD-Morenci 230 kV bus. All are owned by FMI and would need to be mitigated by FMI.

The four buses with voltage deviations greater than 10%, do not belong to SWTC. These are the Copper Verde 345 kV bus, the Copper Verde 230 kV bus, the Frisco 230 kV bus, and the PD-Morenci 230 kV bus. All are owned by FMI and would need to be mitigated by FMI.

The one overloaded transmission element is the SWTC Greenlee 345/230 kV transformer, which occurs for loss of the FMI Greenlee to Copper Verde 345 kV line along with loss of any other element. The one exception being Springerville to Greenlee 345 kV line. Mitigation will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

The two non-solved cases are loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Greenlee 345/230 kV transformer; Common Right of Way #1, which is made up og the loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Morenci to Greenlee 230 kV line.

Mitigation for each of these non-solved cases will be accomplished by shedding load.

2016LW Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

2016 Light Winter Scenario Results

2016LW Scenario Category P0 Analysis:

With all lines and facilities in service, the SWTC system Saguaro Bypass scenario for 2016 light winter conditions, meets the requirements and measures of the TPL Standards and does not require any further plans to meet Category P0 criteria.

2016LW Scenario Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads

- Under P1 outages, there is one (1) transmission elements that exceeded their emergency rating.

There were no non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

No mitigation plans are needed for Category P1 voltage violations on the SWTC system.

No mitigation plans are needed for Category P1 voltage deviations on the SWTC system.

The one element exhibiting thermal overload issues is the SWTC Greeenlee 345/230 kV transformer, which occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, or loss of the FMI PD-Morenci to Frisco 230 kV line, or loss of the FMI Copper Verde to Frisco 230 kV line. The overload of the Greenlee 345/230 kV transformer will be mitigated by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

2016LW Scenario Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

There were no non-solved cases found on the system under the Category P2 criterion.

Mitigation Plans

No mitigation plans are needed for Category P2 voltage violations and thermal overloads on the SWTC system.

2016LW Scenario Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2016LW Scenario Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2016LW Scenario Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2016LW Scenario Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:
- Under one P6 outage, there are four (4) Buses with a voltage less than 0.90 per unit.

Voltage Deviations:

- Under one P6 outage, there are four (4) Buses with a voltage deviation greater than 10%.

Thermal Overloads

- Under various P6 outages, there are one (1) transmission elements that exceeded their emergency rating.

There were two (2) non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

Of the four buses with voltages less than 0.90 per unit, none belong to SWTC.
These are the Copper Verde 345 kV bus, the Copper Verde 230 kV bus, the Frisco 230kV bus, and the PD-Morenci 230 kV bus. All are owned by FMI and would need to be mitigated by FMI.

The four buses with voltage deviations greater than 10%, do not belong to SWTC. These are the Copper Verde 345 kV bus, the Copper Verde 230 kV bus, the Frisco 230 kV bus, and the PD-Morenci 230 kV bus. All are owned by FMI and would need to be mitigated by FMI.

The overload of the SWTC Greenlee 345/230 kV transformer occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, by itself or, along with any other element. Overload also occurs for loss of the Copper Verde to Frisco 230 kV line or the PD-Morenci to Frisco 230 kV line. Mitigation will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

One of the two non-solved cases involves loss of the SWTC Greenlee 345/230 kV transformer along with loss of the FMI Greenlee to Copper Verde 345 kV line. Mitigation will be accomplished by shedding load.

The second of the non-solved cases is the loss of Common ROW #1 which involves loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Morenci to Greenlee 230 kV line. Mitigation will be accomplished by shedding load.

2016LW Scenario Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

2020 Heavy Summer Results

2020 Heavy Summer Conditions

The 2020HS SWTC base case developed from the WECC approved 2020 Heavy Summer SWAT-AZ base case, and coordinated through SWAT, was used as the base model for this projected timeframe. The load levels within the case were adjusted to represent the non-coincidental loads of the Member systems totaling 745.8 MW served by SWTC transmission (not including system losses). Apache station generation dispatch is at 408 MW.

There are no system additions represented in this base year. These results are discussed below.

2020HS Category P0 Analysis:

With all lines and facilities in service, the SWTC system for 2020 heavy summer conditions, for this scenario, meets the requirements and measures of the TPL Standards and does not require any further plans to meet Category P0 criteria.

2020HS Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:
- Under one P1 outages, there is one (1) bus with voltages in excess of 1.05 per unit.

Voltage Deviations:
- None

Thermal Overloads:
- Under one P1 outages, there is one (1) transmission element that exceeded its emergency rating.

There were no non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

The bus with voltage in excess of 1.05 per unit does not belong to SWTC, nor does the outaged element that caused the voltages to be in excess of 1.05 per unit belong to SWTC. The outage is for loss of one TEP Vail2 345/138 kV transformer and the element is the Vail2 345 kV bus which is owned by TEP and would need to be mitigated by TEP.

The overloaded transmission element is the Tucson to Oracle 115 kV line which occurs for the Saguaro to Marana Tap 115 kV outage. The element is owned by Western and it would be their responsibility to mitigate.

2020HS Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

There were no non-solved cases found on the system under the Category P2 criterion.

Mitigation Plans

No mitigation plans are needed for Category P2 voltage violations voltage deviations and thermal overloads on the SWTC system.

2020HS Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2020HS Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2020HS Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2020HS Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- Under various P6 outages, there are seven (7) transmission elements that exceeded their emergency ratings.

There were five (5) non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

The seven overloaded transmission elements are the Saguaro East to Marana Tap 115 kV line, the Marana Tap to Marana 115 kV line, the Three Points to Sandario Tap 115 kV line, one Copper Verde 345/230 kV transformer, one Bicknell 230/115 kV transformer, the Bicknell 345/230 kV transformer, the Greenlee 345/230 kV transformer.

The overloads of the Western Saguaro East 115 kV line occur for various P6 outages. These overloads are limited by disconnect switches at Marana Tap, which are owned by Western and could also be limited by jumpers at Saguaro that are owned by APS. This overload will be resolved in the spring of 2016 when WAPA installs the proposed Saguaro Bypass Project.

The overloads of the SWTC Marana Tap to Marana 115 kV line occur for loss of the Bicknell 345/230 kV along with the loss of the New Tucson to Sahuarita line. These overloads are limited by disconnect switches at Marana Tap, which are owned by Western and could also be limited by jumpers at Saguaro, which are owned by APS. As needed, SWTC would implement load shedding to reduce overloads of its Marana Tap to Marana 115 kV line. This overload will be resolved in the spring of 2016 when WAPA installs the proposed Saguaro Bypass Project.

The overloads of the SWTC Three Points to Sandario 115 kV line occur for various P6 outages. This overload will be mitigated by Saguaro Bypass Project (Spring 2016). Other projects under study eliminate all Thermal Violations of this line.

The overload of one FMI Copper Verde 345/230 kV transformer occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of either the SWTC Apache to Butterfield 230 kV line or loss of the TEP Winchester to Willow 345 kV line. Mitigation would be the responsibility of FMI.

The overload of one SWTC Bicknell 230/115 kV transformer occurs for loss of the 2nd SWTC Bicknell 230/115 kV transformer, along with loss of the Western Saguaro East to Marana Tap 115 kV line. Mitigation will be accomplished by shedding load.

The overload of the SWTC Bicknell 345/230 kV transformer occurs for loss of the SWTC Apache to Butterfield 230 kV line, along with loss of either the Western Saguaro East to Marana Tap 115 kV line or loss of the SWTC Marana to Avra 115 kV line or the loss of the Avra to Sandario 115 kV line. Mitigation will be accomplished either by the addition of a 2nd Bicknell 345/230 kV transformer or by shedding load.

The thermal issues involving the overload of the SWTC Greenlee 345/230 kV transformer occur for loss of the FMI Greenlee to Copper Verde 345 kV line, along with any other element. Mitigation will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

Two of the five non-solved outages involve loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of either the SWTC Greenlee 345/230 kV transformer, or loss of the SWTC Apache to Redtail 230 kV line. Mitigation would be the responsibility of FMI or will be accomplished by shedding load.

In order to mitigate two of the three remaining non-solved cases, which involve loss of the SWTC Bicknell 345/230 kV transformer, along with loss of the SWTC Pantano to New Tucson 230 kV line; or loss of the SWTC Apache to Butterfield 230 kV line along with loss of the SWTC Bicknell 345/23 kV transformer, it will be necessary to add a 2nd Bicknell 345/230 kV transformer or shed load, to bring post contingency voltages and thermal loading within the Category P6 criterion.

One of the five non-solved cases is loss of Common ROW #1 which involves loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Morenci to Greenlee 230 kV line. Mitigation will be accomplished by shedding load.

2020HS Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

2020 Heavy Summer Scenario Results

2020HS Scenario Category P0 Analysis:

CATEGORY P0 CRITERIA VIOLATIONS AND MITIGATION PLANS

With all lines and facilities in service, the SWTC system for 2020 heavy summer conditions, for this scenario, meets the requirements and measures of the TPL Standards and does not require any further plans to meet Category P0 criteria.

2020HS Scenario Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:

- Under one P1 outage, there is one (1) buses with voltages in excess of 1.05 per unit.
- Under three P1 outages, there is seven (7) buses with a voltage less than 0.95 per unit.

Voltage Deviations:

- Under two P1 outages, there are four (4) buses with voltage deviations greater than 5%.

Thermal Overloads:

- Under four P1 outages, there is two (2) transmission elements that exceeded its emergency rating.

There were no non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

The bus with voltages in excess of 1.05 per unit does not belong to SWTC, nor does the outaged element that caused the voltages to be in excess of 1.05 per unit belong to SWTC. This is the Vail2 345 kV buse. The Vail2 345 kV bus is owned by TEP and would need to be mitigated by TEP.

Three of the seven buses with a voltage less than 0.95 per unit are: SWTC San Rafael 230 kV bus, the Mural 115 kV bus, and the Boothill 115 kV bus which occurs for loss of the SWTC Butterfield to Tombstone Junction 230 kV line. Mitigation will be accomplished by the addition of a 20 MVAR capacitor bank at San Rafael. The Mural 115 kV bus, and the Boothill 115 kV bus are owned by APS and would need to be mitigated by APS.

The remaining four Buses are the Copper Verde 345 kV bus, the Copper Verde 230 kV bus, the Frisco 230 kV bus and the PD-Morenci 230kV bus which occurs for the loss of the Greenlee to Copper Verde 345 kV line. The Frisco 230 kV bus and the PD-Morenci 230kV bus also have voltages below 0.95 per unit for the Copper Verde to Frisco 345 kV outage. Mitigation would be the responsibility of FMI.

The four buses with voltage deviations greater than 5% are the, Copper Verde 345 kV, San Rafael 230 kV and the Mural 115 kV bus, and the Boothill 115 kV bus.

Voltage deviations at the FMI Copper Verde 345 kV bus occurs for loss of the FMI Greenlee to Copper Verde 345 kV line. Mitigation would be the responsibility of FMI.

Voltage deviations at the SWTC San Rafael 230 kV bus occur for loss of the SWTC Butterfield to Tombstone Junction 230 kV line. Mitigation will be accomplished by the addition of a 20 MVAR capacitor bank at San Rafael.

Voltage deviations at the Mural 115 kV bus, and the Boothill 115 kV bus occur for loss of the SWTC Butterfield to Tombstone Junction 230 kV line. The Mural 115 kV bus, and the Boothill 115 kV bus are owned by APS and would need to be mitigated by APS.

The transmission element that is overloaded is the SWTC Greenlee 345/230 kV transformer.

The SWTC Greenlee 345/230 kV transformer overload occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, loss of the FMI PD-Morenci to Frisco 230 kV line or loss of the FMI Copper Verde to Frisco 230 kV line. Mitigation of this overload will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

2020HS Scenario Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 criteria violations are as follows:

Voltage Violations:

- Under one P2 outage, there is one (1) bus with a voltage less than 0.95 per unit.

Voltage Deviations:

- Under one P2 outage, there is three (3) buses with a voltage deviation greater than 5%.

Thermal Overloads:

- None

There are no non-solved cases found on the system under the Category P2 criterion.

Mitigation Plans

One of the buses with a voltage less than 0.95 per unit and a voltage deviation greater than 5% is the SWTC San Rafael 230 kV bus which occurs for a breaker failure of any Butterfield 230 kV breaker. This outage removes from service all 230 kV lines into and out of Butterfield and mitigation will be accomplished by either the addition of a 20 MVAR capacitor bank at San Rafael or by shedding load.

The other buses with a voltage less than 0.95 per unit and a voltage deviation greater than 5% are the Mural 115 kV bus, and the Boothill 115 kV bus which occurs for loss of the Butterfield 230 kV breaker. The Mural 115 kV bus, and the Boothill 115 kV bus are owned by APS and would need to be mitigated by APS

No mitigation plans are needed for Category P2 thermal violations on the SWTC system.

2020HS Scenario Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2020HS Scenario Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2020HS Scenario Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2020HS Scenario Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:
- None

Thermal Overloads:
- Under various P6 outages, there are five (5) transmission elements that exceeded their emergency ratings.

There were six (6) non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

The five overloaded transmission elements are the Tucson to Oracle 115 kV line, one Copper Verde 345/230 kV transformer, the Bicknell 345/230 kV transformer one Bicknell 230/115 kV transformer and the Greenlee 345/230 kV transformer.

The Tucson to Oracle 115 kV line overload occurs for the Springerville to Greenlee 345 kV line & Springerville to Vail 345 kV line outage and the Springerville to Vail 345 kV line & Pinal West to South line outage. Since this line is owned by Western it would need to be mitigated by Western.

The overload of one FMI Copper Verde 345/230 kV transformer occurs for loss of the SWTC Apache to Redtail 230 kV line, along with loss of either the SWTC Greenlee 345/230 kV transformer, or loss of the TEP Winchester to Willow 345 kV line. Mitigation would be the responsibility of FMI.

The overload of one Bicknell 230/115 kV transformer occurs for loss of the 2nd SWTC Bicknell 230/115 kV transformer, along with loss of the Western Saguaro East to Marana Tap 115 kV line. Mitigation will be accomplished by shedding load.

The overload of the SWTC Bicknell 345/230 kV transformer occurs for loss of the SWTC Apache to Butterfield 230 kV line, along with loss of the Western Saguaro East to Marana Tap 115 kV line. Mitigation will be accomplished either by the addition of a 2nd Bicknell 345/230 kV transformer or by shedding load.

The overload of the SWTC Greenlee 345/230 kV transformer occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, along with any other element or the. Mitigation will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

Two of the six non-solved outages involve loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of either the SWTC Greenlee 345/230 kV transformer or loss of the SWTC Apache to Redtail 230 kV line. Mitigation will be accomplished by shedding load.

One of the six non-solved cases is loss of Common ROW #1 which involves loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Morenci to Greenlee 230 kV line. Mitigation will be accomplished by shedding load.

In order to mitigate the three remaining non-solved cases, which involve loss of the SWTC Apache to Butterfield 230 kV line, along with loss of the SWTC Sahuarita to Bicknell 230 kV line; loss of the SWTC Apache to Butterfield 230 kV line, along with loss of the SWTC Bicknell 345/230 kV transformer or loss of the SWTC Bicknell 345/230 kV transformer, along with loss of the Western Saguaro East to Marana Tap 115 kV line, it will be necessary to add a 2nd Bicknell 345/230 kV transformer or shed load, to bring post contingency voltages and thermal loading within the Category P6 criterion.

2020HS Scenario Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:s
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

LONG TERM ASSESSMENT (2021-2025)

2025 Heavy Summer Results

2025 Heavy Summer Conditions

The 2025HS SWTC base case developed from the coordinated Arizona 2024HS seed case was used as the base model for this projected timeframe. The load levels within the case were adjusted to represent the non-coincidental loads of the Member systems totaling 823.0 MW served by SWTC transmission (not including system losses).

There are no system additions planned for this base year.

2025HS Category P0 Analysis:

The 2025HS SWTC base case developed from the WECC approved 2024 Heavy Summer base case, and coordinated through SWAT-AZ, was used as the base model for this projected timeframe. The load levels within the case were adjusted to represent the non-coincidental loads of the Member systems (excluding AEC) totaling 823.0 MW served by SWTC transmission (not including system losses). Apache station generation dispatch is at 408 MW.

There were no system additions represented in this base year.

2025HS Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:

- Under one P1 outage, there is one (1) bus with voltages in excess of 1.05 per unit.
- Under four P1 outages, there are five (5) buses with voltages below 0.95 per unit.

Voltage Deviations:

- Under one P1 outage, there is one (1) bus with a voltage deviation greater than 5%.

Thermal Overloads:

- Under various P1 outages, there are three (3) transmission elements that exceeded their emergency ratings.

There were no non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

The bus with voltages in excess of 1.05 per unit does not belong to SWTC, nor does the outaged elements that caused the voltages to be in excess of 1.05 per unit belong to SWTC. The Vail2 345 kV bus is owned by TEP and would need to be mitigated by TEP.

The five Buses with voltages below 0.95 per unit are Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV, PD-Morenci 230 kV, Redtail 230 kV which occurs under four outages.

One of the four outages is the FMI Greenlee to Copper Verde 345 kV line which results in voltage violations for Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV, PD-Morenci 230 kV Buses. Mitigation would be the responsibility of FMI.

The second of the four outages is the FMI Copper Verde to Frisco 230 kV line which causes violations on the Frisco 230 kV and PD-Morenci 230 kV Buses. As these are FMI facilities, mitigation would be the responsibility of FMI.

The third outage is on the FMI PD Morenci to Frisco 230 kV line, which results in a voltage violation on the PD-Morenci 230 kV bus. Mitigation would be the responsibility of FMI.

The fourth outage is the Apache-Redtail 230 kV line results in a voltage violation on the Redtail 230 kV bus. Mitigation will be accomplished by moving one of the 50 MVAR Cap Banks from SWTC Morenci Substation to SWTC Dos Condados substation.

The Tucson to Oracle 115 kV line overload occurs for the Western Saguaro East to Marana Tap 115 kV line. Since this line is owned by Western it would need to be mitigated by Western.

The overload of the Western Saguaro East to Marana Tap 115 kV line occurs for the loss of various P1 elements and mitigation includes a bypass of the Saguaro East- Marana Tap Connection by directly tying ED-5 To Marana Tap in the spring of 2016.

The overload of the SWTC Greenlee 345/230 kV transformer occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, loss of the FMI PD-Morenci to Frisco 230 kV line or loss of the FMI Copper Verde to Frisco 230 kV line. Mitigation of this overload will be accomplished by implementing the Greenlee Transformer Overload Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

2025HS Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 criteria violations are as follows:

Voltage Violations:
- Under three P2 outages, there are seven (7) Buses with a voltage less than 0.95 per unit.

Voltage Deviations:
- Under three P2 outages, there are seven (7) Buses with a voltage deviation greater than 5%.

Thermal Overloads:
- Under two P2 outages, there are two (2) transmission elements exceeding their emergency ratings.

There is one (1) non-solved cases found on the system under the Category P2 criterion.

Mitigation Plans:

Three Buses with voltages less than 0.95 per unit are Dos Condados 230 kV, Hackberry 230 kV, Redtail 230 kV, which occurs for the breaker failure of Apache #202 230 kV. Mitigation will include moving one of the 50 MVAR Cap Banks from Morenci Substation to Dos Condados.

The other four Buses with voltages less than 0.95 per unit are Bicknell 115kV, Bicknell 230kV, Three Points 115 kV, and Valencia-SW 115kV which occurs for breaker failure Bicknell #205 230 kV. Breaker failure Bicknell #203 230kV results in violations on the Bicknell 115kV, Three Points 115 kV, and Valencia-SW 115kV Buses. Mitigation for both of these contingencies includes shedding local load and/or an additional 20MVAR of capacitor banks.

Coincidentally, these same contingencies result in voltage deviations greater than 5% on the same Buses. Mitigation as above includes shedding local load and/or installing additional capacitor banks.

One of the two overloaded transmission elements is the Western Saguaro East to Marana Tap 115 kV line, which occurs for a breaker failure of Bicknell 230 kV breaker #205; and breaker failure of Bicknell 230 kV breaker #203. This overload will be mitigated by Saguaro Bypass Project (Spring 2016).

The other is the Three Points to Sandario 115 kV line, which occurs for the breaker failure of Bicknell 230 kV breaker #203. This overload will be mitigated by Saguaro Bypass Project (Spring 2016). Other projects under study eliminate all Thermal Violations of this line.

The one non-solved case is a breaker failure of Apache 230 kV breaker #207.
Mitigation of the breaker failure of Apache 230 kV breaker #207, which causes a loss of both Apache 230/115 kV transformers, will be accomplished by either a redispatch of Apache station generation or by shedding load.

2025HS Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2025HS Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2025HS Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2025HS Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:

- Under three P6 outages, there are eleven (11) buses with voltages below 0.90 per unit.

Voltage Deviations:

- Under three P6 outages, there are five (5) buses with voltage deviations greater than 10%

Thermal Overloads:

- Under numerous P6 outages, there are four (4) transmission elements that exceeded their emergency ratings.

There were three non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

The eleven buses exhibiting voltages less than 0.90 per unit are the Dos Condados 230 kV, Hackberry 230 kV, Redtail 230 kV, Bicknell 230 kV, Bicknell 115 kV, Three Points 115 kV, Valencia 115 kV, Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV, and PD-Morenci 230 kV.

Low voltages at the SWTC Dos Condados 230 kV, Hackberry 230 kV, and Redtail 230 kV bus occur for loss of the SWTC Apache to Redtail 230 kV line, along with loss of the TEP Springerville to Vail 345 kV line. Mitigation will be accomplished either by moving a 50MVAR capacitor bank from Morenci 230kV substation to Dos Condados, by shedding load, or by implementing the Hackberry-Thatcher Reverse Power Relay Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment.

Low voltages at the SWTC Bicknell 230 kV bus, Bicknell, Three Points and Valencia 115 kV buses occur for the loss of the Bicknell 345/230 transformer along with the loss of the Sahuarita to Bicknell 230 kV line. Mitigation will be accomplished either by installing 20 MVAR of additional capacitor banks at Bicknell and/or Three Points or by shedding load.

Low voltages at the FMI Copper Verde 230 kV and 345 kV and FMI Frisco and PD-Morenci 230 kV buses, occur for loss of the FMI Greenlee to Copper Verde 345 kV line along with loss of the TEP Winchester to Willow 345 kV line. Mitigation would be the responsibility of FMI.

The five buses with voltage deviations greater than 10% are the Dos Condados 230 kV, Redtail 230 kV, Bicknell 230 kV, Bicknell 115 kV, and Copper Verde 345 kV buses.

Voltage deviations at the SWTC Dos Condados 230 kV and the Redtail 230 kV bus occur for loss of the SWTC Apache to Redtail 230 kV line, along with loss of the Springerville to Vail 345 kV line.

Mitigation will be accomplished either by moving a 50MVAR capacitor bank from Morenci 230kV substation to Dos Condados, by shedding load, or by implementing the Hackberry-Thatcher Reverse Power Relay Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment.

Voltage deviations at the SWTC Bicknell 230 kV and Bicknell 115 kV buses occur for the loss of the Bicknell 345/230 transformer along with the loss of the Sahuarita to Bicknell 230 kV line. Mitigation will be accomplished either by installing 20 MVAR of additional capacitor banks at Bicknell and/or Three Points or by shedding load

Voltage deviations at the FMI Copper Verde 345 kV and the FMI Frisco and PD-Morenci 230 kV buses, occur for loss of the FMI Greenlee to Copper Verde 345 kV line along with loss of the TEP Winchester to Willow 345 kV line. Mitigation would be the responsibility of FMI.

The seven overloaded transmission elements are the Saguaro East to Marana Tap 115 kV line, the Marana Tap to Marana 115 kV line, the Three Points to Sandario 115 kV line, the Bicknell 345/230 kV, one Bicknell 230/115 kV, one Copper Verde 345/230 kV transformer, and the Greenlee 345/230 kV transformer.

The overloads of the Western Saguaro East to Marana Tap 115 kV line and the Marana Tap to Marana 115 kV line occur for various P6 outages and mitigation includes a bypass of the Saguaro East- Marana Tap Connection by directly tying ED-5 to Marana Tap. This project is scheduled to be installed in spring 2016.

The overload of the SWTC Three Points to Sandario 115 kV line occurs for various P6 outages. Mitigation will be accomplished either by upgrading the line or by shedding load.

The overload of one of the Bicknell 230/115 kV transformers occurs for loss of the other SWTC Bicknell 230/115 kV Transformer along with the loss of the Saguaro East to Marana Tap115 kV line. Mitigation would be accomplished by shedding local load.

The overload of the Bicknell 345/230 kV transformer occurs for the loss of the Apache to Butterfield 230 kV line and either the Saguaro East to Marana Tap 115 kV line, the Marana to Avra 115 kV line, the Avra to Sandario 115kV line, or the Sandario to Three Points 115 kV line. Mitigation would be accomplished by the addition of a 2nd Bicknell 345/230 kV transformer or dropping load in local area to reduce loading on the transformer.

The overload of one FMI Copper Verde 345/230 kV transformer occurs for loss of the SWTC Apache to Redtail 230 kV line, along with loss of the SWTC Greenlee 345/230 kV transformer, or for loss of the TEP Winchester to Willow 345 kV line, along with loss of the SWTC Greenlee 345/230 kV transformer. Miitigation would be the responsibility of FMI.

The overload of the SWTC Greenlee 345/230 kV transformer occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, along with any other element. Mitigation will be accomplished by implementing the Greenlee Transformer Overload Procedure as noted in Section 1.8.2 Special

Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

In order to mitigate four of the seven non-solved cases, which involve loss of the SWTC Bicknell 345/230 kV transformer, along with loss of the SWTC Pantano to New Tucson 230 kV line; or loss of the SWTC Apache to Butterfield 230 kV line, or loss of the SWTC New Tucson to Sahuarita 230 kV line, or the Saguaro East to Marana Tap 115 kV line it will be necessary to add a 2nd Bicknell 345/230 kV transformer or shed load, to bring post contingency voltages and thermal loading within the Category P6 criterion.

One of the nine non-solved cases is loss of Common ROW #1 which involves loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Morenci to Greenlee 230 kV line. Mitigation will be accomplished by shedding load.

Two of the seven non-solved outages involve loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of either the SWTC Greenlee 345/230 kV transformer, or loss of the SWTC Apache to Redtail 230 kV line. Mitigation would be the responsibility of FMI.

2025HS Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

2025 Heavy Summer Scenario Results

2025HS Scenario Category P0 Analysis:

CATEGORY P0 CRITERIA VIOLATIONS AND MITIGATION PLANS

With all lines and facilities in service, the SWTC system for 2020 heavy summer conditions, for this scenario, meets the requirements and measures of the TPL Standards and does not require any further plans to meet Category P0 criteria.

2025HS Scenario Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:

- Under one P1 outages, there is one (1) bus with voltages in excess of 1.05 per unit.
- Under four P1 outages, there are twenty (20) buses with voltages less than 0.95 per unit.

Voltage Deviations:

- Under three P1 outages, there are sixteen (16) buses with voltage deviations greater than 5%.

Thermal Overloads:

- Under three P1 outages, there is one (1) transmission element that exceeded its emergency rating.

There were no non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

The bus with voltage in excess of 1.05 per unit does not belong to SWTC, nor does the outaged elements that caused the voltage to be in excess of 1.05 per unit belong to SWTC, this is the Vail2 345 kV bus. The Vail2 345 kV bus is owned by TEP and would need to be mitigated by TEP.

The twenty buses with a voltage less than 0.95 per unit are the San Rafael 230 kV San Rafael 69 kV buses, Mural 115 kV, Boothill 115 kV, Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV, PD-Morenci 230 kV, Sandario SW 115 k V, Valencia SW 115 kV, Three Points 115 kV, Marana 115 kV, Avra Valley 115 kV, Twin Peak 115 kV, Sandy Hill 115 kV, Sandario 115 k V, San Xavier 115 kV, RattleSnake 115 kV, Brawley 115 kV, Black Mountain 115 kV.

Low voltages at the SWTC San Rafael 230 kV, San Rafael 69 kV buses occur for loss of the SWTC Butterfield to Tombstone Junction 230 kV line. Mitigation will be accomplished by the addition of a 20MVAR capacitor bank at San Rafael.

Low voltages at the APS Mural 115 kV, Boothill 115 kV buses occur for loss of the SWTC Butterfield to Tombstone Junction 230 kV line. Mitigation will be the responsibility of APS.

Low voltages at the FMI Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV, PD-Morenci 230 kV buses occur for loss of the FMI Greenlee to Copper Verde 345 kV line. Mitigation would be the responsibility of FMI.

Low voltages at the FMI Frisco and PD-Morenci 230 kV buses occur for loss of the FMI Copper Verde to Frisco 230 kV line. Mitigation would be the responsibility of FMI.

Low voltages at the Sandario SW 115 k V, Valencia SW 115 kV, Three Points 115 kV, Marana 115 kV, Avra Valley 115 kV, Twin Peak 115 kV, Sandy Hill 115 kV, Sandario 115 k V, San Xavier 115 kV, RattleSnake 115 kV, Brawley 115 kV, Black Mountain 115 kV buses occur for loss of Group_Marana 115 kV lines. Mitigation is being developed as part of an ongoing study for this project, possibilities include the addition of Capacitor Banks, additional transmission lines, etc.

The sixteen buses with voltage deviations greater than 5% are the San Rafael 230 kV and San Rafael 69 kV buses, Mural 115 kV, Boothill 115 kV, Copper Verde 345 kV, Sandario SW 115 k V, Valencia SW 115 kV, Marana 115 kV, Avra Valley 115 kV, Twin Peak 115 kV, Sandy Hill 115 kV, Sandario 115 k V, San Xavier 115 kV, RattleSnake 115 kV, Brawley 115 kV, Black Mountain 115 kV.

Voltage deviations at the SWTC San Rafael 230 kV and San Rafael 69 kV buses occur for loss of either the SWTC Butterfield to Tombstone Junction 230 kV line. Mitigation will be accomplished by the addition of a 20 MVAR capacitor bank at San Rafael.

Voltage deviations at the Mural 115 kV, Boothill 115 kV buses occurs for loss of either the SWTC Butterfield to Tombstone Junction 230 kV line. Mitigation will be accomplished by APS.

Voltage deviation at the FMI Copper Verde 345 kV bus occurs for loss of the FMI Greenlee to Copper Verde 345 kV line. Mitigation would be the responsibility of FMI.

Voltage deviations at the Sandario SW 115 k V, Valencia SW 115 kV, Marana 115 kV, Avra Valley 115 kV, Twin Peak 115 kV, Sandy Hill 115 kV, Sandario 115 k V, San Xavier 115 kV, RattleSnake 115 kV, Brawley 115 kV, Black Mountain 115 kV occur for loss of the SWTC Marana Group. Mitigation is being developed as part of an ongoing study for this project, possibilities include the addition of Capacitor Banks, additional transmission lines, etc.

The transmission element that is overloaded is the Greenlee 345/230 kV transformer.
The overload of the SWTC Greenlee 345/230 kV transformer occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, loss of the FMI PD-Morenci to Frisco 230 kV line or loss of the FMI Copper Verde to Frisco 230 kV line. Mitigation of this overload will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

2025HS Scenario Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 criteria violations are as follows:

Voltage Violations:

- Under one P2 outages, there are five (5) buses with voltages less than 0.95 per unit.

Voltage Deviations:

- Under one P2 outages, there are four (4) buses with voltage deviations greater than 5%.

Thermal Overloads:

- None

There is one (1) non-solved case found on the system under the Category P2 criterion.

Mitigation Plans:

The five buses with voltages less than 0.95 are the Kartchner 115 kV, San Rafael 230 kV, San Rafael 69 kV, Mural 115 kV, and Boothill 115 kV buses.

Low voltages at the SWTC Kartchner 115 kV, SWTC San Rafael 230 kV and SWTC San Rafael 69 kV buses occur for a breaker failure of any Butterfield 230 kV breaker. This outage removes from service all 230 kV lines into and out of Butterfield. Mitigation for the Kartchner 115 kV bus will be accomplished by either the addition of a capacitor bank in the Kartchner area or by shedding load. Mitigation for the San Rafael 230 kV bus will be accomplished either by the addition of a 20 MVAR capacitor bank at San Rafael or by shedding load.

Low voltages at the APS Mural 115 kV, and Boothill 115 kV buses buses occur for a breaker failure of any Butterfield 230 kV breaker. This outage removes from service all 230 kV lines into and out of Butterfield. Mitigation will be accomplished by the Buses owner, APS.

The two buses with voltage deviations are the Apache 115 kV and San Rafael 230 kV buses.

Voltage deviations at the SWTC Apache 115 kV bus occur a breaker failure of the Apache 230 kV breaker #207. This outage causes a loss of both Apache 230/115 kV transformers and mitigation will be accomplished either by a redispatch of Apache station generation or by shedding load.

Voltage deviations at the San Rafael 230 kV bus occur for a breaker failure of any Butterfield 230 kV breaker and mitigation will be accomplished either by the addition of a 20 MVAR capacitor bank at San Rafael or by shedding load.

No mitigation plans are needed for Category P2 thermal overloads on the SWTC system.

The one non-solved case is for a bus fault at the Apache 115 kV main bus, in which all elements connected to the bus are transfer tripped, due to the main and transfer configuration of the bus.

Mitigation will be accomplished by either a redispatch of Apache station generation or by shedding load.

2025HS Scenario Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2025HS Scenario Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2025HS Scenario Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2025HS Scenario Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:
- Under numerous P6 outages, there are fifteen (15) buses with voltages less than 0.90 per unit.

Voltage Deviations:
- Under various P6 outages, there are fifteen (15) buses with voltage deviations greater than 10%.

Thermal Overloads:
- Under numerous P6 outages, there are three (3) transmission elements that exceeded their emergency ratings.

There were nine (9) non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

The fifteen buses exhibiting voltages less than 0.90 per unit are the Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV, PD-Morenci 230 kV, Sandario SW 115 k V, Valencia SW 115 kV, Three Points 115 kV, Marana 115 kV, Avra Valley 115 kV, Twin Peak 115 kV, Sandy Hill 115 kV, Sandario 115 k V, San Xavier 115 kV, RattleSnake 115 kV, Brawley 115 kV, Black Mountain 115 kV.

Low voltages at the Sandario SW 115 k V, Valencia SW 115 kV, Three Points 115 kV, Marana 115 kV, Avra Valley 115 kV, Twin Peak 115 kV, Sandy Hill 115 kV, Sandario 115 k V, San Xavier 115 kV, RattleSnake 115 kV, Brawley 115 kV, Black Mountain 115 kV Buses occur for loss of the TEP Winchester to Vail 345 kV line, or loss of the TEP Springerville to Vail2 345 kV line, along with loss of the Western Saguaro East to Marana Tap 115 kV line. Mitigation is being developed as part of an ongoing study for this project, possibilities include the addition of Capacitor Banks, additional transmission lines, or by shedding load.

Low voltages at the FMI Copper Verde 230 and 345 kV buses, and the FMI Frisco and PD-Morenci 230 kV buses, occur for loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Hackberry to Morenci 230 kV line; or for loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the TEP Winchester to Willow 345 kV line . Mitigation would be the responsibility of FMI.

The fifteen buses with voltage deviations greater than 10% are the Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV, PD-Morenci 230 kV, Sandario SW 115 k V, Valencia SW 115 kV, Three Points 115 kV, Marana 115 kV, Avra Valley 115 kV, Twin Peak 115 kV, Sandy Hill 115 kV, Sandario 115 k V, San Xavier 115 kV, RattleSnake 115 kV, Brawley 115 kV, Black Mountain 115 kV. .

Voltage Deviations at the Sandario SW 115 k V, Valencia SW 115 kV, Three Points 115 kV, Marana 115 kV, Avra Valley 115 kV, Twin Peak 115 kV, Sandy Hill 115 kV, Sandario 115 k V, San Xavier 115 kV, RattleSnake 115 kV, Brawley 115 kV, Black Mountain 115 kV Buses occur for loss of the TEP Winchester to Vail 345 kV line, or loss of the TEP Springerville to Vail2 345 kV line, along with loss of the Western Saguaro East to Marana Tap 115 kV line. Mitigation is being developed as part of an ongoing study for this project, possibilities include the addition of Capacitor Banks, additional transmission lines, or by shedding load.

Voltage deviations at the Dos Condados 230 kV bus occur for loss of the SWTC Apache to Redtail 230 kV line, along with loss of either the TEP Springerville to Greeenlee 345 kV line, or loss of the SWTC Greenlee 345/230 kV transformer. The deviations also occur for loss of the SWTC Redtail to Dos Condados 230 kV line, along with loss of the SWTC Dos Condados to Hackberry 230 kV line. Mitigation will be accomplished either by the addition of reactive resources at Dos Condados or by shedding load.

Voltage Deviations at the FMI Copper Verde 230 and 345 kV buses, and the FMI Frisco and PD-Morenci 230 kV buses, occur for loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Hackberry to Morenci 230 kV line; or for loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the TEP Winchester to Willow 345 kV line. Mitigation would be the responsibility of FMI.

The three overloaded transmission elements are the Tucson to Oracle 115 kV line, one Copper Verde 345/230 kV transformer, and the Greenlee 345/230 kV transformer.

The overload of the Western Tucson to Oracle line occurs for the loss of various P6 elements. Mitigation will be accomplished by WAPA, the owner of the line.

The overload of both FMI Copper Verde 345/230 kV transformers occurs for loss of the TEP Winchester to Willow 345 kV line, along with loss of the SWTC Greenlee 345/230 kV transformer, or for loss of the SWTC Apache to Redtail 230 kV line, along with loss of the SWTC Greenlee 345/230 kV transformer. Mitigation would be the responsibility of FMI.

The overload of the SWTC Greenlee 345/230 kV transformer occurs for loss of the FMI Copper Verde to Frisco 230 kV line, PD Morenci to Frisco 230 kV line, or Greenlee to Copper Verde 345 kV line. The overload also occurs for the loss of the Greenlee to Copper Verde 345 kV line, in conjunction with any other element. Mitigation will be accomplished by implementing the Greenlee Transformer Overload Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

Two of the nine non-solved outages involve loss of the FMI Greenlee to Copper Verde 345 kV line along with loss of either the SWTC Greenlee 345/230 kV transformer, or loss of the SWTC Apache to Redtail 230 kV line. Mitigation will be accomplished either by the addition of a 2nd Greenlee 345/230 kV transformer or by shedding load.

Six non-solved cases involve loss of the SWTC Apache to Butterfield 230 kV line, along with loss of the SWTC Sahuarita to Bicknell 230 kV line; loss of the Apache to Butterfield 230 kV line, along with loss of the Western Saguaro East to Marana Tap 115 kV line; loss of the SWTC Apache to Butterfield 230 kV line, along with loss of the Bicknell 345/230 kV transformer; loss of the SWTC Bicknell 345/230 kV transformer, along with loss of the Western Saguaro East to Marana Tap 115 kV line; loss of one SWTC Bicknell 230/115 kV transformer, along with loss of the Western Saguaro East to Marana Tap 115 kV line; loss of the SWTC Bicknell 345/230 kV transformer, along with loss of the SWTC Pantano to New Tucson 230 kV line; loss of the SWTC Bicknell 345/230 kV transformer, along with loss of the New Tucson to Sahuarita 230 kV line. It will be necessary to add a 2nd Bicknell 345/230 kV transformer or shed load, to bring post contingency voltages and thermal loading within the Category P6 criterion.

The last of the nine non-solved cases is loss of Common ROW #1 which involves loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Morenci to Greenlee 230 kV line. Mitigation will be accomplished by shedding load.

2025HS Scenario Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:

- None

Voltage Deviations:

- None

Thermal Overloads:

- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

2025 Light Winter Results

2025 Light Winter Conditions

The 2025LW base case developed from the WECC approved 2015lwa.sav base case, and coordinated through SASG was used as the base model for this projected timeframe. The load levels within the case were adjusted to represent approximately 75% of the peak non-coincidental winter peak loads of the Member systems (excluding AEC) totaling 321 MW served by SWTC transmission (not including system losses). Apache station generation dispatch is at 326 MW.

There were no system additions represented in this base year.

2025LW Category P0 Analysis:

With all lines and facilities in service, the SWTC system for 2024 light winter conditions, meets the requirements and measures of the TPL Standards and does not require any further plans to meet Category P0 criteria.

2025LW Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:

- Under three P1 outages, there are seven (7) buses with voltages in excess of 1.05 per unit.

Voltage Deviations:

- None

Thermal Overloads:

- Under twoP1 outage, there is one (1) bus with a thermal overload.

There were three (3) non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

Two of the buses with voltages in excess of 1.05 per unit do not belong to SWTC, nor do the outaged elements that caused the voltages to be in excess of 1.05 per unit belong to SWTC. These are the Westwing 345 kV and the Vail2 345 kV buses. The Westwing 345 kV bus is owned by several entities and would need to be mitigated by those entities. The Vail2 345 kV bus is owned by TEP and would need to be mitigated by TEP.

The other five Buses with voltages greater than 1.05 are the Adams 115 kV bus, the Adams Tap 115 kV bus, the Nogales 115kV, the Mural 115 kV bus, and the Boothill 115 kV bus. The Adams, Adams Tap, and Nogales 115 kV buses are owned by WAPA and would need to be mitigated by WAPA. The Mural, and Boothill 115 kV buses are owned by APS and would need to be mitigated by APS.

The overload of the SWTC Greenlee 345/230 kV transformer occurs for loss of the FMI Copper Verde to Frisco 230 kV line or the loss of the Greenlee to Copper Verde 345kN line. Mitigation of this overload will be accomplished by implementing the Greenlee Transformer Overload Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

2025LW Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

There were no non-solved case found on the system under the Category P2 criterion.

Mitigation Plans

No mitigation plans are needed for Category P2 voltage violations and thermal overloads on the SWTC system.

2025LW Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2025LW Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2025LW Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2025LW Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:
- Under one P6 outages, there are four (4) buses with voltages below 0.90 per unit.

Voltage Deviations:
- Under one P6 outage, there are three (3) buses with voltage deviations greater than 10%.

Thermal Overloads:
- Under numerous P6 outages, there is one (1) transmission element that exceeded its emergency rating.

There are three (3) non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

The four buses exhibiting voltages less than 0.90 per unit are the Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV, and PD-Morenci 230 kV Buses. Low voltage occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Hackberry to Morenci 230 kV line. Mitigation would be the responsibility of FMI.

Low voltages at the SWTC Hackberry 230 kV bus occur for loss of the SWTC Hackberry to Morenci 230 kV line, along with loss of the SWTC Dos Condados to Hackberry 230 kV line. Mitigation will be accomplished by implementing the Hackberry-Thatcher Reverse Power Relay Procedure as noted in Section 1.8.2 Special Protection Systems of the 2015 Transmission Planning Asessment.

The three buses with voltage deviations greater than 10% are the FMI Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV buses occur for the P6 contingency Greenlee to Copper Verde 345 kV along with Hackberry to Morenci 230 kV. As the owner, FMI would be responsible for mitigation.

The one overloaded transmission element is the SWTC Greenlee 345/230 kV transformer, for loss of the FMI Greenlee to Copper Verde 345 kV line along with any other element. Mitigation will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

The three non-solve cases involve loss of Common ROW #1; loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Greenlee 345/230 kV transformer; and loss of the SWTC Apache to Butterfield 230 kV line, along with loss of the SWTC Bicknell 345/230 kV transformer.

In order to mitigate the loss of Common ROW #1, it will be necessary to shed load. Mitigation of the loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Greenlee 345/230 kV transformer, will be accomplished either by the addition of a 2nd Greenlee 345/230 kV transformer or by shedding load. Mitigation of the loss of the SWTC Apache to Butterfield 230 kV line, along with loss of the SWTC Bicknell 345/230 kV transformer will be accomplished either by the addition of a 2nd Bicknell 345/230 kV transformer or by shedding load.

2025LW Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

2025 Light Winter Scenario Results

2025LW Scenario Category P0 Analysis:

CATEGORY P0 CRITERIA VIOLATIONS AND MITIGATION PLANS

With all lines and facilities in service, the SWTC system for 2024 light winter conditions, for this scenario, meets the requirements and measures of the TPL Standards and does not require any further plans to meet Category P0 criteria.

2025LW Scenario Category P1 Analysis:

CATEGORY P1 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P1 criteria violations are as follows:

Voltage Violations:
- Under five P1 outages, there are 5 (5) Buses with voltages in excess of 1.05 per unit.

Voltage Deviations:
- None

Thermal Overloads:
- Under two P1 outage, there is one (1) transmission element that exceeded its emergency rating.

There were no non-solved cases found on the system under the Category P1 criterion.

Mitigation Plans

Two of the five buses with voltages in excess of 1.05 per unit do not belong to SWTC, nor do the outaged elements that caused the voltage to be in excess of 1.05 per unit belong to SWTC. These are the Westwing and Vail2 345 kV buses. The Westwing 345 kV bus is owned by several entities and would need to be mitigated by those entities. The Vail2 345 kV bus is owned by TEP and would need to be mitigated by TEP.

The other three Buses with voltages greater than 1.05 are the Adams 115 kV bus, the Mural 115 kV bus, and the Boothill 115 kV bus. This occurs under the Adams Group 115 kV, the Adams to Adams Tap 115 kV, and the Main Bus Fault for Apache 115 kV. The Adams 115 kV bus is owned by WAPA and would need to be mitigated by WAPA. The Mural, and Boothill 115 kV buses are owned by APS and would need to be mitigated by APS.

The one overloaded transmission element is the SWTC Greenlee 345/230 kV transformer, for loss of the FMI Greenlee to Copper Verde 345 kV line or the loss of the FMI Copper Verde to Frisco 230 kV line. Mitigation will be accomplished by implementing the Greenlee Transformer

Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

2025LW Scenario Category P2 Analysis:

CATEGORY P2 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P2 criteria violations are as follows:

Voltage Violations:
- Under one P2 outage, there is three (3) Buses with a voltage in excess of 1.05 per unit.

Voltage Deviations:
- None

Thermal Overloads:
- None

There was one (1) non-solved case found on the system under the Category P2 criterion.

Mitigation Plans:

The three Buses with voltages greater than 1.05 are the Adams 115 kV bus, the Mural 115 kV bus, and the Boothill 115 kV bus. The contingency case on the system is a bus fault at the Apache 115 kV main bus. The Adams 115 kV bus is owned by WAPA and would need to be mitigated by WAPA. The Mural, and Boothill 115 kV buses are owned by APS and would need to be mitigated by APS.

No mitigation plans are needed for Category P2 thermal overloads on the SWTC system.

2025LW Scenario Category P3 Analysis:

CATEGORY P3 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P3 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P3 voltage violations and thermal overloads on the SWTC system.

2025LW Scenario Category P4 Analysis:

CATEGORY P4 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P4 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P4 voltage violations and thermal overloads on the SWTC system.

2025LW Scenario Category P5 Analysis:

CATEGORY P5 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P5 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P5 voltage violations and thermal overloads on the SWTC system.

2025LW Scenario Category P6 Analysis:

CATEGORY P6 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P6 criteria violations are as follows:

Voltage Violations:

- Under four P6 outages, there are three (3) buses with voltages in excess of 1.05 per unit.
- Under one P6 outages, there are four (4) buses with voltages less than 0.90 per unit.

Voltage Deviations:

- Under one P6 outage, there are three (3) buses with voltage deviations greater than 10%.

Thermal Overloads:

- Under various P6 outages, there is one (1) transmission element that exceeded its emergency rating.

There are two (2) non-solved cases found on the system under the Category P6 criterion.

Mitigation Plans

The three Buses with voltages greater than 1.05 are the Adams 115 kV bus, the Mural 115 kV bus, and the Boothill 115 kV bus. The contingencies are: loss of the Bicknell to Three Points 115 kV line along with Adams to Apache 115 kV line, the Adams to Apache 115 kV line and the Apache to Butterfield 230 kV line, Common Row #2, and Common Row #3. The Adams 115 kV bus is owned by WAPA and would need to be mitigated by WAPA. The Mural, and Boothill 115 kV buses are owned by APS and would need to be mitigated by APS.

The four buses exhibiting voltages less than 0.90 per unit are the Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV, and PD-Morenci 230 kV Buses. Low voltage occurs for loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Hackberry to Morenci 230 kV line. Mitigation would be the responsibility of FMI.

The three buses with voltage deviations greater than 10% are the FMI Copper Verde 230 kV, Copper Verde 345 kV, Frisco 230 kV buses, which occur for the P6 contingency Greenlee to Copper Verde 345 kV along with Hackberry to Morenci 230 kV. As the owner, FMI would be responsible for mitigation.

The one overloaded transmission element is the SWTC Greenlee 345/230 kV transformer, for loss of the FMI Greenlee to Copper Verde 345 kV line along with any other element. Mitigation will be accomplished by implementing the Greenlee Transformer Operating Procedure as noted in Section 1.8.2 Special Protection Schemes of the 2015 Transmission Planning Asessment. There will be no loss of firm load under this procedure.

The two non-solved cases involve loss of Common ROW #1; loss of the FMI Greenlee to Copper Verde 345 kV line, along with loss of the SWTC Greenlee 345/230 kV transformer.

In order to mitigate a loss of Common ROW #1, will be necessary to shed load. Mitigation of the loss of the FMI Greenlee to Copper Verde 345 kV line, along with the loss of the SWTC Geeenlee 345/230 kV transformer will be accomplished either by the addition of a 2nd Greenlee 345/230 kV transformer or by shedding load.

2025LW Scenario Category P7 Analysis:

CATEGORY P7 CRITERIA VIOLATIONS AND MITIGATION PLANS

The Category P7 criteria violations are as follows:

Voltage Violations:
- None

Voltage Deviations:
- None

Thermal Overloads:
- None

Mitigation Plans

No mitigation plans are needed for Category P7 voltage violations and thermal overloads on the SWTC system.

REACTIVE MARGIN ANALYSIS

Q-V Analyses for reactive margin were performed for the interconnected SWTC transmission system for heavy summer and light winter conditions for the years 2016, 2020, and 2025. As noted earlier, the heavy summer plots only are included in this report and can be found in Appendix D.

STABILITY ANALYSIS

Transient stability analyses were performed for the interconnected SWTC transmission system for heavy summer and light winter conditions for the years 2016, 2020, and 2025, using the cases listed in the Power Flow Analyses Section above. As with the reactive margin analysis, only the heavy summer plots are included in this report.

Only a representative sample of the P1 and P6 outage conditions under heavy summer conditions for the study years 2016 and 2020 only are included in this report.

The outages considered in this report are as follows:

P1 Outage conditions:

- Apache to Butterfield 230 kV Line
- Apache to Redtail 230 kV Line
- Bicknell to Vail 345 kV Line
- Saguaro East to Marana 115 kV Line

P6 Outage Conditions:

- Apache to Butterfield 230 kV & Saguaro East to Marana Tap 115 kV
- Apache to Butterfield 230 kV & Bicknell to Vail 345 kV

Under 2016HS and 2020HS conditions, the P6 outage of Apache to Butterfield 230 kV & Bicknell to Vail 345 kV lines did not solve, and plots for the P6 outage Bicknell to Vail 345 kV & Saguaro East to Marana Tap 115 kV lines has been included. For double-contingency outages of the above lines, operating procedures are in place to curtail load.

These selected stability plots can be found in Appendix E.

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR PLAN

2016 – 2025

TECHNICAL STUDY REPORT APPENDICES

APPENDIX A: Current and Planned Transmission System Maps

FIGURE 1: SWTC NORTHERN AREA SYSTEM

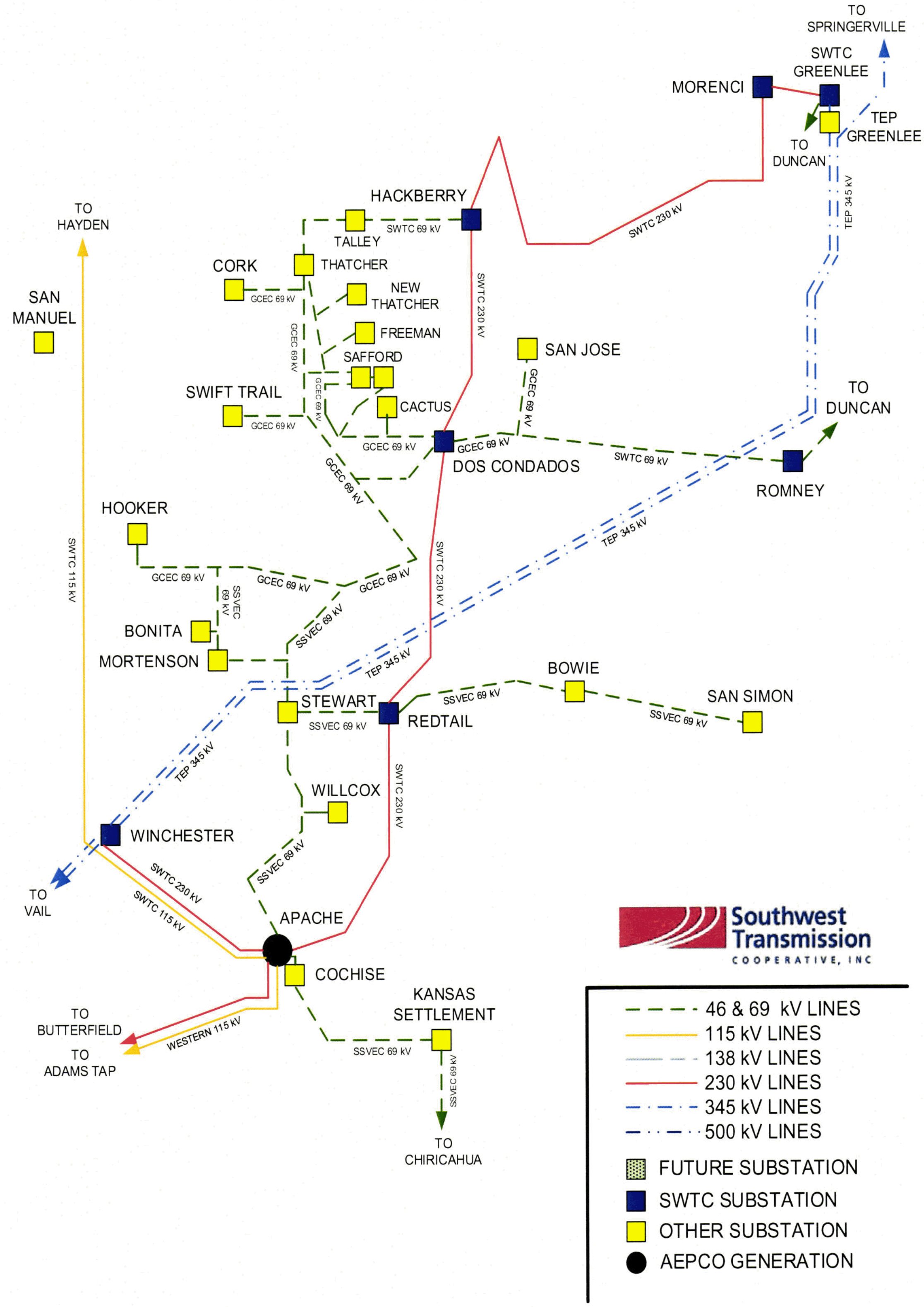


FIGURE 2: SWTC SOUTHERN AREA SYSTEM

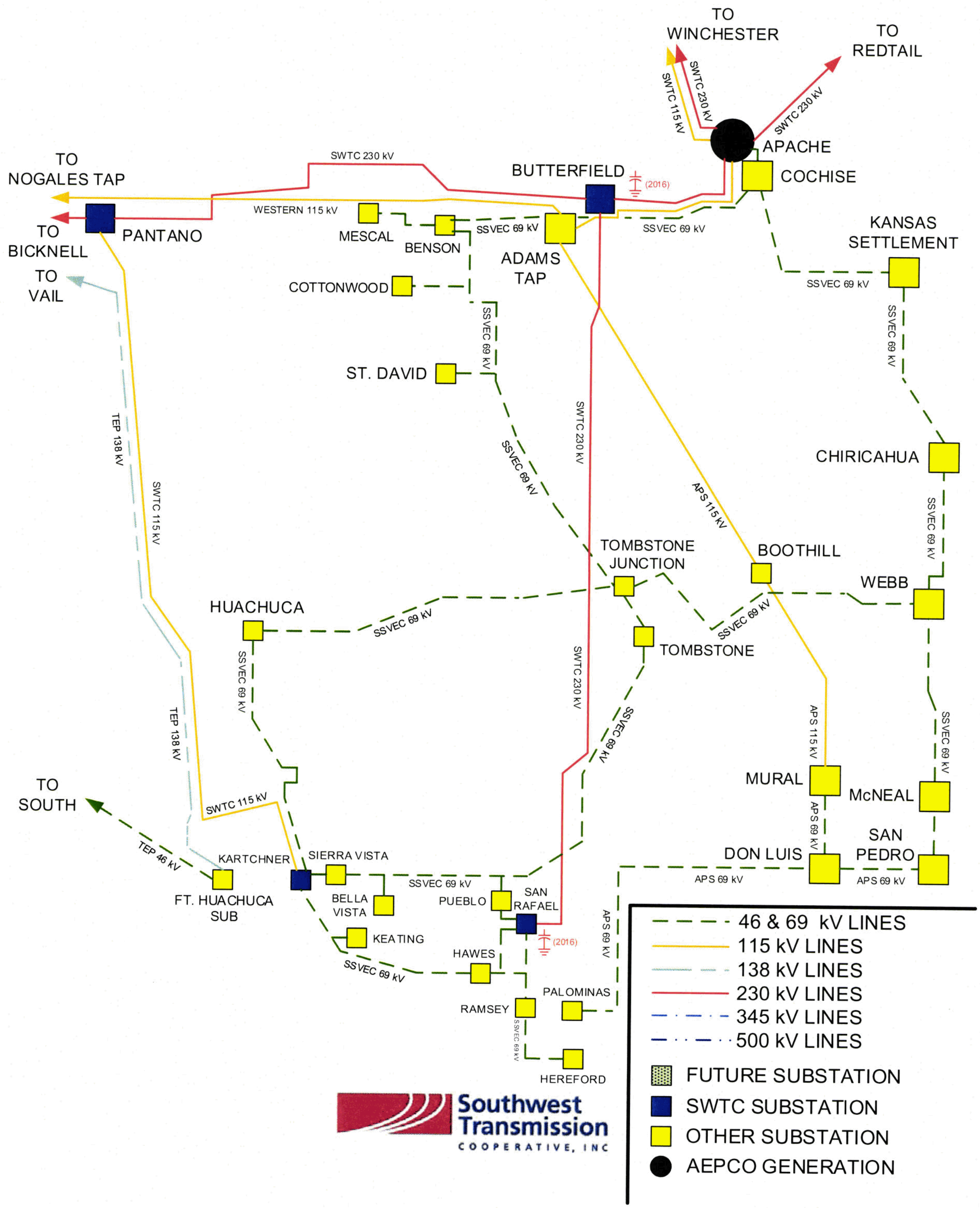


FIGURE 3: SWTC WESTERN AREA SYSTEM

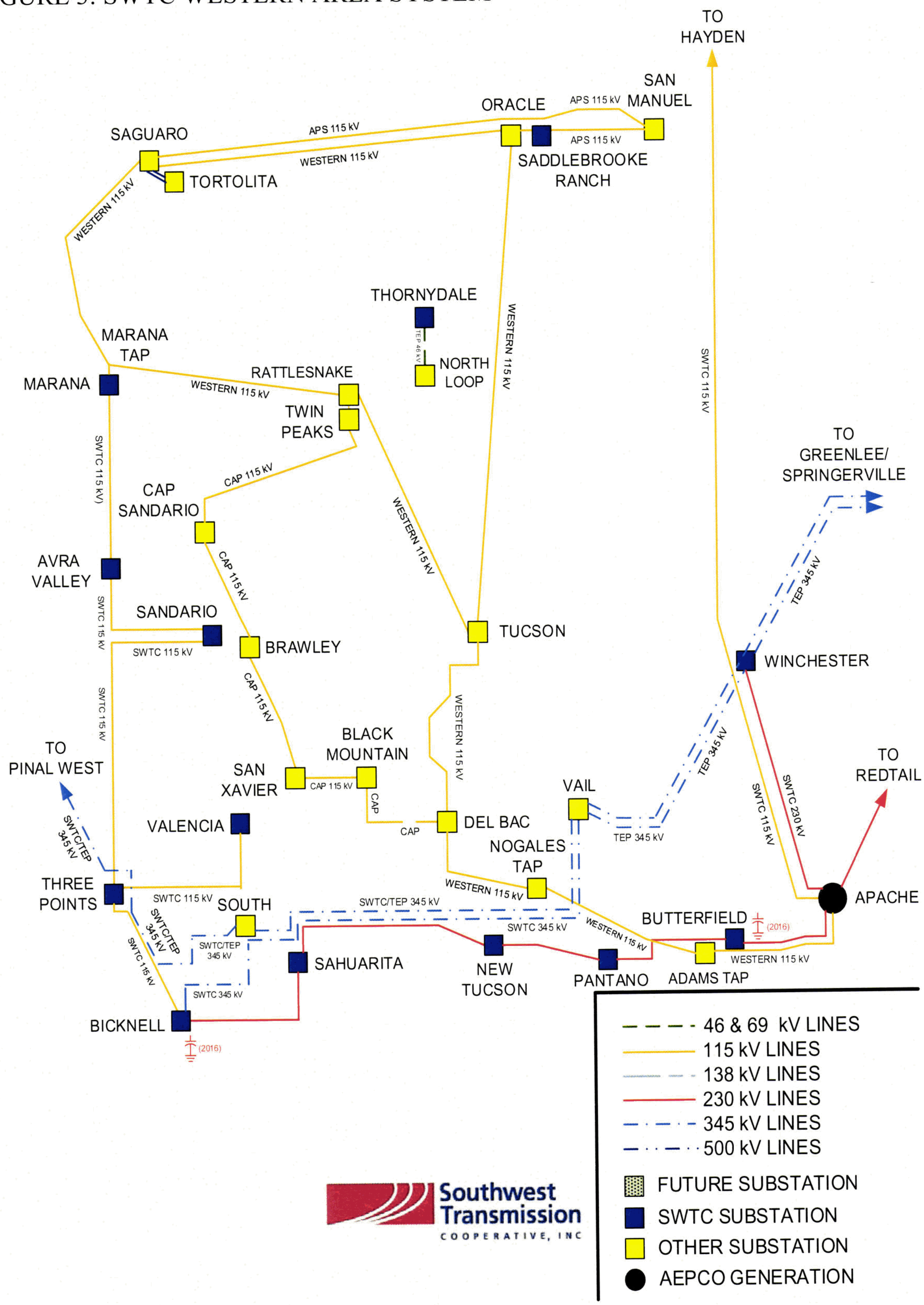
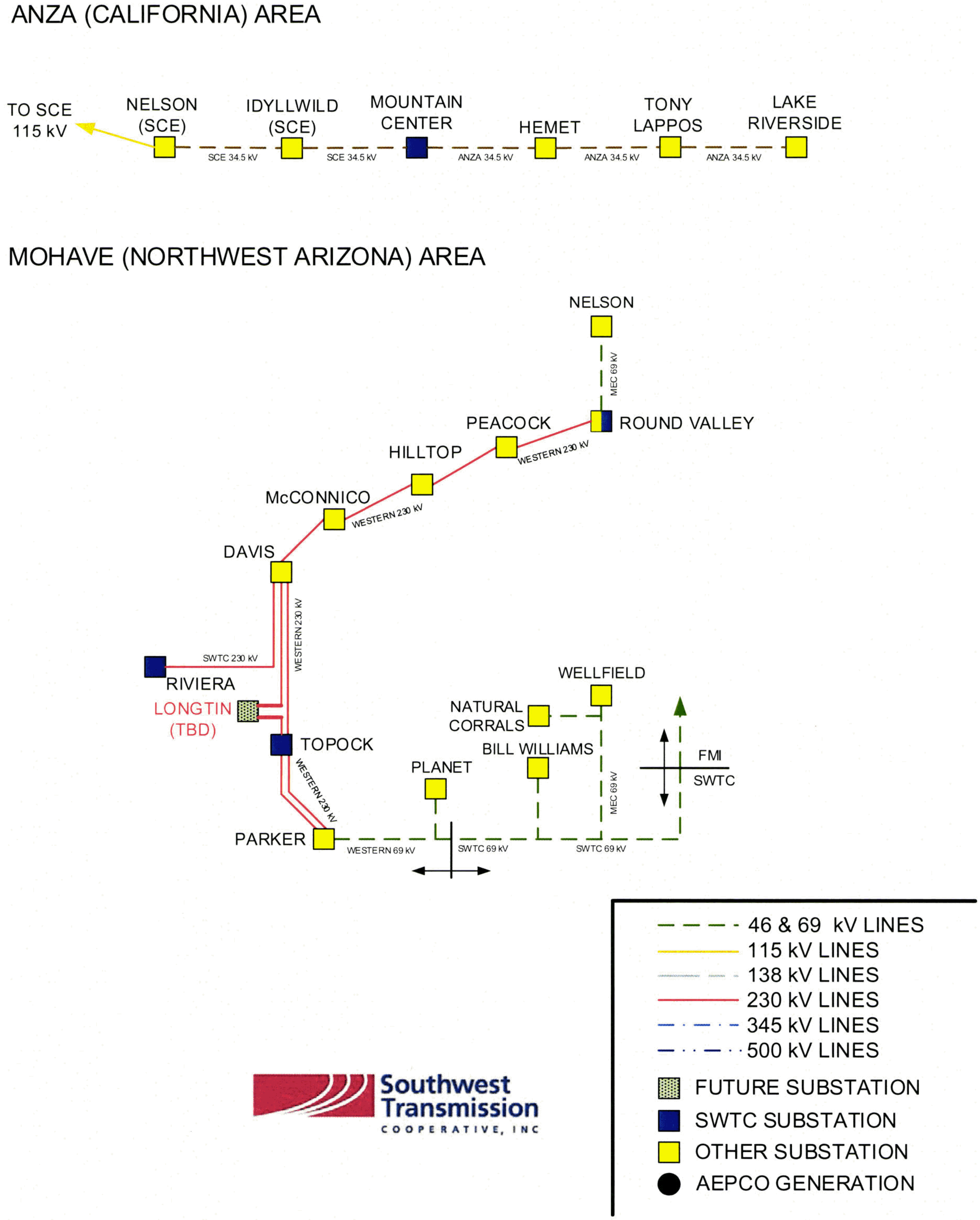


FIGURE 4: SWTC CALIFORNIA & NORTHWEST ARIZONA SYSTEM



Southwest Transmission Cooperative, Inc

FIGURE 5: SWTC WESTERN AREA SCENARIO #1 2016-2025

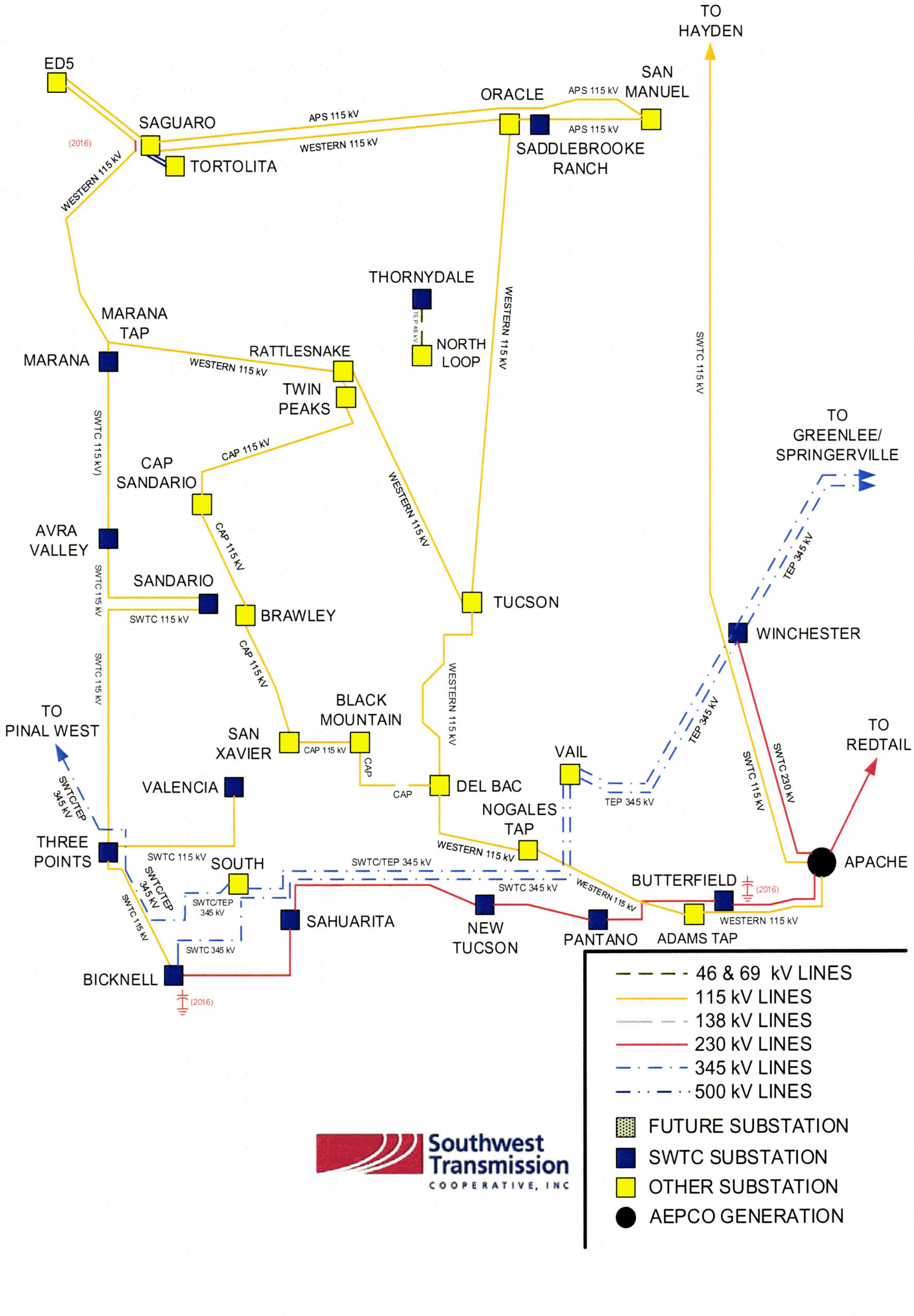


FIGURE 6: SWTC WESTERN AREA SYSTEM SCENARIO #2 2020-2025

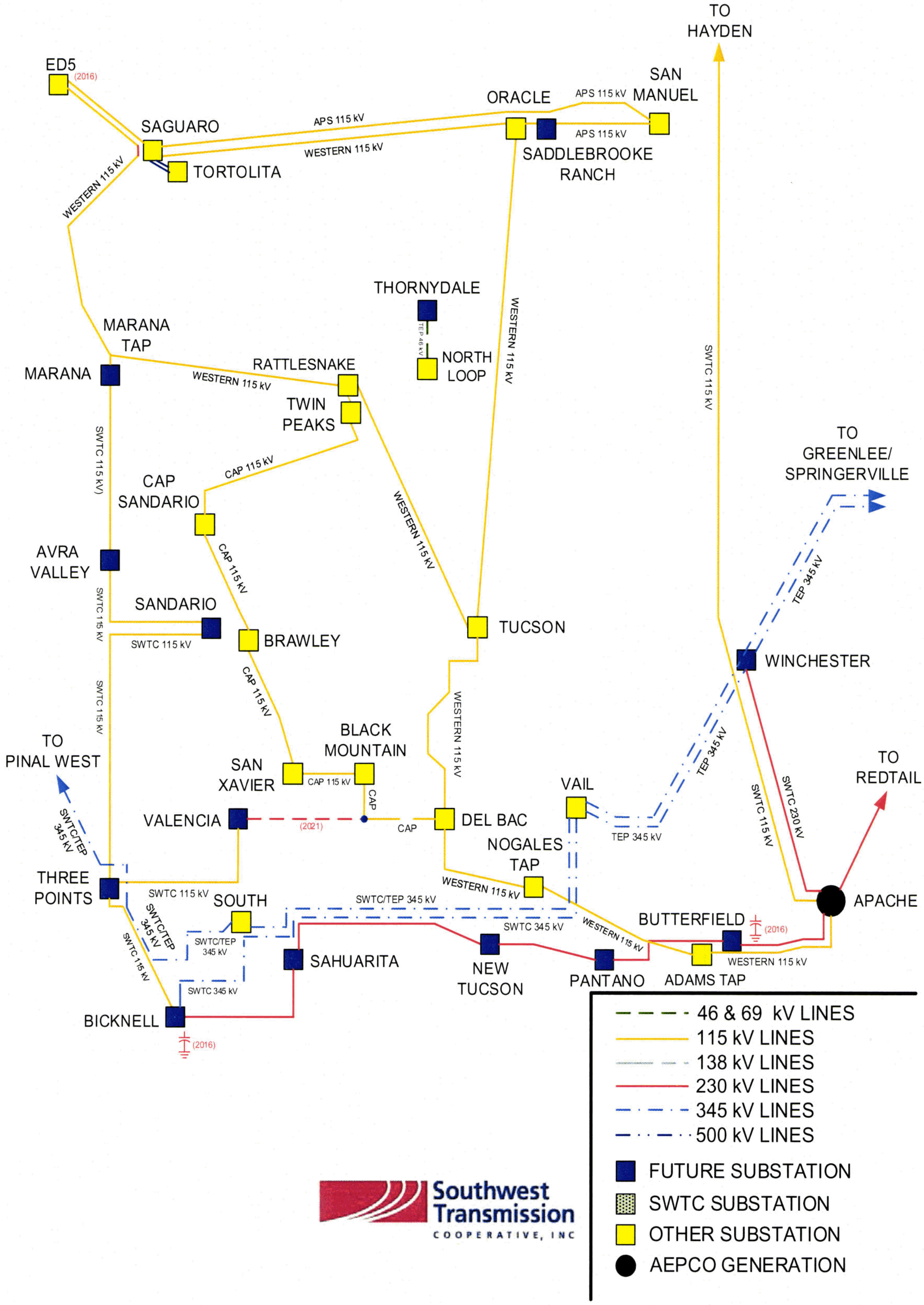


FIGURE 7: SWTC SOUTHERN AREA SYSTEM SCENARIO #2 2020-2025

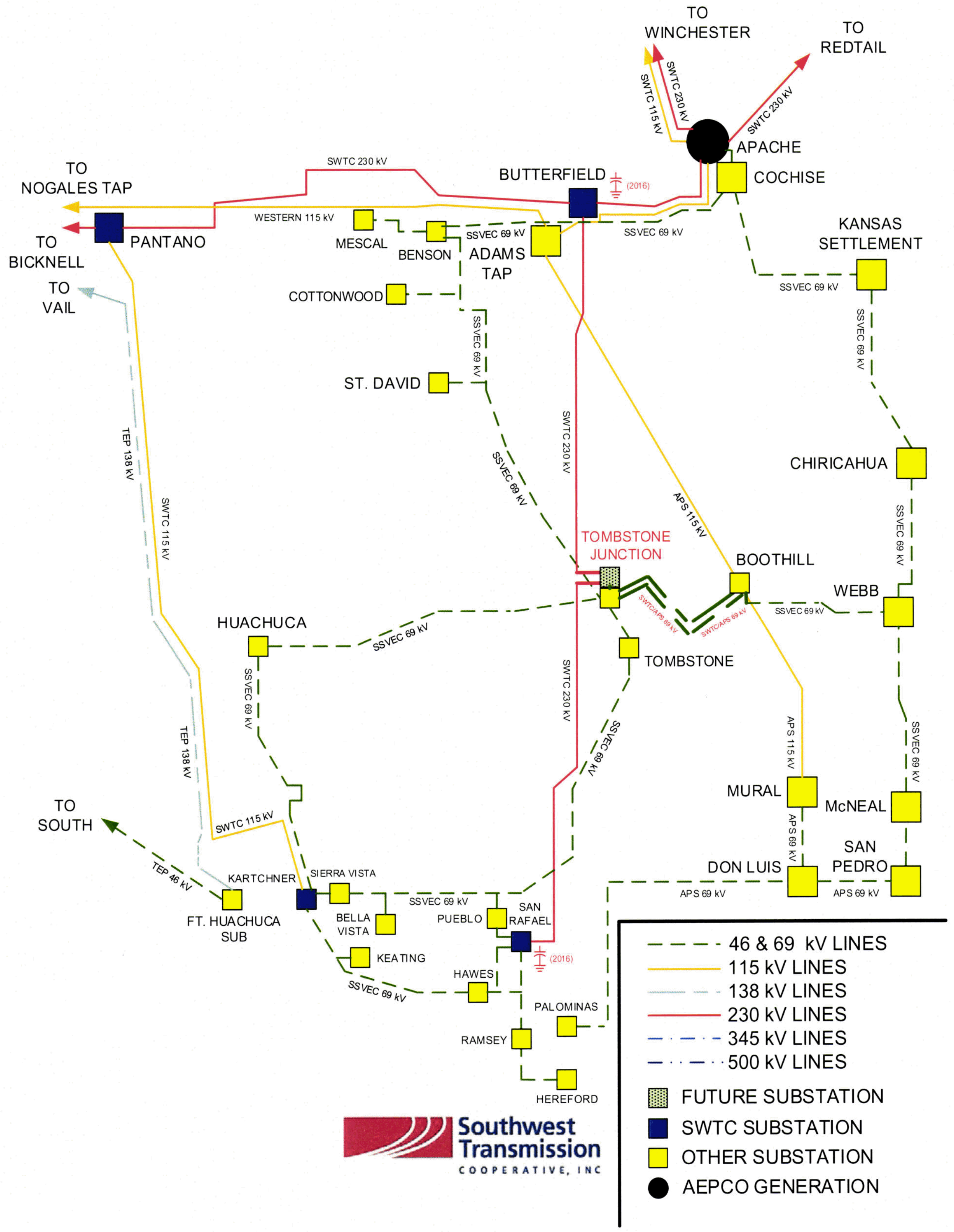
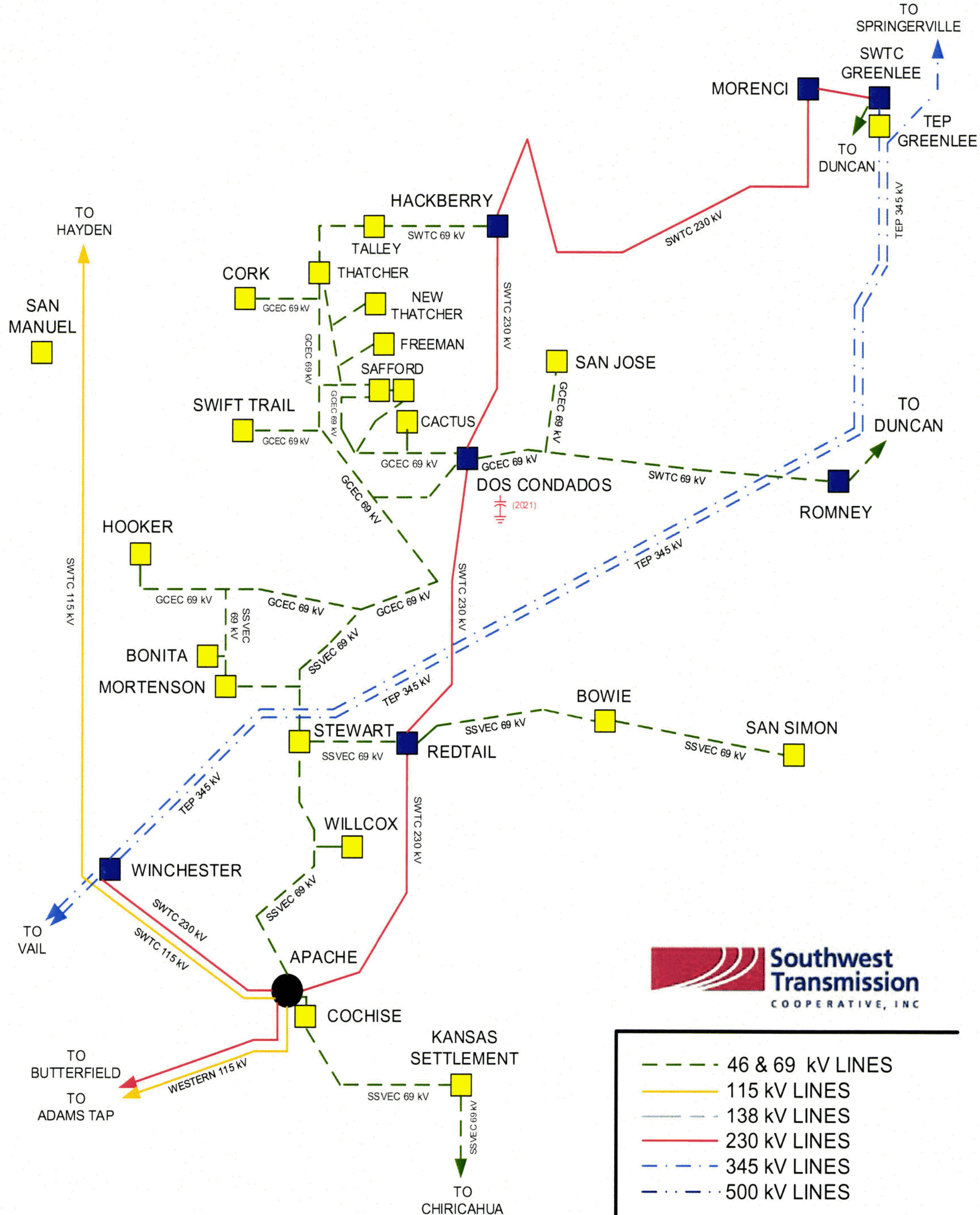


FIGURE 8: SWTC NORTHERN AREA SYSTEM SECNARIO #2 2020-2025



APPENDIX B: 2016-2025 Contingency List

The following contingency list was used for all cases of this Technical Study.

Contingency 1 represents loss of the Adams Tap to Apache, Adams Tap to Nogales and the Adams to Adams Tap 115 kV lines, which are considered as a P1. It is referred to as the Adams Group.
Contingency 2 represents the loss of various line segments related to the CAP system, south of Rattlesnake and is referred to as the CAP Group.

Contingencies 3 – 20 represent various breaker failure and main bus fault scenarios (P2).

Contingencies 21 – 28 represent common ROW or adjacent transmission circuit outages as defined by NERC for Category P7 conditions.

Contingencies 29 – 105 represent P1 outage scenarios.

Contingencies 106 – 297 represent P6 outage scenarios.

Contingencies 298 – 303 represent various P1 and P6 outage scenarios which were chosen for the purposes of running voltage and transient stability plots.

Contingencies 304 – 307 represent various P3 outage scenarios.

Contingencies 308 – 318 represent various P4 outage scenarios which were run with voltage and transient stability plots.

Contingencie 319 represents the only P7 on the SWTC system.

1). **Adams_Group,P1-2:** ADAMSTAP115, APACHE115 | ADAMSTAP115, NOGALES,115 | ADAMS115, ADAMSTAP,115
2). **CAP_Group,P1-2:** RATTLSNK,115, TWINPEAK,115 | TWINPEAK,115, SANDARIO,115 | SANDARIO,115, BRAWLEY,115 | BRAWLEY,115, SANXAVER,115 | SANXAVER,115, SNYDHILL,115 | BLACKMTN,115, SNYDHILL,115
3). **Breaker_APA201,P2-3:** APACHE,230,17030,APACHST3,20 | APACHE,230, APACHE,115
4). **Breaker_APA202,P2-3:** APACHE,230, APACHST3,20 | APACHE,230, REDTAIL,230
5). **Breaker_APA204,P2-3:** APACHE,230, APACHST2,20,
6). **Breaker_APA205,P2-3:** APACHE,230 APACHST2,20 | APACHE,230, WINCHSTR,230,1 ,0
7). **Breaker_APA207,P2-3:** APACHE,230, APACHE,115 | APACHE,230, APACHE,115
8). **Breaker_APA210,P2-3:** APACHE,230, APACHCT4,13.8
9). **Breaker_APA211,P2-3:** APACHE,230, APACHCT4,13.8| APACHE,230, APACHE,115
10). **MainBusFault_APA115,P2-2:** APACHE,230, APACHE,115 | APACHE,230, APACHE,115 | APACHE,115, APACHST1,13.8 | APACHE,115,17026,APACHCT3,13.8 | APACH-SW,69, APACHE,115 | ADAMSTAP,115,APACHE,115 | ADAMSTAP,115, NOGALES,115 | ADAMS,115, ADAMSTAP,115 | APACHE,115, HAYDENAZ,115
11). **Breaker_BICK202,P2-3:** BICKNELL,230, BICKNELL,115 | BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345

12). **Breaker_BICK203,P2-3:** BICKNELL,230, BICKNELL,115 | BICKNELL,230, BICKNELL,115
13). **Breaker_BICK204,P2-3:** BICKNELL,230, BICKNELL,115 | SAHUARIT,230, BICKNELL,230
14). **Breaker_BICK205,P2-3**SAHUARIT,230, BICKNELL,230 | BICKNELL,345,VAIL,345| BICKNELL,345, BICKNELL,230
15). **MainBusFault_BICK115,P2-2:** BICKNELL,69, BICKNELL,115 | BICKNELL,24.9, BICKNELL,115 | BICKNELL,230, BICKNELL,115 | BICKNELL,230, BICKNELL,115 | BICKNELL,115, THREEPNT,115 | BICKNELL,115, FP
16). **Breaker_BUTE230,P2-3:** APACHE,230, BUTERFLD,230 | BUTERFLD,230, PANTANO,230 | BUTERFLD,230, SAN RAF,230 | BUTERFLD,230, TOMB JCT,230,1,0
17). **Breaker_PANT230,P2-3:** BUTERFLD,230, PANTANO,230 | PANTANO,230, NEWTUCSN,230 | PANTANO,230, PANTANO,115
18). **Breaker_RED230,P2-3:** APACHE,230, RED TAIL,230 | RED TAIL,230, DOSCONDO,230
19). **Breaker_WINC230,P2-3:** WINCHSTR,345, WINCHSTR,230 | WINCHSTR,345, VAIL,345 | WINCHSTR,345, WILLOW,345
20). **Breaker_WINC230_2,P2-3:** WINCHSTR,345, WINCHSTR,230 | WINCHSTR,345, VAIL,345 | WINCHSTR,345, VAIL,345 | WINCHSTR,345, GREENLEE,345
21). **CommonROW_1,P6-1-1:** GREENLEE,345, COPPERVR,345 | MORENCI,230, GREEN-SW,230
22). **CommonROW_2,P6-1-1:** BUTERFLD,230, PANTANO,230 | ADAMSTAP,115, APACHE,115| ADAMSTAP,115, NOGALES,115 | ADAMS,115, ADAMSTAP,115
23). **CommonROW_3,P6-1-1:**APACHE,230, BUTERFLD,230 | ADAMSTAP,115, APACHE,115 | ADAMSTAP,115, NOGALES,115 | ADAMS,115, ADAMSTAP,115
24). **CommonROW_4,P6-1-1:**APACHE,230, BUTERFLD,230 | APACHE,115, HAYDENAZ,115
25). **CommonROW_5,P6-1-1:** VAIL,345, ,SOUTH,345| NEWTUCSN,230, SAHUARIT,230
26). **CommonROW_6,P6-1-1:** PINALWES,345, SOUTH,345 | BICKNELL,115, THREEPNT,115
27). **CommonROW_7,P6-1-1:** PINALWES,345, SOUTH,345 | THREEPNT,115, SNDARIO,115
28). **CommonROW_9,P6-1-1:** APACHE,230, BUTERFLD,230 | APACHE,230, WINCHSTR,230
29). **APAC115HAYD115,P1-2:** APACHE,115, HAYDENAZ,115
30). **APAC230APAC115,P1-3:** APACHE,230, APACHE,115
31). **APAC230APAC115,P1-3:** APACHE,230, APACHE,115
32). **APAC230WINC230,P1-2:** APACHE,230,WINCHSTR,230
33). **WINC345WINC230,P1-3:** WINCHSTR,345, WINCHSTR,230
34). **WINC345VAIL345,P1-2:** WINCHSTR,345, VAIL,345 | WINCHSTR,345, VAIL,345
35). **GREE345COPP345,P1-2:**GREENLEE,345, COPPERVR,345
36). **GREE345GREE345,P1-2:** GREEN-SW,345, GREENLEE,345
37). **SPRI345GREE345,P1-2:** SPRINGR,345, GREENLEE,345 | SPRINGR,345,GREENLEE,345
38). **BUTE230PANT230,P1-2:** BUTERFLD,230, PANTANO,230
39). **RED 230DOSC230,P1-2:** RED TAIL,230, DOSCONDO,230
40). **DOSC230HACK230,P1-2:** DOSCONDO,230, HACKBERY,230
41). **HACK230MORE230,P1-2:** HACKBERY,230, MORENCI,230
42). **MORE230GREE230,P1-2:** MORENCI,230, GREEN-SW,230
43). **GREE345GREE230,P1-3:** GREEN-SW,345, GREEN-SW,230
44). **PANT230NEWT230,P1-2:** PANTANO,230, NEWTUCSN,230
45). **PANT230PANT115,P1-3:** PANTANO,230, PANTANO,115
46). **NEWT230SAHU230,P1-2:** NEWTUCSN,230, SAHUARIT,230
47). **SAHU230BICK230,P1-2:** SAHUARIT,230, BICKNELL,230
48). **PANT115KART115,P1-2:** PANTANO,115, KARTCHNR,115
49). **VAIL345SOUT345,P1-2:** VAIL,345, SOUTH,345
50). **BICK345BICK230,P1-3:** BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345
51). **PINA345SOUT345,P1-2:** PINALWES,345, SOUTH,345
52). **PINA500PINA345,P1-3:** PINAL_W,500, PINALWES,345
53). **WEST345PINA345,P1-2:** WESTWING,345, PINALWES,345
54). **WEST500WEST345,P1-3:**WESTWING,500, WESTWING,345
55). **BICK230BICK115,P1-3:** BICKNELL,230 ,BICKNELL,115
56). **BICK230BICK115,P1-3:** BICKNELL,230, BICKNELL,115
57). **BICK115THRE115,P1-2:** BICKNELL,115, THREEPNT,115
58). **THRE115SNDA115,P1-2:** THREEPNT,115, SNDARIO,115
59). **THRE115VALE115,P1-2:** THREEPNT,115, VALEN-SW,115

60). **AVRA115SNDA115,P1-2:** AVRA,115, SNDARIO,115
61). **MARA115AVRA115,P1-2:** MARANA,115, AVRA,115,
62). **SPRI345VAIL345,P1-2:** SPRINGR,345, VAIL2,345: SPRINGR,345, VAIL2,345
63). **SAG.115SAG.115,P1-2:** SAG.EAST,115, SAG.WEST,115
64). **SAG.115ORAC115,P1-2:** SAG.EAST,115, ORACLE,115
65). **SAGU500SAG.115,P1-3:** SAGUARO,500, SAG.EAST,115
66). **SAGU500SAG.115,P1-3:** SAGUARO,500, SAG.WEST,115
67). **SAGU230SAG.115,P1-3:** SAGUARO,230, SAG.EAST,115
68). **SAGU230SAG.115,P1-3:** SAGUARO,230, SAG.WEST,115
69). **ORAC115ORAC115,P1-2:** ORACLE,115, ,ORACLEAZ,115
70). **ORAC115S.BR115,P1-2:** ORACLE,115, S.BRKRCH,115
71). **TUCS115ORAC115,P1-2:** TUCSON,115, ORACLE,115
72). **SAG.115SNMA115,P1-2:** SAG.WEST,115, SNMANUEL,115
73). **S.BR115SNMA115,P1-2:** S.BRKRCH,115, SNMANUEL,115
74). **SAG.115THRN115,P1-2:** SAG.EAST,115, THRNYDLE,115
75). **THRN115TWIN115,P1-2:** THRNYDLE,115, TWINPEAK,115
76). **SNDA115BRAW115,P1-2:** SNDARIO,115, BRAWLEY,115
77). **VALE115BLAC115,P1-2:** VALEN-SW,115, BLACKMTN,115
78). **SAGU500TORT500,P1-2:** SAGUARO,500, TORTOLIT,500
79). **SAGU500TORT500,P1-2:** SAGUARO,500,16000,TORTOLIT,500
80). **VAIL345VAIL138,P1-3:** VAIL,345, VAIL,138
81). **VAIL345VAIL138,P1-3:** VAIL2,345, VAIL,138
82). **BUTE230SAN 230,P1-2:** BUTERFLD,230, SAN RAF,230
83). **BUTE230TOMB230,P1-2:** BUTERFLD,230, TOMB JCT,230
84). **TOMB230SAN 230,P1-2:** TOMB JCT,230, SAN RAF,230
85). **TOMB69TOMB230,P1-3:** TOMB JCT,69, TOMB JCT,230
86). **COPP345COPP230,P1-3:** COPPERVR,345, COPPERVR,230
87). **COPP345COPP230,P1-3:** COPPERVR,345, COPPERVR,230
88). **COPP230FRIS230,P1-2:** COPPERVR,230, FRISCO,230
89). **PD-M230FRIS230,P1-2:** PD-MORNC,230, FRISCO,230
90). **PINA500DUKE500,P1-2:** PINAL_C,500, DUKE,500
91). **PINA500DUKE500,P1-2:** PINAL_W,500, DUKE,500
92). **GREE345WILL345,P1-2:** GREENLEE,345, WILLOW,345,
93). **GREE345WINC345_2,P1-2:** GREENLEE,345, WIINCHESTER,345
94). **WINC345WILL345,P1-2:** WINCHSTR,345, WILLOW,345
95). **WINC345WILL345_2,P1-2:** WINCHSTR,345, GREENLEE,345
96). **ADAMTP115APAC115,P1-2:** ADAMSTAP,115, APACHE,115
97). **ADAMTP115NOGA115,P1-2:** ADAMSTAP,115, NOGALES,115
98). **ADAM115ADAMTP115,P1-2:** ADAMS,115, ADAMSTAP,115
99). **MARATP115MARA115,P1-2:** MARANATP,115, MARANA,115
100). **SAG.115MARATP115,P1-2:** SAG.EAST,115, MARANATP,115
101). **MARA1TP15RSNK115,P1-2:** MARANATP,115, RATTLSNK,115
102). **RSNK115TUCS115,P1-2:** RATTLSNK,115, TUCSON,115
103). **ADAM115BOOTHILL115,P1-2:** ADAMS,115, BOOTHILL,115
104). **BOOTHILL115MURAL115,P1-2:** BOOTHILL,115, MURAL,115
105). **BOOTHILL115BOOTHILL69,P1-3:** BOOTHILL,69, BOOTHILL,115
106). **APAC230BUTE230 | APAC230RED 230,P6-1-1:**
APACHE,230, BUTERFLD,230 | APACHE,230RED TAIL,230
107). **APAC230BUTE230 | WINC345WINC230,P6-1-2:**
APACHE,230, BUTERFLD,230 | WINCHSTR,345, WINCHSTR,230
108). **APAC230BUTE230 | WINC345WILL345,P6-1-1:**
APACHE,230, BUTERFLD,230 | WINCHSTR,345, WILLOW,345
109). **APAC230BUTE230 | WINC345GREE345,P6-1-1:**
APACHE,230, BUTERFLD,230 | WINCHSTR,345, GREENLEE,345
110). **APAC230BUTE230 | WINC345VAIL345,P6-1-1:**
APACHE,230 BUTERFLD,230 | WINCHSTR,345, VAIL,345
111). **APAC230BUTE230 | GREE345COPP345,P6-1-1:**

APACHE,230, BUTERFLD,230 | GREENLEE,345, COPPERVR,345

112). APAC230BUTE230 | SPRI345GREE345,P6-1-1:
APACHE,230, BUTERFLD,230 | SPRINGR,345, GREENLEE,345

113). APAC230BUTE230 | HACK230MORE230,P6-1-1:
APACHE,230, BUTERFLD,230 | HACKBERY,230, MORENCI,230

114). APAC230BUTE230 | GREE345GREE230,P6-1-2:
APACHE,230, BUTERFLD,230 | GREEN-SW,345, GREEN-SW,230

115). APAC230BUTE230 | SAHU230BICK230,P6-1-1:
APACHE,230, BUTERFLD,230 | SAHUARIT,230, BICKNELL,230

116). APAC230BUTE230 | VAIL345SOUT345,P6-1-1:
APACHE,230, BUTERFLD,230 | VAIL,345, SOUTH,345

117). APAC230BUTE230 | BICK230BICK115,P6-1-2:
APACHE,230, BUTERFLD,230 | BICKNELL,230, BICKNELL,115

118). APAC230BUTE230 | BICK115THRE115,P6-1-1:
APACHE,230, BUTERFLD,230 | BICKNELL,115, THREEPNT,115

119). APAC230BUTE230 | THRE115SNDA115,P6-1-1:
APACHE,230, BUTERFLD,230 | THREEPNT,115, SNDARIO,115

120). APAC230BUTE230 | AVRA115SNDA115,P6-1-1:
APACHE,230, BUTERFLD,230 | AVRA,115, ,SNDARIO,115

121). APAC230BUTE230 | MARA115AVRA115,P6-1-1:
APACHE,230, BUTERFLD,230 | MARANA,115, AVRA,115

122). APAC230BUTE230 | SPRI345VAIL345,P6-1-1:
APACHE,230, BUTERFLD,230 | SPRINGR,345, VAIL2,345

123). APAC230RED 230 | APAC230WINC230,P6-1-1:
APACHE,230, RED TAIL,230 | APACHE,230, WINCHSTR,230

124). APAC230RED 230 | WINC345WINC230,P6-1-2:
APACHE,230, RED TAIL,230 | WINCHSTR,345, WINCHSTR,230

125). APAC230RED 230 | WINC345WILL345,P6-1-1:
APACHE,230, RED TAIL,230 | WINCHSTR,345, WILLOW,345

126). APAC230RED 230 | WINC345GREE345,P6-1-1:
APACHE,230, RED TAIL,230 | WINCHSTR,345, GREENLEE,345

127). APAC230RED 230 | WINC345VAIL345,P6-1-1:
APACHE,230, RED TAIL,230 | WINCHSTR,345,16105,VAIL,345

128). APAC230RED 230 | GREE345COPP345,P6-1-1:
APACHE,230, RED TAIL,230 |GREENLEE,345, COPPERVR,345

129). APAC230RED 230 | SPRI345GREE345,P6-1-1:
APACHE,230, RED TAIL,230 | SPRINGR,345, GREENLEE,345

130). APAC230RED 230 | HACK230MORE230,P6-1-1:
APACHE,230, RED TAIL,230 | HACKBERY,230, MORENCI,230,1,0

131). APAC230RED 230 | GREE345GREE230,P6-1-2:
APACHE,230, RED TAIL,230 | GREEN-SW,345, GREEN-SW,230

132). APAC230RED 230 | SAHU230BICK230,P6-1-1:
APACHE,230, RED TAIL,230 | SAHUARIT,230, BICKNELL,230

133). APAC230RED 230 | VAIL345SOUT345,P6-1-1:
APACHE,230, RED TAIL,230 | VAIL,345, SOUTH,345

134). APAC230RED 230 | BICK345BICK230,P6-1-2:
APACHE,230, RED TAIL,230 | BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345

135). APAC230RED 230 | BICK230BICK115,P6-1-1:
APACHE,230, RED TAIL,230 | BICKNELL,230, BICKNELL,115

136). APAC230RED 230 | BICK115THRE115,P6-1-1:
APACHE,230, RED TAIL,230 | BICKNELL,115, THREEPNT,115

137). APAC230RED 230 | THRE115SNDA115,P6-1-1:
APACHE,230, RED TAIL,230 | THREEPNT,115, SNDARIO,115

138). APAC230RED 230 | AVRA115SNDA115,P6-1-1:
APACHE,230, RED TAIL,230 | AVRA,115, SNDARIO,115

139). APAC230RED 230 | MARA115AVRA115,P6-1-1:
APACHE,230, RED TAIL,230 | MARANA,115, AVRA,115

140). APAC230RED 230 | SPRI345VAIL345,P6-1-1:
APACHE,230, RED TAIL,230 | SPRINGR,345, VAIL2,345

141). APAC230RED 230 | SAG.115MARA115,P6-1-1:
APACHE,230, RED TAIL,230 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

142). APAC230WINC230 | WINC345WINC230,P6-1-2:
APACHE,230, WINCHSTR,230 | WINCHSTR,345, WINCHSTR,230

143). APAC230WINC230 | WINC345WILL345,P6-1-1:
APACHE,230, WINCHSTR,230 |WINCHSTR,345, WILLOW,345

144). APAC230WINC230 | WINC345GREE345,P6-1-1:
APACHE,230, WINCHSTR,230 |WINCHSTR,345, GREENLEE,345

145). APAC230WINC230 | WINC345VAIL345,P6-1-1:
APACHE,230, WINCHSTR,230 | WINCHSTR,345, VAIL,345

146). APAC230WINC230 | GREE345COPP345,P6-1-1:
APACHE,230, WINCHSTR,230 | GREENLEE,345, COPPERVR,345

147). APAC230WINC230 | SPRI345GREE345,P6-1-1:
APACHE,230, WINCHSTR,230| SPRINGR,345, GREENLEE,345

148). APAC230WINC230 | HACK230MORE230,P6-1-1:
APACHE,230, WINCHSTR,230 | HACKBERY,230, MORENCI,230

149). APAC230WINC230 | GREE345GREE230,P6-1-2:
APACHE,230, WINCHSTR,230 | GREEN-SW,345, GREEN-SW,230

150). APAC230WINC230 | SAHU230BICK230,P6-1-1:
APACHE,230, WINCHSTR,230 | SAHUARIT,230, BICKNELL,230

151). APAC230WINC230 | VAIL345SOUT345,P6-1-1:
APACHE,230, WINCHSTR,230 | VAIL,345, SOUTH,345

152). APAC230WINC230 | BICK345BICK230,P6-1-2:
APACHE,230, WINCHSTR,230 | BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345

153). APAC230WINC230 | BICK230BICK115,P6-1-2:
APACHE,230, WINCHSTR,230 | BICKNELL,230, BICKNELL,115

154). APAC230WINC230 | BICK115THRE115,P6-1-1:
APACHE,230, WINCHSTR,230 | BICKNELL,115, THREEPNT,115

155). APAC230WINC230 | THRE115SNDA115,P6-1-1:
APACHE,230, WINCHSTR,230 | THREEPNT,115, SNDARIO,115

156). APAC230WINC230 | AVRA115SNDA115,P6-1-1:
APACHE,230, WINCHSTR,230 | AVRA,115, SNDARIO,115

157). APAC230WINC230 | MARA115AVRA115,P6-1-1:
APACHE,230, WINCHSTR,230 | MARANA,115, AVRA,115

158). APAC230WINC230 | SPRI345VAIL345,P6-1-1:
APACHE,230, WINCHSTR,230 | SPRINGR,345, VAIL2,345

159). APAC230WINC230 | SAG.115MARA115,P6-1-1:
APACHE,230, WINCHSTR,230 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

160). WINC345WINC230 | WINC345WILL345,P6-2-1:
WINCHSTR,345, WINCHSTR,230 | WINCHSTR,345, WILLOW,345

161). WINC345WINC230 | WINC345GREE345,P6-2-1:
WINCHSTR,345, WINCHSTR,230 | WINCHSTR,345, GREENLEE,345

162). WINC345WINC230 | WINC345VAIL345,P6-2-1:
WINCHSTR,345, WINCHSTR,230 | WINCHSTR,345, VAIL,345

163). WINC345WINC230 | GREE345COPP345,P6-2-1:
WINCHSTR,345, WINCHSTR,230 | GREENLEE,345, COPPERVR,345

164). WINC345WINC230 | SPRI345GREE345,P6-2-1:
WINCHSTR,345, WINCHSTR,230 | SPRINGR,345, GREENLEE,345

165). WINC345WINC230 | VAIL345SOUT345,P6-2-1:
WINCHSTR,345, WINCHSTR,230 |VAIL,345,SOUTH,345

166). WINC345WINC230 | SPRI345VAIL345,P6-2-1:
WINCHSTR,345, WINCHSTR,230 | SPRINGR,345, VAIL2,345

167). WINC345WINC230 | SAG.115MARA115,P6-2-1:

WINCHSTR,345, WINCHSTR,230 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

168). **WINC345WILL345 | WINC345VAIL345,P6-1-1:**
WINCHSTR,345, WILLOW,345 | WINCHSTR,345, VAIL,345

169). **WINC345GREE345 | WINC345VAIL345,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | WINCHSTR,345, VAIL,345

170). **WINC345WILL345 | GREE345COPP345,P6-1-1:**
WINCHSTR,345, WILLOW,345 | GREENLEE,345, COPPERVR,345

171). **WINC345GREE345 | GREE345COPP345,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | GREENLEE,345, COPPERVR,345

172). **WINC345WILL345 | SPRI345GREE345,P6-1-1:**
WINCHSTR,345, WILLOW,345 | SPRINGR,345, GREENLEE,345

173). **WINC345GREE345 | SPRI345GREE345,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | SPRINGR,345, GREENLEE,345

174). **WINC345WILL345 | HACK230MORE230,P6-1-1:**
WINCHSTR,345, WILLOW,345 | HACKBERY,230, MORENCI,230

175). **WINC345GREE345 | HACK230MORE230,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | HACKBERY,230, MORENCI,230

176). **WINC345WILL345 | GREE345GREE230,P6-1-2:**
WINCHSTR,345, WILLOW,345 | GREEN-SW,345, GREEN-SW,230

177). **WINC345GREE345 | GREE345GREE230,P6-1-2:**
WINCHSTR,345, ,GREENLEE,345 | GREEN-SW,345, GREEN-SW,230

178). **WINC345WILL345 | SAHU230BICK230,P6-1-1:**
WINCHSTR,345, WILLOW,345 | SAHUARIT,230, BICKNELL,230,1,0

179). **WINC345GREE345 | SAHU230BICK230,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | SAHUARIT,230, BICKNELL,230,1,0

180). **WINC345WILL345 | VAIL345SOUT345,P6-1-1:**
WINCHSTR,345, WILLOW,345 | VAIL,345, SOUTH,345

181). **WINC345GREE345 | VAIL345SOUT345,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | VAIL,345, SOUTH,345

182). **WINC345WILL345 | BICK345BICK230,P6-1-2:**
WINCHSTR,345, WILLOW,345 | BICKNELL,345, ,BICKNELL,230 | BICKNELL,345,VAIL,345

183). **WINC345GREE345 | BICK345BICK230,P6-1-2:**
WINCHSTR,345, GREENLEE,345 | BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345

184). **WINC345WILL345 | BICK230BICK115,P6-1-2:**
WINCHSTR,345, WILLOW,345 | BICKNELL,230, BICKNELL,115

185). **WINC345GREE345 | BICK230BICK115,P6-1-2:**
WINCHSTR,345, GREENLEE,345 | BICKNELL,230, BICKNELL,115

186). **WINC345WILL345 | BICK115THRE115,P6-1-1:**
WINCHSTR,345, WILLOW,345 | BICKNELL,115, THREEPNT,115

187). **WINC345GREE345 | BICK115THRE115,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | BICKNELL,115, THREEPNT,115

188). **WINC345WILL345 | THRE115SNDA115,P6-1-1:**
WINCHSTR,345, WILLOW,345 | THREEPNT,115, SNDARIO,115

189). **WINC345GREE345 | THRE115SNDA115,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | THREEPNT,115, SNDARIO,115

190). **WINC345WILL345 | AVRA115SNDA115,P6-1-1:**
WINCHSTR,345, WILLOW,345 |AVRA,115, SNDARIO,115

191). **WINC345GREE345 | AVRA115SNDA115,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | AVRA,115, SNDARIO,115

192). **WINC345WILL345 | MARA115AVRA115,P6-1-1:**
WINCHSTR,345, WILLOW,345 | MARANA,115, AVRA,115

193). **WINC345GREE345 | MARA115AVRA115,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | MARANA,115, AVRA,115

194). **WINC345WILL345 | SPRI345VAIL345,P6-1-1:**
WINCHSTR,345, WILLOW,345 | SPRINGR,345, VAIL2,345

195). **WINC345GREE45 | SPRI345VAIL345,P6-1-1:**

WINCHSTR,345, GREENLEE,345 | SPRINGR,345, VAIL2,345

196). **WINC345WILL345 | SAG.115MARA115,P6-1-1:**
WINCHSTR,345, WILLOW,345 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

197). **WINC345GREE345 | SAG.115MARA115,P6-1-1:**
WINCHSTR,345, GREENLEE,345 | MARANATP,115,MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

198). **WINC345VAIL345 | GREE345COPP345,P6-1-1:**
WINCHSTR,345, VAIL,345 | GREENLEE,345, COPPERVR,345

199). **WINC345VAIL345 | SPRI345GREE345,P6-1-1:**
WINCHSTR,345, VAIL,345 | SPRINGR,345, GREENLEE,345

200). **WINC345VAIL345 | HACK230MORE230,P6-1-1:**
WINCHSTR,345, VAIL,345 | HACKBERY,230, MORENCI,230,1,0

201). **WINC345VAIL345 | GREE345GREE230,P6-1-2:**
WINCHSTR,345, VAIL,345 |GREEN-SW,345, GREEN-SW,230

202). **WINC345VAIL345 | SAHU230BICK230,P6-1-1:**
WINCHSTR,345, VAIL,345 | SAHUARIT,230, BICKNELL,230

203). **WINC345VAIL345 | VAIL345SOUT345,P6-1-1:**
WINCHSTR,345, VAIL,345 | VAIL,345, SOUTH,345

204). **WINC345VAIL345 | BICK345BICK230,P6-1-2:**
WINCHSTR,345, VAIL,345 | BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345

205). **WINC345VAIL345 | BICK230BICK115,P6-1-2:**
WINCHSTR,345, VAIL,345 | BICKNELL,230, BICKNELL,115

206). **WINC345VAIL345 | BICK115THRE115,P6-1-1:**
WINCHSTR,345, VAIL,345 | BICKNELL,115, THREEPNT,115

207). **WINC345VAIL345 | THRE115SNDA115,P6-1-1:**
WINCHSTR,345, VAIL,345 | THREEPNT,115, SNDARIO,115

208). **WINC345VAIL345 | AVRA115SNDA115,P6-1-1:**
WINCHSTR,345, VAIL,345 | AVRA,115, SNDARIO,115

209). **WINC345VAIL345 | MARA115AVRA115,P6-1-1:**
WINCHSTR,345, VAIL,345 | MARANA,115, AVRA,115

210). **WINC345VAIL345 | SPRI345VAIL345,P6-1-1:**
WINCHSTR,345, VAIL,345 | SPRINGR,345, VAIL2,345

211). **WINC345VAIL345 | SAG.115MARA115,P6-1-1:**
WINCHSTR,345, VAIL,345 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

212). **GREE345COPP345 | SPRI345GREE345,P6-1-1:**
GREENLEE,345, COPPERVR,345 | SPRINGR,345, GREENLEE,345

213). **GREE345COPP345 | HACK230MORE230,P6-1-1:**
GREENLEE,345, COPPERVR,345 | HACKBERY,230, MORENCI,230

214). **GREE345COPP345 | GREE345GREE230,P6-1-2:**
GREENLEE,345, COPPERVR,345 | GREEN-SW,345, GREEN-SW,230

215). **GREE345COPP345 | SAHU230BICK230,P6-1-1:**
GREENLEE,345, COPPERVR,345 | SAHUARIT,230, BICKNELL,230

216). **GREE345COPP345 | VAIL345SOUT345,P6-1-1:**
GREENLEE,345, COPPERVR,345 | VAIL,345, SOUTH,345

217). **GREE345COPP345 | BICK345BICK230,P6-1-2:**
GREENLEE,345, COPPERVR,345 | BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345

218). **GREE345COPP345 | BICK230BICK115,P6-1-2**
GREENLEE,345, COPPERVR,345 | BICKNELL,230, BICKNELL,115

219). **GREE345COPP345 | BICK115THRE115,P6-1-1**
GREENLEE,345, COPPERVR,345 | BICKNELL,115, THREEPNT,115

220). **GREE345COPP345 | THRE115SNDA115,P6-1-1**
GREENLEE,345, COPPERVR,345| THREEPNT,115, SNDARIO,115

221). **GREE345COPP345 | AVRA115SNDA115,P6-1-1**
GREENLEE,345, COPPERVR,345 | AVRA,115, SNDARIO,115

222). **GREE345COPP345 | MARA115AVRA115,P6-1-1**

GREENLEE,345, COPPERVR,345 | MARANA,115, AVRA,115

223). GREE345COPP345 | SPRI345VAIL345,P6-1-1
GREENLEE,345, COPPERVR,345 | SPRINGR,345, VAIL2,345

224). GREE345COPP345 | SAG.115MARA115,P6-1-1
GREENLEE,345, COPPERVR,345 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 |MARANATP,115, RATTLSNK,115 | RATTLSNK,115TUCSON,115

225). SPRI345GREE345 | HACK230MORE230,P6-1-1
SPRINGR,345, GREENLEE,34 5| HACKBERY,230, MORENCI,230

226). SPRI345GREE345 | GREE345GREE230,P6-1-2
SPRINGR,345, GREENLEE,345 | GREEN-SW,345, GREEN-SW,230

227). SPRI345GREE345 | SAHU230BICK230,P6-1-1
SPRINGR,345, GREENLEE,345 | SAHUARIT,230, BICKNELL,230

228). SPRI345GREE345 | VAIL345SOUT345,P6-1-1
SPRINGR,345, GREENLEE,345 | VAIL,345, SOUTH,345

229). SPRI345GREE345 | BICK345BICK230,P6-1-2
SPRINGR,345, GREENLEE,345 | BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345

230). SPRI345GREE345 | BICK230BICK115,P6-1-2
SPRINGR,345, GREENLEE,345 | BICKNELL,230, BICKNELL,115

231). SPRI345GREE345 | BICK115THRE115,P6-1-1
SPRINGR,345, GREENLEE,345 | BICKNELL,115, THREEPNT,115

232). SPRI345GREE345 | THRE115SNDA115,P6-1-1
SPRINGR,345, GREENLEE,345 | THREEPNT,115, SNDARIO,115

233). SPRI345GREE345 | AVRA115SNDA115,P6-1-1
SPRINGR,345, GREENLEE,345 | AVRA,115, SNDARIO,115

234). SPRI345GREE345 | MARA115AVRA115,P6-1-1
SPRINGR,345, GREENLEE,345 | MARANA,115, AVRA,115

235). SPRI345GREE345 | SPRI345VAIL345,P6-1-1
SPRINGR,345, GREENLEE,345 | SPRINGR,345, VAIL2,345

236). SPRI345GREE345 | SAG.115MARA115,P6-1-1
SPRINGR,345, GREENLEE,345 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

237). HACK230MORE230 | VAIL345SOUT345,P6-1-1
HACKBERY,230, MORENCI,230 | VAIL,345, SOUTH,345

238). HACK230MORE230 | SPRI345VAIL345,P6-1-1
HACKBERY,230, MORENCI,230 | SPRINGR,345,16106,VAIL2,345

239). HACK230MORE230 | SAG.115MARA115,P6-1-1
HACKBERY,230, MORENCI,230 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

240). GREE345GREE230 | VAIL345SOUT345,P6-2-1
GREEN-SW,345, GREEN-SW,230 | VAIL,345, SOUTH,345

241). GREE345GREE230 | SPRI345VAIL345,P6-2-1
GREEN-SW,345, GREEN-SW,230 | SPRINGR,345, VAIL2,345

242). GREE345GREE230 | SAG.115MARA115,P6-2-1
GREEN-SW,345, GREEN-SW,230 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

243). SAHU230BICK230 | VAIL345SOUT345,P6-1-1
SAHUARIT,230, BICKNELL,230 | VAIL,345, SOUTH,345

244). SAHU230BICK230 | SPRI345VAIL345,P6-1-1
SAHUARIT,230, BICKNELL,230 | SPRINGR,345, VAIL2,345

245). SAHU230BICK230 | SAG.115MARA115,P6-1-1
SAHUARIT,230, BICKNELL,230 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

246). VAIL345SOUT345 | BICK345BICK230,P6-1-2
VAIL,345, SOUTH,345 | BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345

247). VAIL345SOUT345 | BICK230BICK115,P6-1-2
VAIL,345, SOUTH,345 | BICKNELL,230, BICKNELL,115

248). VAIL345SOUT345 | BICK115THRE115,P6-1-1

VAIL,345, SOUTH,345 | BICKNELL,115, THREEPNT,115

249). VAIL345SOUT345 | THRE115SNDA115,P6-1-1
VAIL,345, SOUTH,345 | THREEPNT,115, SNDARIO,115

250). VAIL345SOUT345 | AVRA115SNDA115,P6-1-1
VAIL,345, SOUTH,345 | AVRA,115, SNDARIO,115

251). VAIL345SOUT345 | MARA115AVRA115,P6-1-1
VAIL,345, SOUTH,345 | MARANA,115, AVRA,115

252). VAIL345SOUT345 | SPRI345VAIL345,P6-1-1
VAIL,345, SOUTH,345 | SPRINGR,345, VAIL2,345

253). VAIL345SOUT345 | SAG.115MARA115,P6-1-1
VAIL,345, SOUTH,345| MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

254). BICK345BICK230 | SPRI345VAIL345,P6-2-1
BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345 | SPRINGR,345, VAIL2,345

255). BICK345BICK230 | SAG.115MARA115,P6-2-1
BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345 | MARANATP,115, MARANA,115 SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

256). BICK230BICK115 | SPRI345VAIL345,P6-2-1
BICKNELL,230, BICKNELL,115 | SPRINGR,345, VAIL2,345

257). BICK230BICK115 | SAG.115MARA115,P6-2-1
BICKNELL,230, BICKNELL,115 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

258). BICK115THRE115 | SPRI345VAIL345,P6-1-1
BICKNELL,115, THREEPNT,115 | SPRINGR,345, VAIL2,345

259). BICK115THRE115 | SAG.115MARA115,P6-1-1
BICKNELL,115, THREEPNT,115 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

260). THRE115SNDA115 | SPRI345VAIL345,P6-1-1
THREEPNT,115, SNDARIO,115 | SPRINGR,345, VAIL2,345

261). THRE115SNDA115 | SAG.115MARA115,P6-1-1
THREEPNT,115, SNDARIO,115 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

262). AVRA115SNDA115 | SPRI345VAIL345,P6-1-1
AVRA,115, SNDARIO,11 5| SPRINGR,345, VAIL2,345

263). AVRA115SNDA115 | SAG.115MARA115,P6-1-1
AVRA,115, SNDARIO,115 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

264). MARA115AVRA115 | SPRI345VAIL345,P6-1-1
MARANA,115, AVRA,115 | SPRINGR,345, VAIL2,345

265). MARA115AVRA115 | SAG.115MARA115,P6-1-1
MARANA,115, AVRA,115 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

266). SPRI345VAIL345 | SAG.115MARA115,P6-1-1
SPRINGR,345, VAIL2,345 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

267). HACK230MORE230 | DOSC230HACK230,P6-1-1
HACKBERY,230, MORENCI,230 | DOSCONDO,230, HACKBERY,230

268). RED 230DOSC230 | DOSC230HACK230,P6-1-1
RED TAIL,230, DOSCONDO,230 | DOSCONDO,230, HACKBERY,230

269). BICK345BICK230 | PANT230NEWT230,P6-2-1
BICKNELL,345,BICKNELL,230 | BICKNELL,345, VAIL,345 | PANTANO,230, NEWTUCSN,230

270). BICK115THRE115 | ADAM115APAC115,P6-1-1
BICKNELL,115, THREEPNT,115 | ADAMSTAP,115, APACHE,115 | ADAMSTAP,115, NOGALES,115 | ADAMS,115, ADAMSTAP,115

271). BICK345BICK230 | NEWT230SAHU230,P6-2-1
BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345 | NEWTUCSN,230, SAHUARIT,230

272). BICK345BICK230 | SAHU230BICK230,P6-2-1

BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345 | SAHUARIT,230, BICKNELL,230

273). **ADAM115APAC115 | APAC230BUTE230,P6-1-1**
ADAMSTAP,115, APACHE,115 | ADAMSTAP,115, ,NOGALES,115 | ADAMS,115, ADAMSTAP,115 | APACHE,230, BUTERFLD,230

274). **PINA345SOUT345 | ADAM115APAC115,P6-1-1**
PINALWES,345, SOUTH,345 | ADAMSTAP,115, APACHE,115 | ADAMSTAP,115, NOGALES,115 | ADAMS,115, ADAMSTAP,115

275). **SPRI345VAIL345 | ADAM115APAC115,P6-1-1**
SPRINGR,345, VAIL2,345 | ADAMSTAP,115, APACHE,115 | ADAMSTAP,115, NOGALES,115 | ADAMS,115, ADAMSTAP,115

276). **SPRI345VAIL345 | PINA345SOUT345,P6-1-1**
SPRINGR,345, VAIL2,345 | PINALWES,345, SOUTH,345

277). **BICK230BICK115 | MARA115AVRA115,P6-2-1**
BICKNELL,230, BICKNELL,115| MARANA,115, AVRA,115

278). **APAC230APAC115 | APAC230BUTE230,P6-2-1**
APACHE,230, APACHE,115 | APACHE,230, BUTERFLD,230

279). **APAC230APAC115 | APAC230RED 230,P6-2-1**
APACHE,230, APACHE,115 | APACHE,230, RED TAIL,230

280). **APAC230APAC115 | APAC230WINC230,P6-2-1**
APACHE,230, APACHE,115 | APACHE,230, WINCHSTR,230

281). **APAC230APAC115 | WINC345WINC230,P6-2-2**
APACHE,230, APACHE,115 | WINCHSTR,345, WINCHSTR,230

282). **APAC230APAC115 | WINC345WILL345,P6-2-1**
APACHE,230, APACHE,115 | WINCHSTR,345, WILLOW,345

283). **APAC230APAC115 | WINC345GREE345,P6-2-1**
APACHE,230, APACHE,115 | WINCHSTR,345, GREENLEE,345

284). **APAC230APAC115 | WINC345VAIL345,P6-2-1**
APACHE,230, APACHE,115 | WINCHSTR,345, VAIL,345

285). **APAC230APAC115 | GREE345COPP345,P6-2-1**
APACHE,230, APACHE,115 | GREENLEE,345, COPPERVR,345

286). **APAC230APAC115 | SPRI345GREE345,P6-2-1**
APACHE,230, APACHE,115 | SPRINGR,345, GREENLEE,345

287). **APAC230APAC115 | HACK230MORE230,P6-2-1**
APACHE,230, APACHE,115 | HACKBERY,230, MORENCI,230

288). **APAC230APAC115 | GREE345GREE230,P6-2-2**
APACHE,230, APACHE,115 | GREEN-SW,345, GREEN-SW,230

289). **APAC230APAC115 | SAHU230BICK230,P6-2-1**
APACHE,230, APACHE,115 | SAHUARIT,230, BICKNELL,230

290). **APAC230APAC115 | VAIL345SOUT345,P6-2-1**
APACHE,230, APACHE,115 | VAIL,345, SOUTH,345

291). **APAC230APAC115 | BICK345BICK230,P6-2-2**
APACHE,230, APACHE,115 | BICKNELL,345, BICKNELL,230 | BICKNELL,345, VAIL,345

292). **APAC230APAC115 | BICK230BICK115,P6-2-2**
APACHE,230, APACHE,115 | BICKNELL,230, BICKNELL,115

293). **APAC230APAC115 | BICK115THRE115,P6-2-1**
APACHE,230, APACHE,115 | BICKNELL,115, THREEPNT,115

294). **APAC230APAC115 | THRE115SNDA115,P6-2-1**
APACHE,230, APACHE,115 | THREEPNT,115, SNDARIO,115

295). **APAC230APAC115 | AVRA115SNDA115,P6-2-1**
APACHE,230, APACHE,115 | AVRA,115, SNDARIO,115

296). **APAC230APAC115 | MARA115AVRA115,P6-2-1**
APACHE,230, APACHE,115 | MARANA,115, AVRA,115

297). **APAC230APAC115 | SPRI345VAIL345,P6-2-1**
APACHE,230, APACHE,115 | SPRINGR,345, VAIL2,345

298). **APAC230BUTE230,P1-2:** APACHE,230, BUTERFLD,230

299). **APAC230RED 230,P1-2:** APACHE,230, RED TAIL,230

300). **BICK345VAIL345,P1-2:** BICKNELL,345, VAIL,345

301). Group_MARA115,,P1-2:
MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, RATTLSNK,115 | RATTLSNK,115, TUCSON,115

302). APAC230BUTE230 | SAG.115MARA115,P6-1-1:
APACHE,230, BUTERFLD,230 | MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115, ,RATTLSNK,115 | RATTLSNK,115, TUCSON,115

303). APAC230BUTE230 | BICK345BICK230,P6-1-2:
APACHE,230, ,BUTERFLD,230| BICKNELL,345, BICKNELL,230| BICKNELL,345, VAIL,345

304). APAC230BUTE230,P3-2: APACHE,230, BUTERFLD,230

305). APAC230RED 230,P3-2: APACHE,230, RED TAIL,230

306). BICK345VAIL345,P3-2: BICKNELL,345, VAIL,345

307). Group_MARA115,,P3-2:
MARANATP,115, MARANA,115 | SAG.EAST,115, MARANATP,115 | MARANATP,115 RATTLSNK,115 | RATTLSNK,115, TUCSON,115

308). Breaker_APA202_P4,P4-2:
APACHE,230, APACHST3,20 | APACHE,230, REDTAIL,230

309). Breaker_BICK204_P4,P4-2:
BICKNELL,230, BICKNELL,115 | SAHUARIT,230, BICKNELL,230

310). Breaker_BICK205_P4,P4-2:
BICKNELL,345, BICKNELL,230 | SAHUARIT,230, BICKNELL,230 | BICKNELL,345, VAIL,345

311). Breaker_BUTE230_P4_SAN,P4-2:
APACHE,230, BUTERFLD,230 | BUTERFLD,230, PANTANO,230 | BUTERFLD,230, SAN RAF,230

312). Breaker_BUTE230_P4_PANT,P4-2:
APACHE,230, BUTERFLD,230 | BUTERFLD,230, PANTANO,230 | BUTERFLD,230, SAN RAF,230

313). Breaker_BUTE230_P4_APAC,P4-2:
APACHE,230, BUTERFLD,230 | BUTERFLD,230, PANTANO,230 | BUTERFLD,230, SAN RAF,230

314). Breaker_PANT230_P4_NEWT,P4-2:
BUTERFLD,230, PANTANO,230 | PANTANO,230, NEWTUCSN,230 | PANTANO,230, PANTANO,115

315). Breaker_PANT230_P4_BUTE,P4-2:
BUTERFLD,230, PANTANO,230 | PANTANO,230, NEWTUCSN,230 |PANTANO,230, PANTANO,115

316). Breaker_RED230_P4_DOS,P4-2:
APACHE,230, RED TAIL,230 | RED TAIL,230, DOSCONDO,230

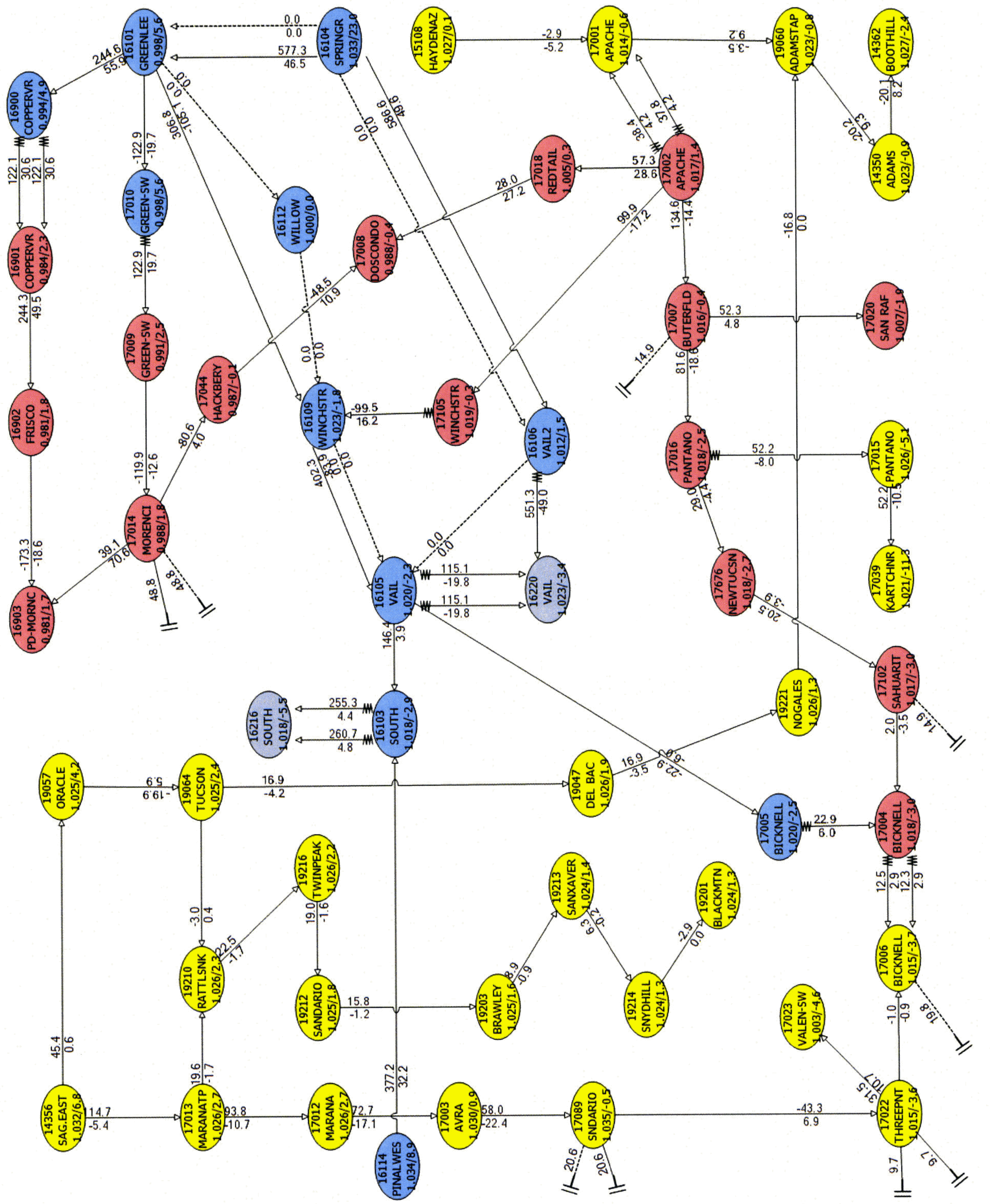
317). Breaker_RED230_P4_APAC,P4-2:
APACHE,230, RED TAIL,230 | RED TAIL,230, DOSCONDO,230

318). Breaker_WINC230_P4,P4-2:
WINCHSTR,345, WINCHSTR,230 | APACHE,230, WINCHSTR,230

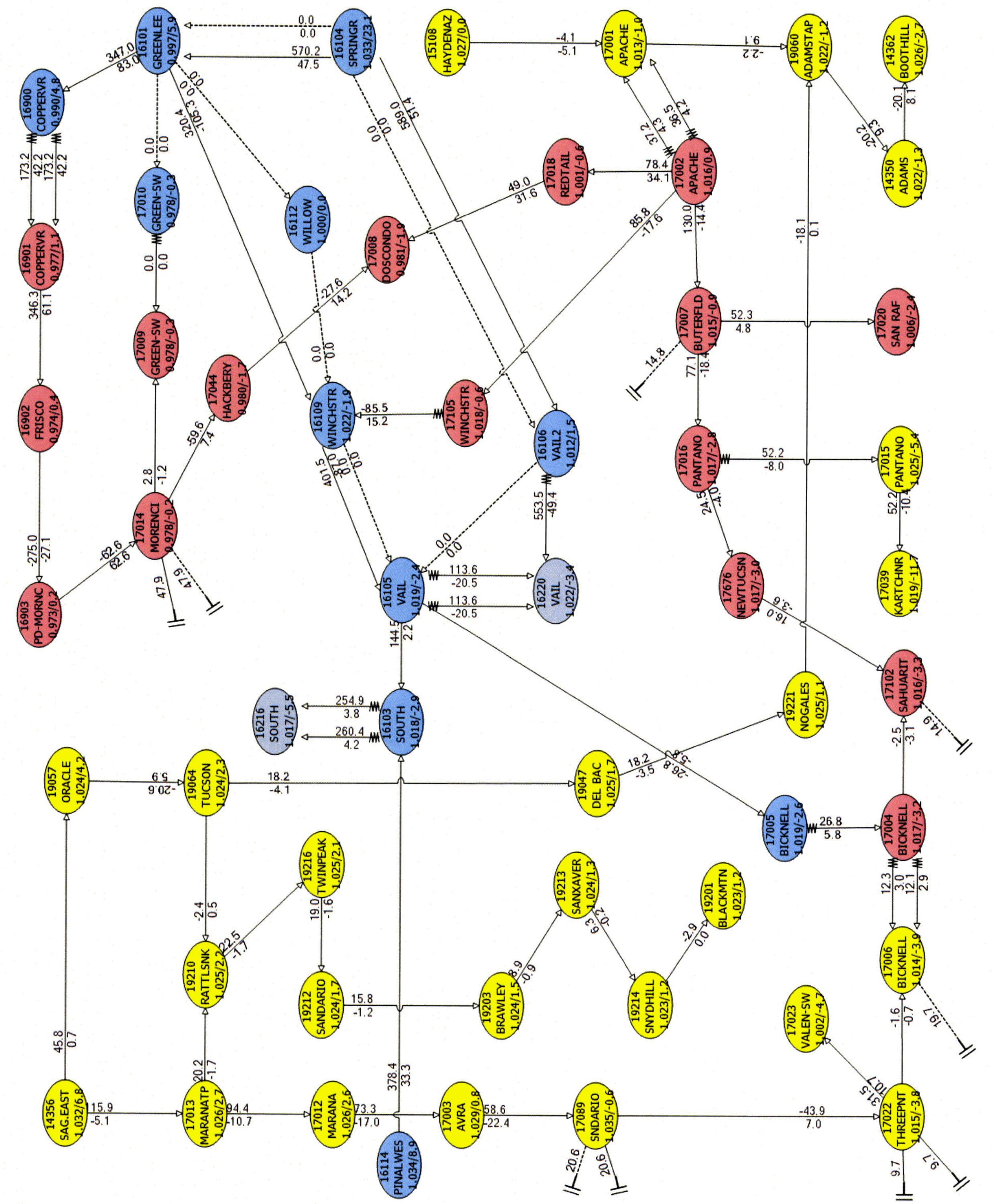
319). APAC230WINC230 | APAC115-HAYD115,P7-1:
APACHE,230, WINCHSTR,230 | APACHE,115, HAYDENAZ,115

APPENDIX C: Power Flow One Line Diagrams

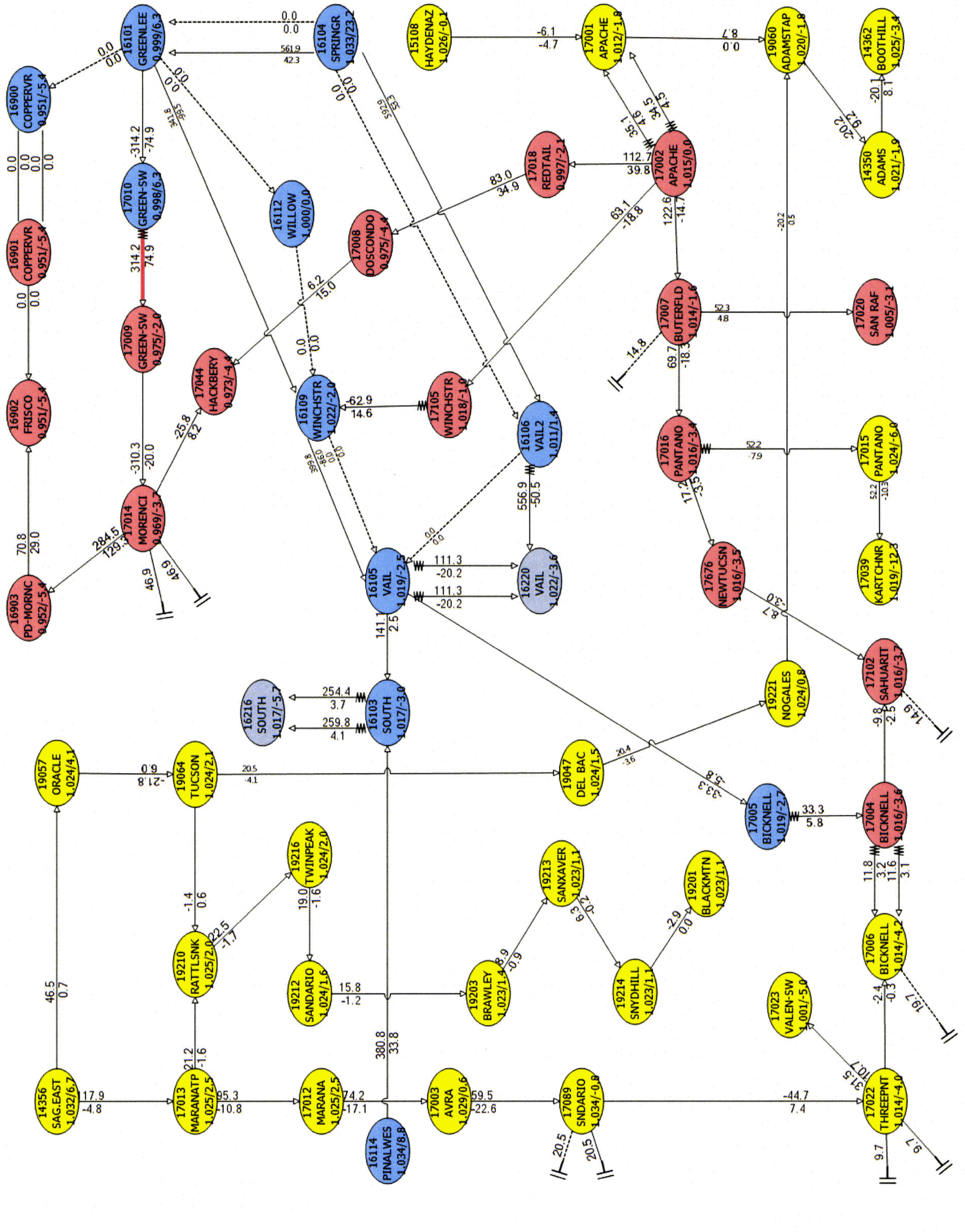
2016HS Southwest Transmission Cooperative Base System



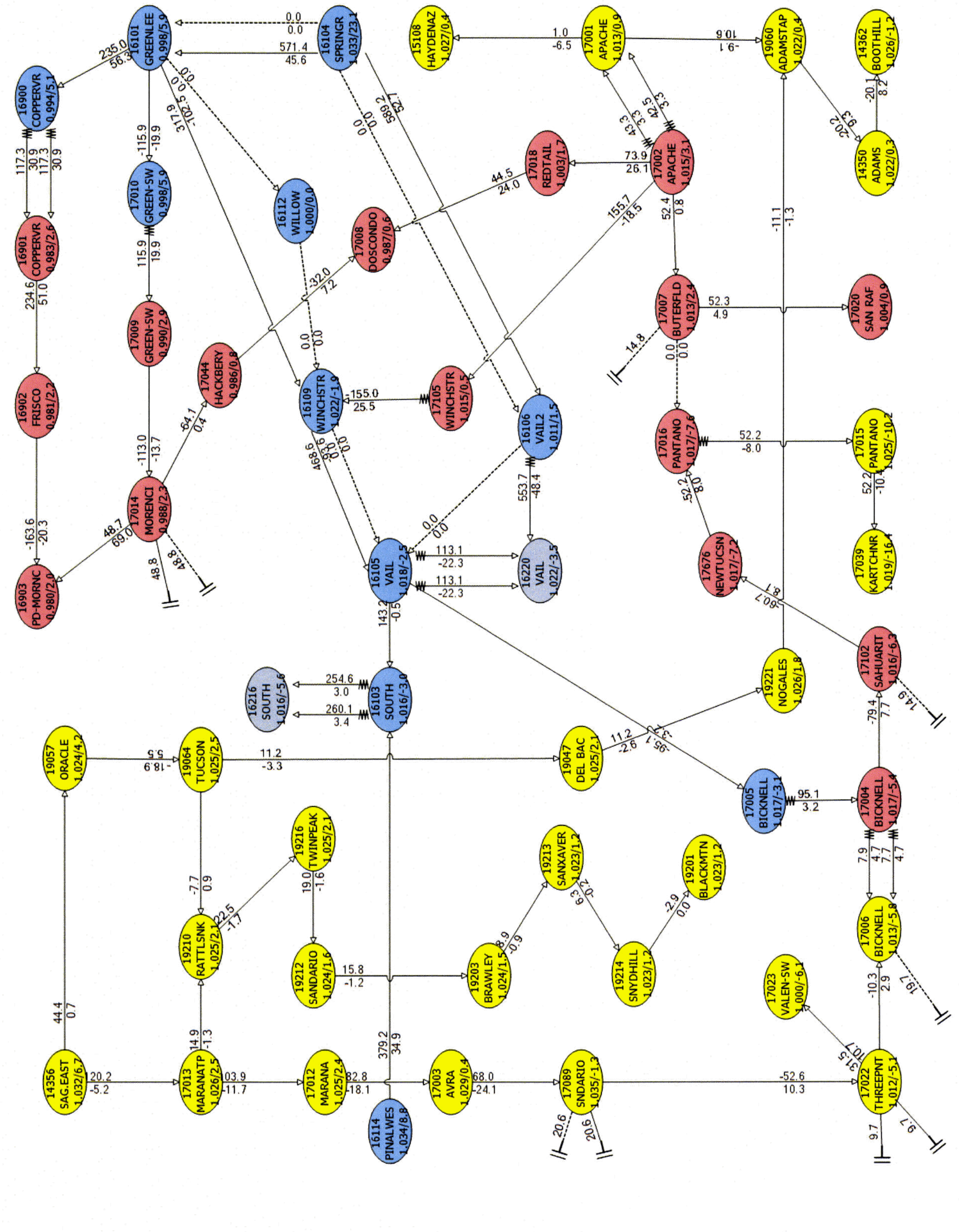
2016HS Southwest Transmission Cooperative Base System with Green-SW to Greenlee 345 kV Line out of service



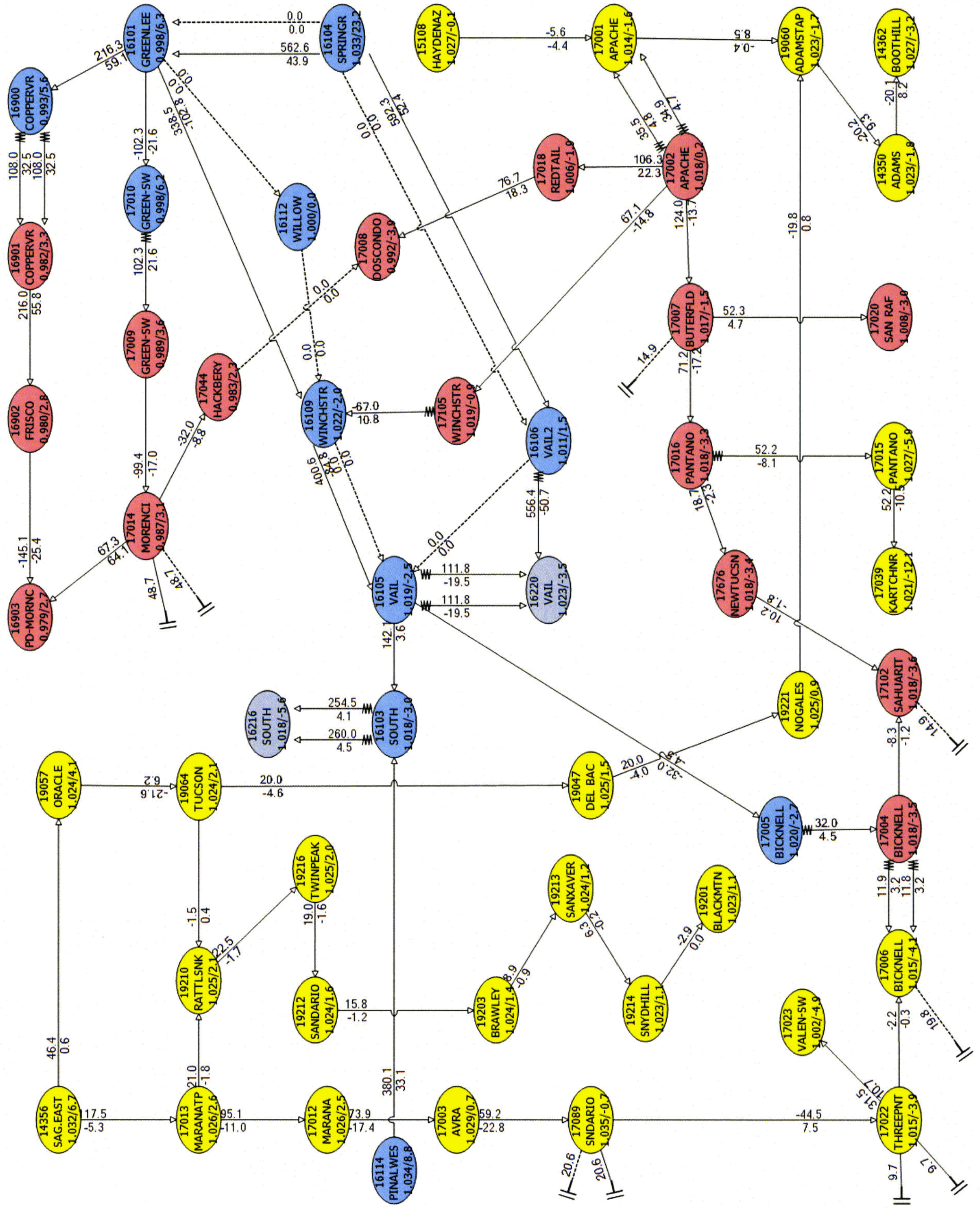
2016HS Southwest Transmission Cooperative Base System with Greenlee to Copper Verde 345 kV Line out of service



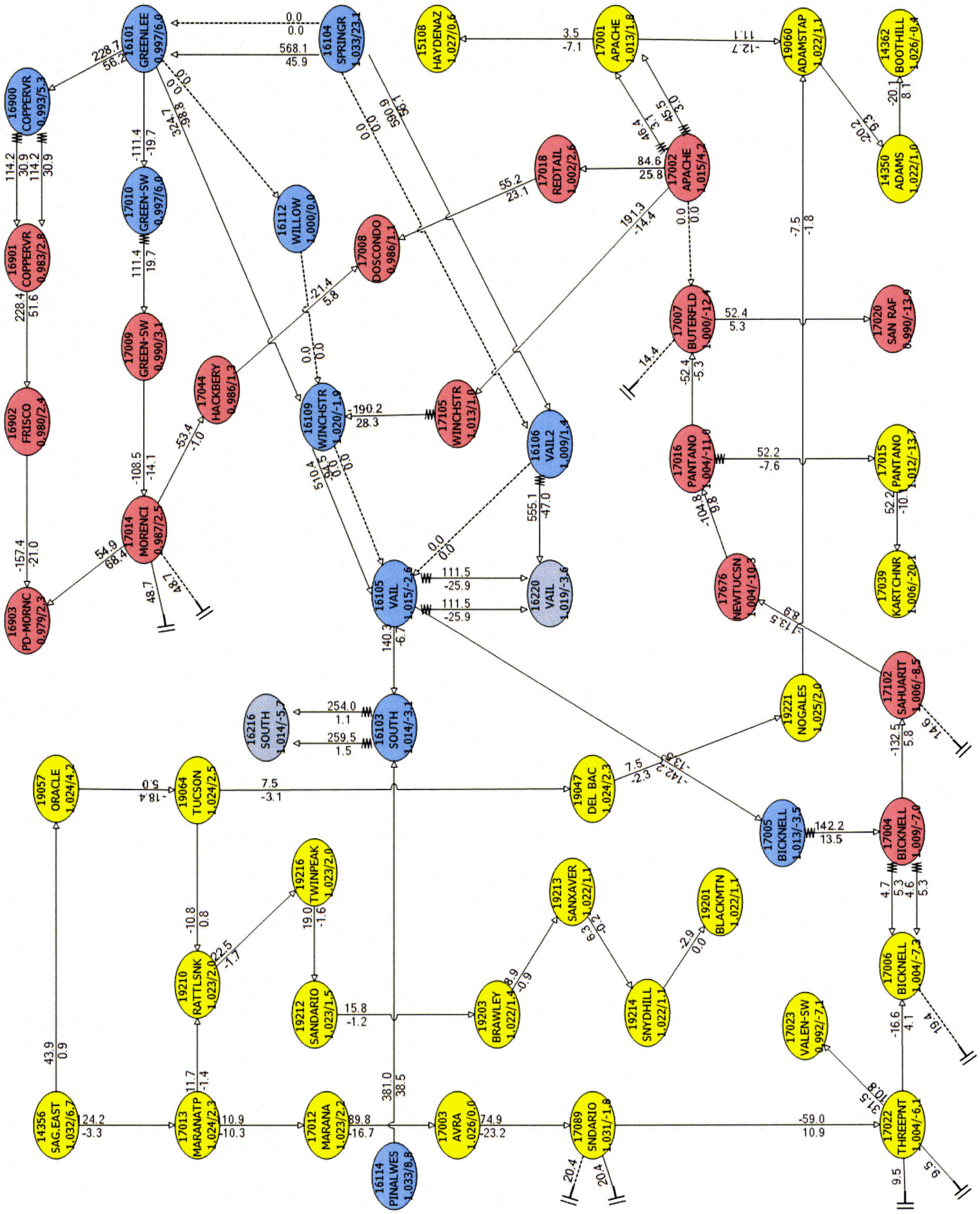
2016HS Southwest Transmission Cooperative Base System with Butterfield to Pantano 230 kV Line out of service



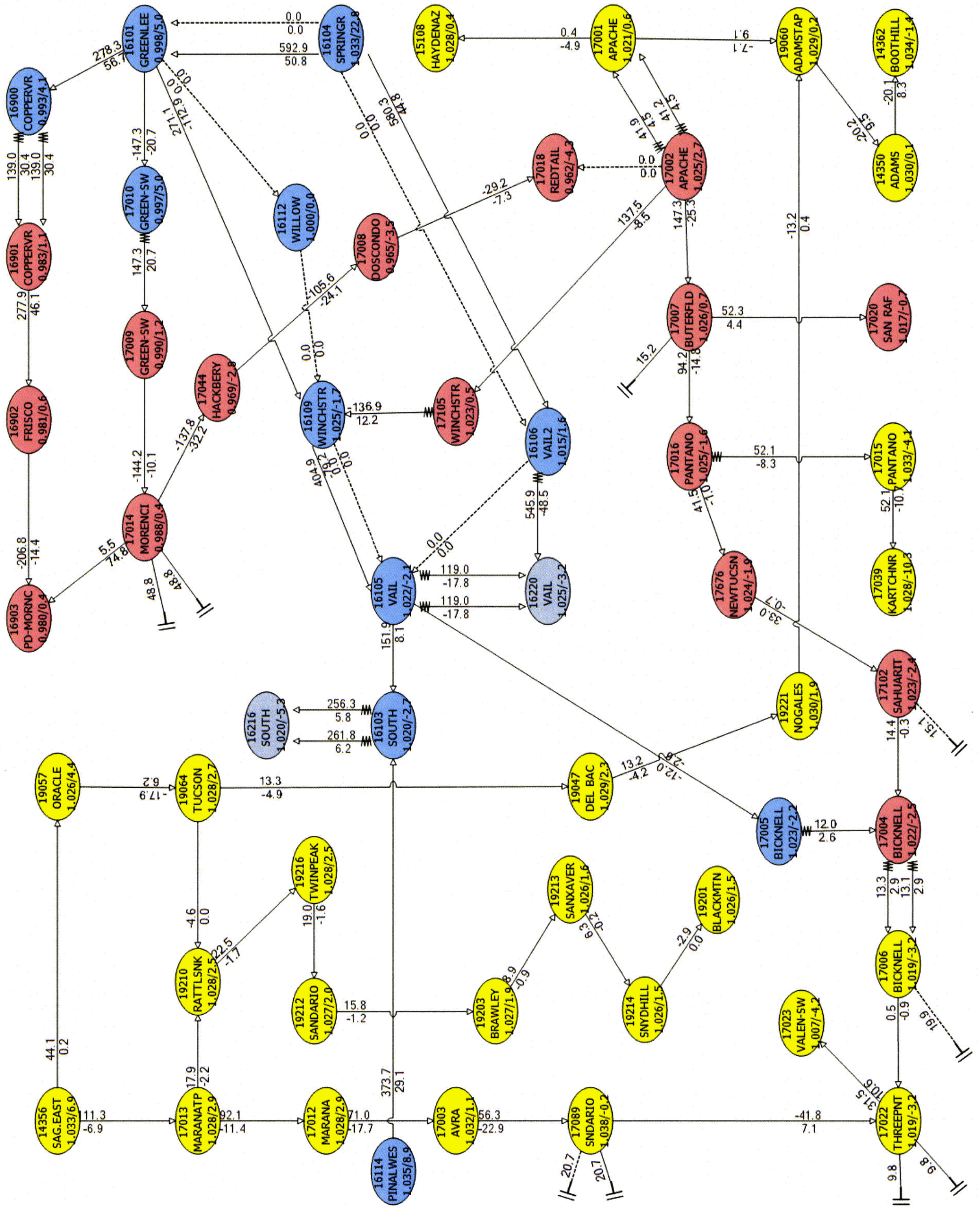
2016HS Southwest Transmission Cooperative Base System with Dos Condados to Hackberry 230 kV Line out of service



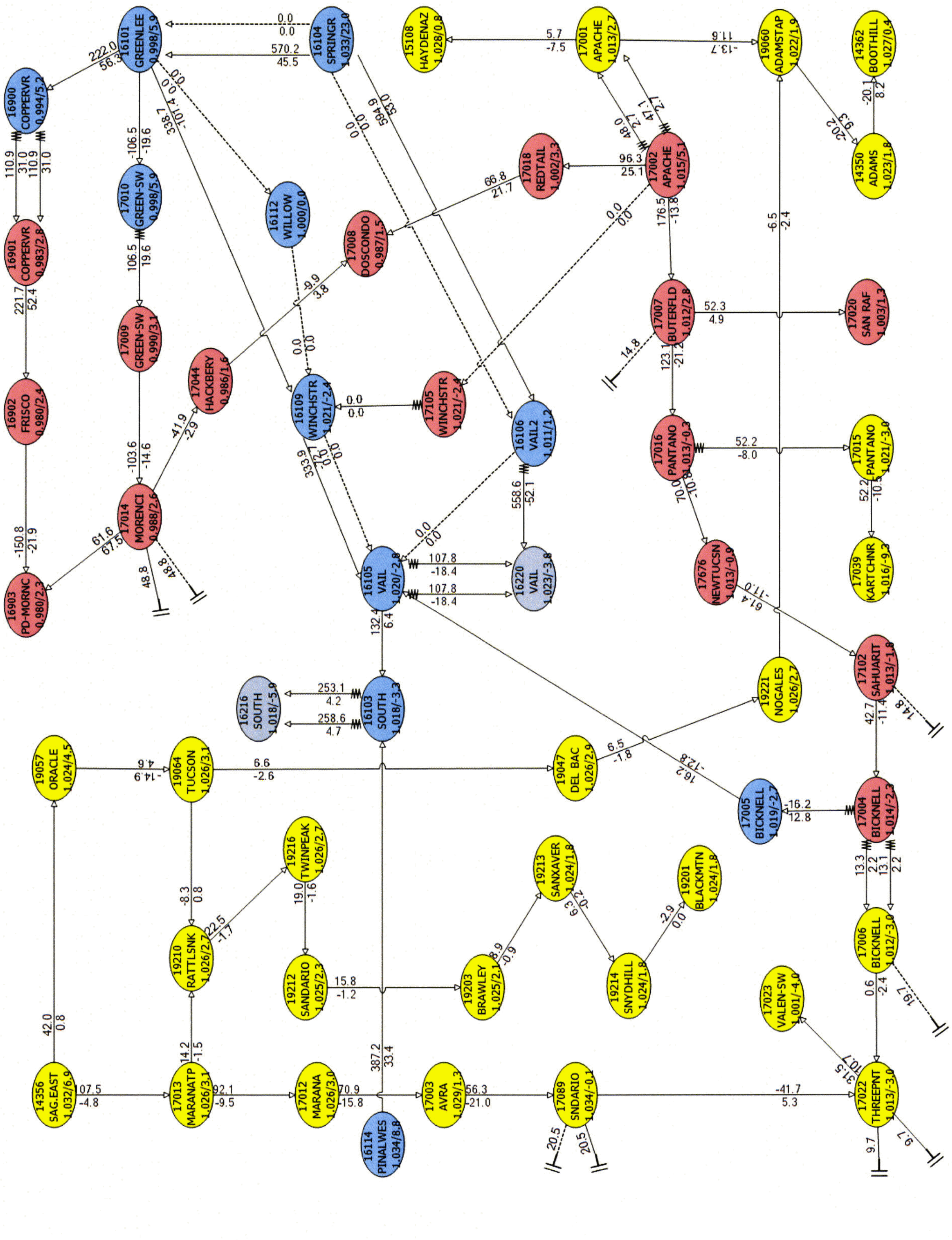
2016HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out of service



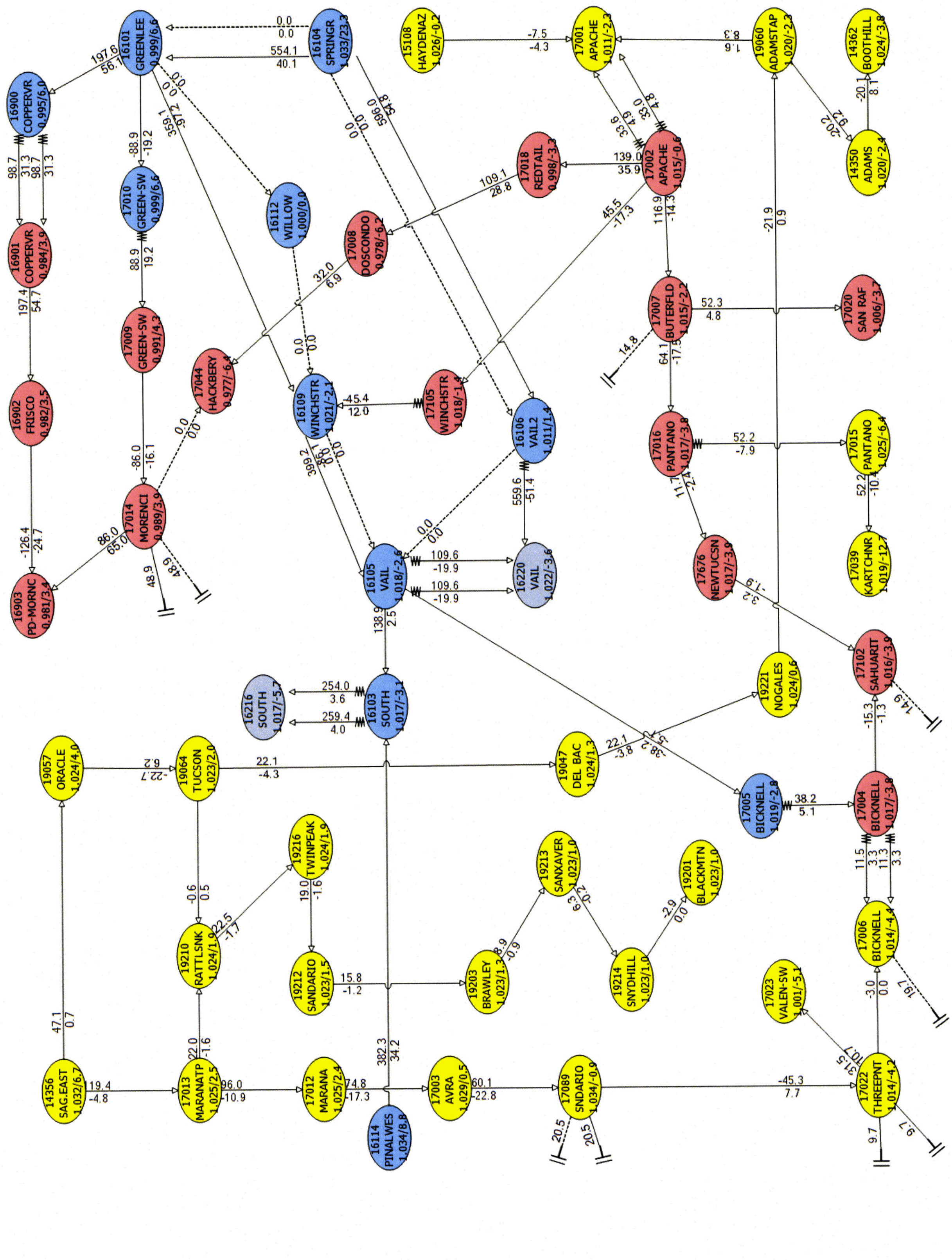
2016HS Southwest Transmission Cooperative Base System with Apache to Redtail 230 kV Line out of service



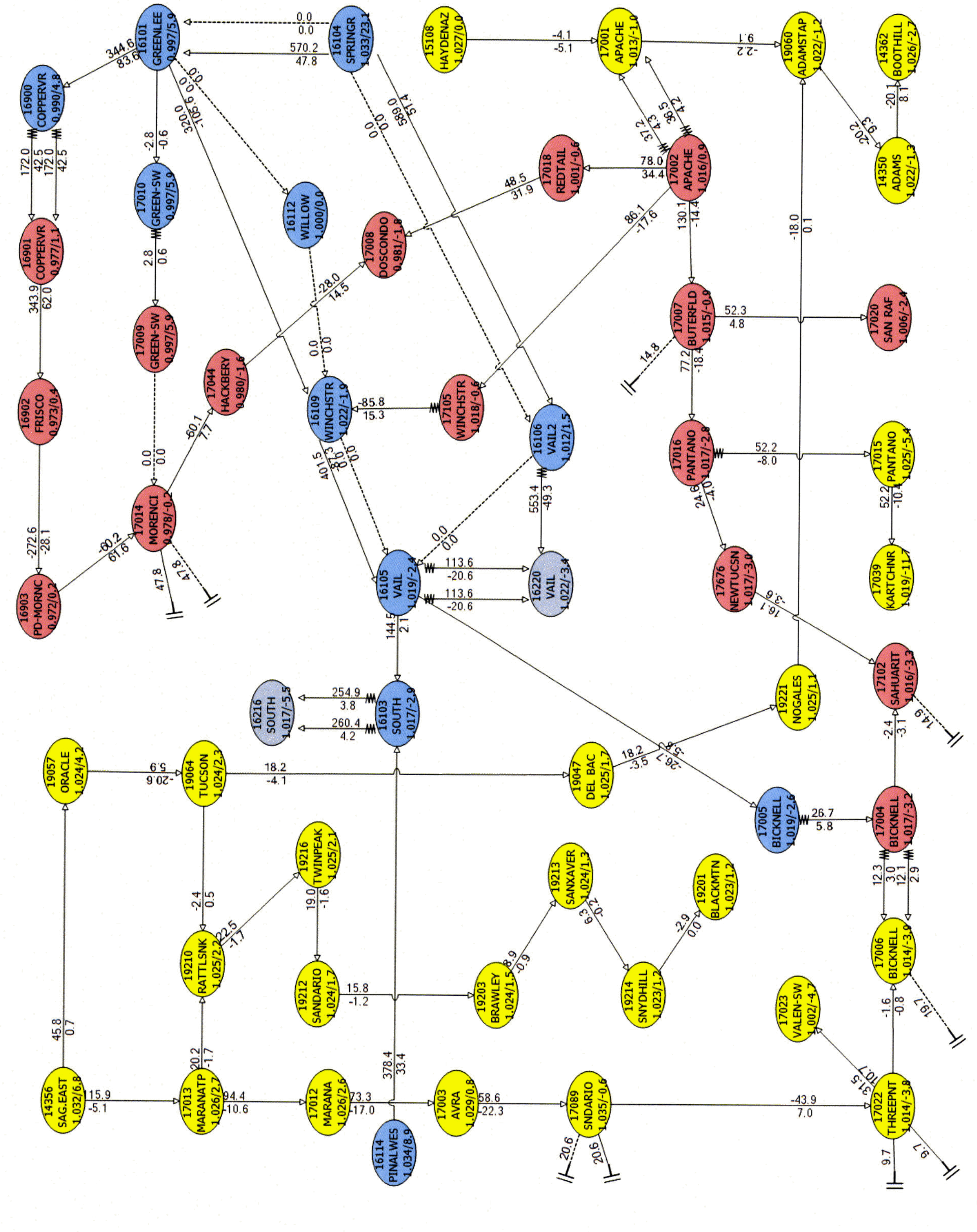
2016HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line out of service



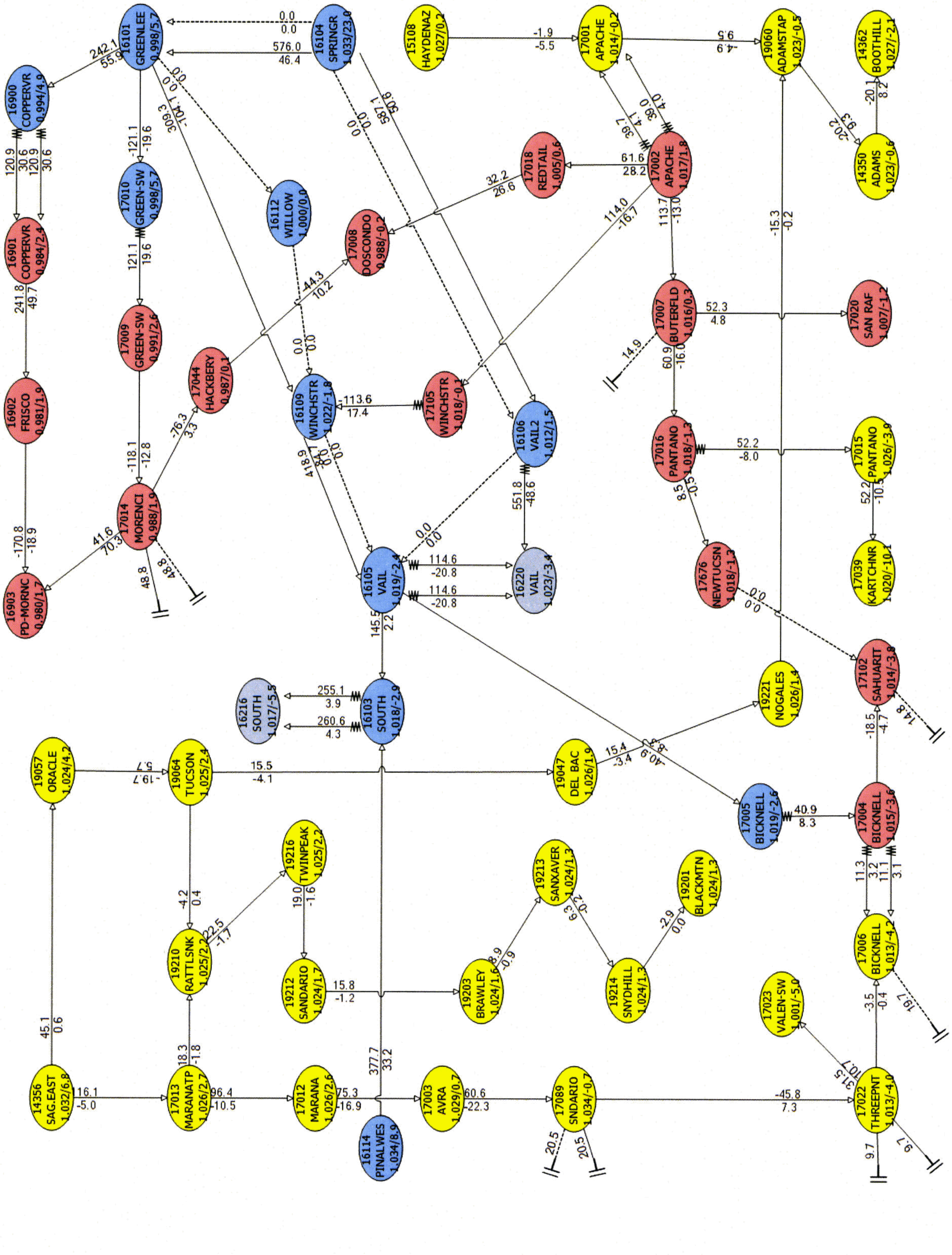
2016HS Southwest Transmission Cooperative Base System with Hackberry to Morenci 230 kV Line out of service



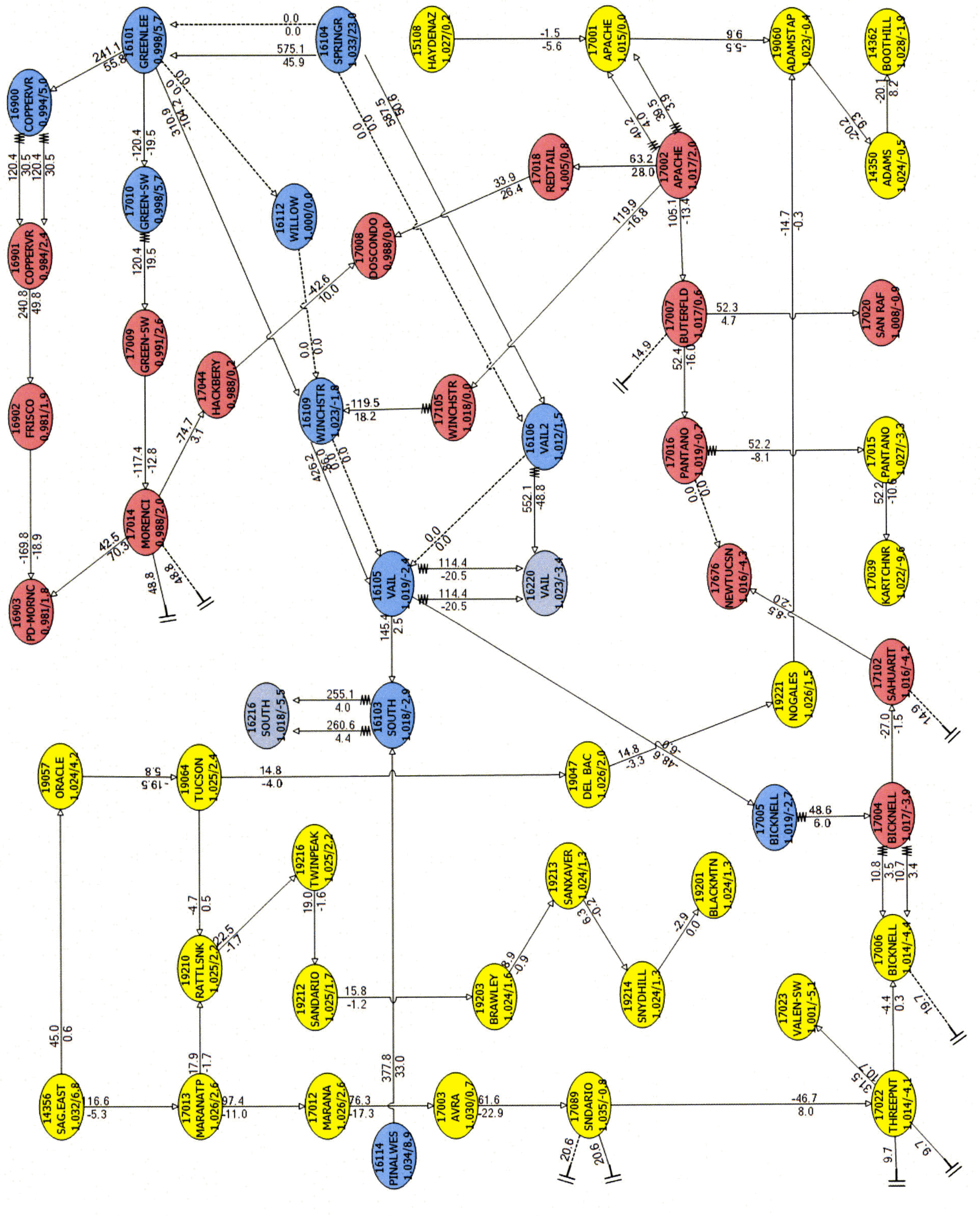
2016HS Southwest Transmission Cooperative Base System with Morenci to Greenlee-SW 230 kV Line out of service



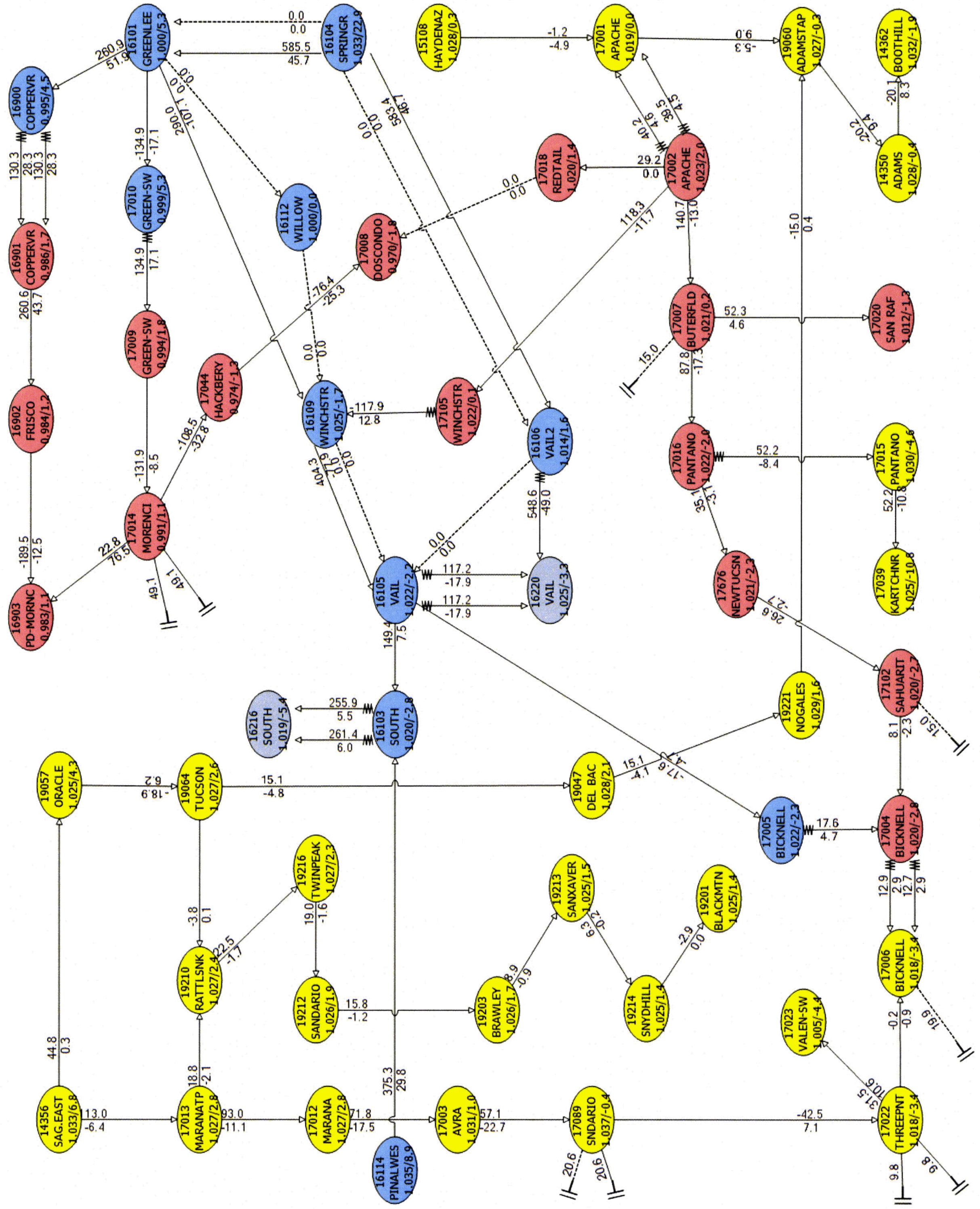
2016HS Southwest Transmission Cooperative Base System with New Tucson to Sahuarita 230 kV Line out of service



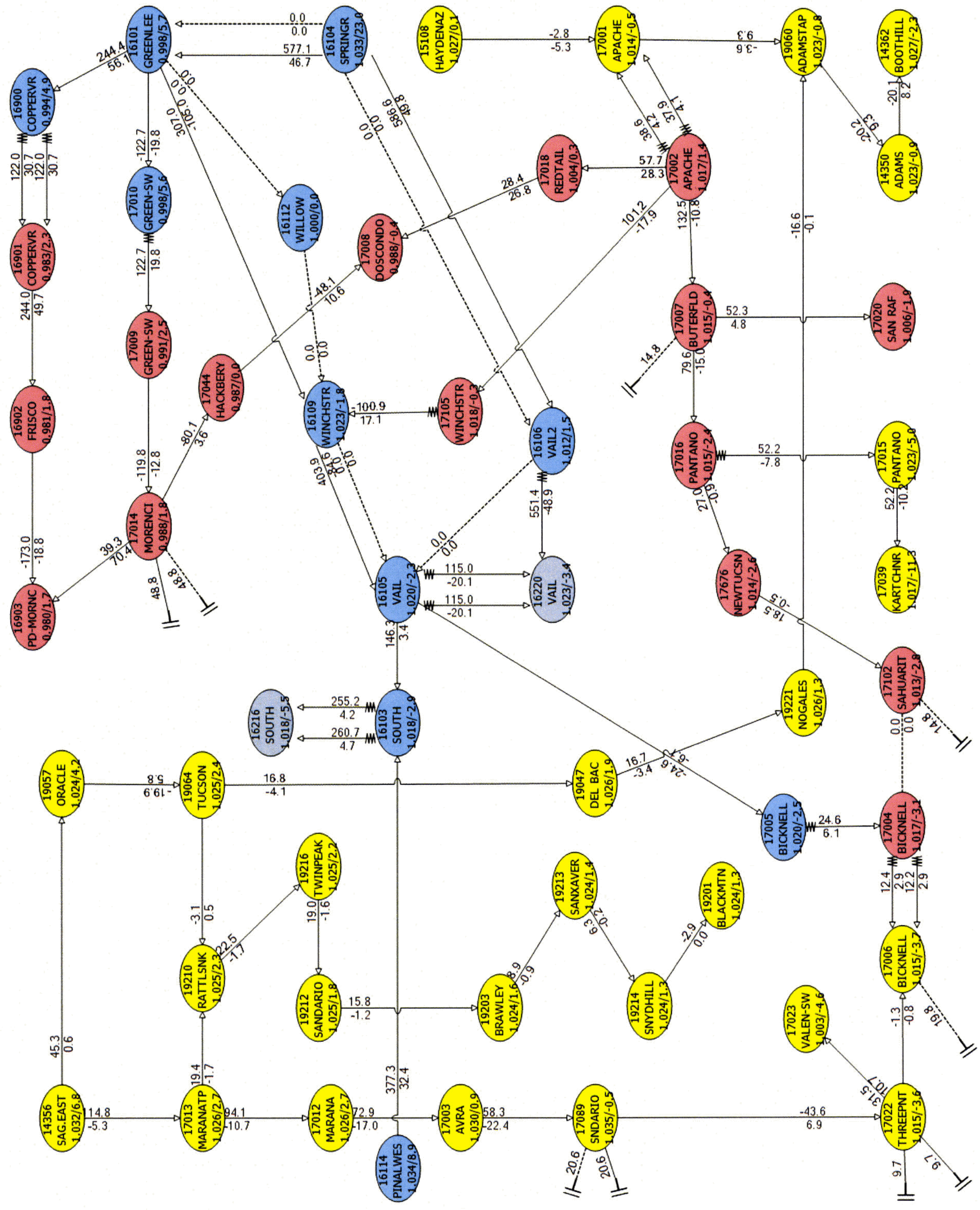
2016HS Southwest Transmission Cooperative Base System with Pantano to New Tucson 230 kV Line out of service



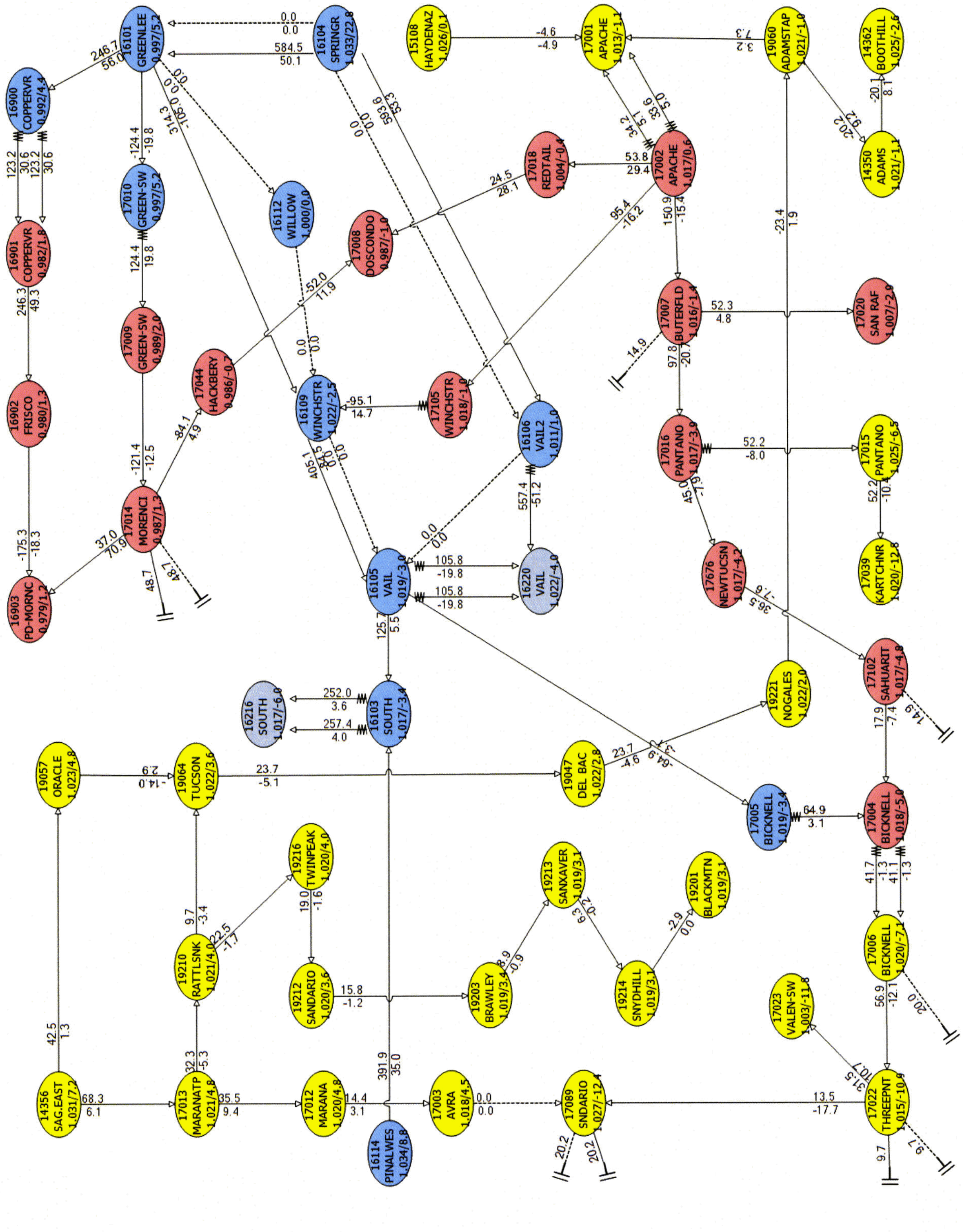
2016HS Southwest Transmission Cooperative Base System with Redtail to Dos Condados 230 kV Line out of service



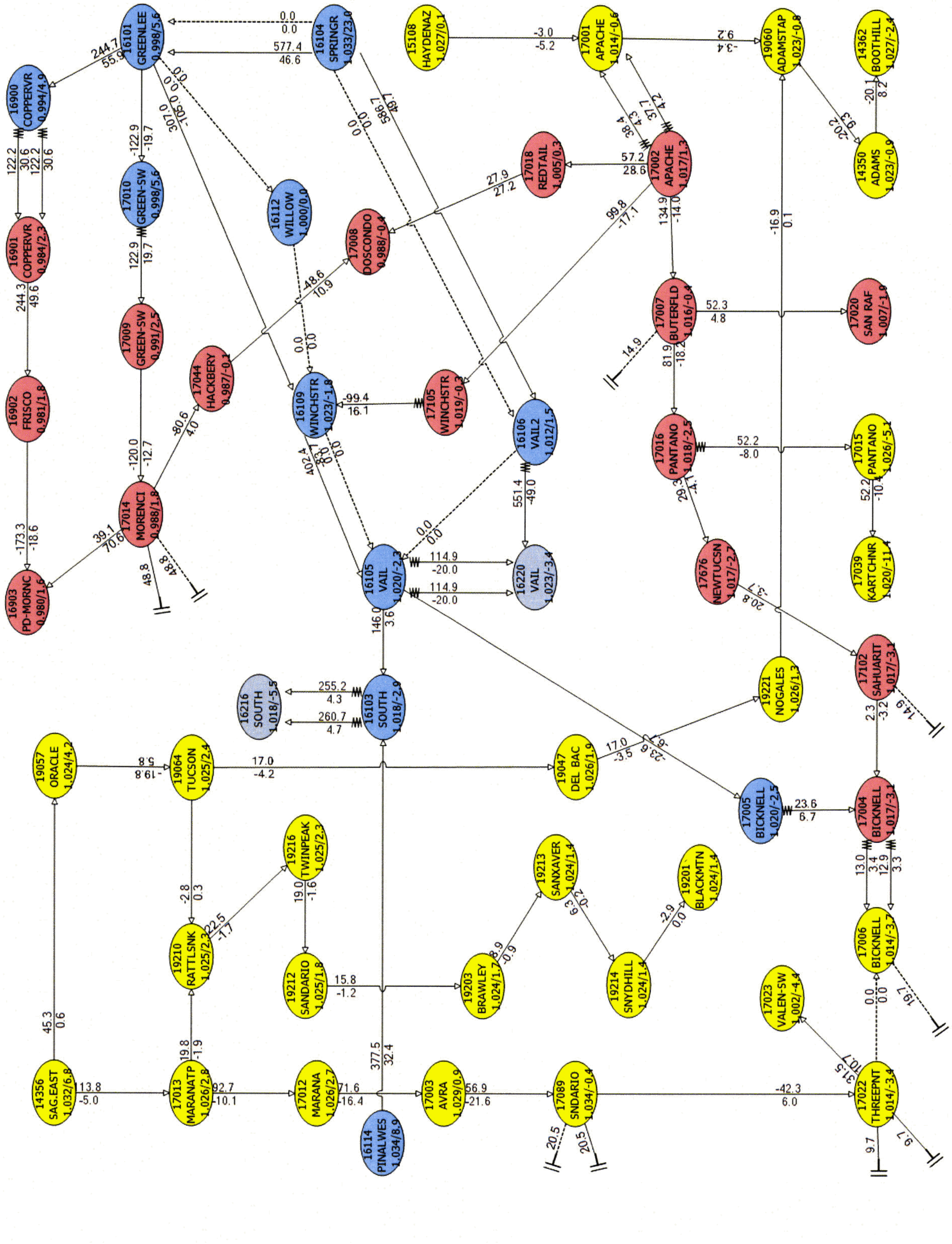
2016HS Southwest Transmission Cooperative Base System with Sahuarita to Bicknell 230 kV Line out of service



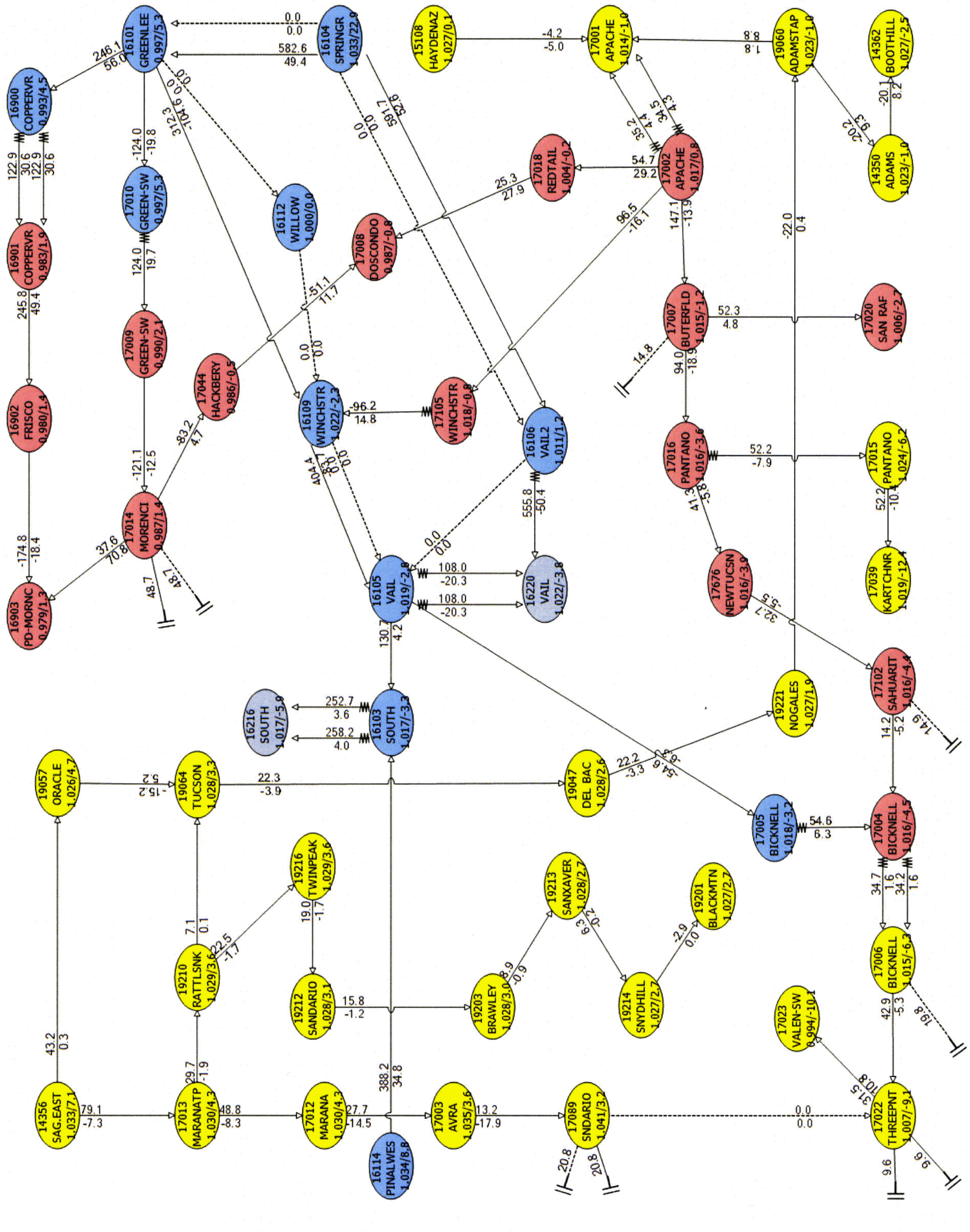
2016HS Southwest Transmission Cooperative Base System with Avra to Sandario 115 kV Line out of service



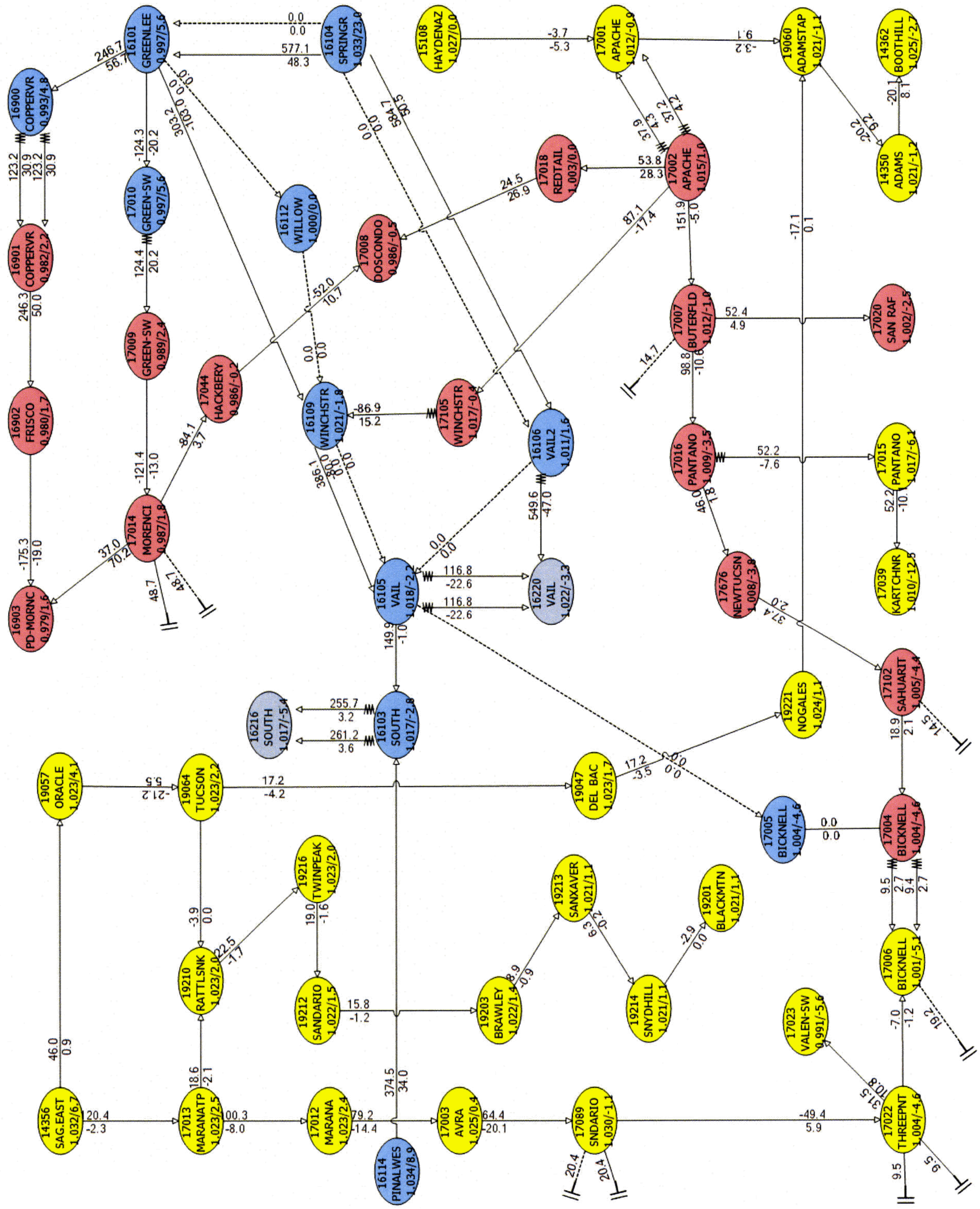
2016HS Southwest Transmission Cooperative Base System with Bicknell to Three Points 115 kV Line out of service



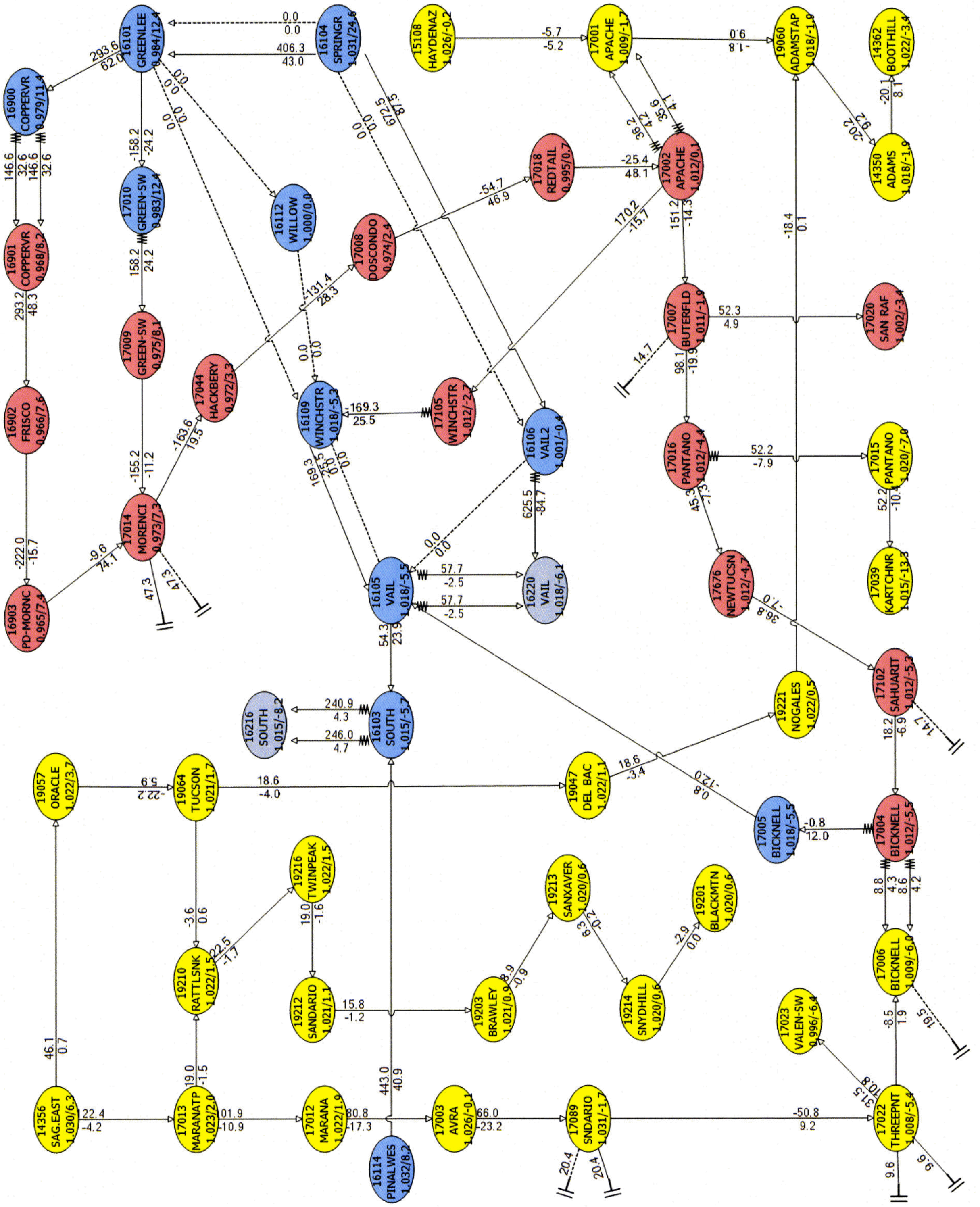
2016HS Southwest Transmission Cooperative Base System with Three Points to Sandario 115 kV Line out of service



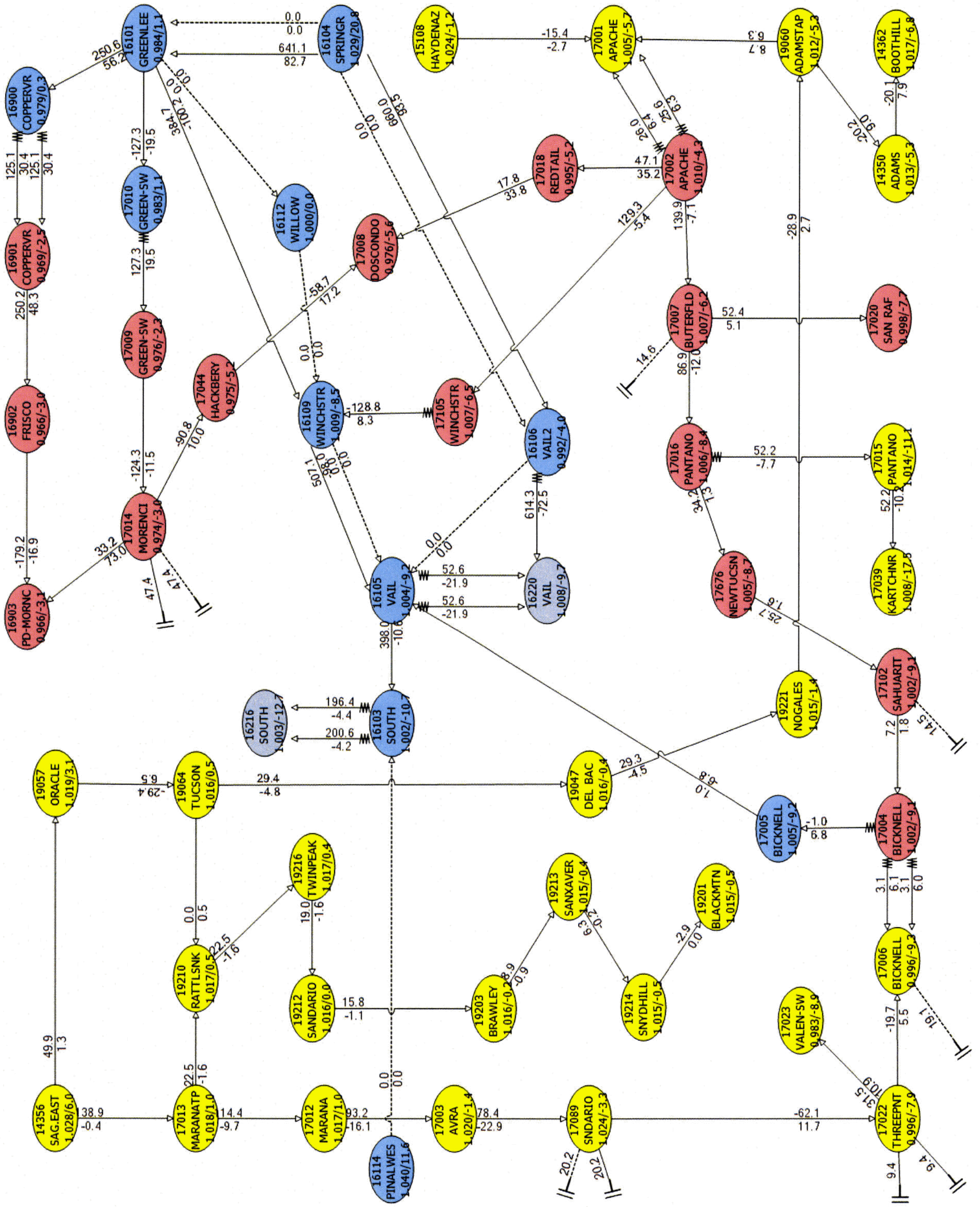
2016HS Southwest Transmission Cooperative Base System with Bicknell to Vail 345 kV Line out of service



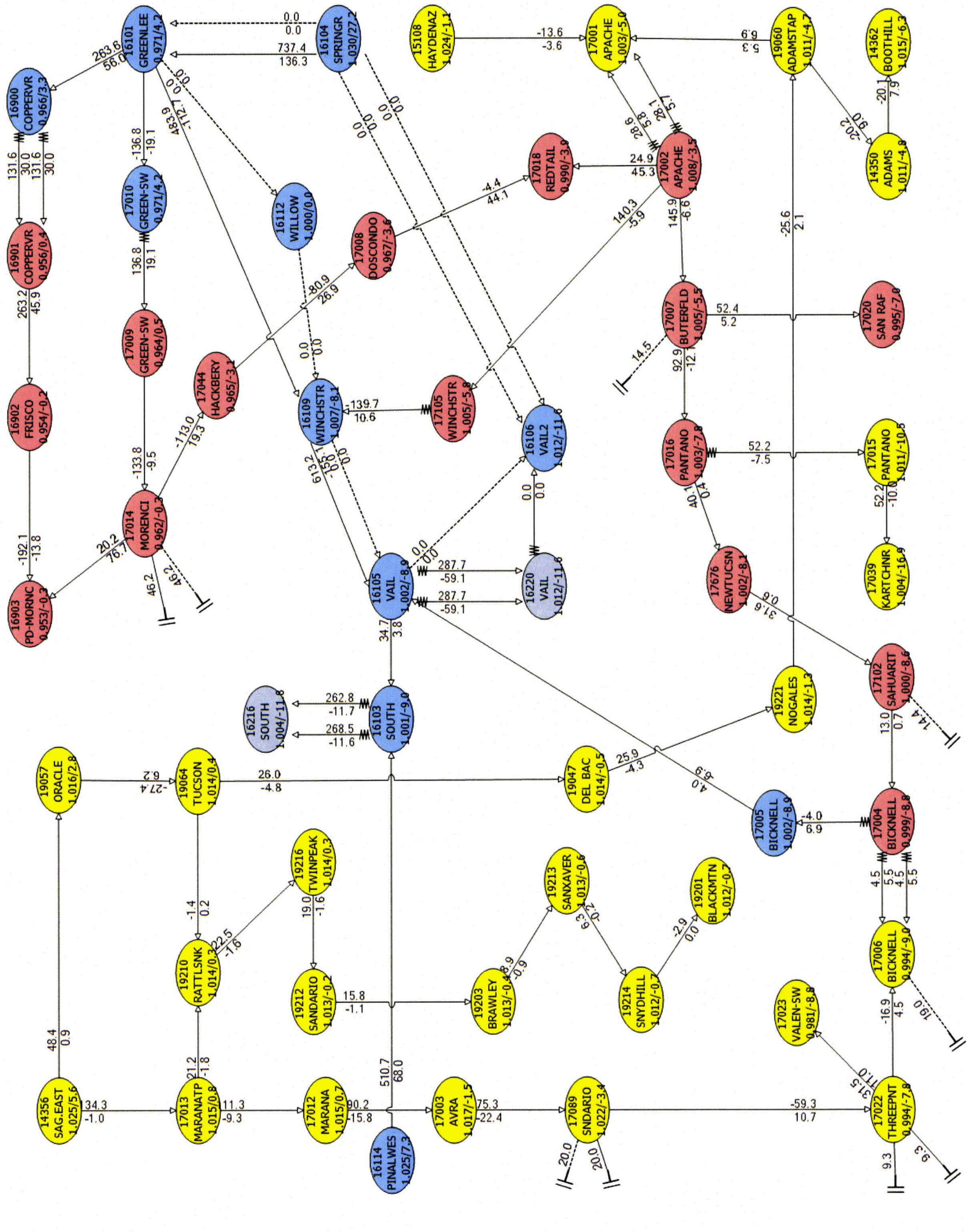
2016HS Southwest Transmission Cooperative Base System with Greenlee to Winchester 345 kV Line out of service



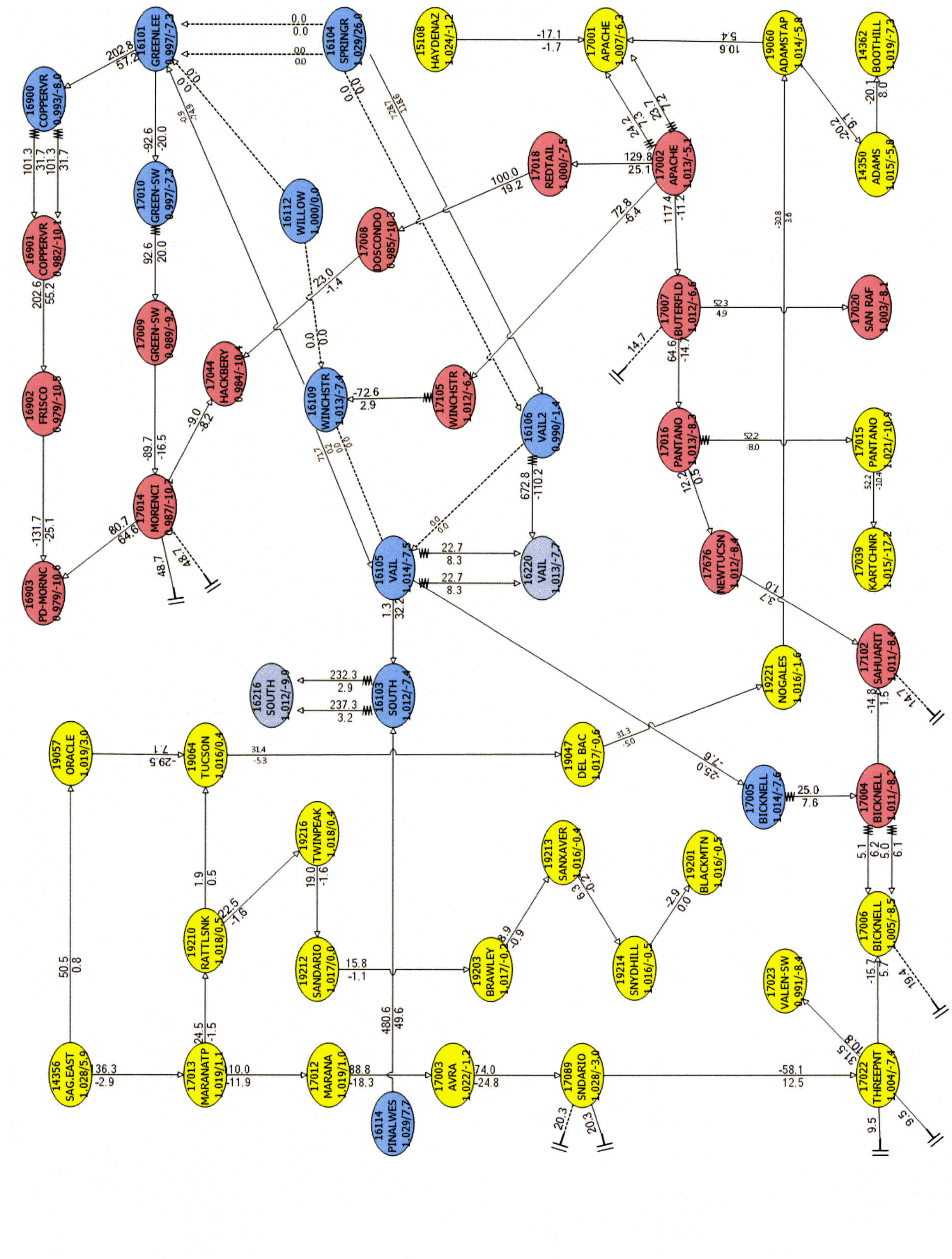
2016HS Southwest Transmission Cooperative Base System with Pinal West to South 345 kV Line out of service



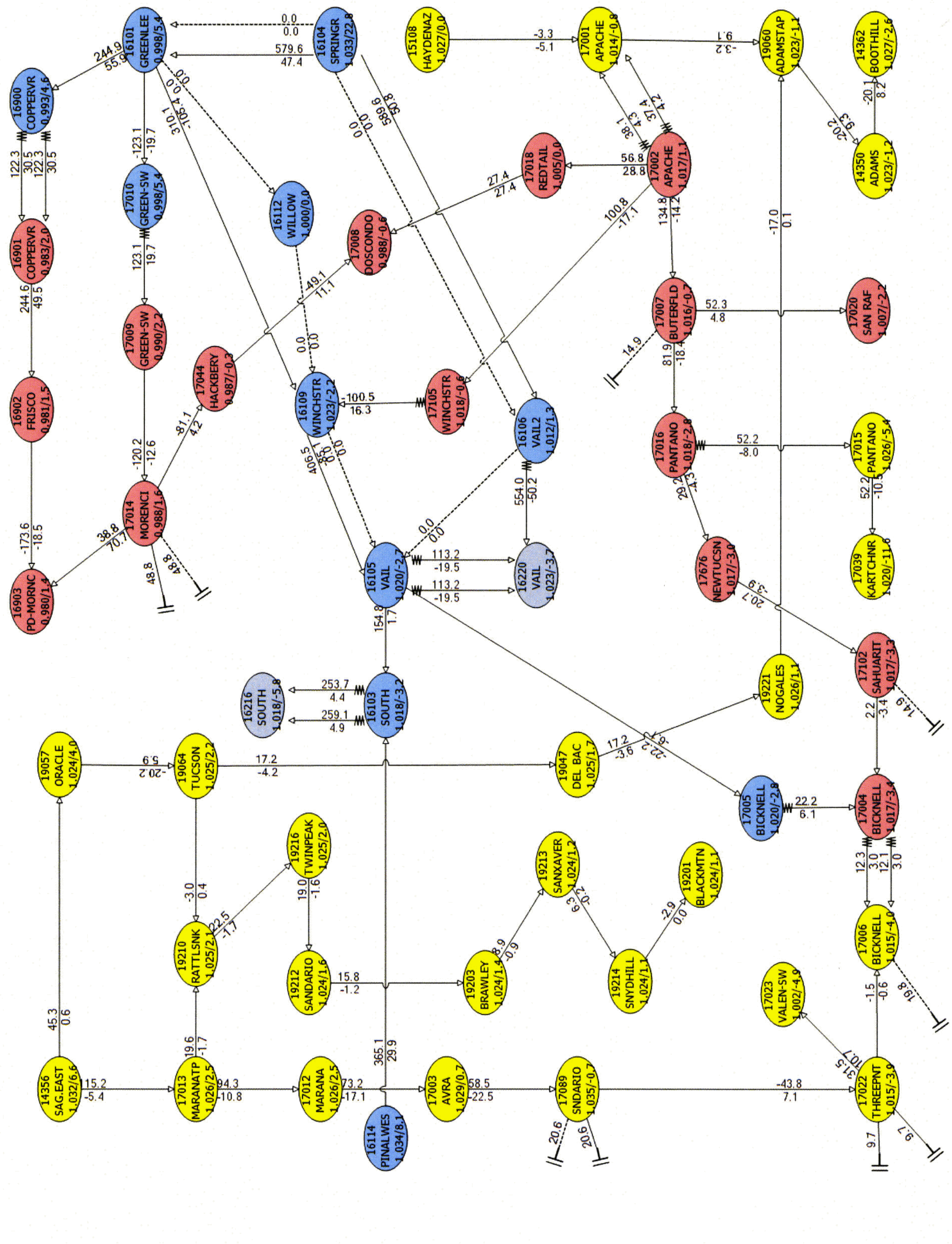
2016HS Southwest Transmission Cooperative Base System with Springerville to Vail2 345 kV Line out of service



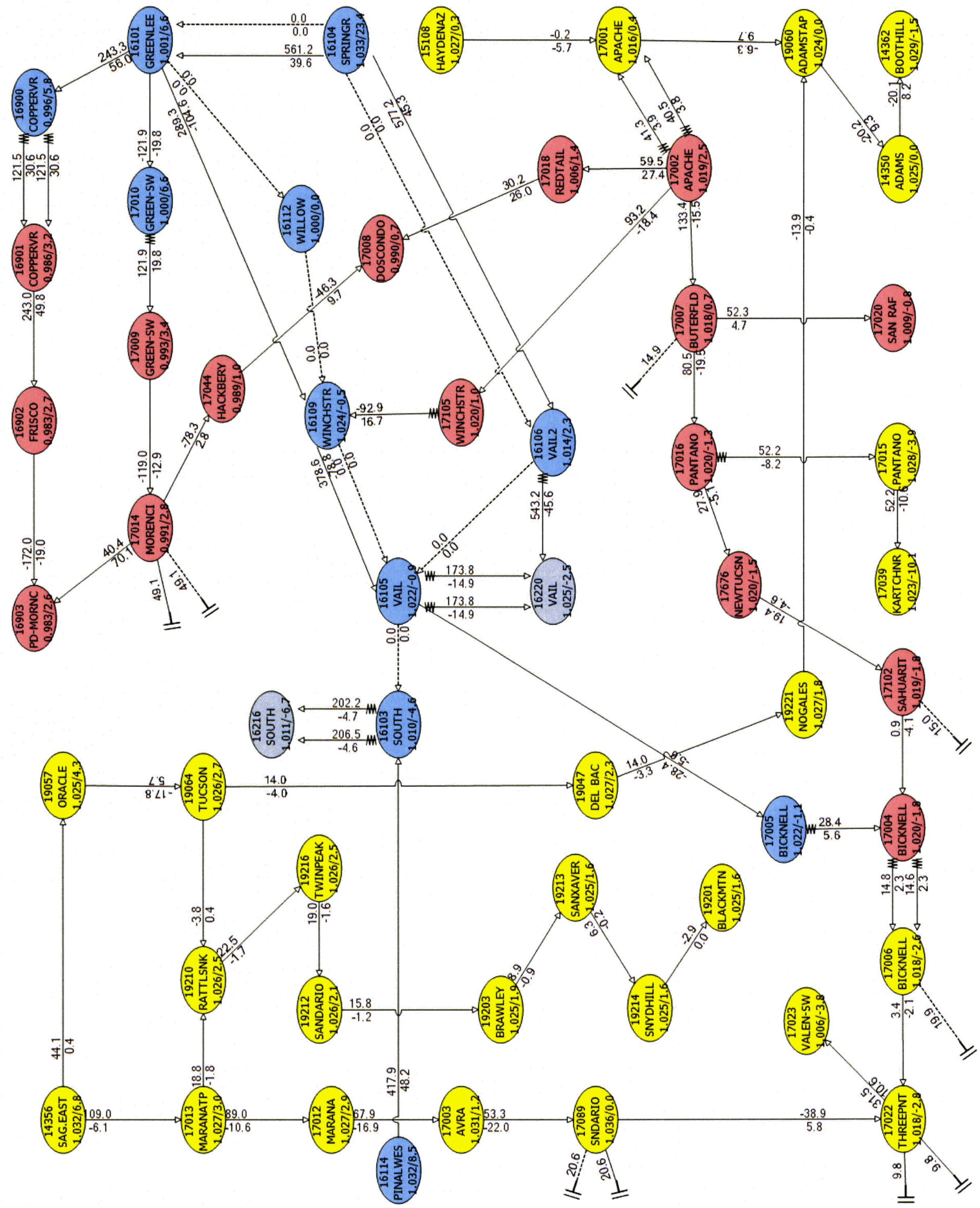
2016HS Southwest Transmission Cooperative Base System with Springerville to Greenlee 345 kV Line out of service



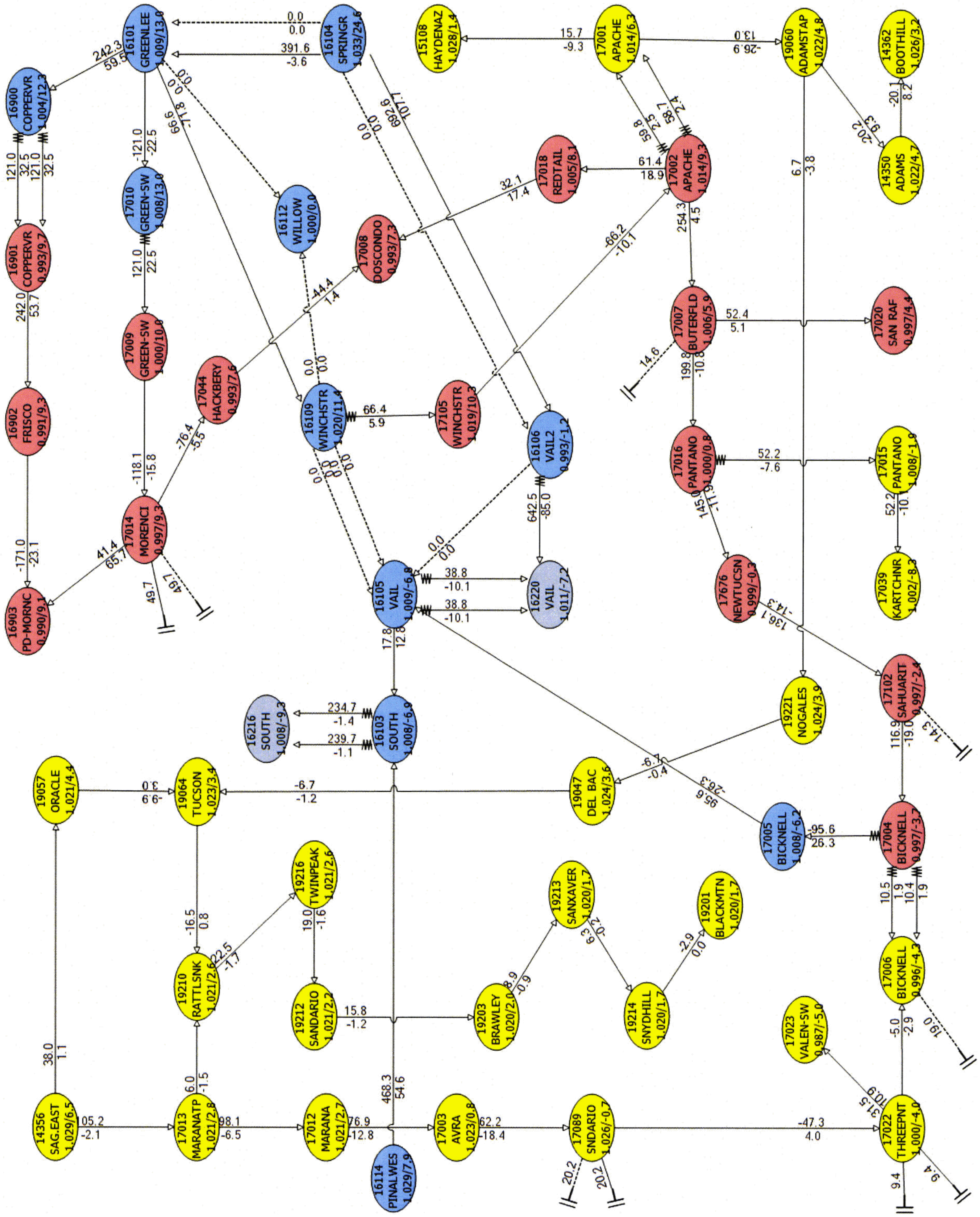
2016HS Southwest Transmission Cooperative Base System with Westwing to Pinal West 345 kV Line out of service



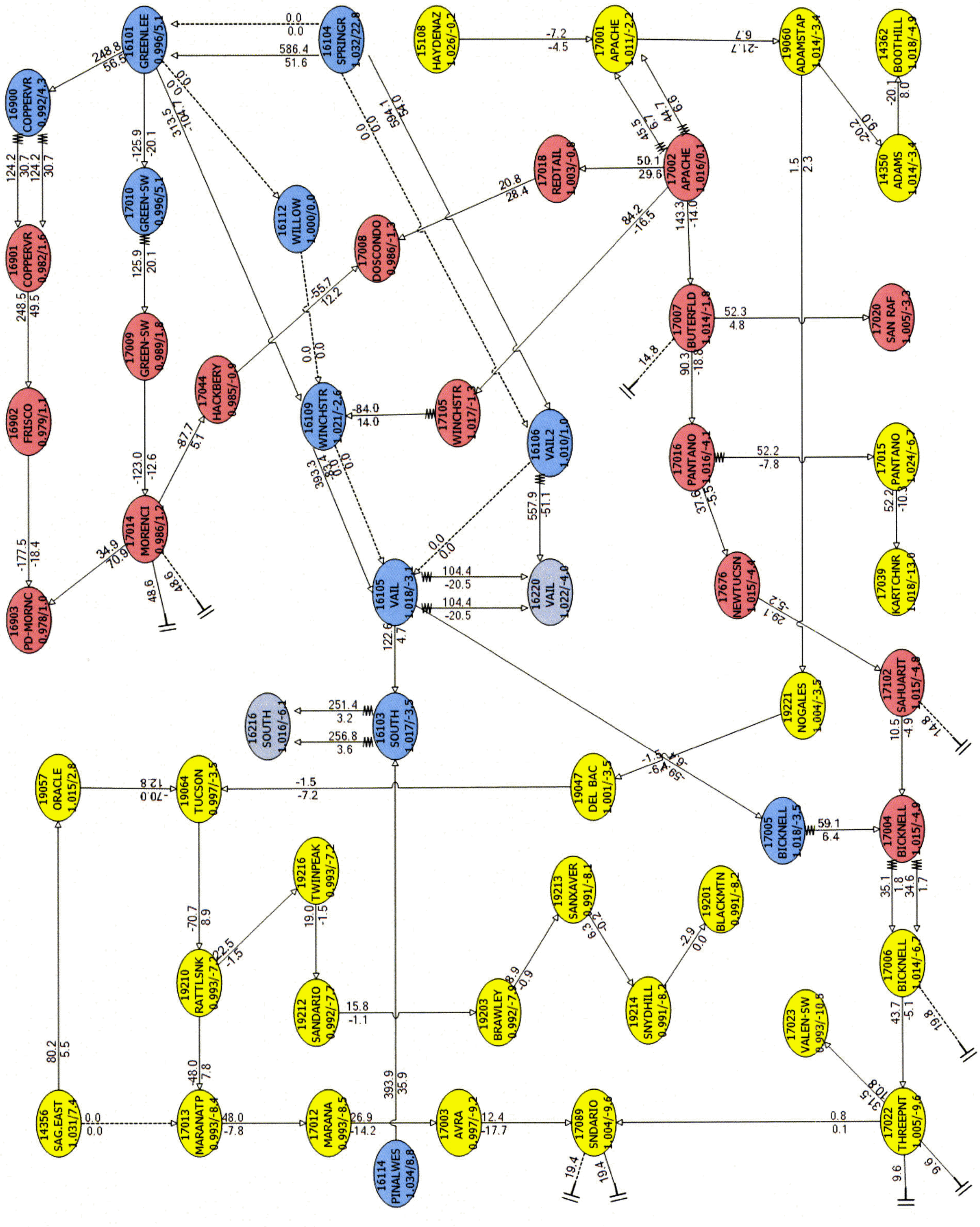
2016HS Southwest Transmission Cooperative Base System with Vail to South 345 kV Line out of service



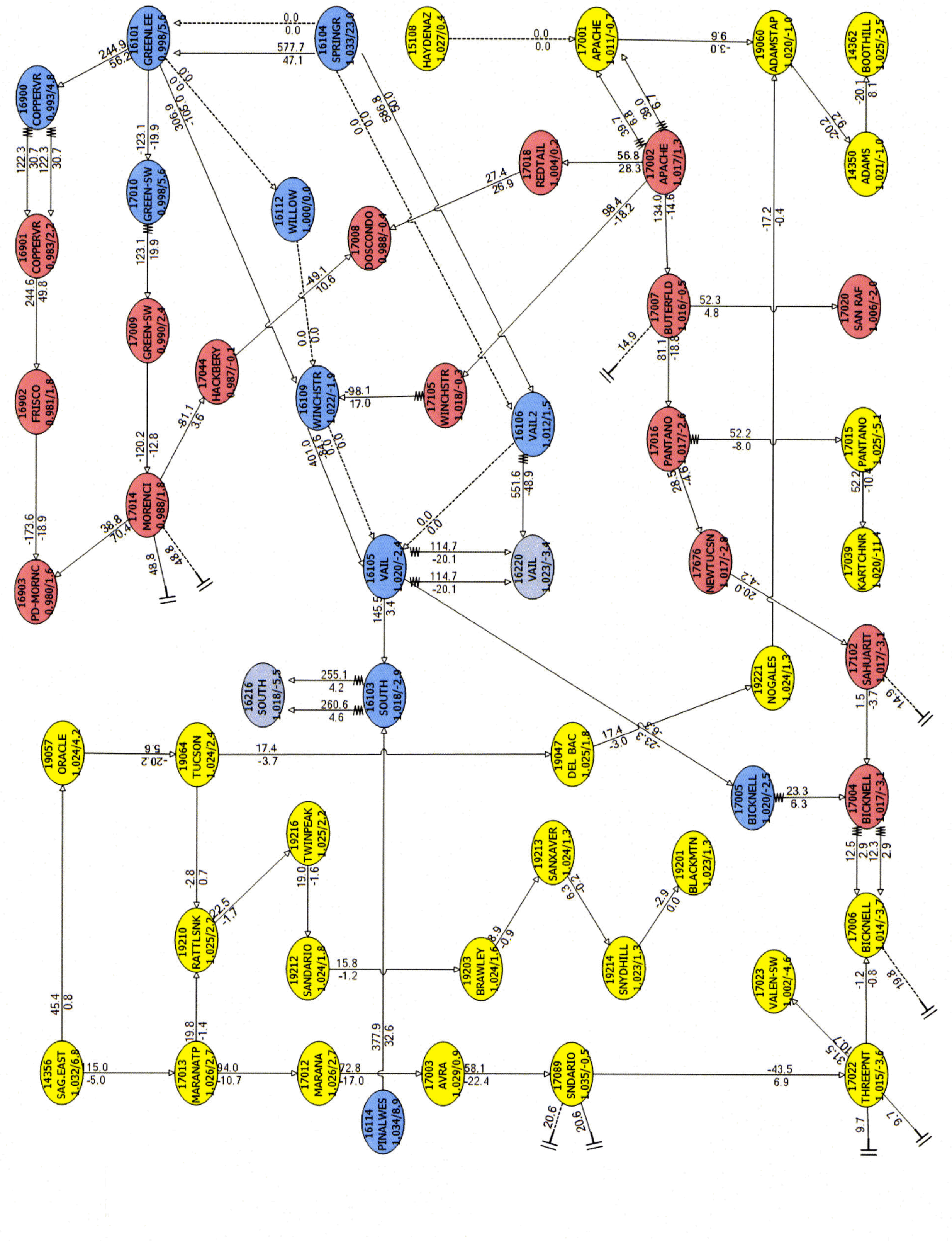
2016HS Southwest Transmission Cooperative Base System with Winchester to Vail 345 kV Line out of service



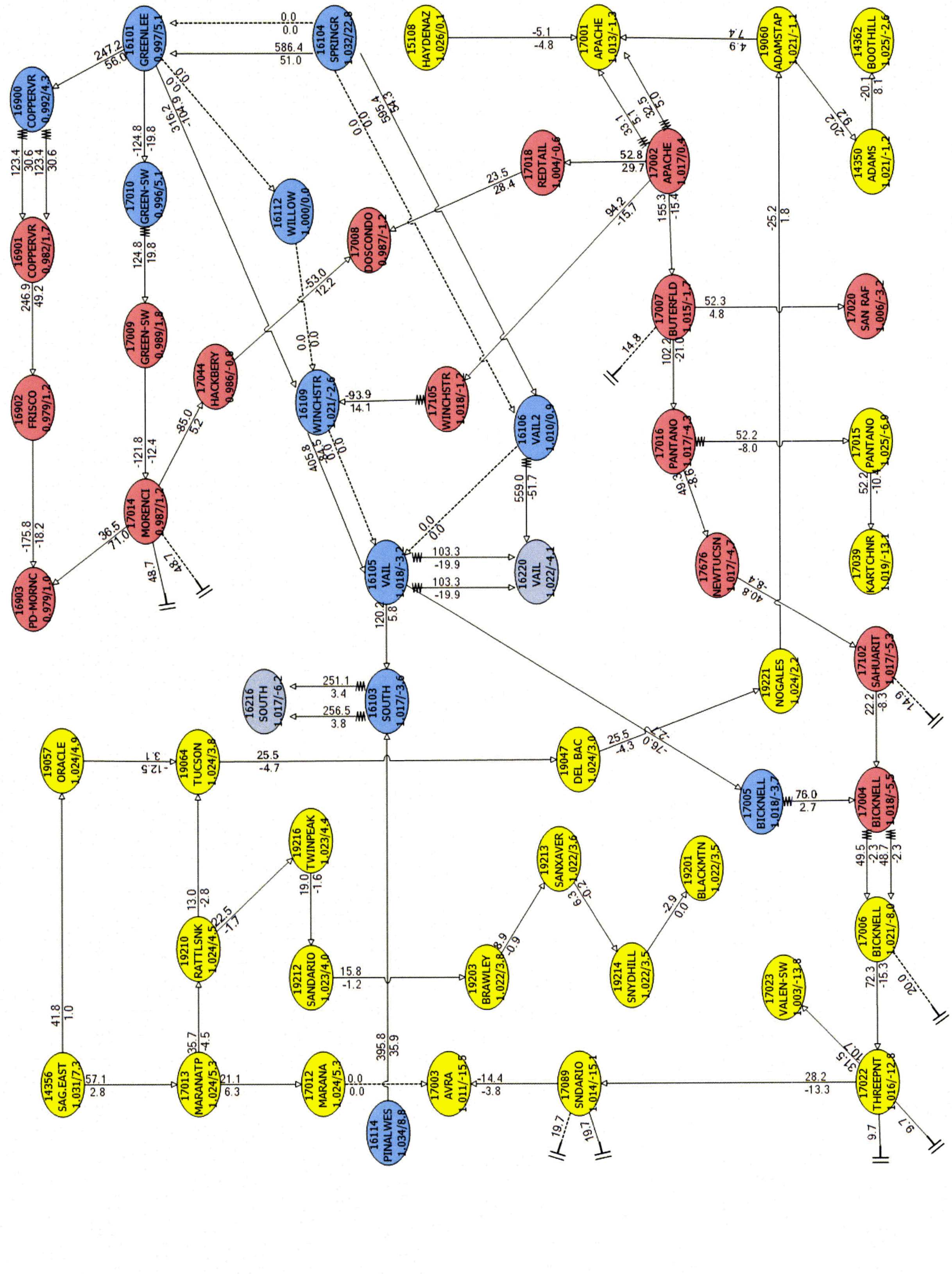
2016HS Southwest Transmission Cooperative Base System with Saguaro East to Marana Tap 115 kV Line out of service



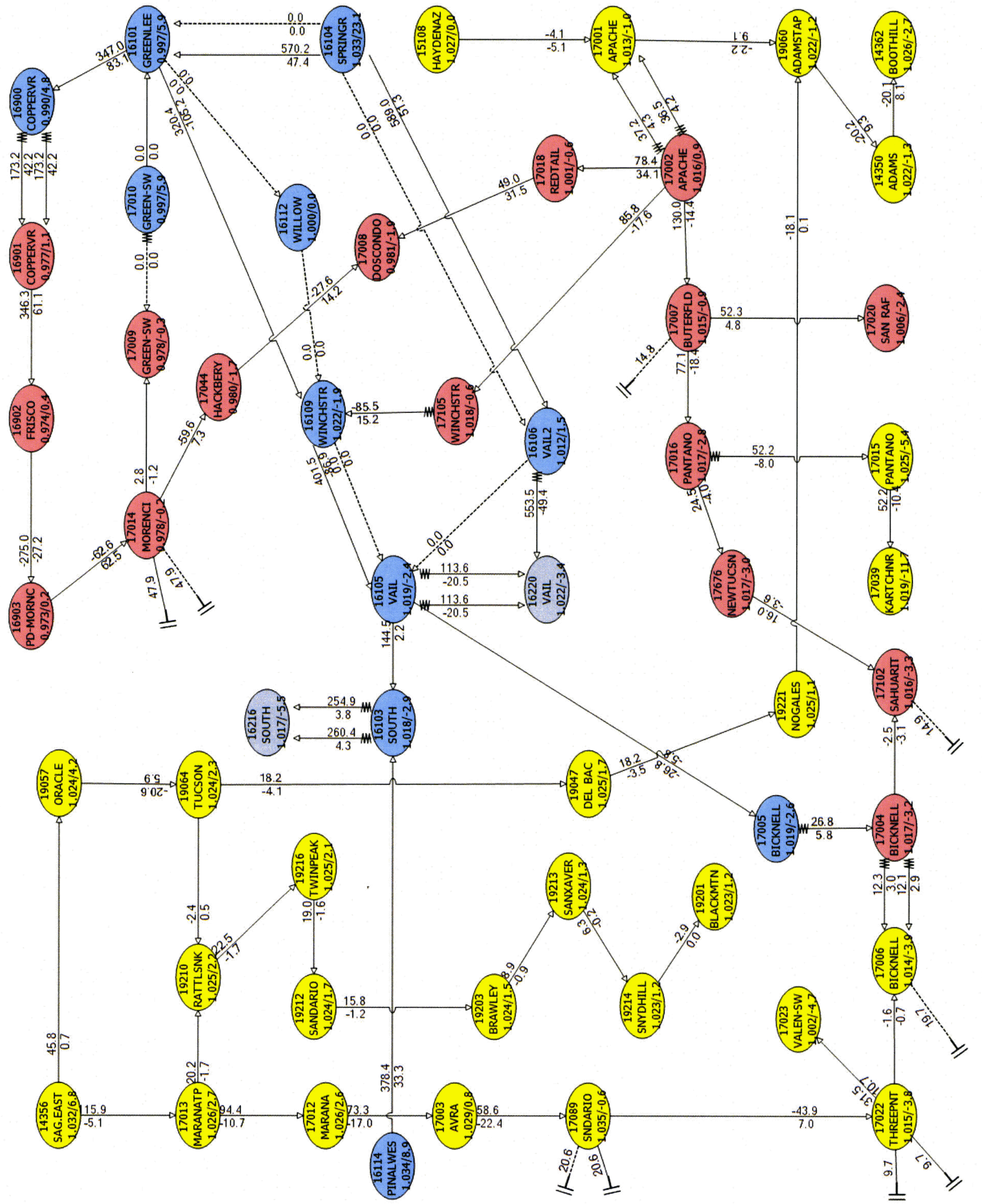
2016HS Southwest Transmission Cooperative Base System with Apache to Hayden 115 kV Line out of service



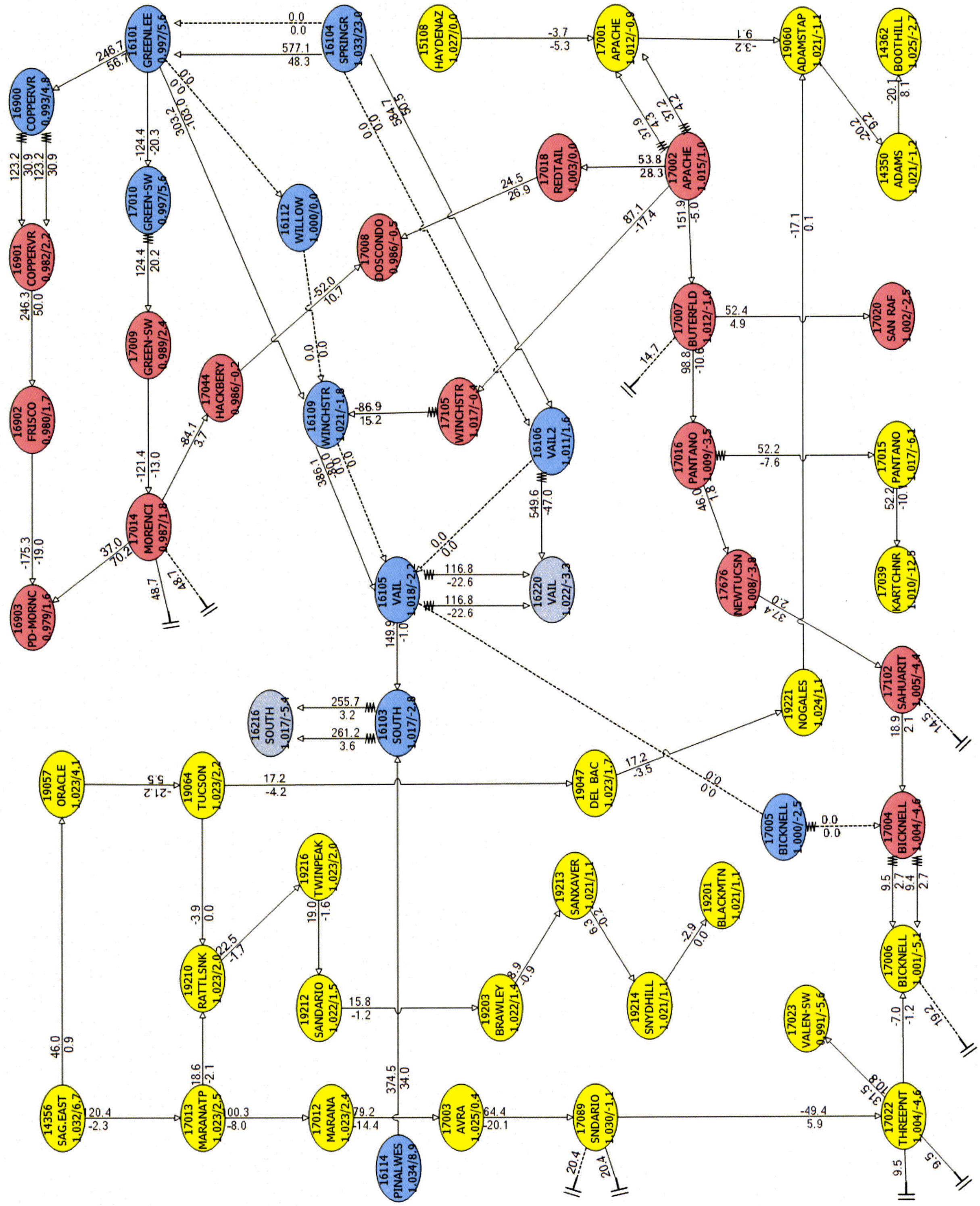
2016HS Southwest Transmission Cooperative Base System with Marana to Avra 115 kV Line out of service



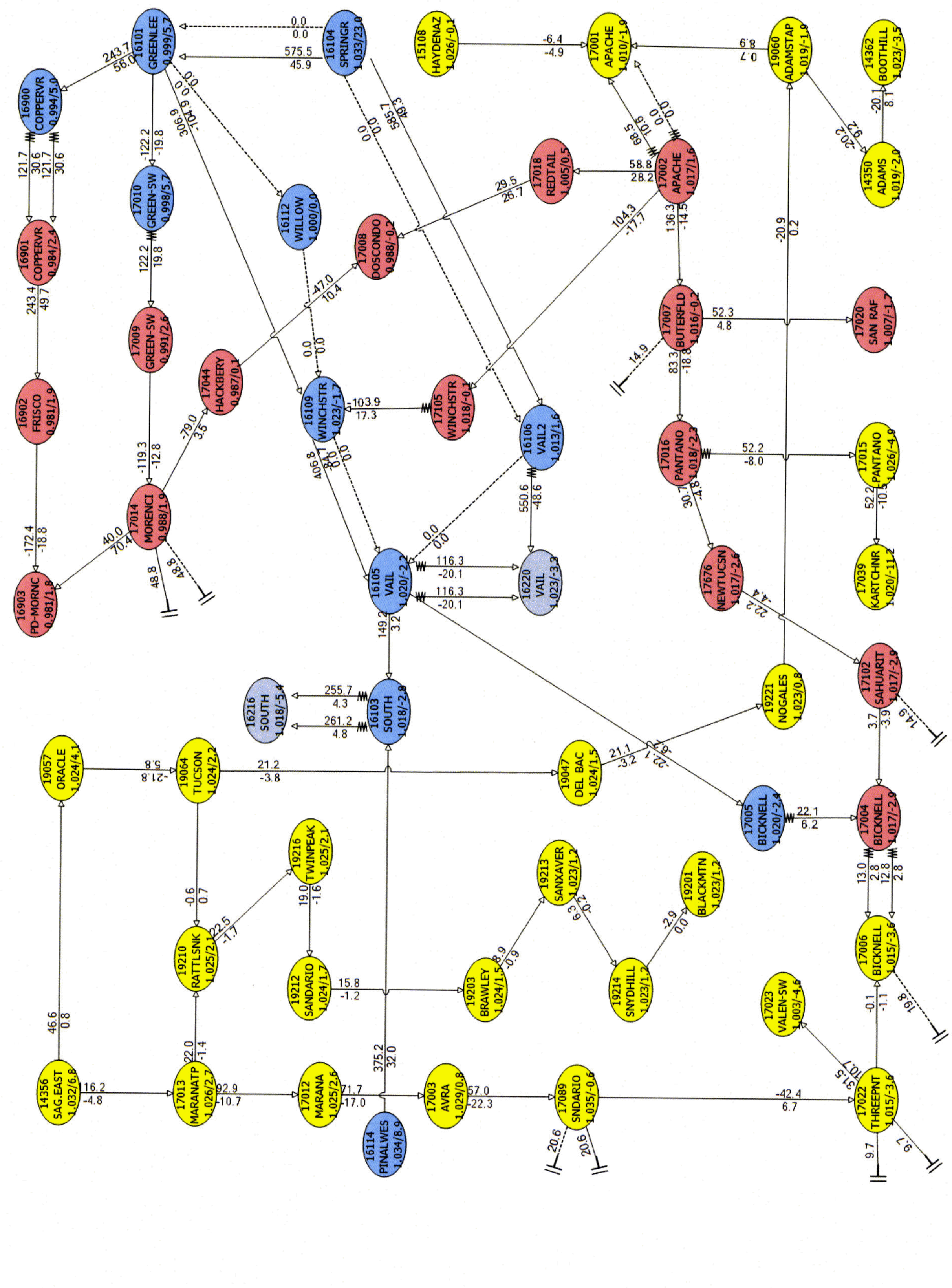
2016HS Southwest Transmission Cooperative Base System with Green-SW 345/230 kV Transformer out of service



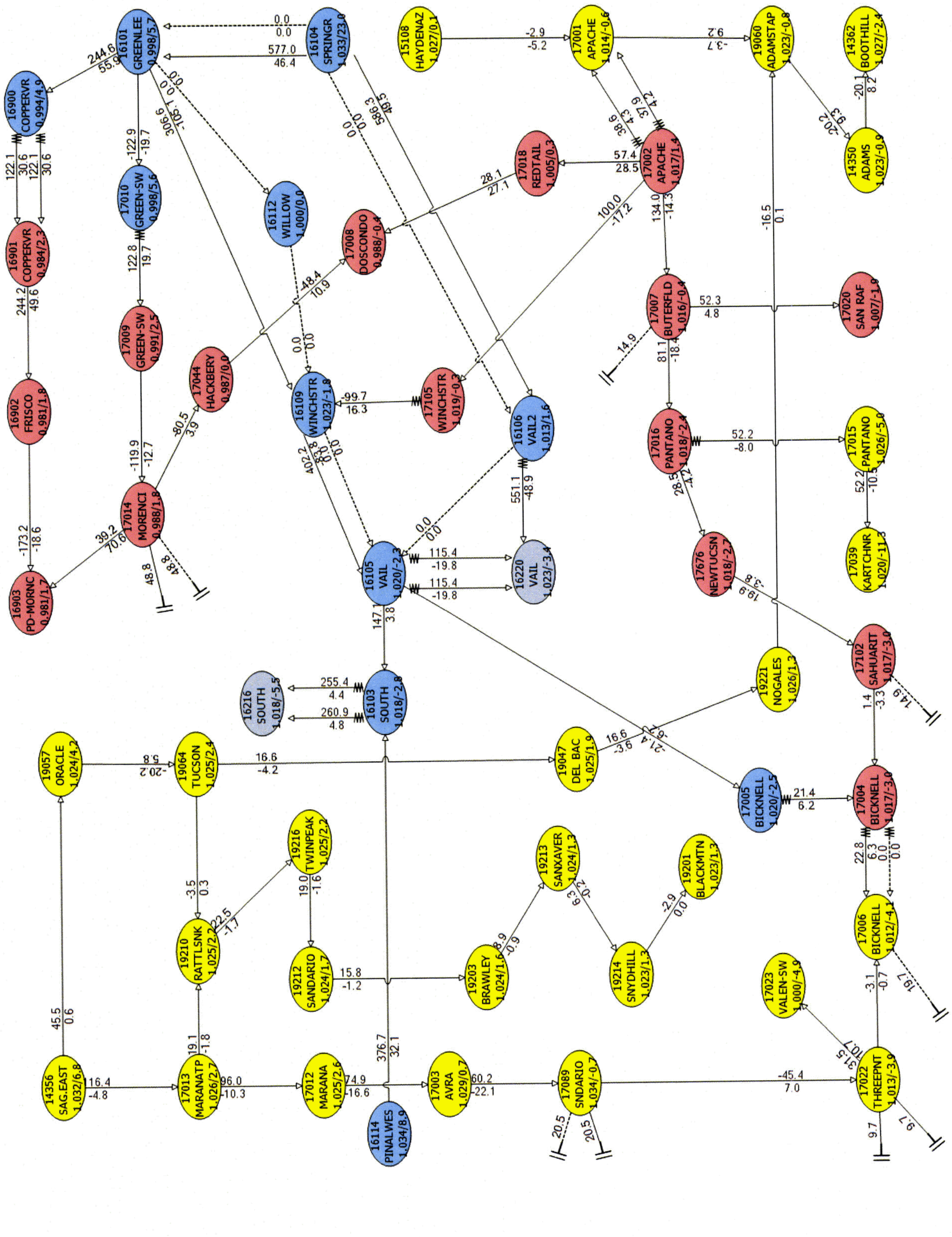
2016HS Southwest Transmission Cooperative Base System with Bicknell 345/230 kV Transformer out of service



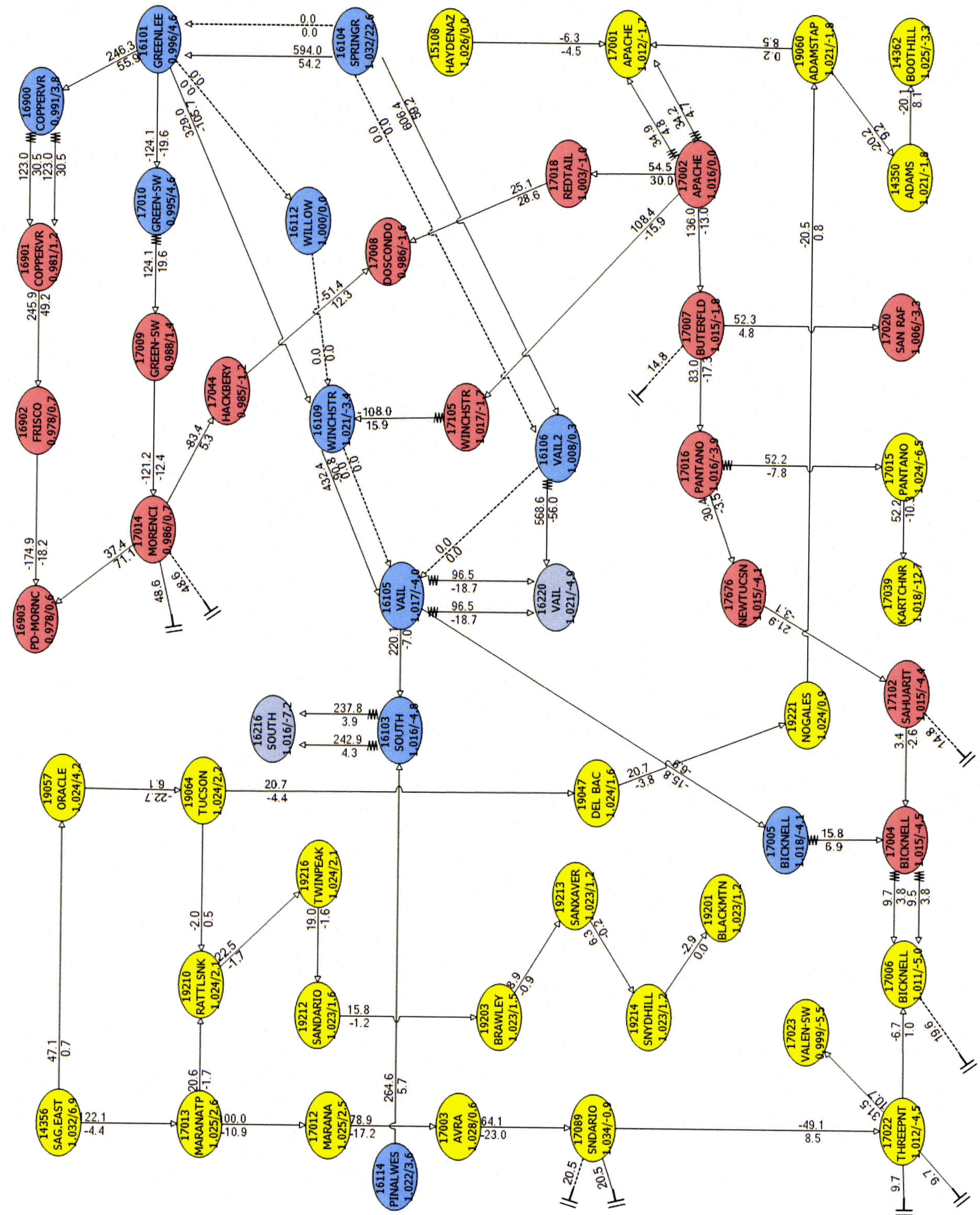
2016HS Southwest Transmission Cooperative Base System with one Apache 230/115 kV Transformer out of service



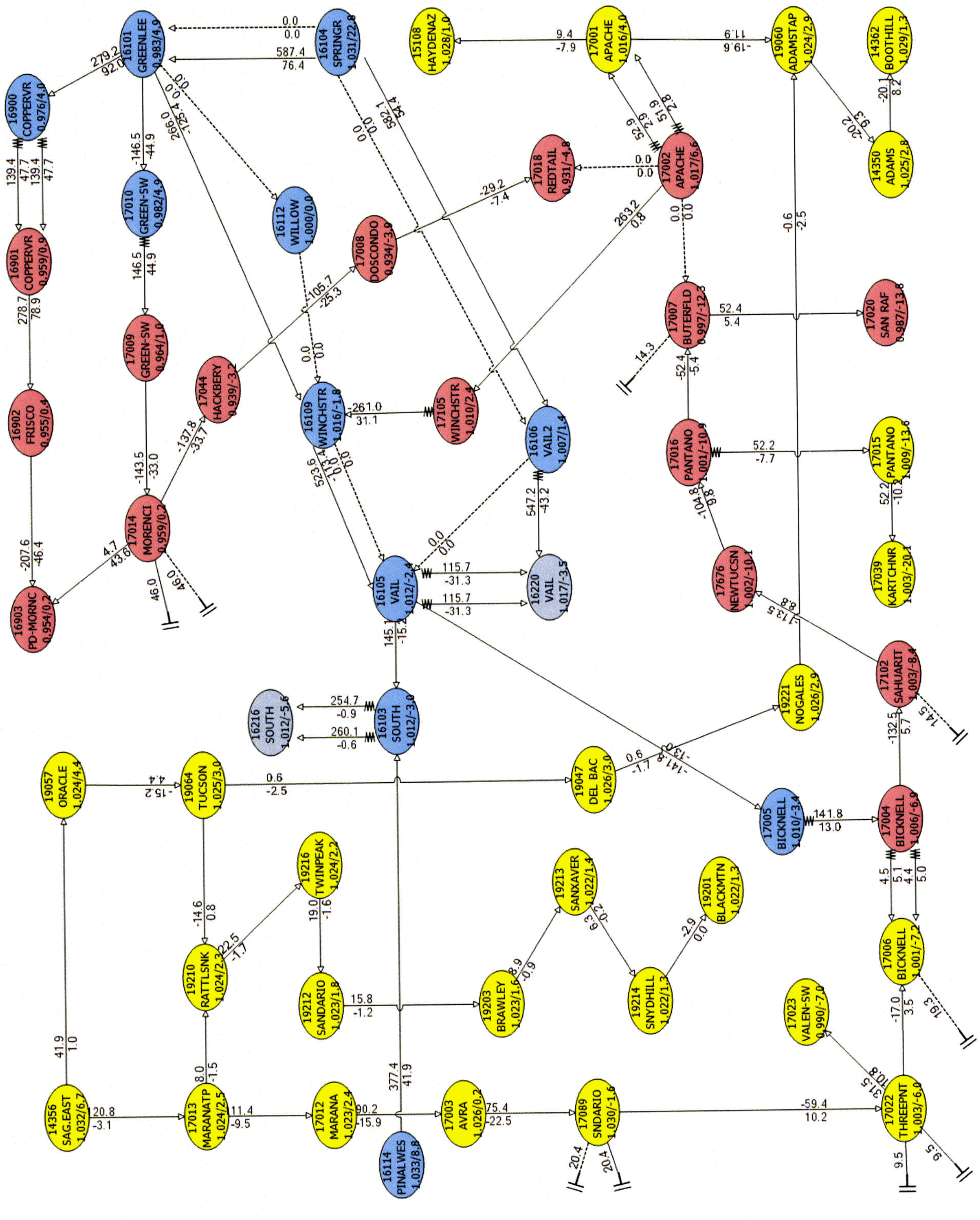
2016HS Southwest Transmission Cooperative Base System with one Bicknell 230/115 kV Transformer out of service



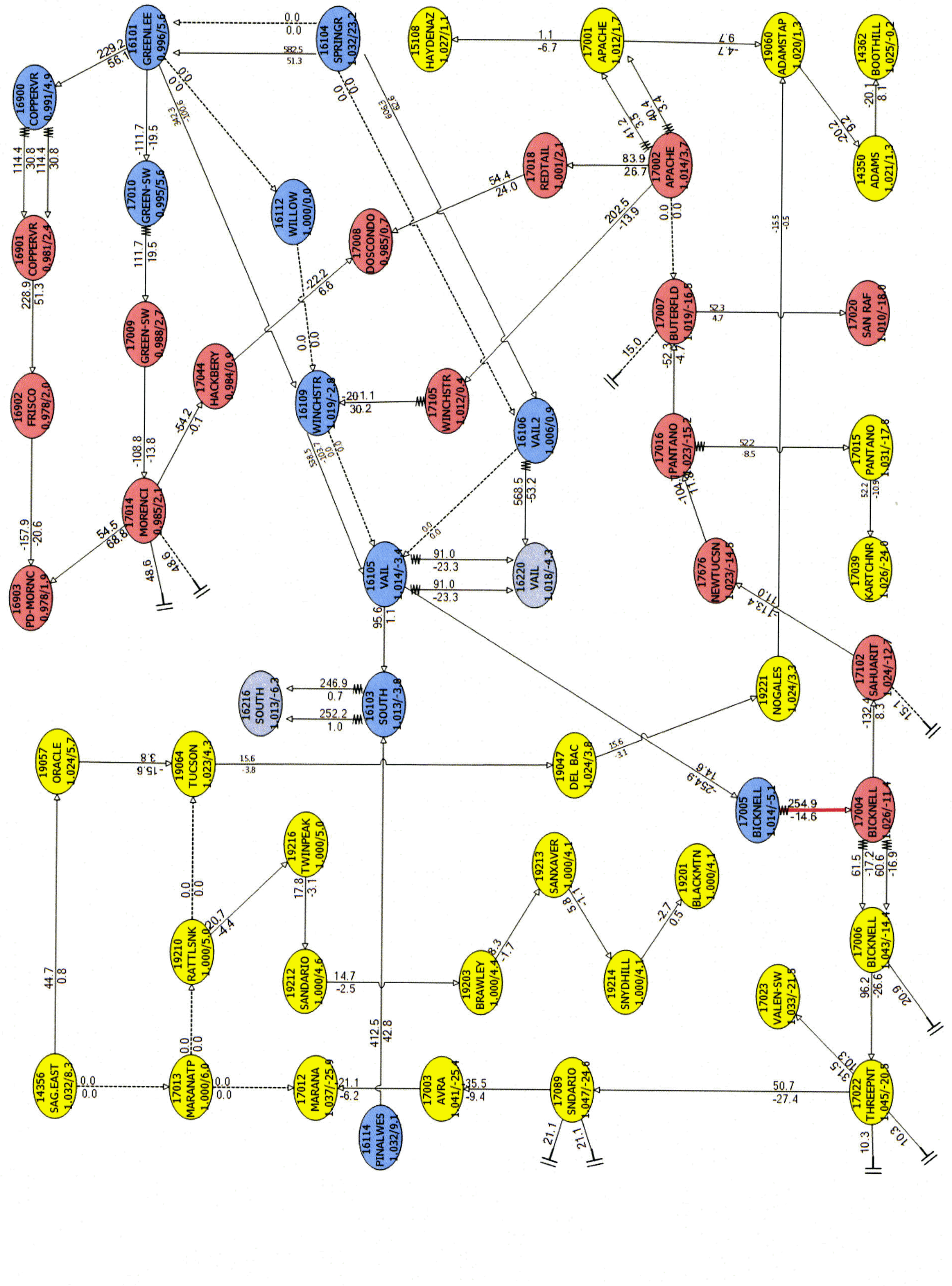
2016HS Southwest Transmission Cooperative Base System with Pinal West 500/345 kV Transformer out of service



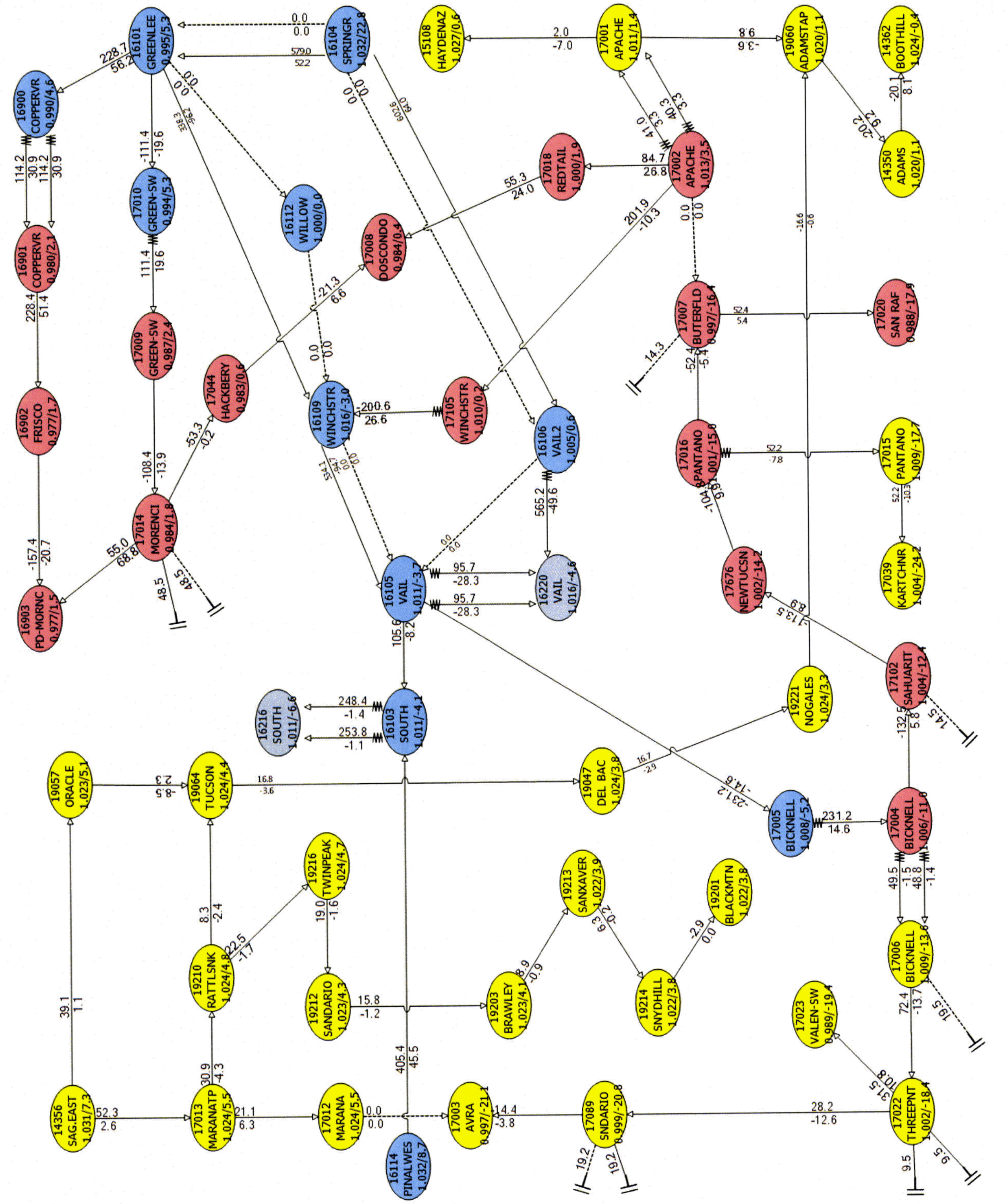
2016HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out followed by the Apache to Redtail 230 kV Line out of service



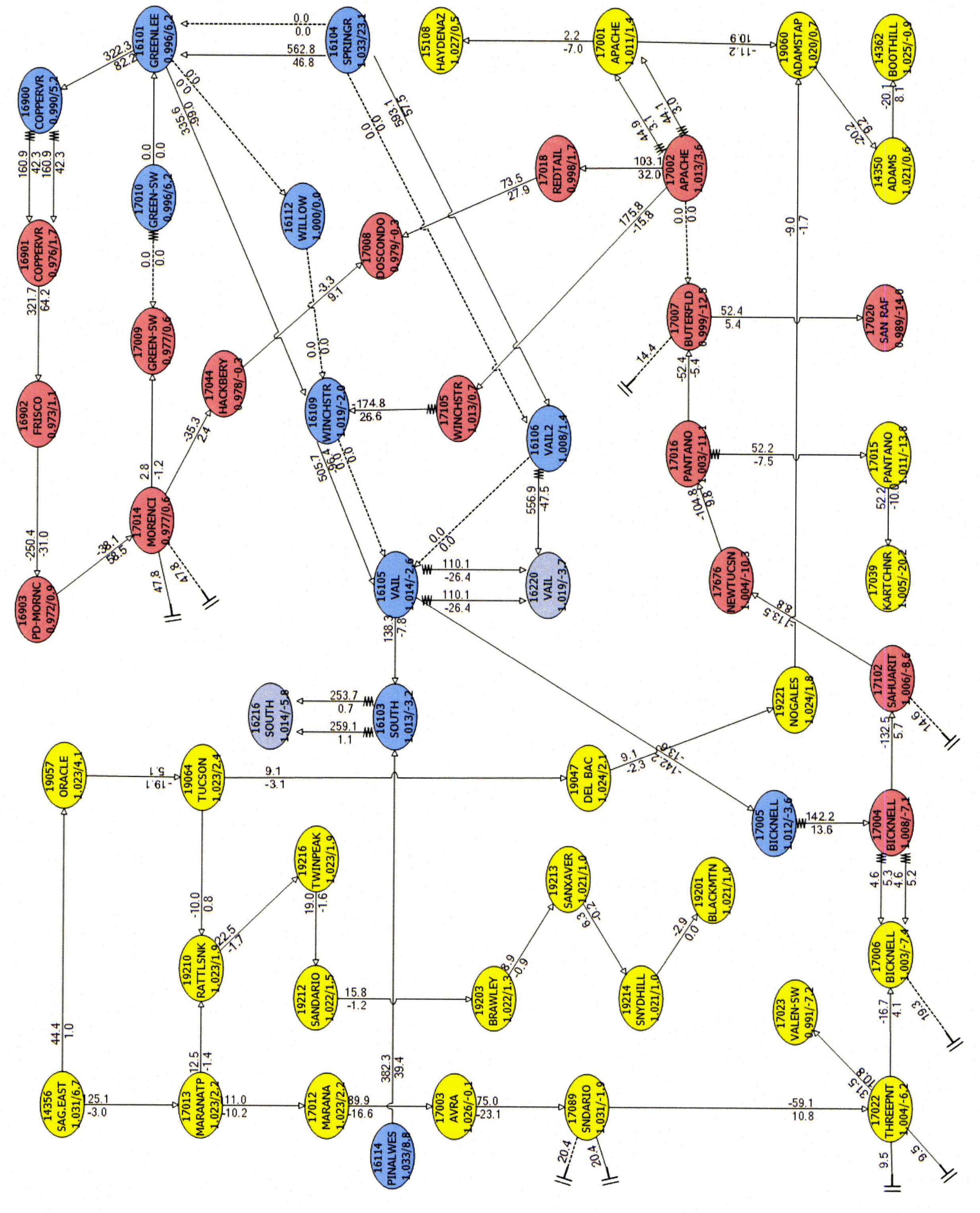
2016HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV out followed by the Saguaro East to Marana 115 kV Line out of service



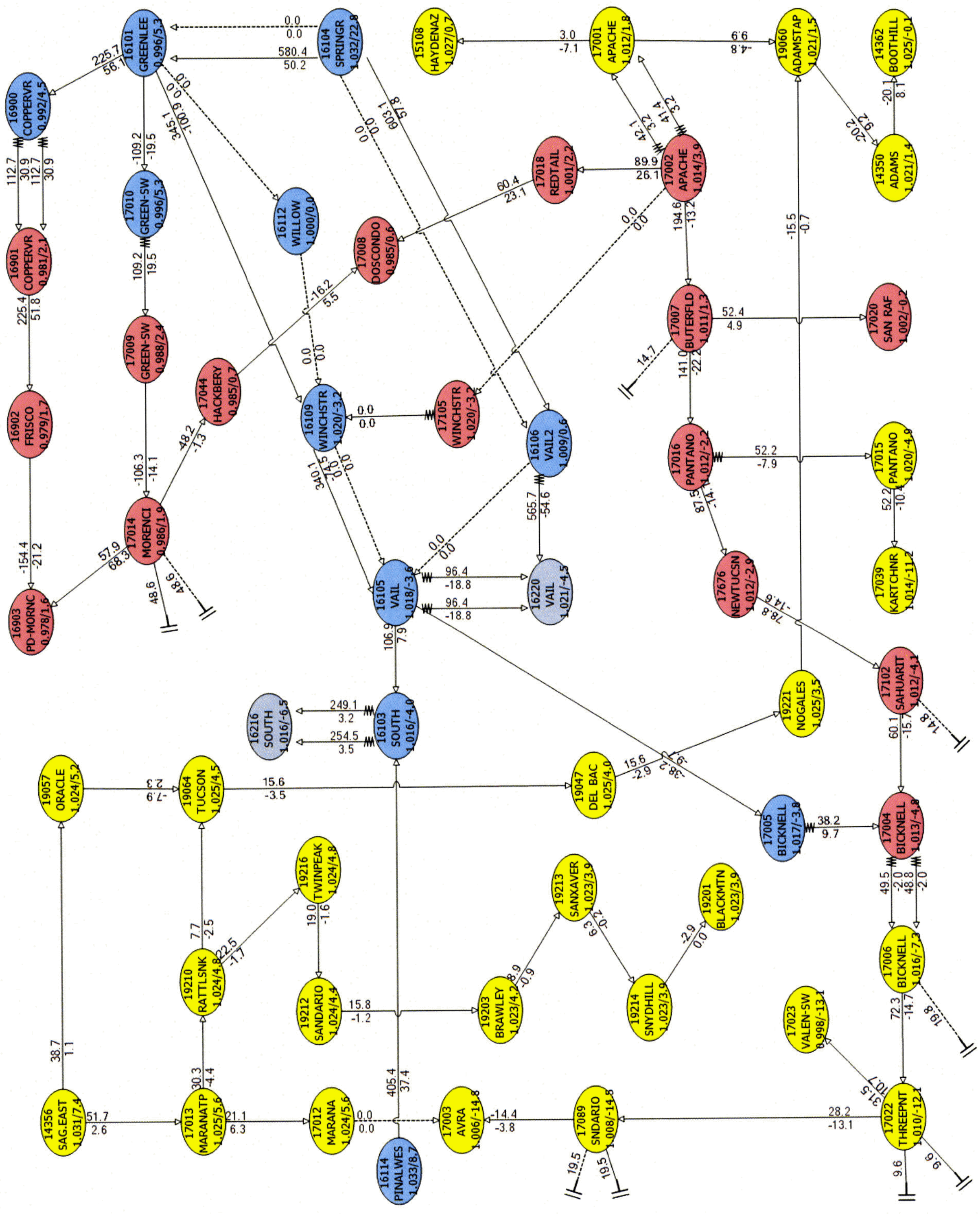
2016HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out followed by the Marana to Avra 115 kV Line out of service



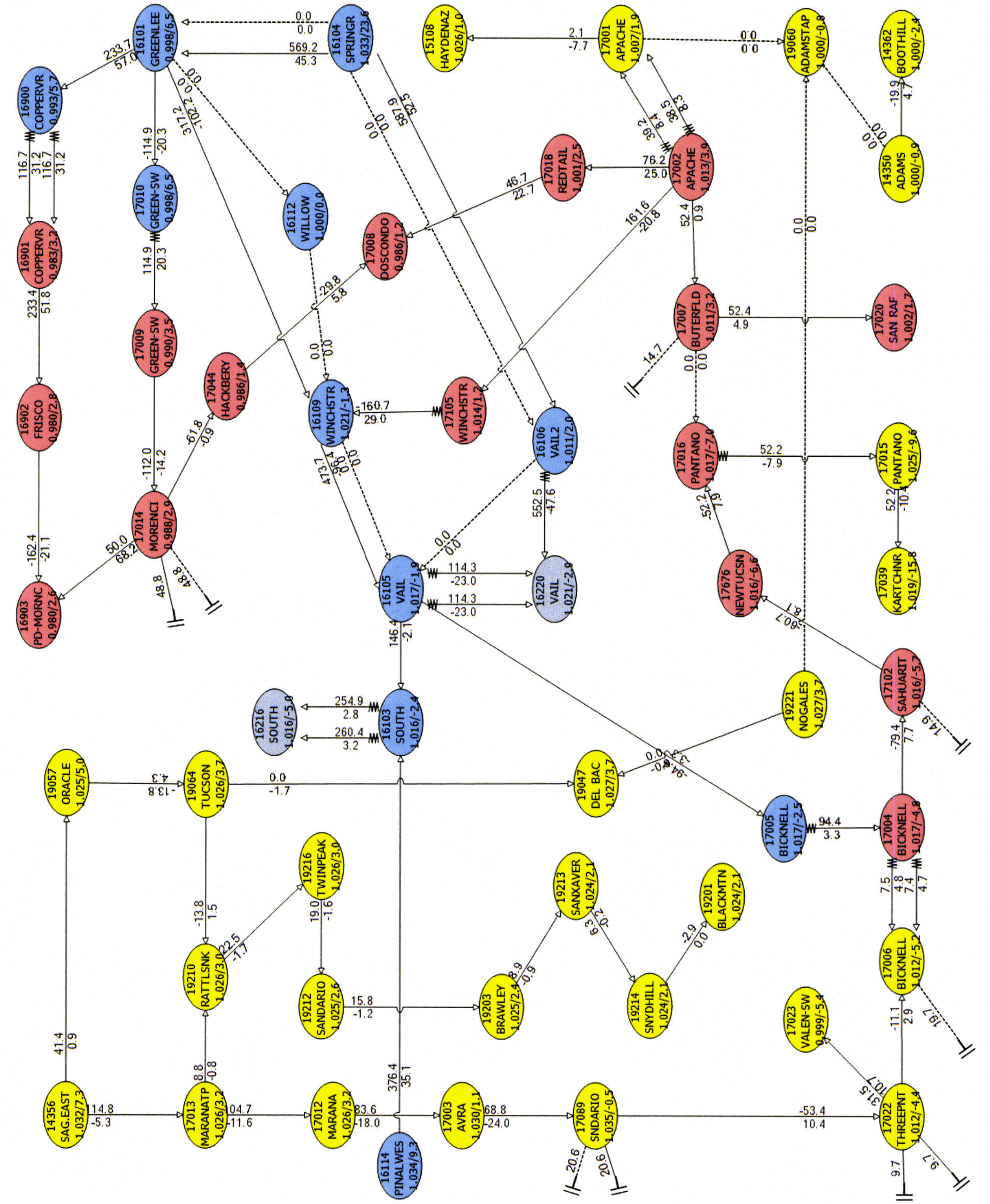
2016HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out followed by the Green-SW 345/230 kV Transformer out of service



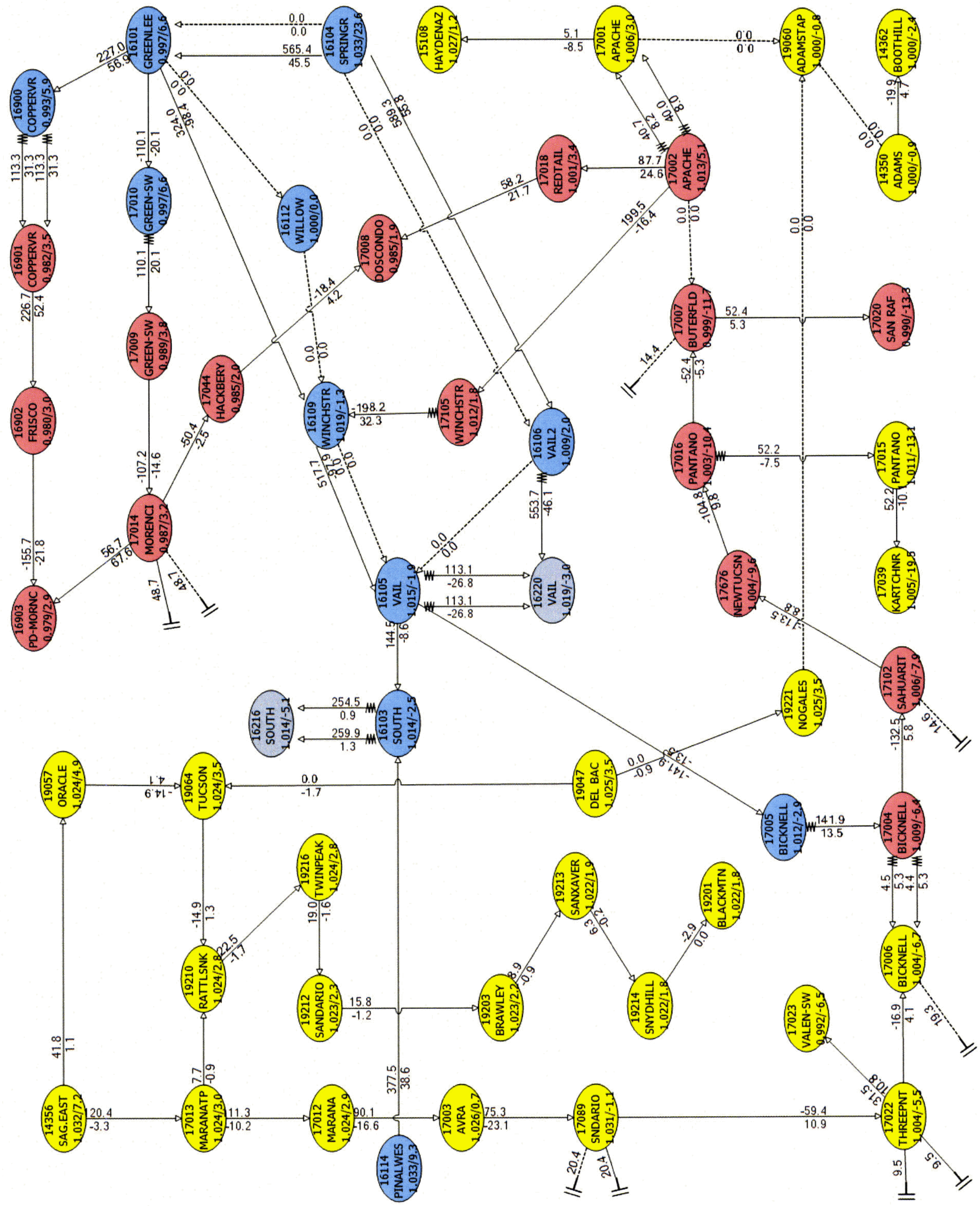
2016HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line out followed by the Marana to Avra 115 kV Line out of service



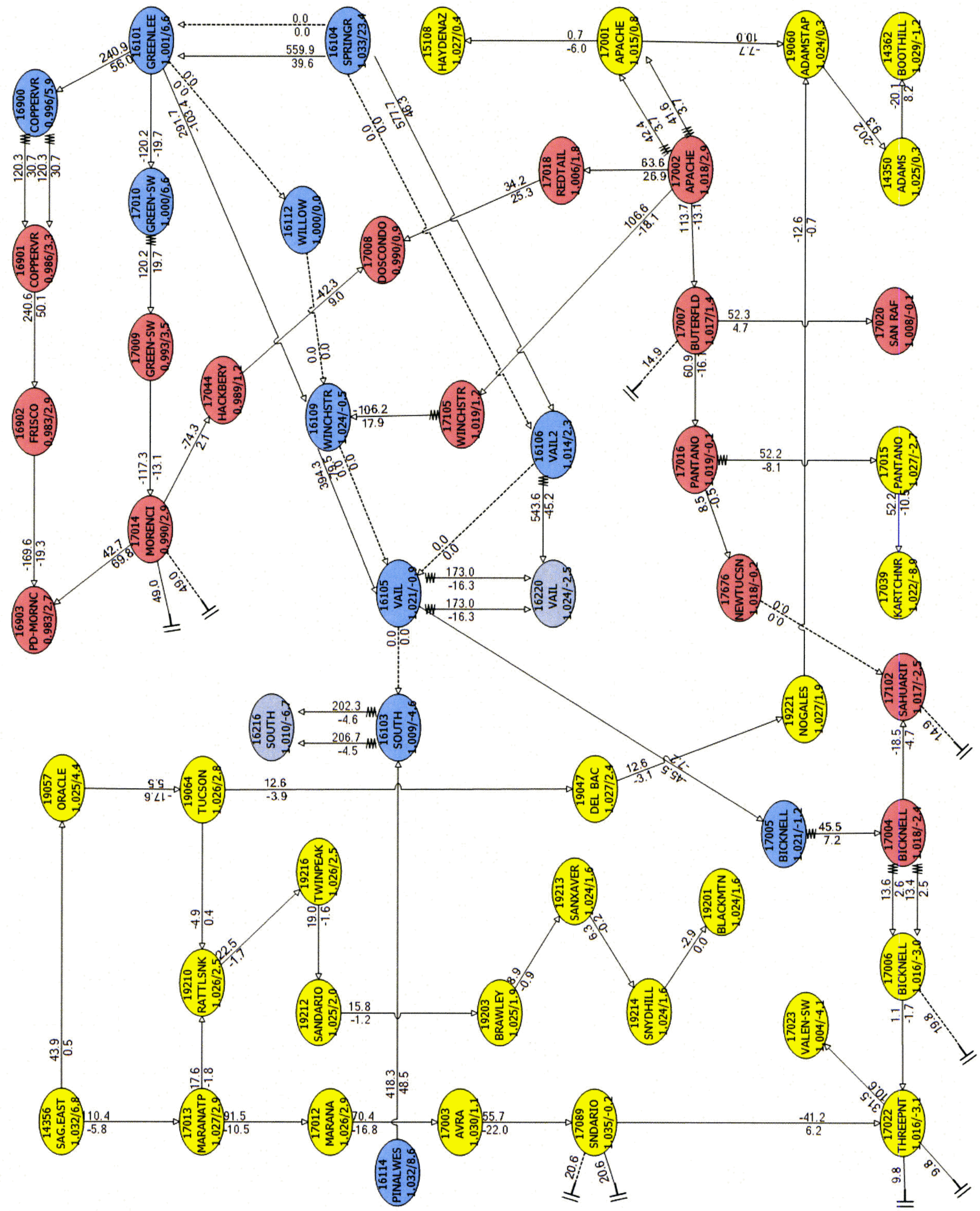
2016HS Southwest Transmission Cooperative Base System with Common Corridor outage of the Butterfield to Pantano 230 kV & Adams Tap to Apache 115 kV Lines



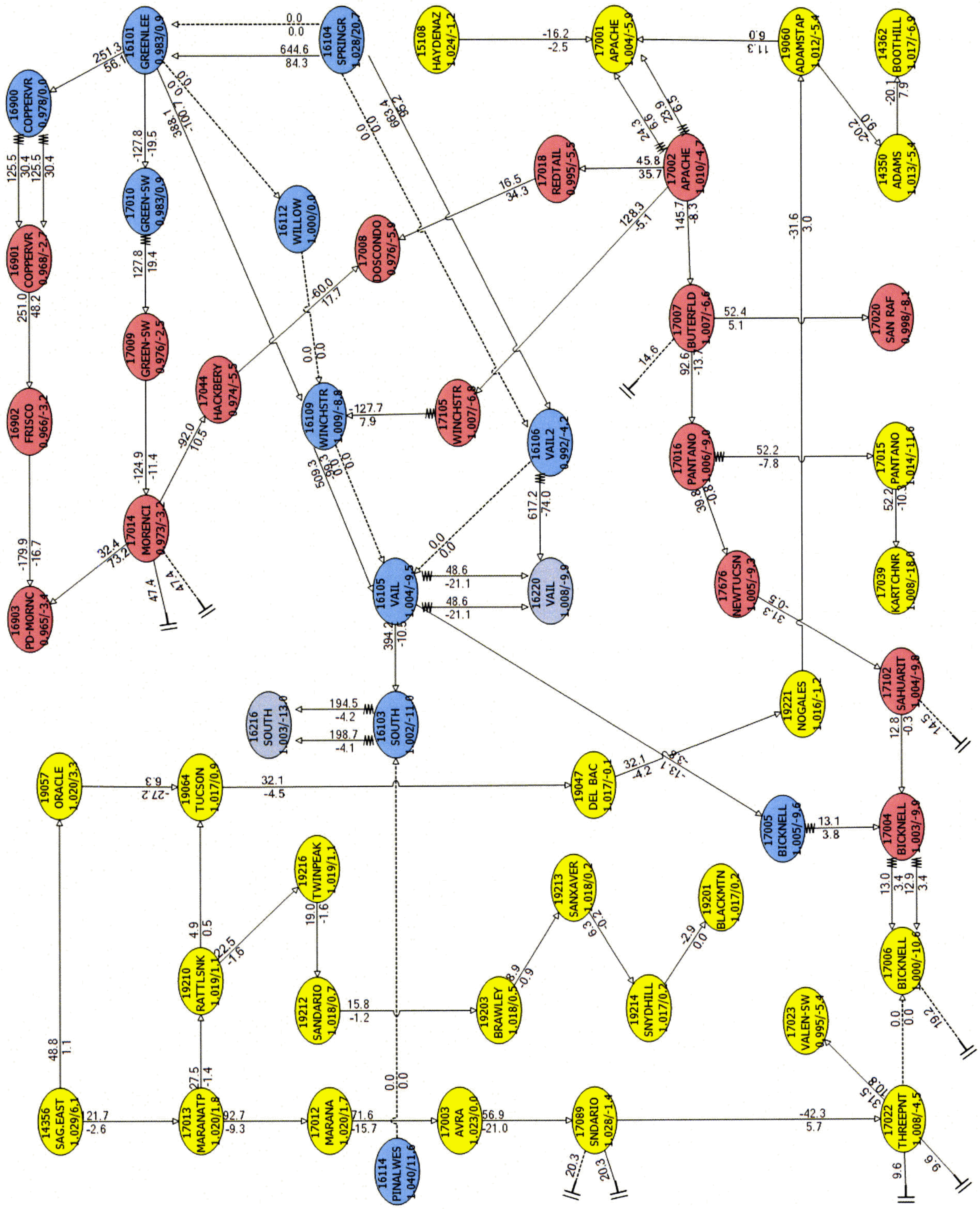
2016HS Southwest Transmission Cooperative Base System with Common Corridor outage of the Apache to Butterfield 230 kV & Adams Tap to Apache 115 kV Lines



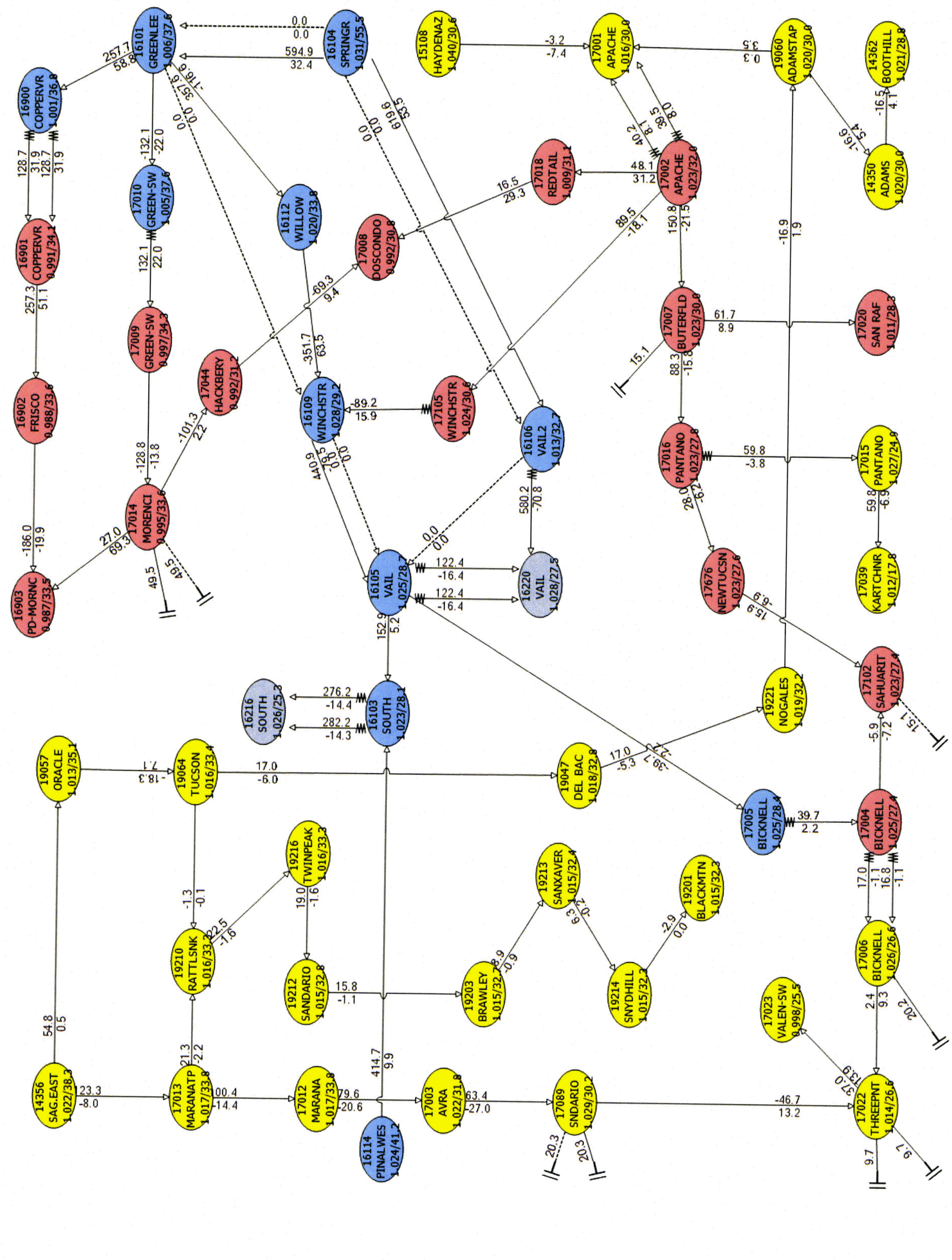
2016HS Southwest Transmission Cooperative Base System with Common Corridor outage of the Vail to South 345 kV & New Tucson to Sahuarita 230 kV Lines



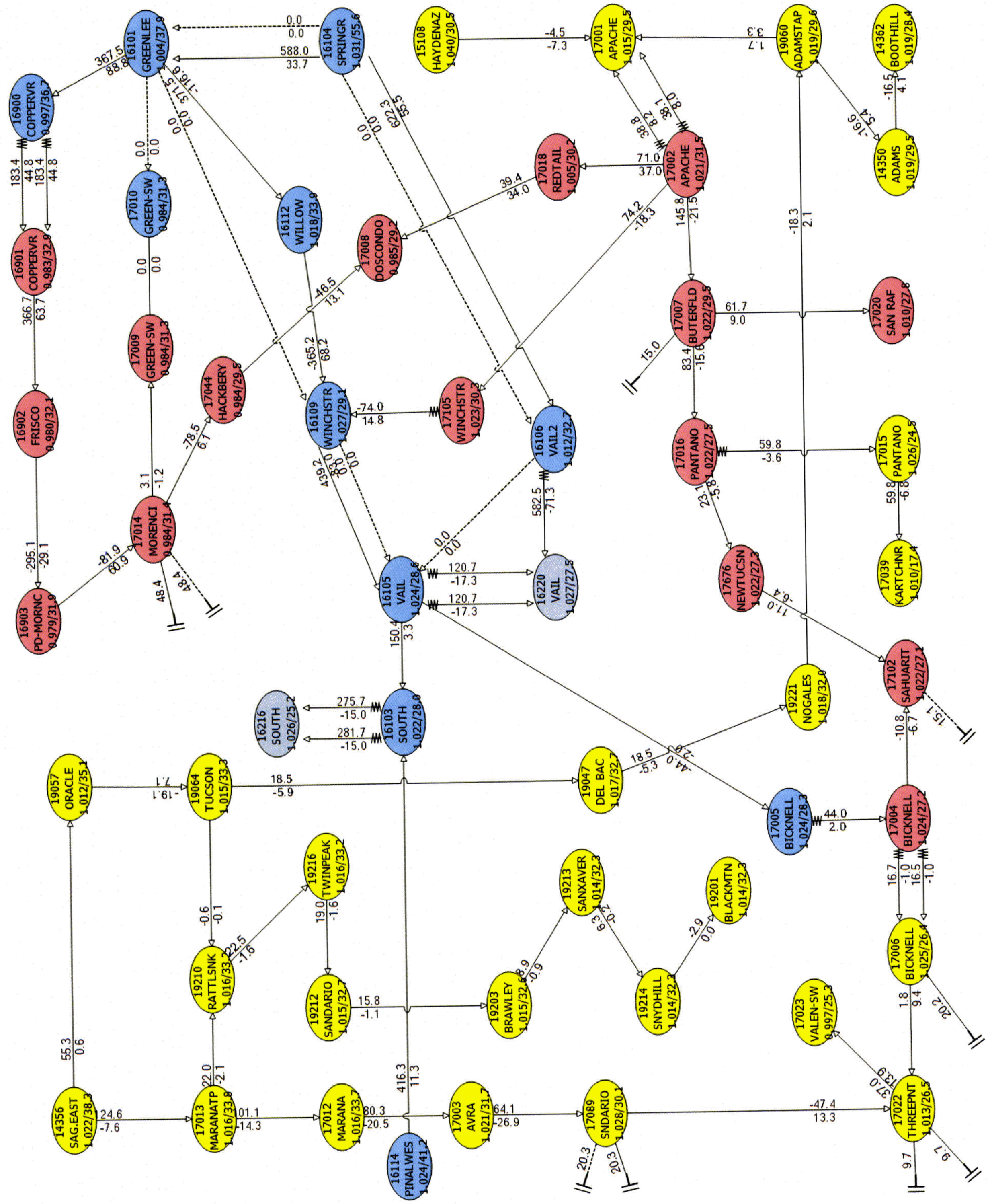
2016HS Southwest Transmission Cooperative Base System with Common Corridor outage of the Pinal West to South 345 kV and Bicknell to Three Points 115 kV Lines



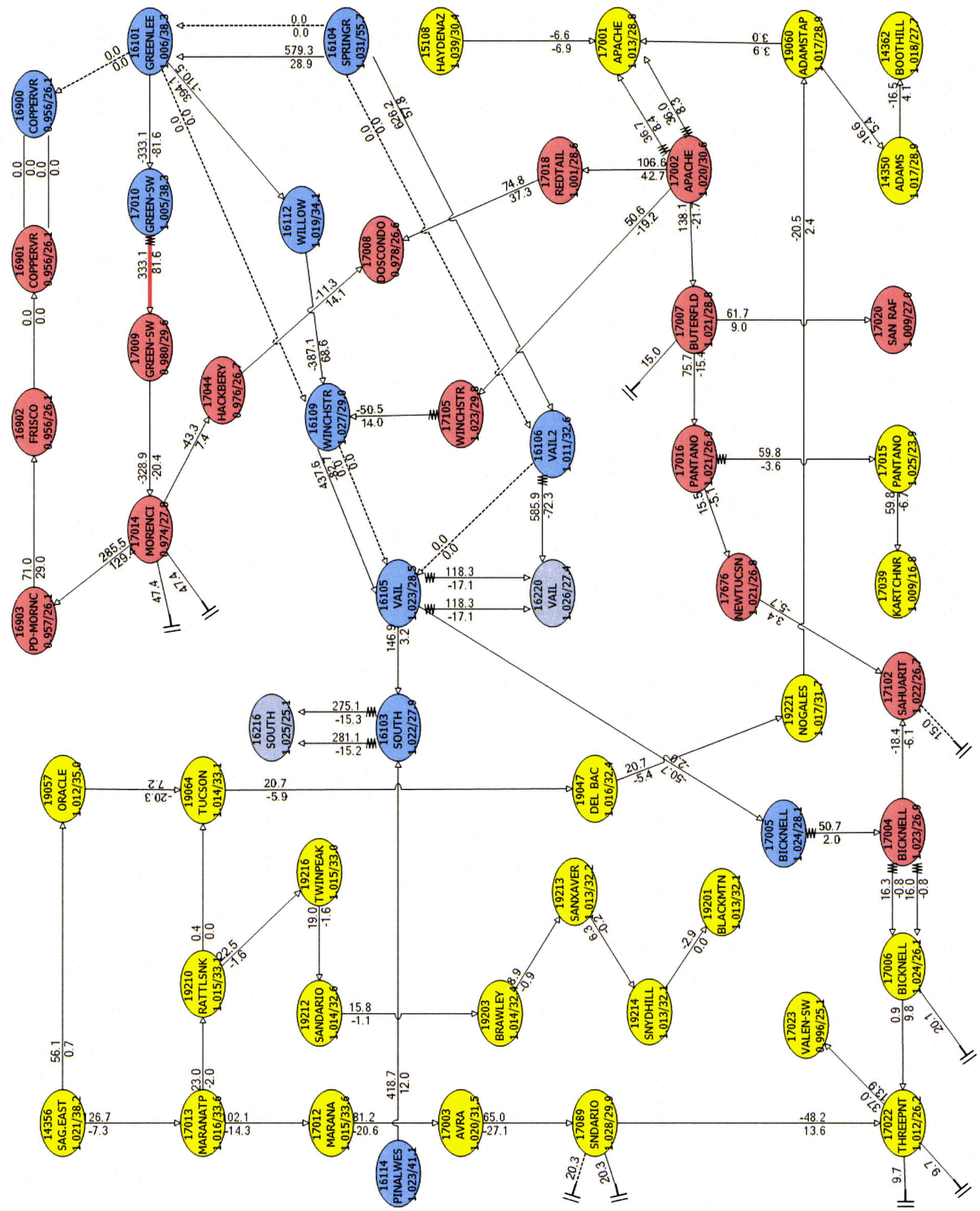
2020HS Southwest Transmission Cooperative Base System



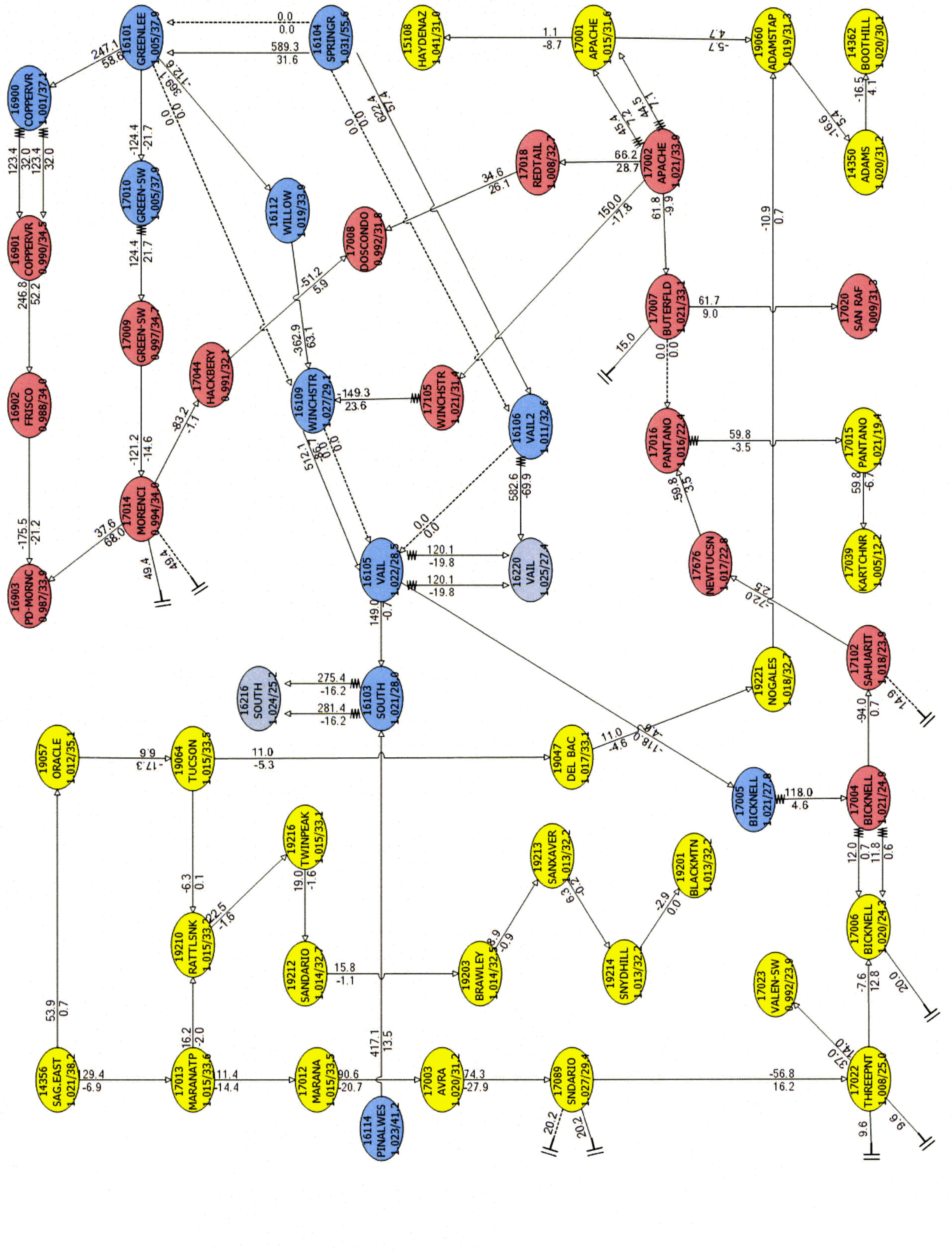
2020HS Southwest Transmission Cooperative Base System with Green-SW to Greenlee 345 kV Line out of service



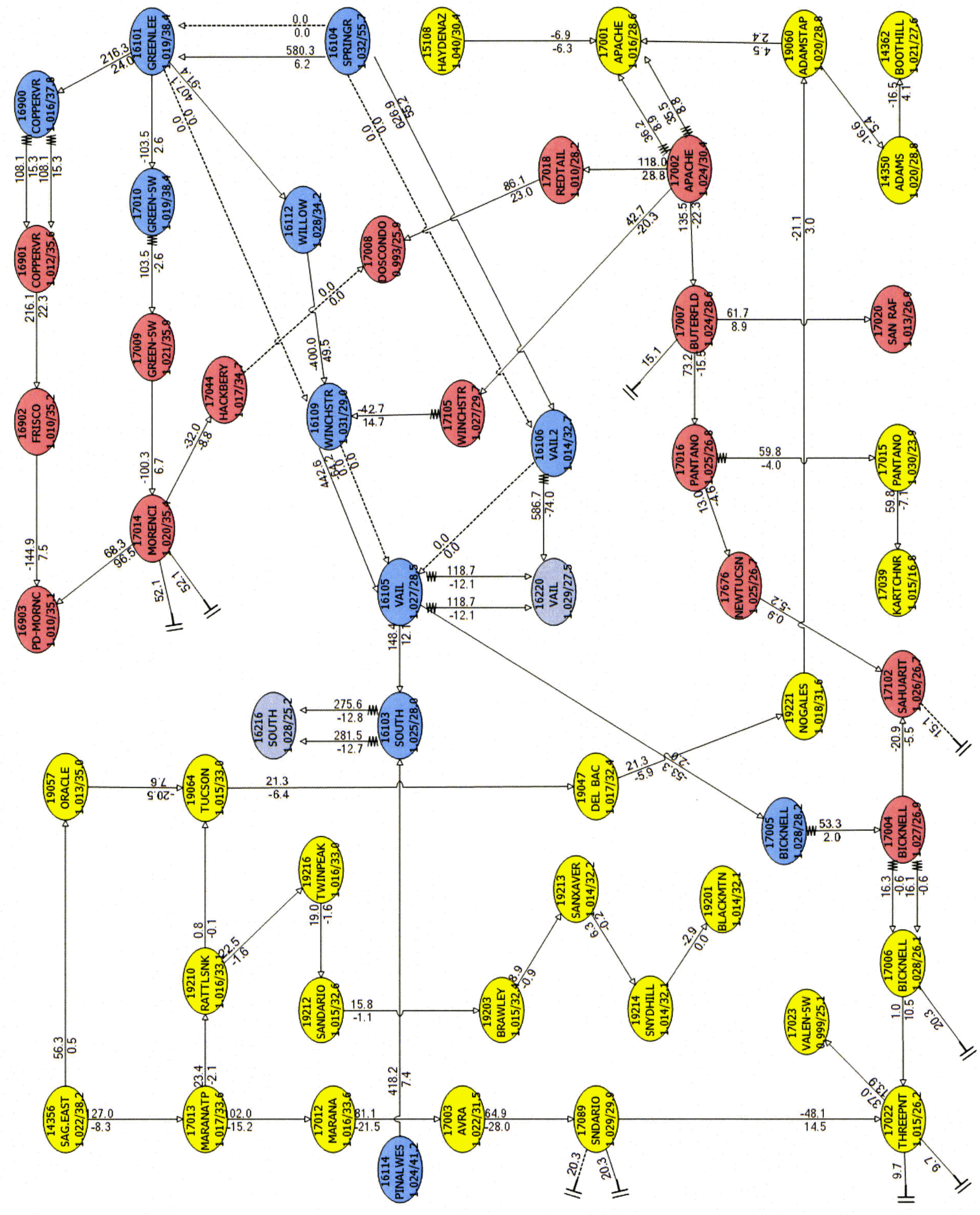
2020HS Southwest Transmission Cooperative Base System with Greenlee to Copper Verde 345 kV Line out of service



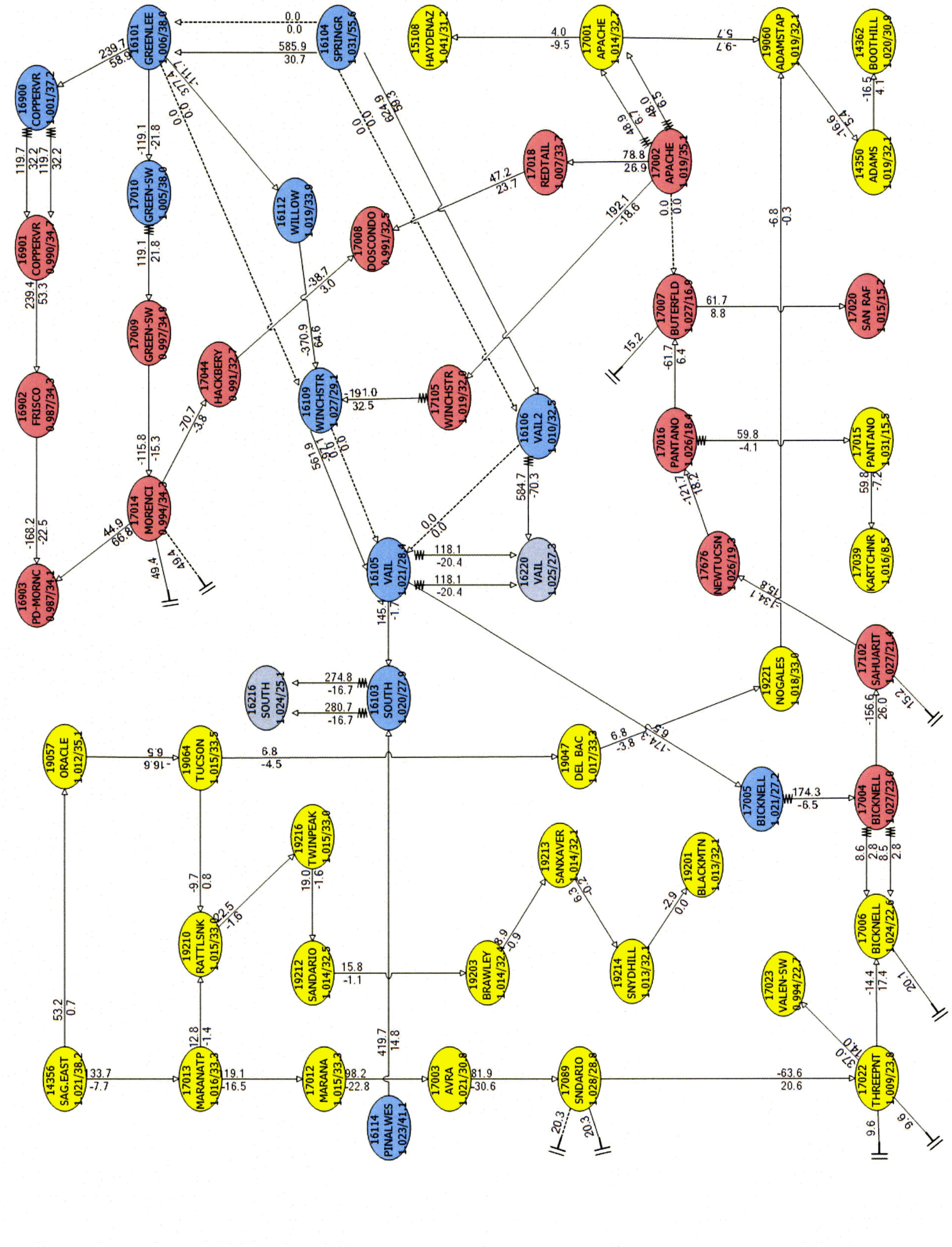
2020HS Southwest Transmission Cooperative Base System with Butterfield to Pantano 230 kV Line out of service



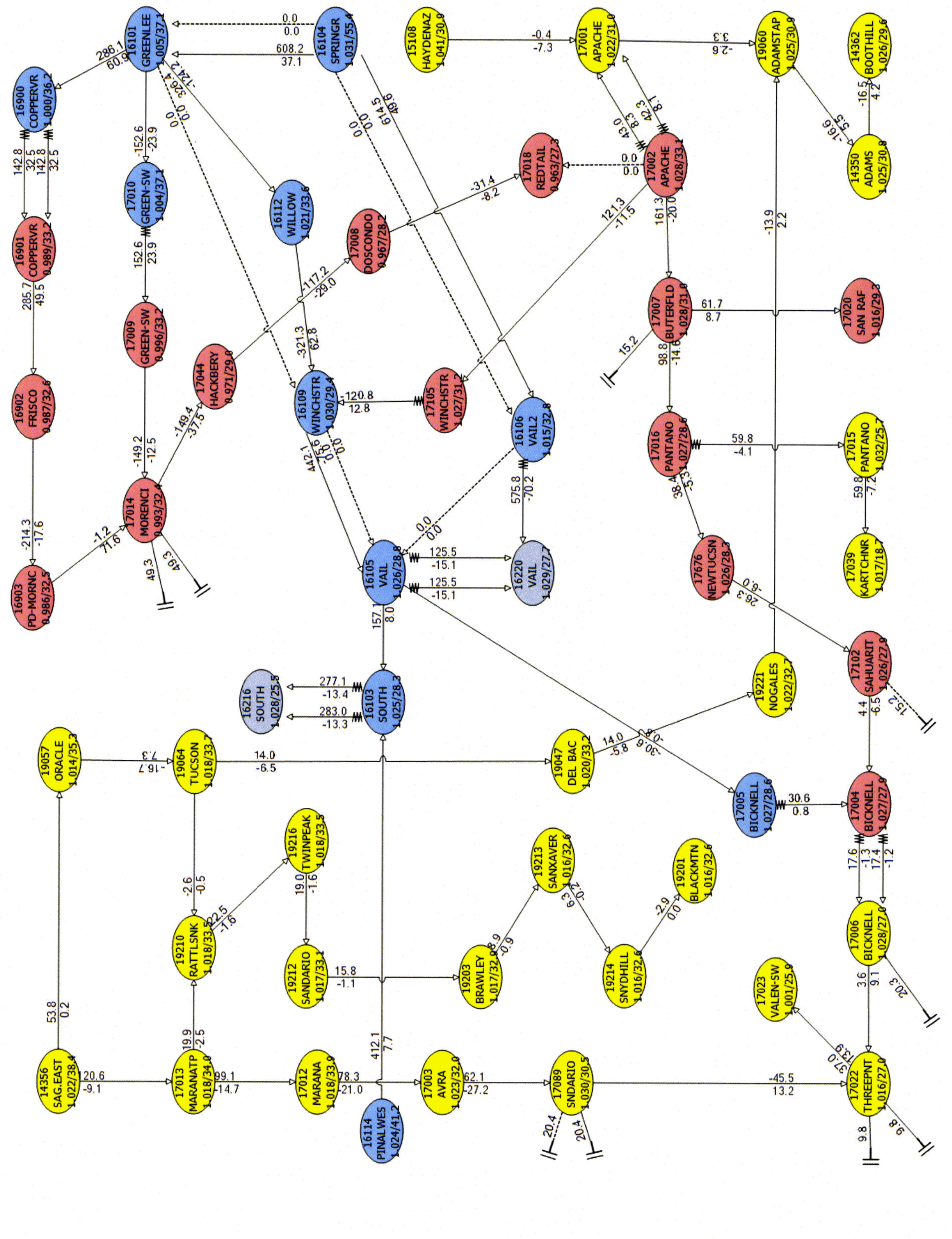
2020HS Southwest Transmission Cooperative Base System with Dos Condados to Hackberry 230 kV Line out of service



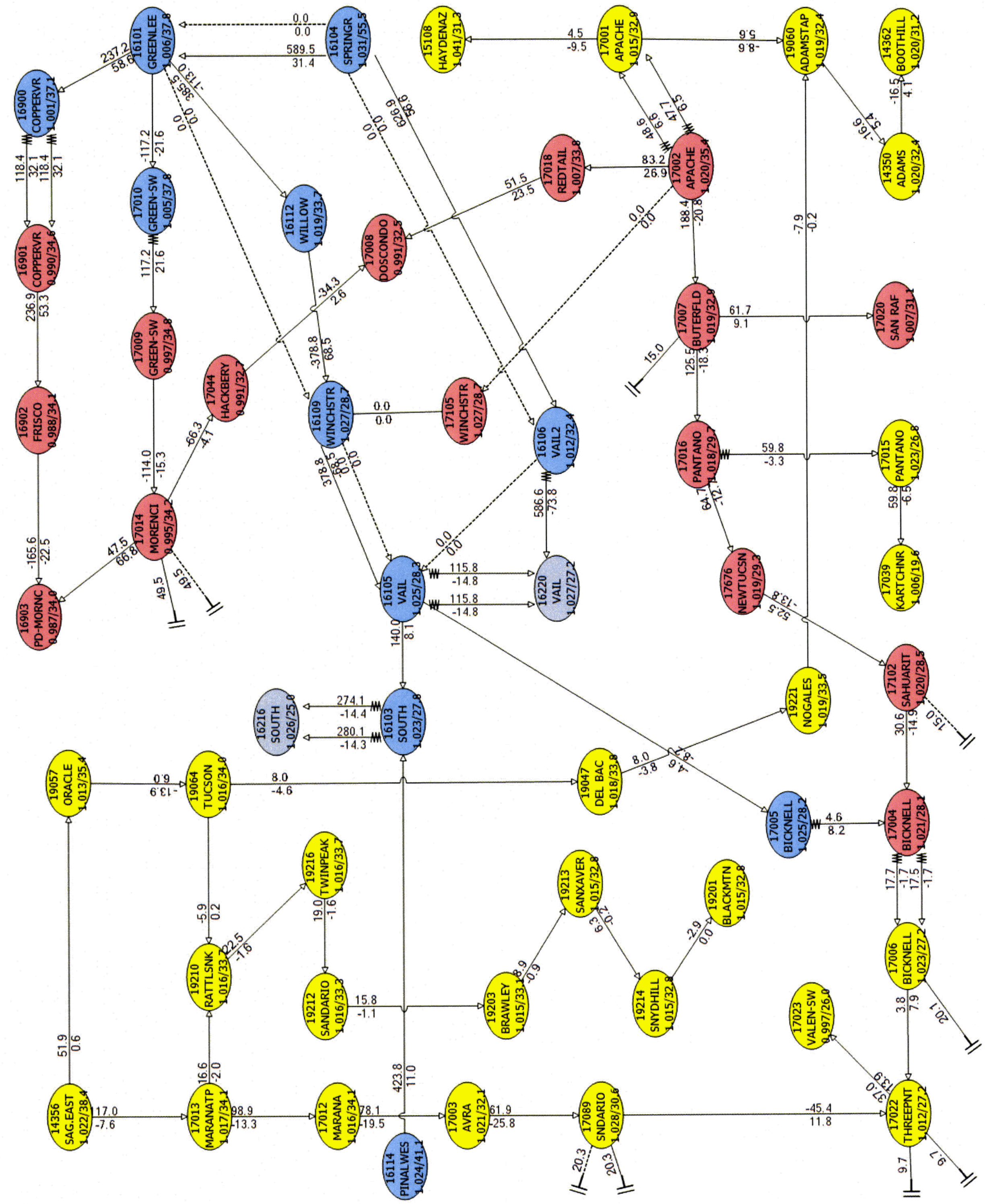
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out of service



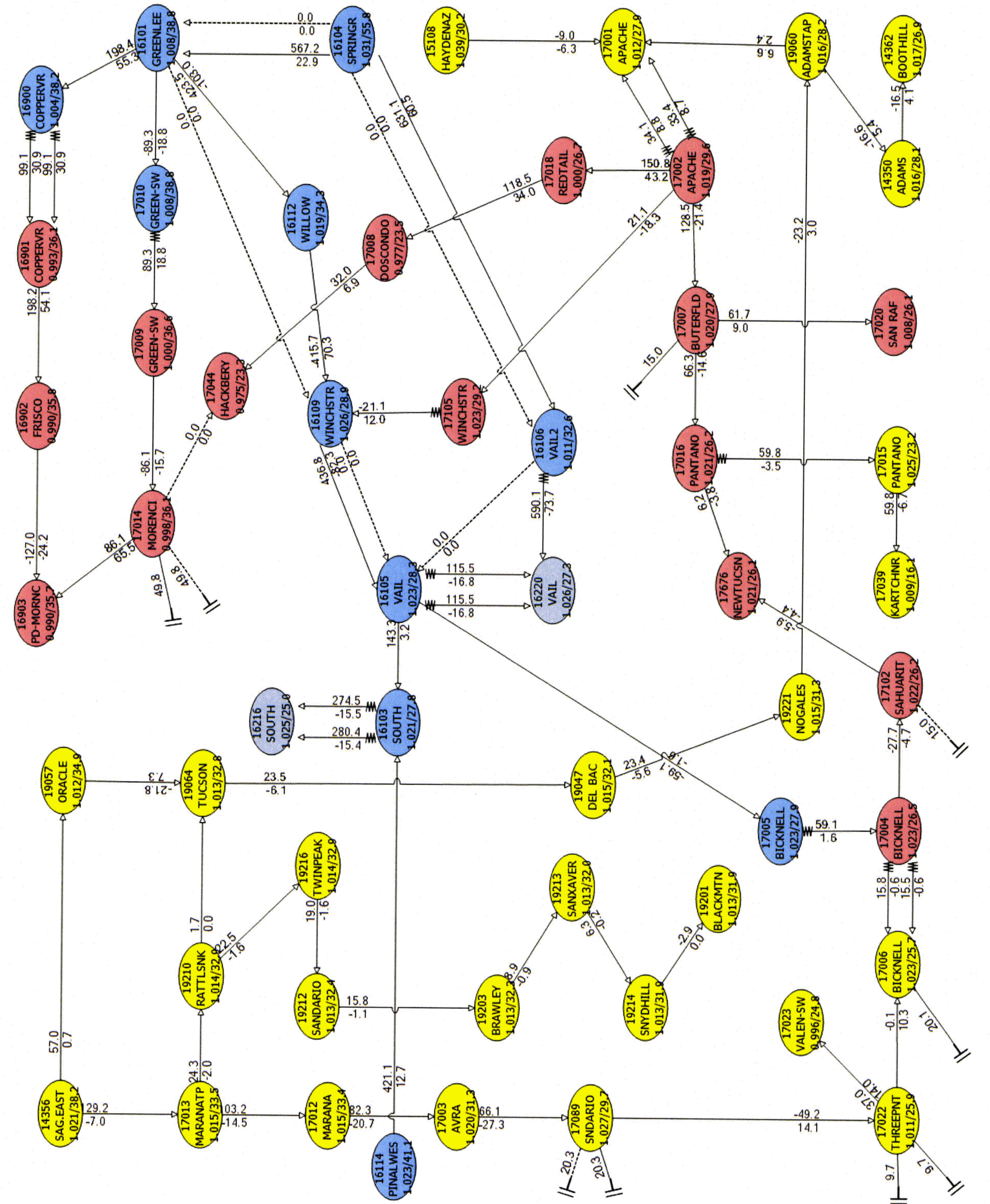
2020HS Southwest Transmission Cooperative Base System with Apache to Redtail 230 kV Line out of service



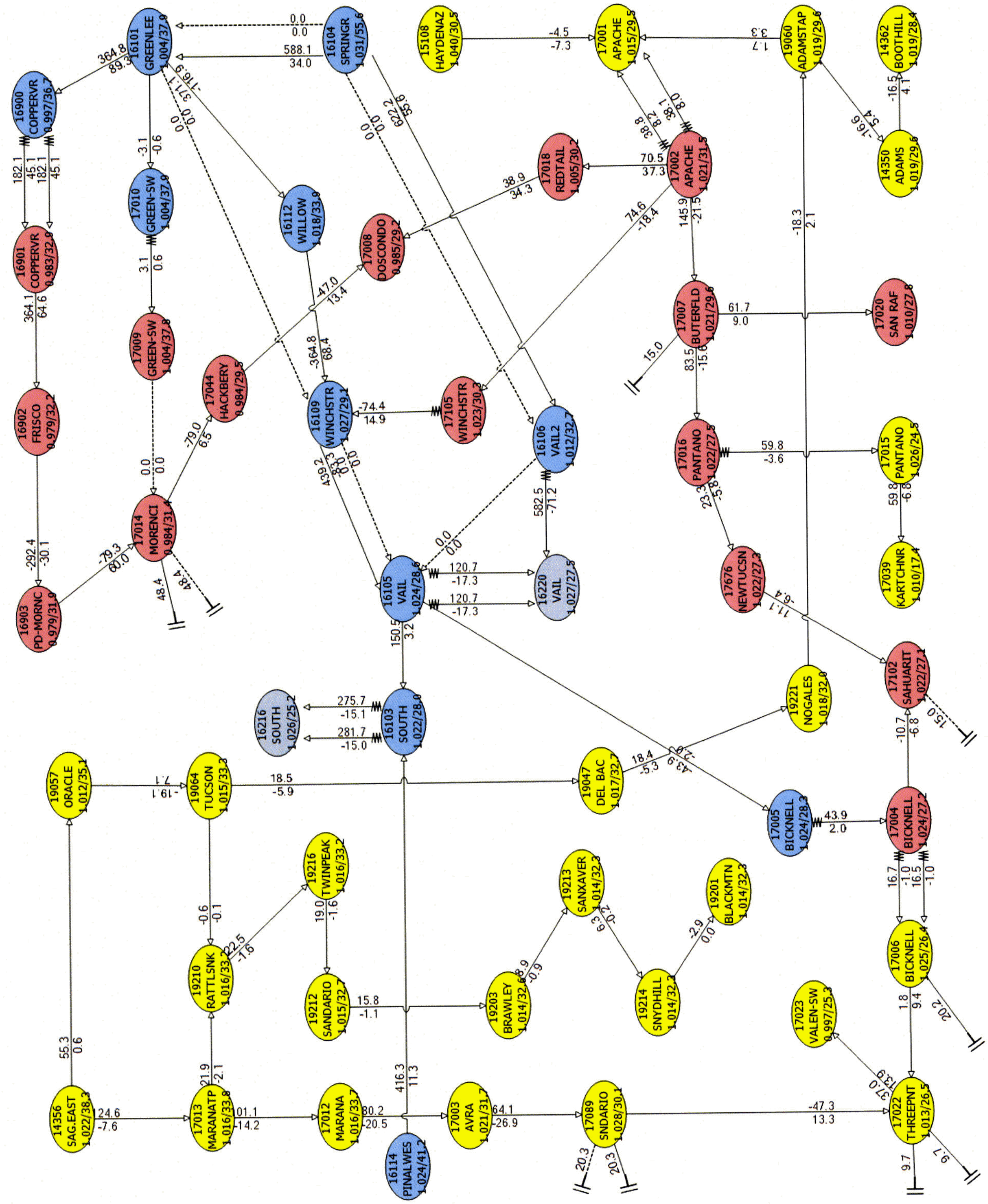
2020HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line out of service



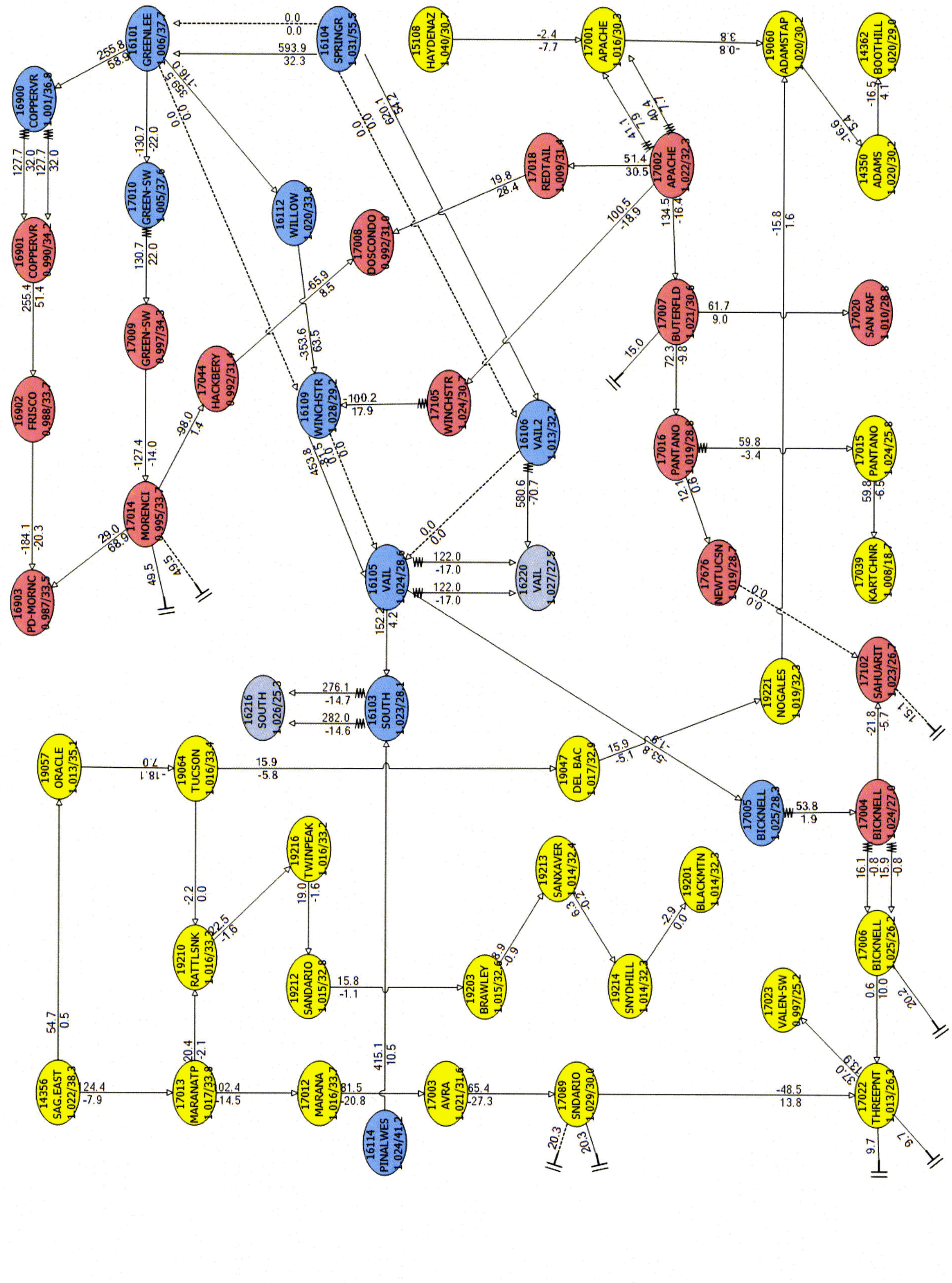
2020HS Southwest Transmission Cooperative Base System with Hackberry to Morenci 230 kV Line out of service



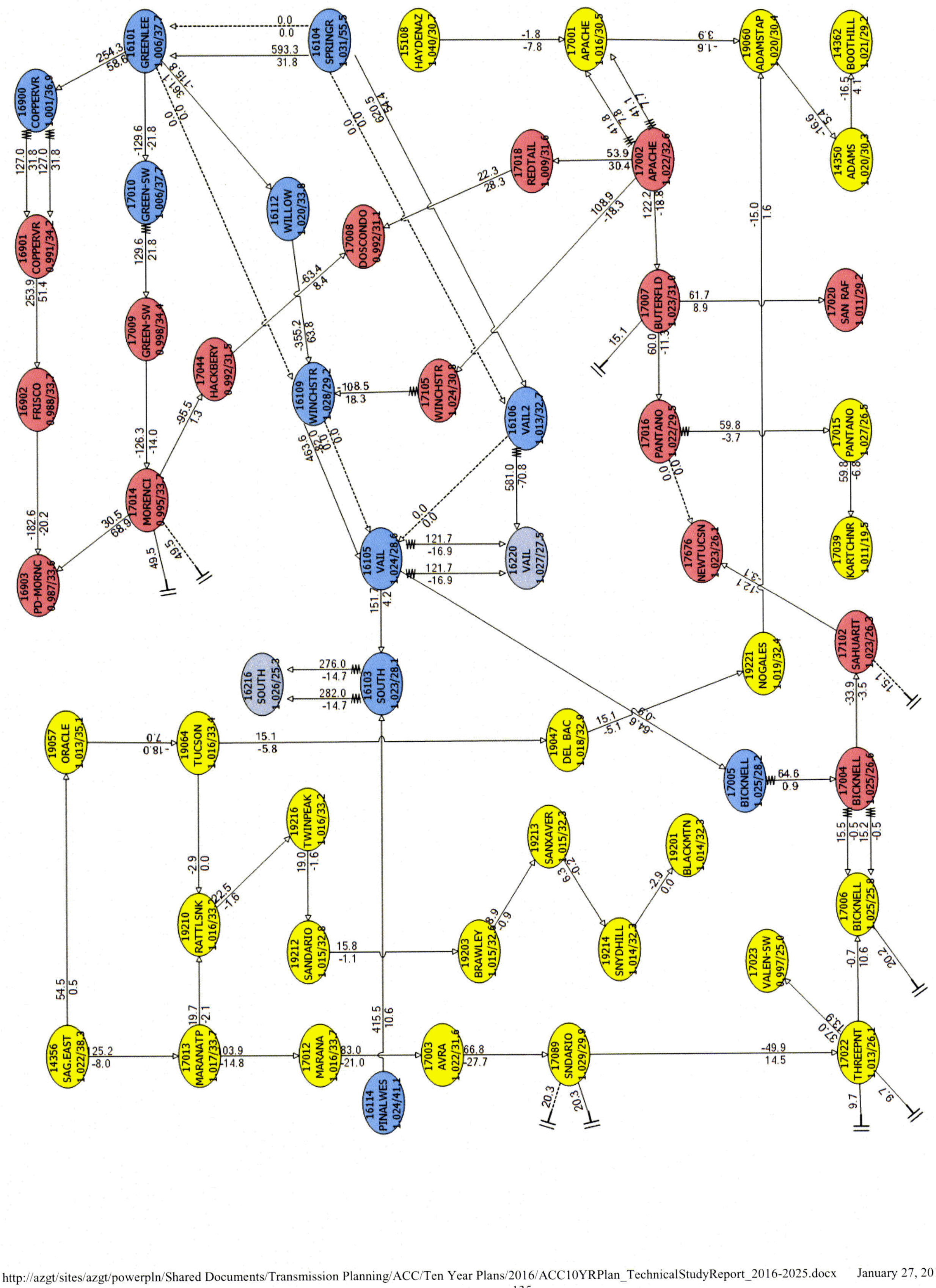
2020HS Southwest Transmission Cooperative Base System with Morenci to Green-SW 230 kV Line out of service



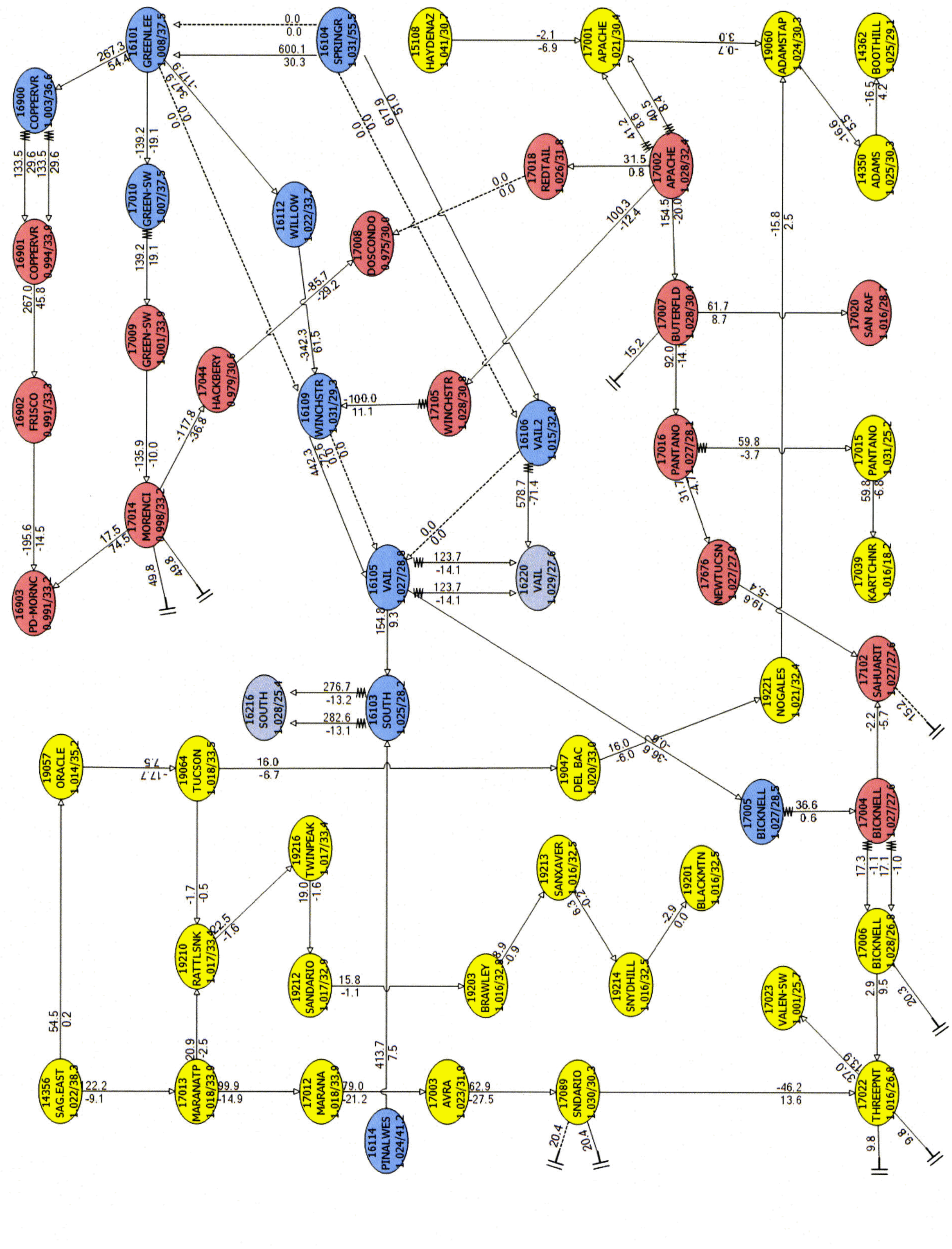
2020HS Southwest Transmission Cooperative Base System with New Tucson to Sahuarita 230 kV Line out of service



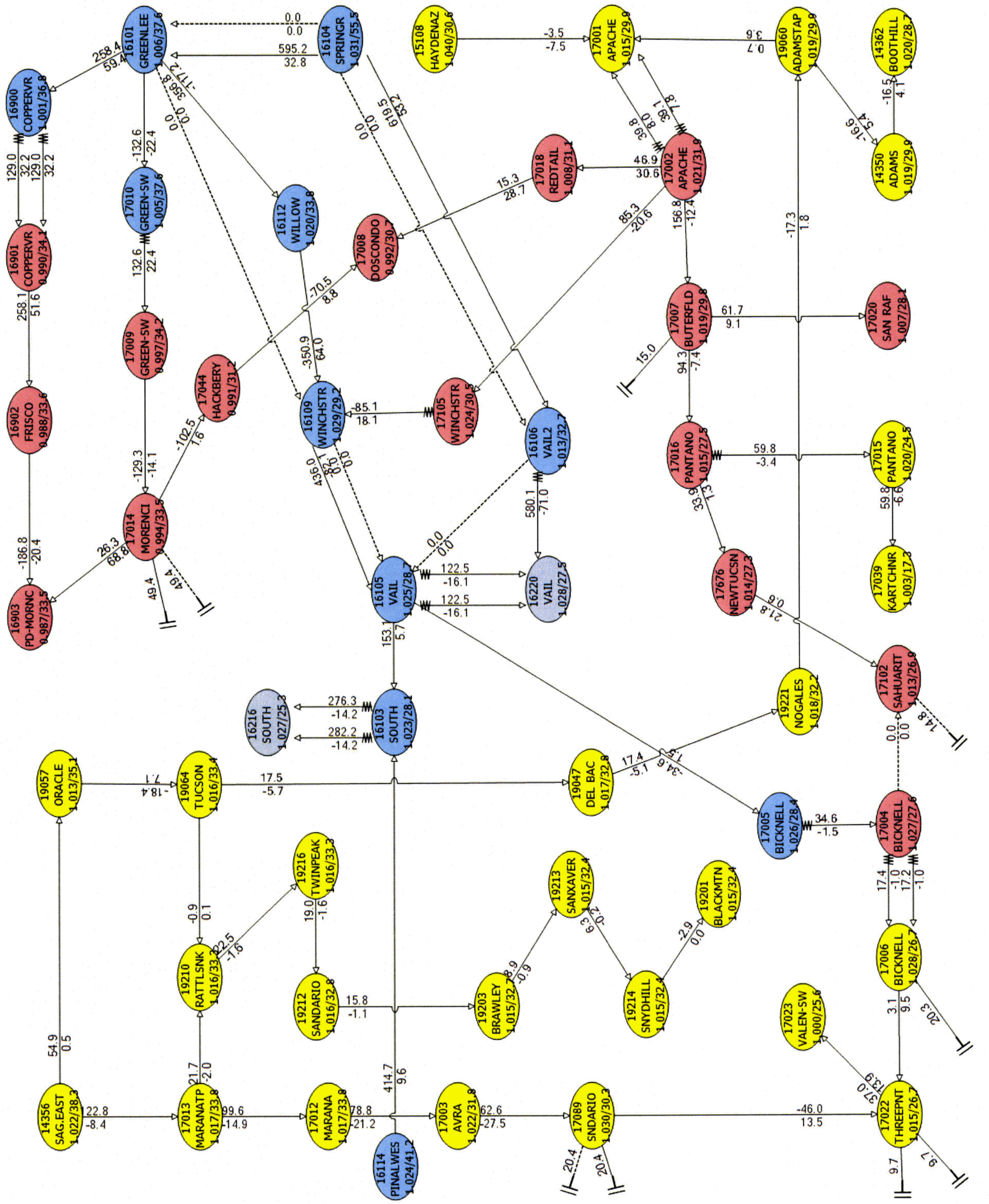
2020HS Southwest Transmission Cooperative Base System with Pantano to New Tucson 230 kV Line out of service



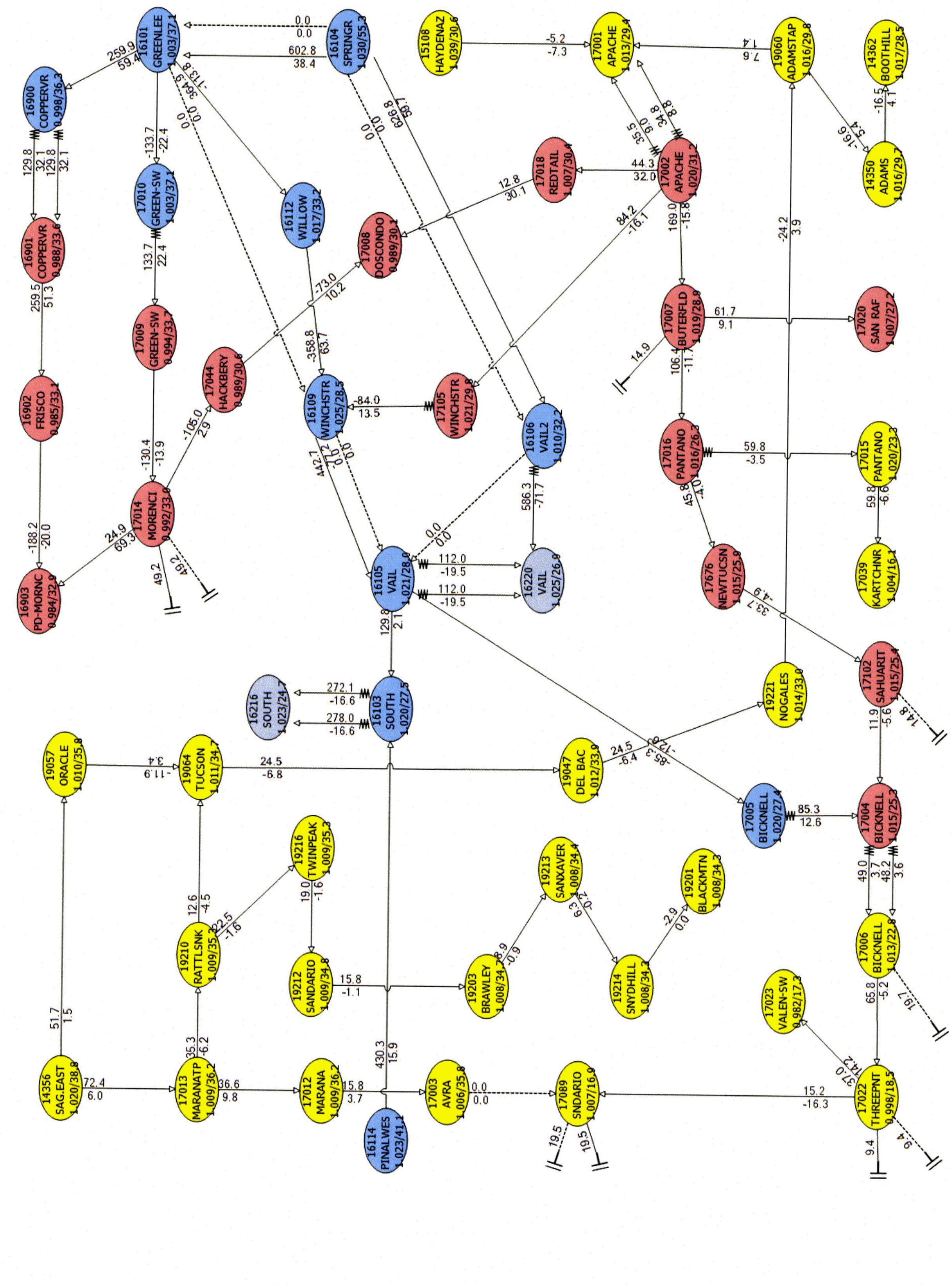
2020HS Southwest Transmission Cooperative Base System with Redtail to Dos Condados 230 kV Line out of service



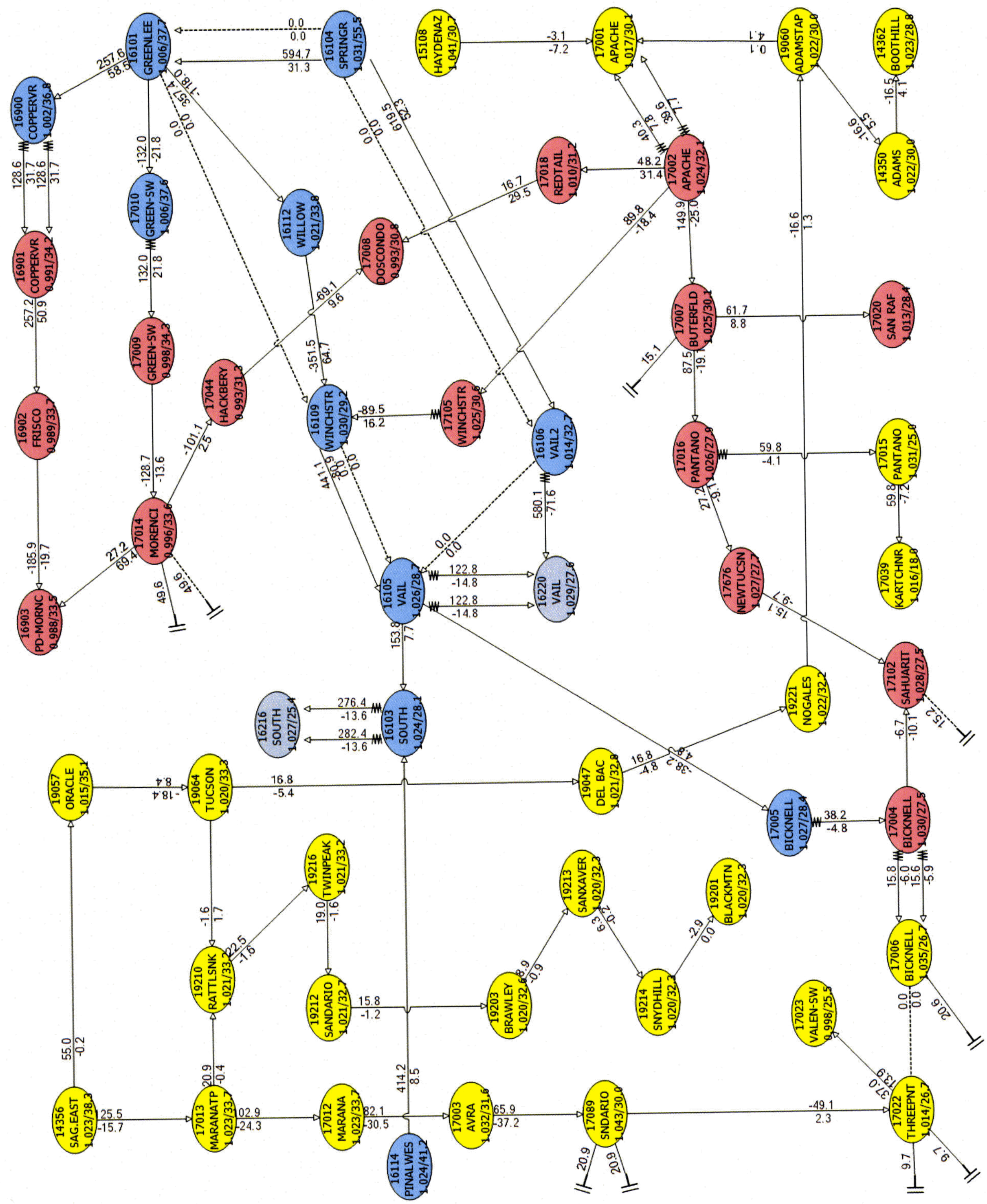
2020HS Southwest Transmission Cooperative Base System with Sahuarita to Bicknell 230 kV Line out of service



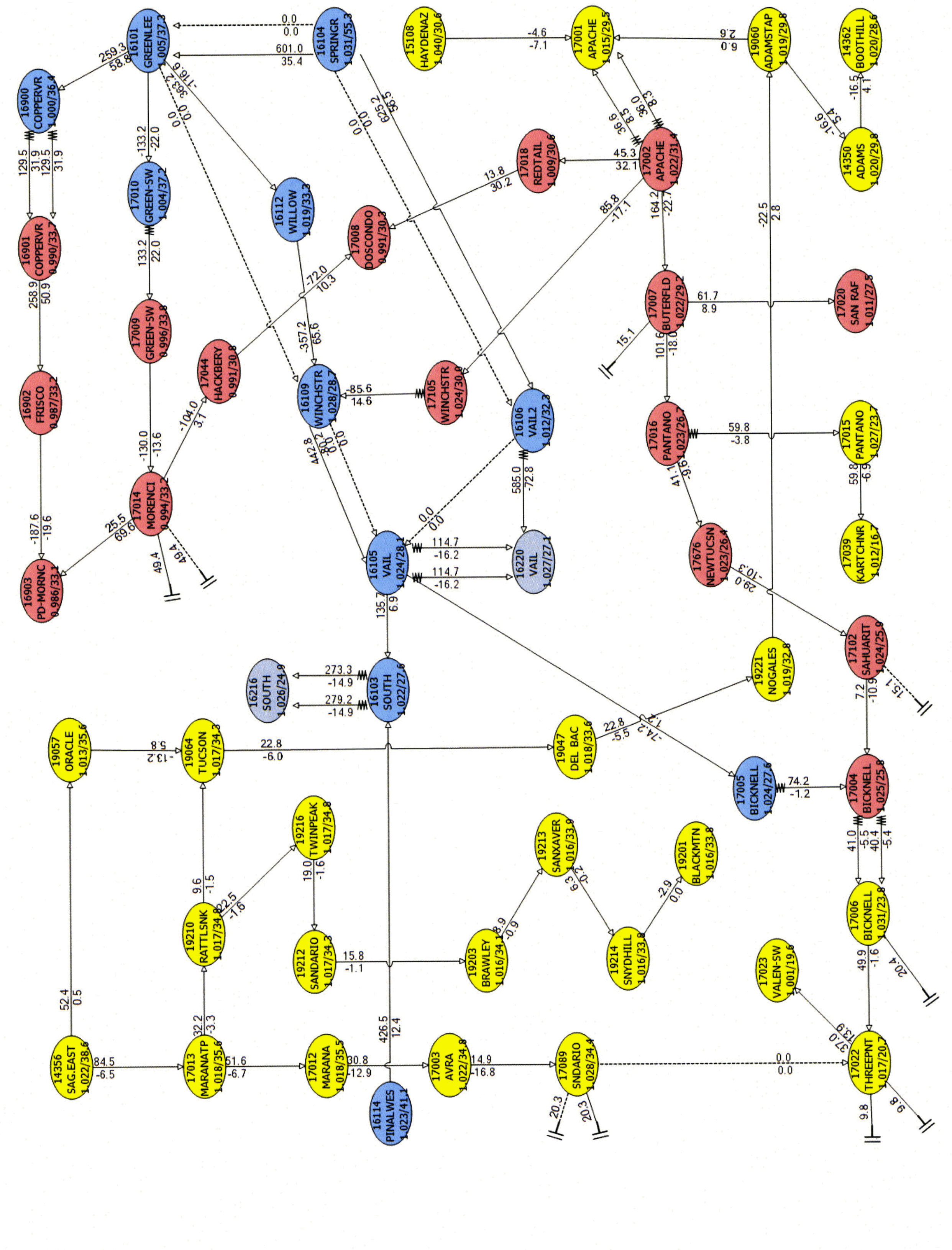
2020HS Southwest Transmission Cooperative Base System with Avra to Sandario 115 kV Line out of service



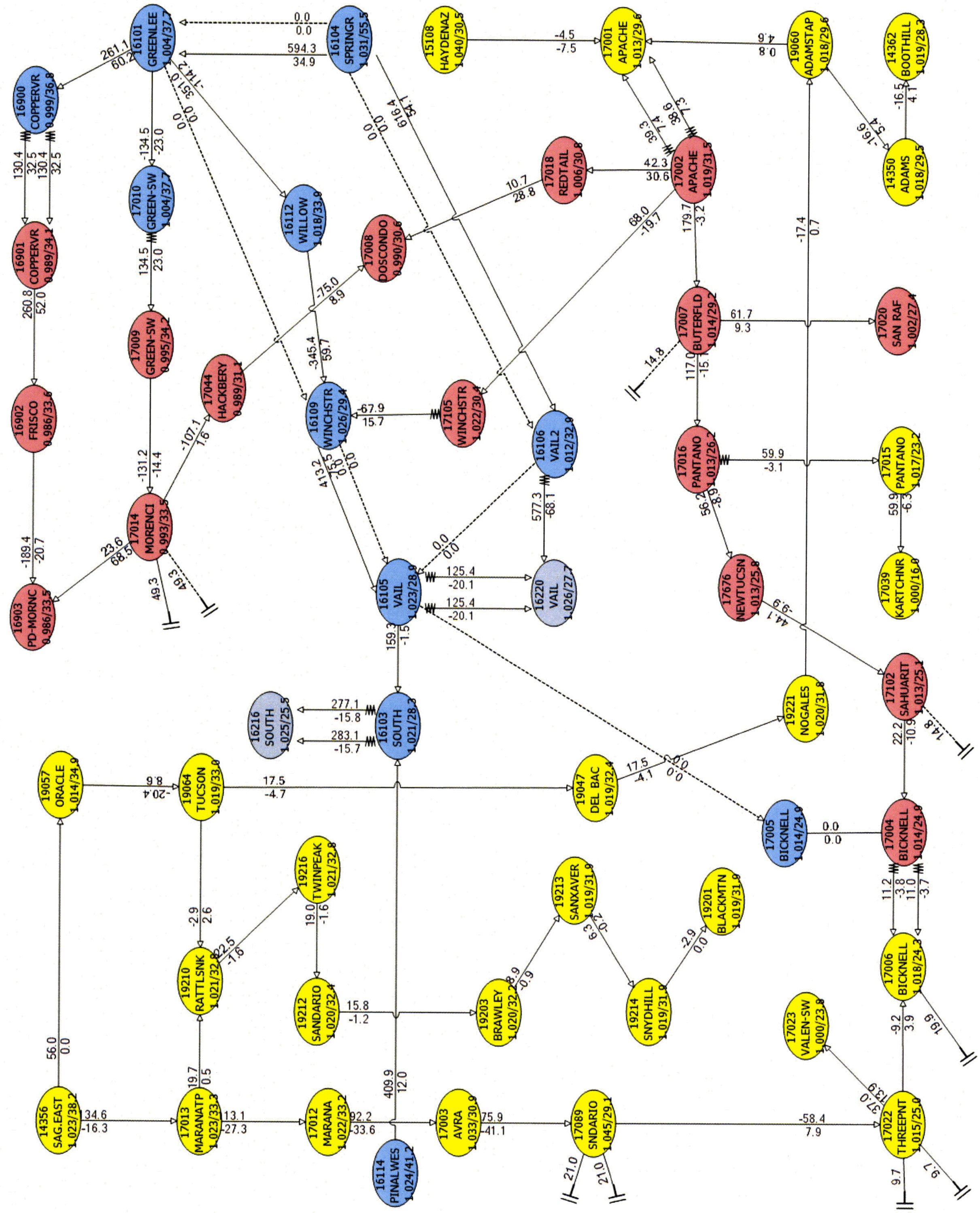
2020HS Southwest Transmission Cooperative Base System with Bicknell to Three Points 115 kV Line out of service



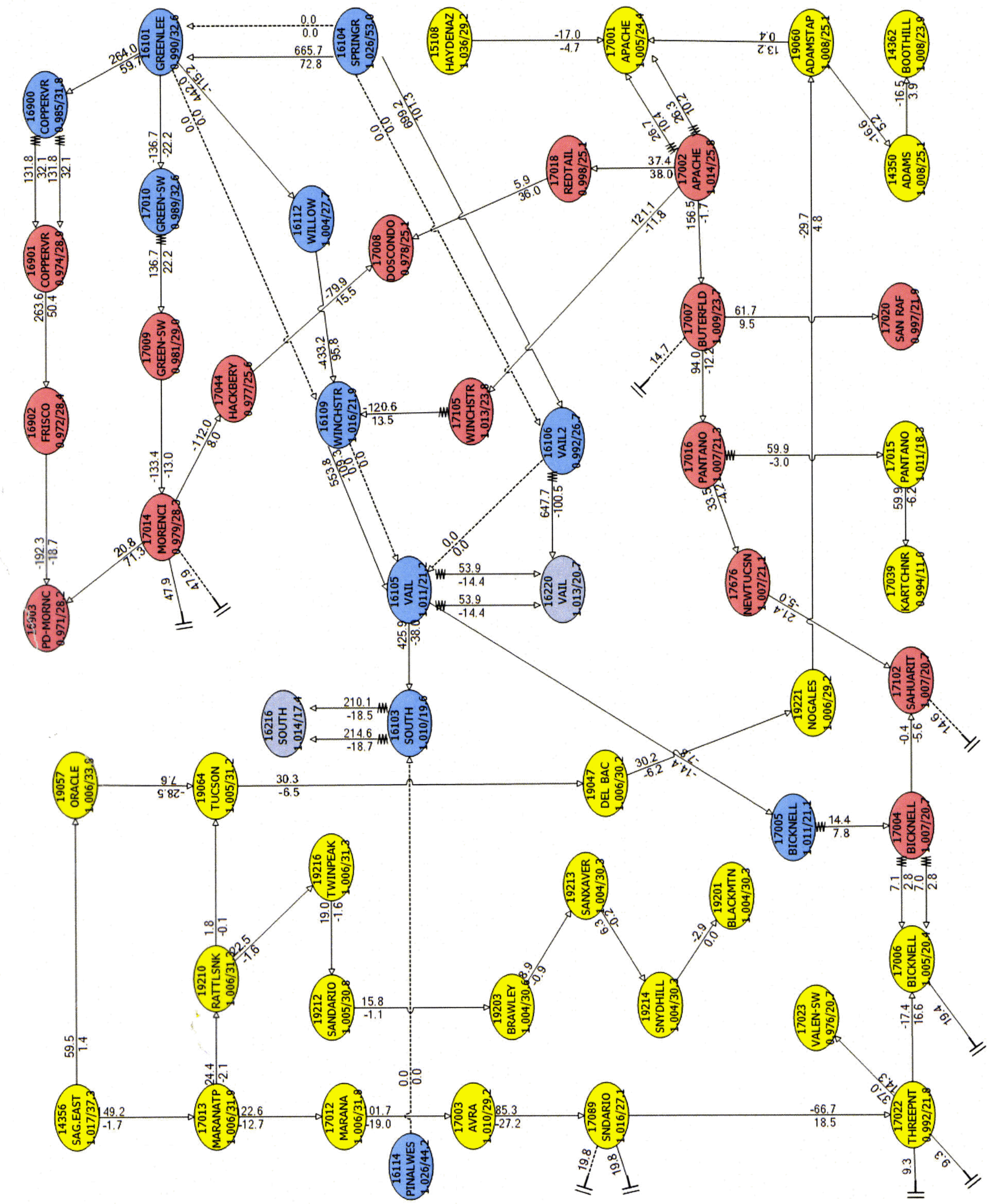
2020HS Southwest Transmission Cooperative Base System with Three Points to Sandario 115 kV Line out of service



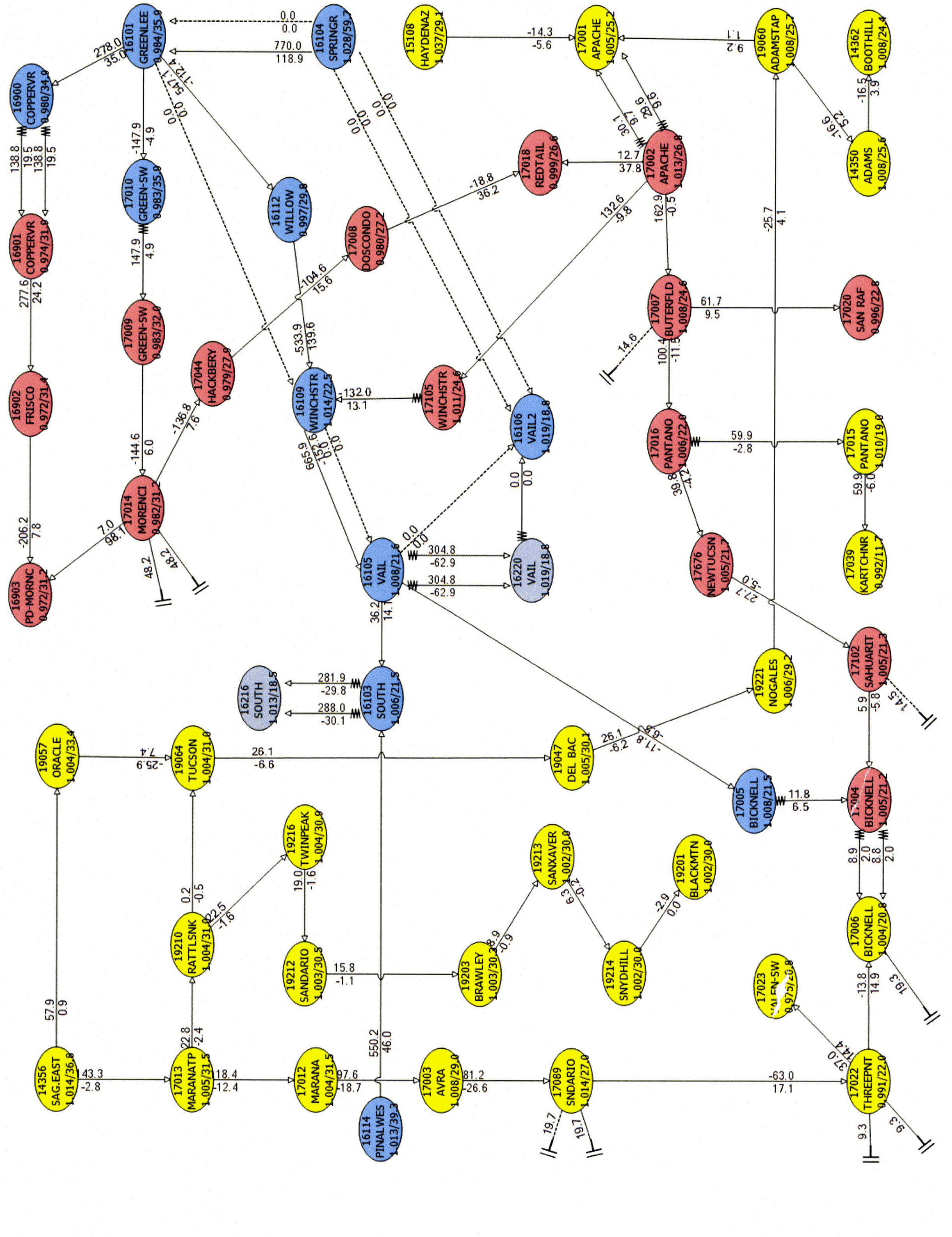
2020HS Southwest Transmission Cooperative Base System with Bicknell to Vail 345 kV Line out of service



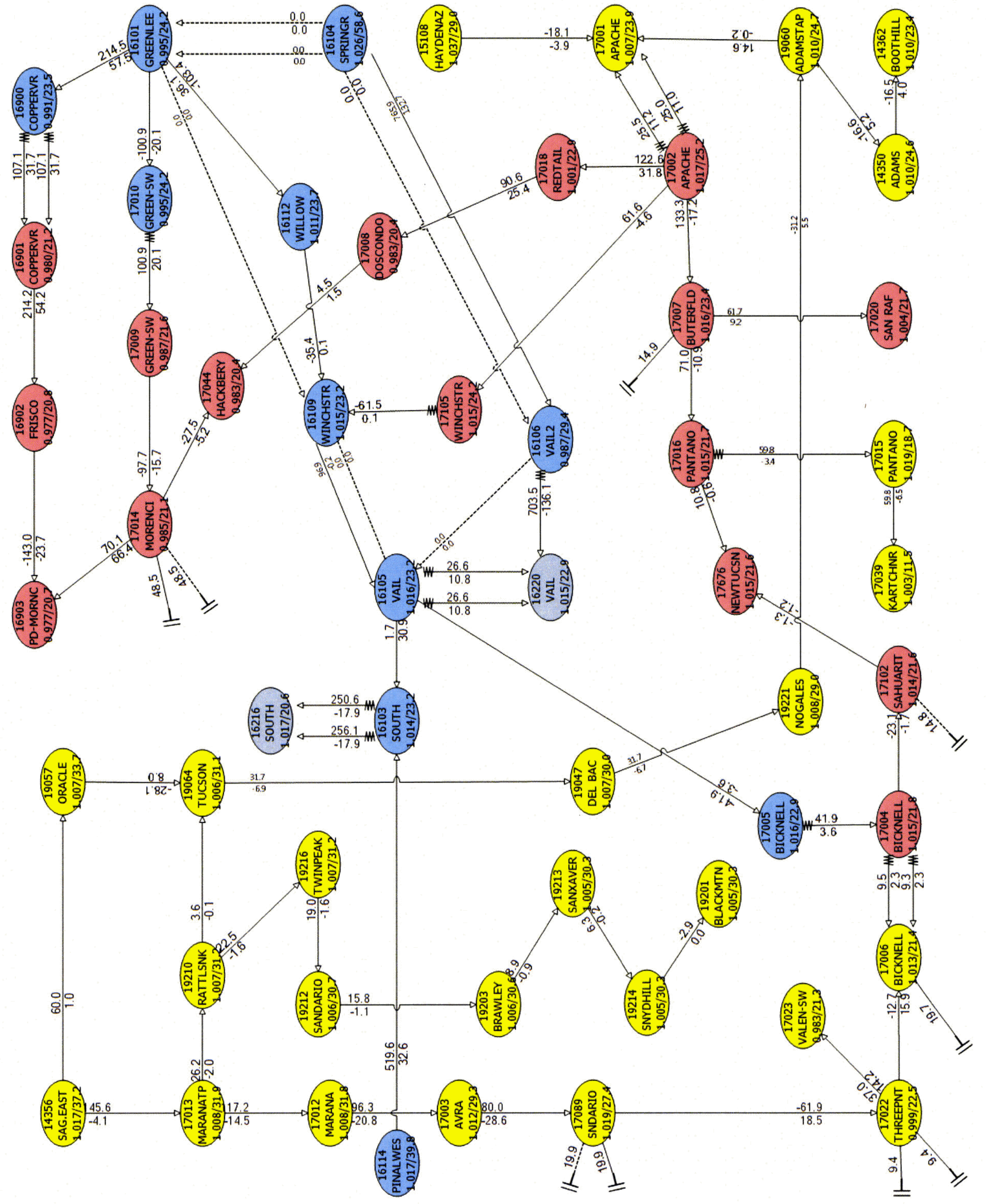
2020HS Southwest Transmission Cooperative Base System with Pinal West to South 345 kV Line out of service



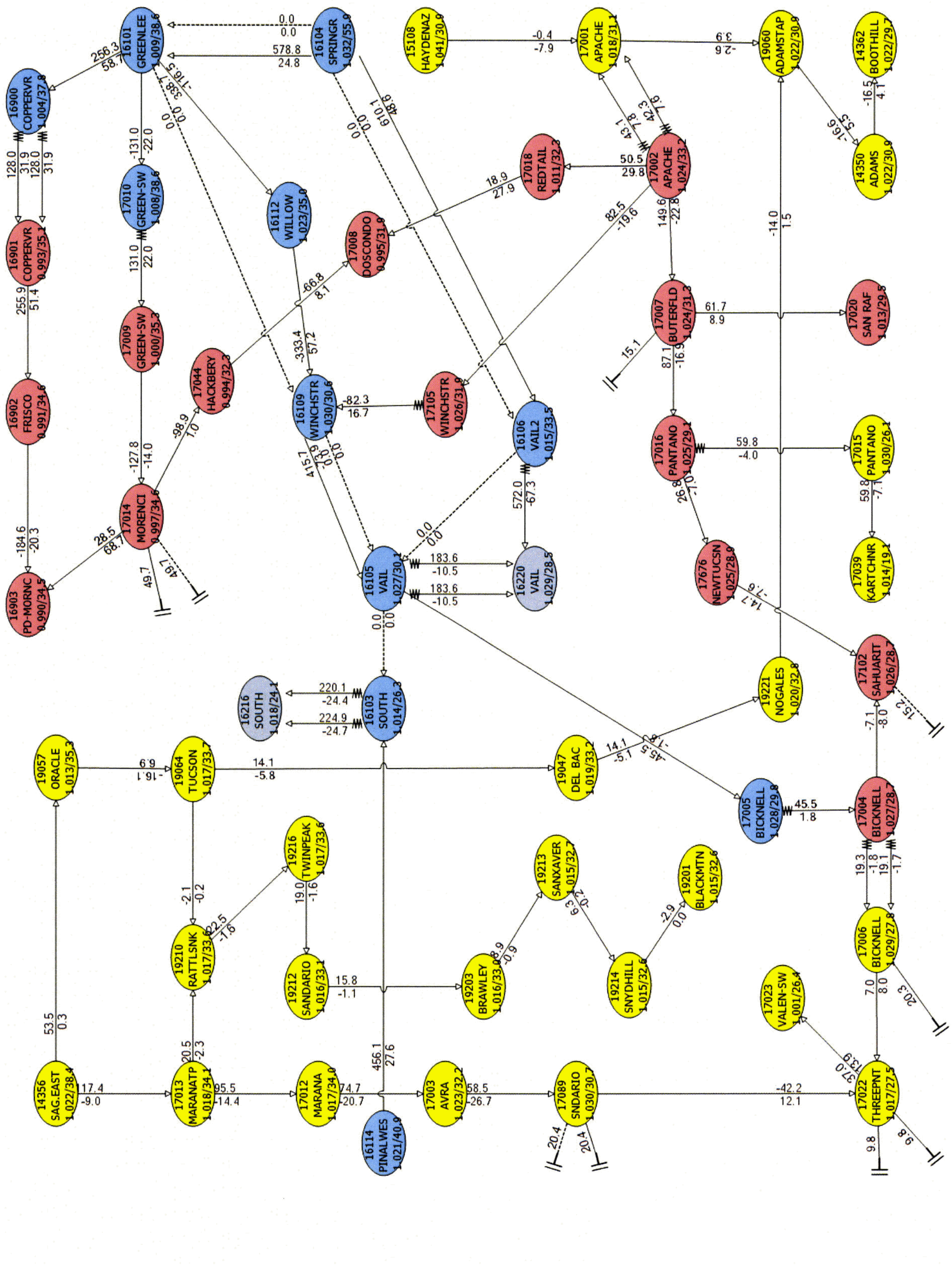
2020HS Southwest Transmission Cooperative Base System with Springerville to Vail2 345 kV Line out of service



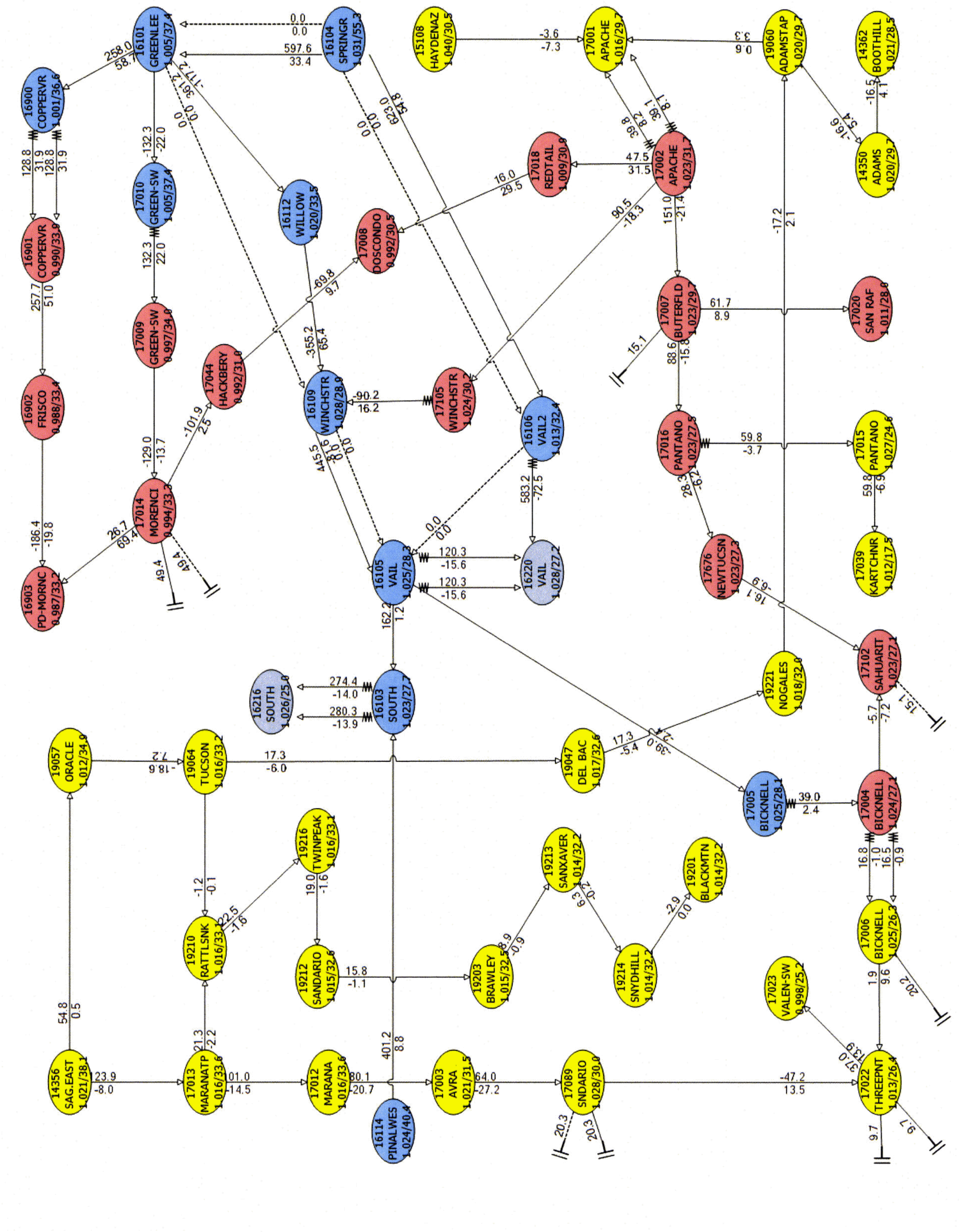
2020HS Southwest Transmission Cooperative Base System with Springerville to Greenlee 345 kV Line out of service



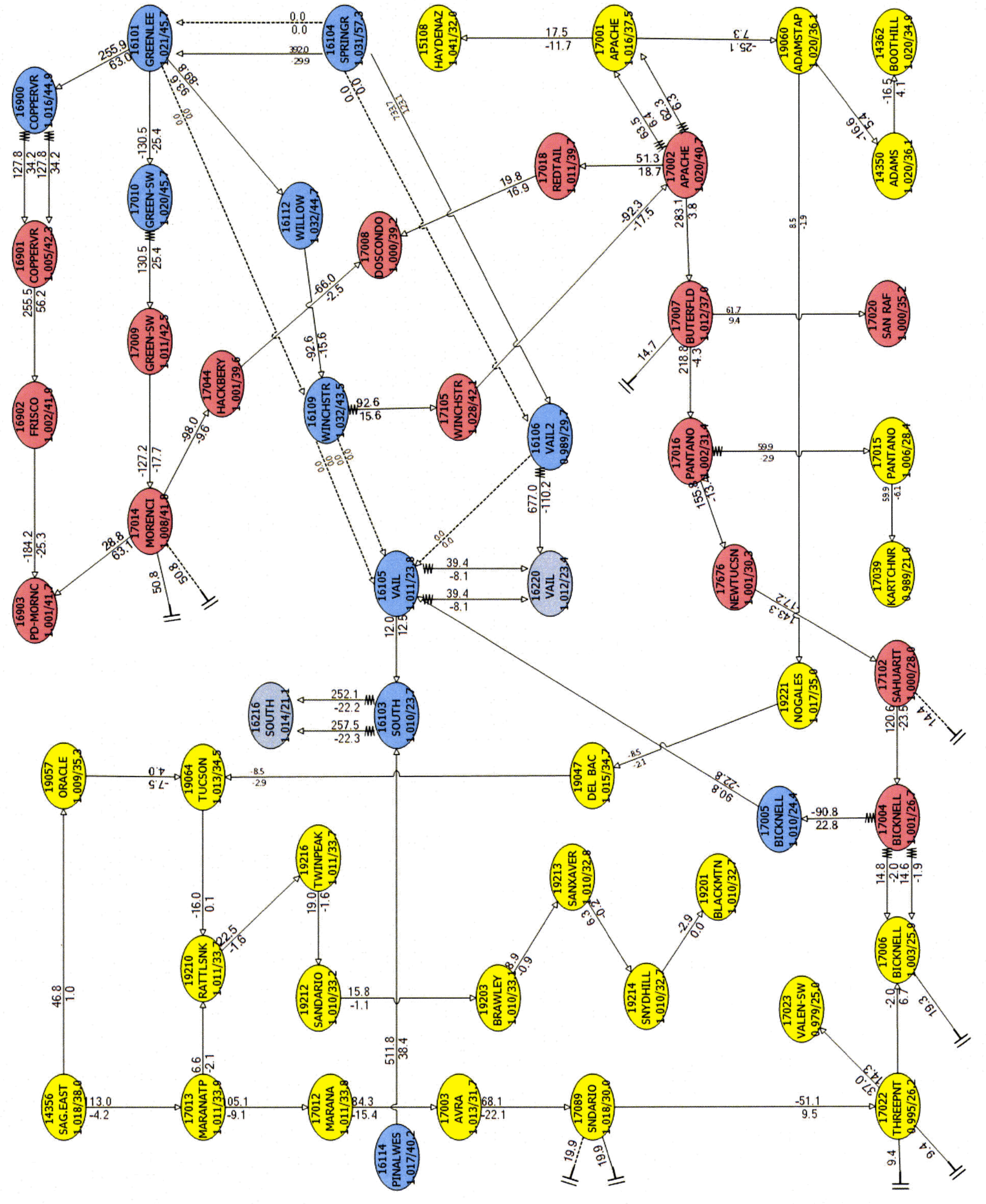
2020HS Southwest Transmission Cooperative Base System with Vail to South 345 kV Line out of service



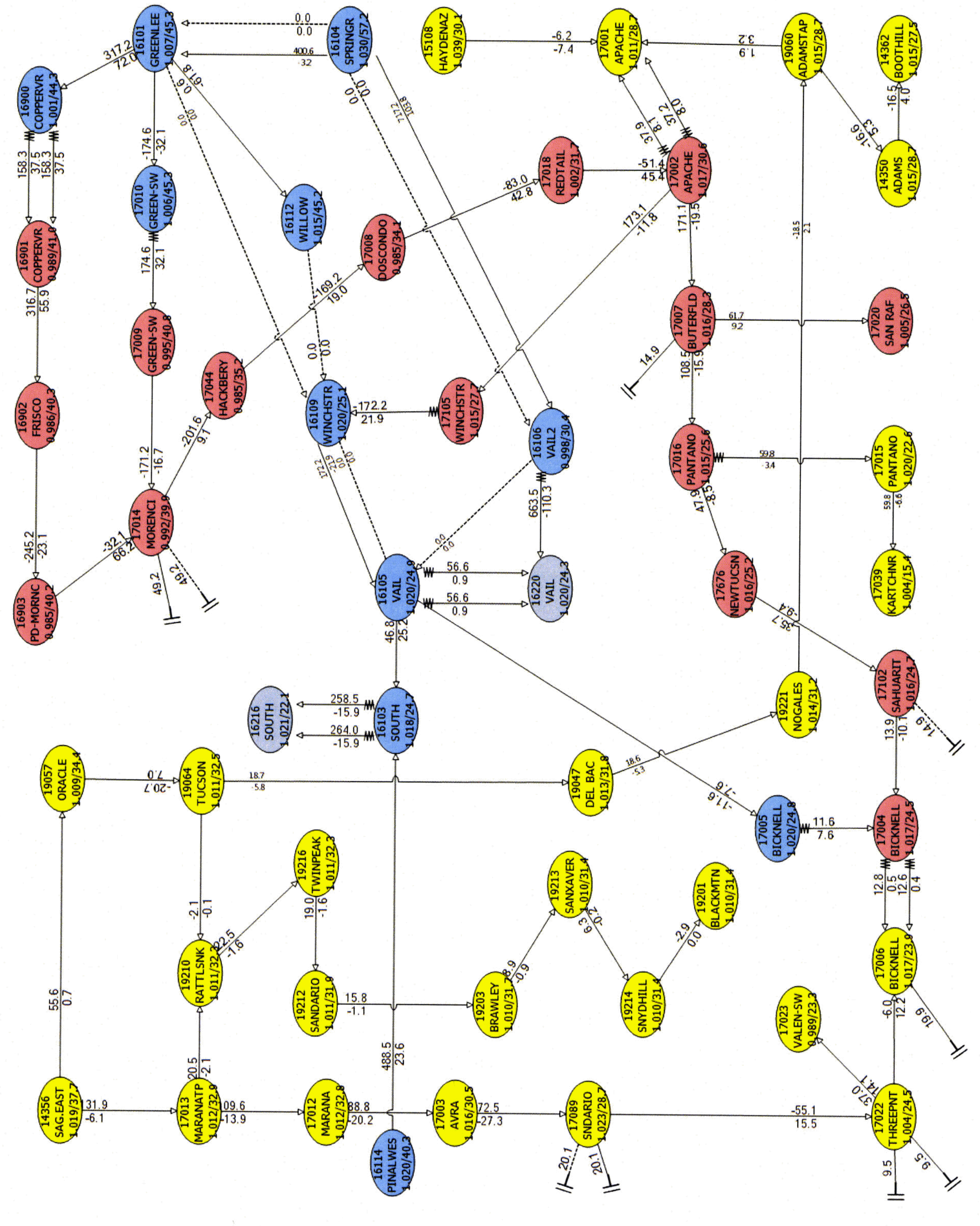
2020HS Southwest Transmission Cooperative Base System with Westwing to Pinal West 345 kV Line out of service



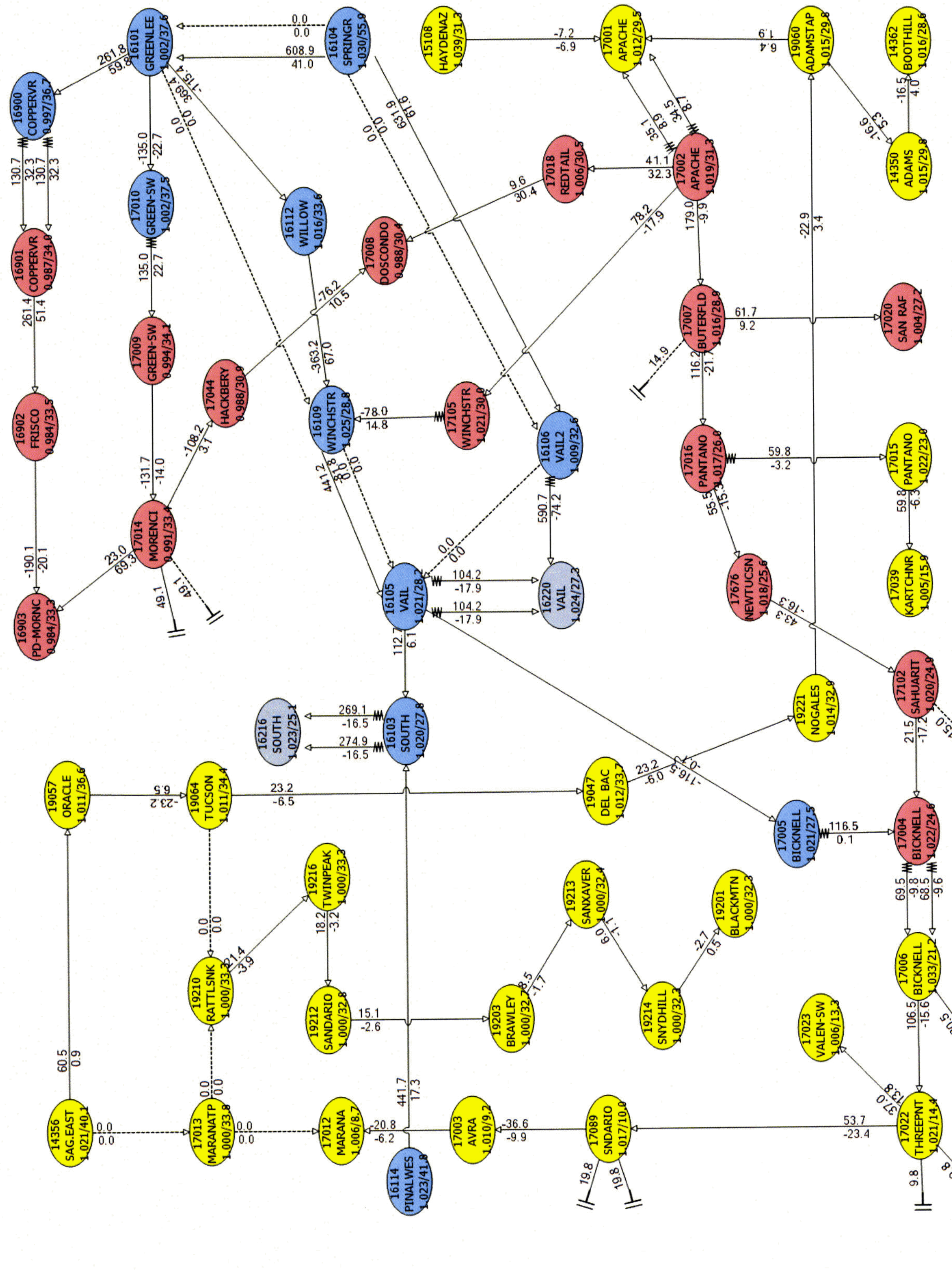
2020HS Southwest Transmission Cooperative Base System with Winchester to Vail 345 kV Line out of service



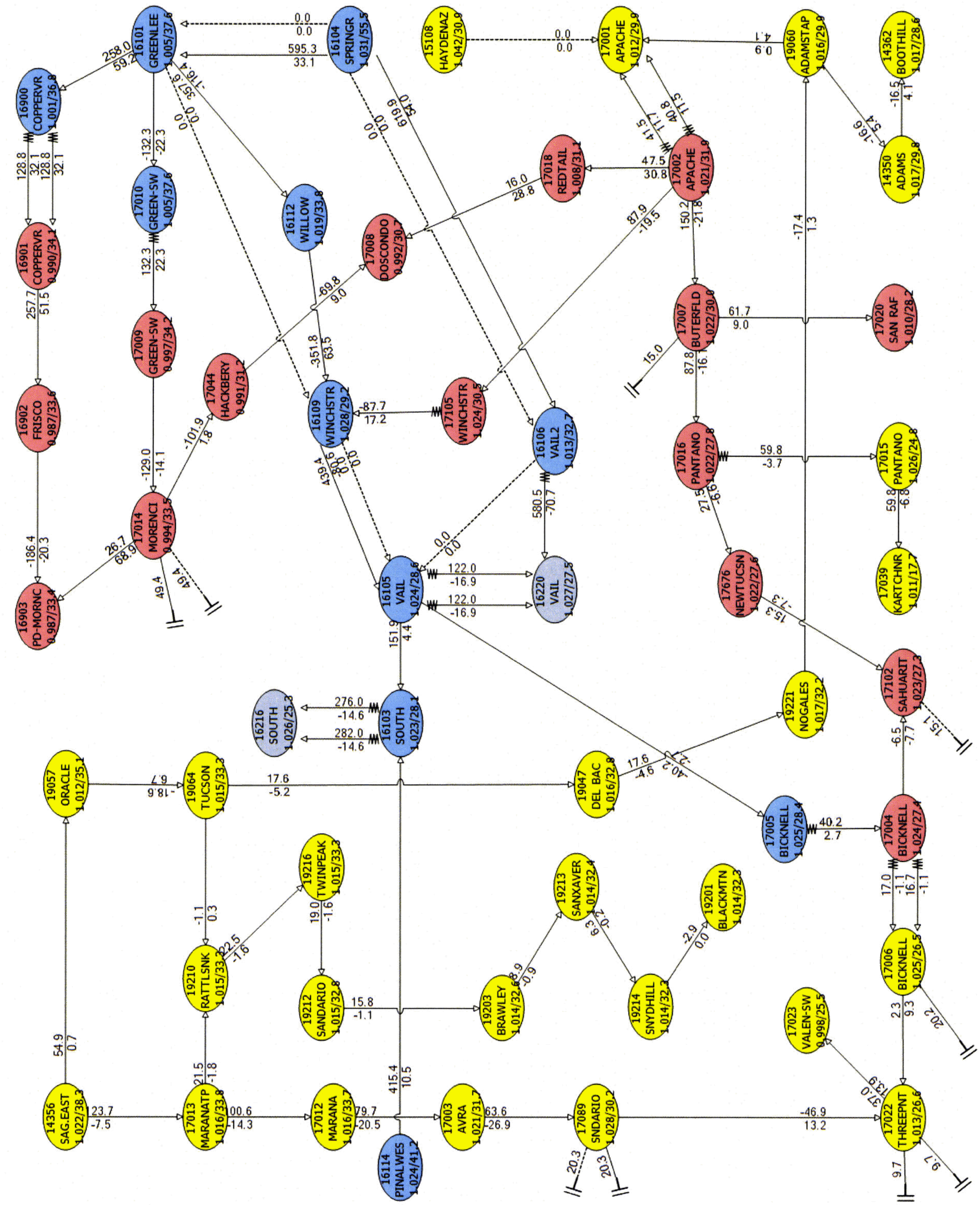
2020HS Southwest Transmission Cooperative Base System with Winchester to Willow 345 kV Line out of service



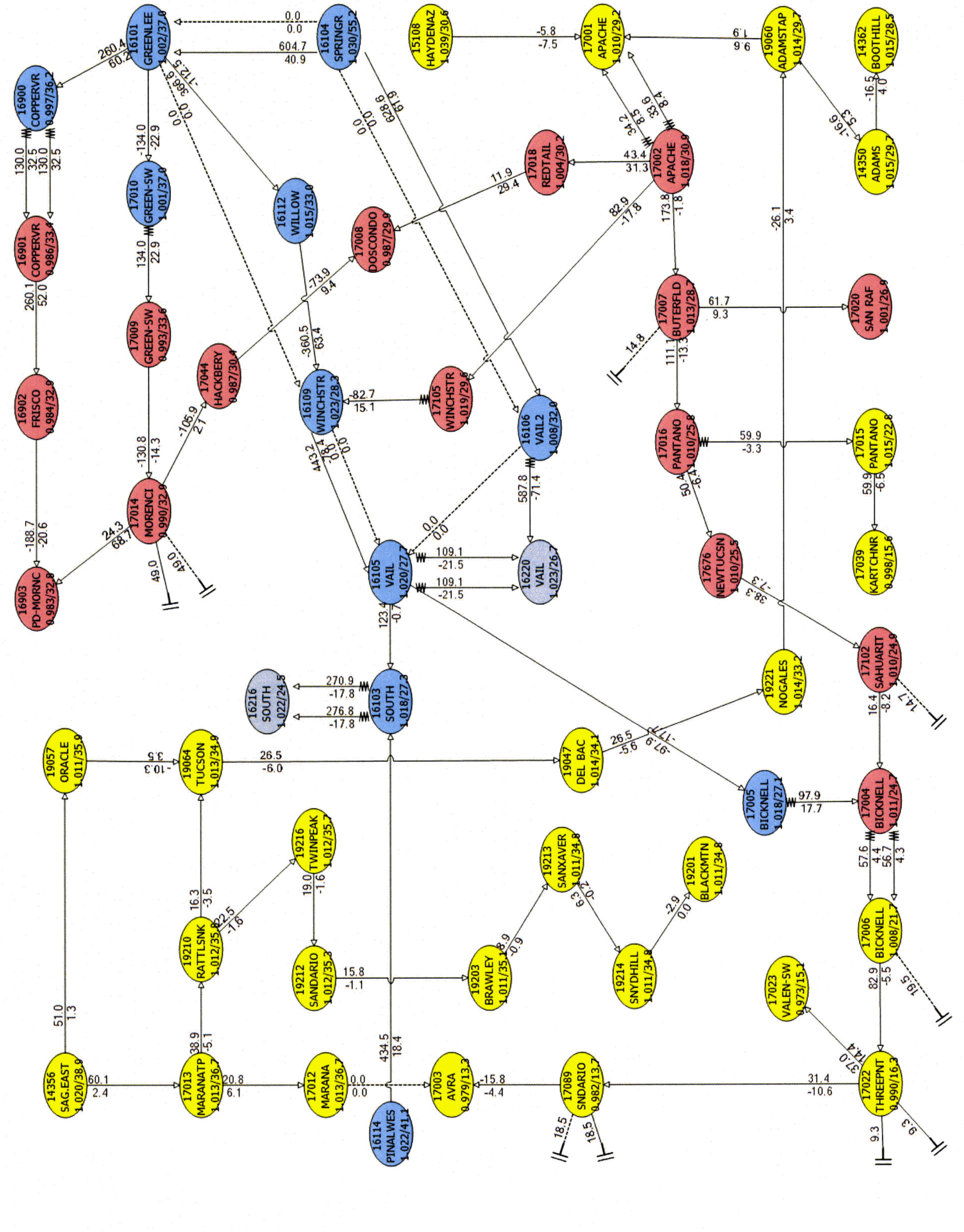
2020HS Southwest Transmission Cooperative Base System with Marana Group 115 kV Line out of service



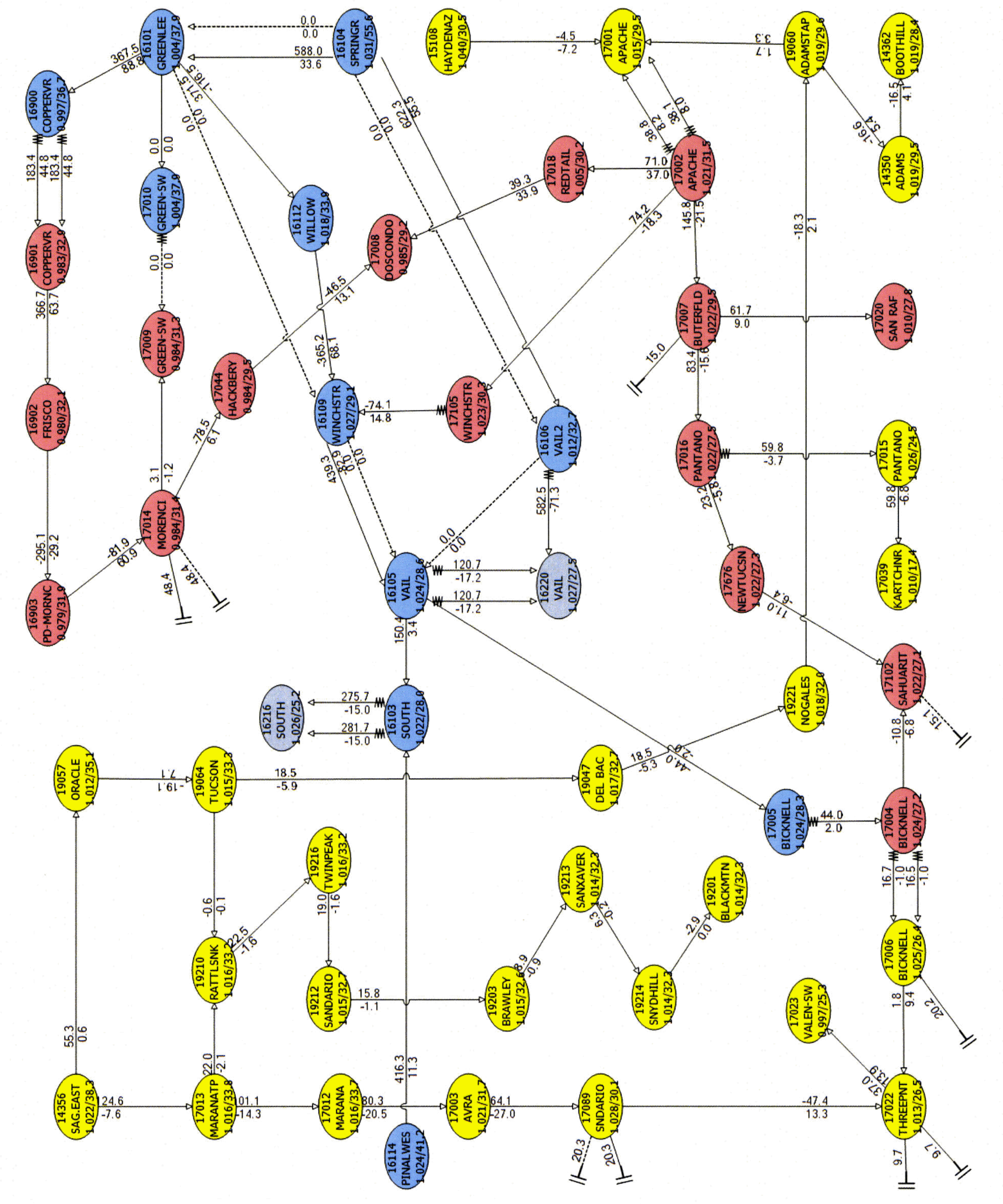
2020HS Southwest Transmission Cooperative Base System with Apache to Hayden 115 kV Line out of service



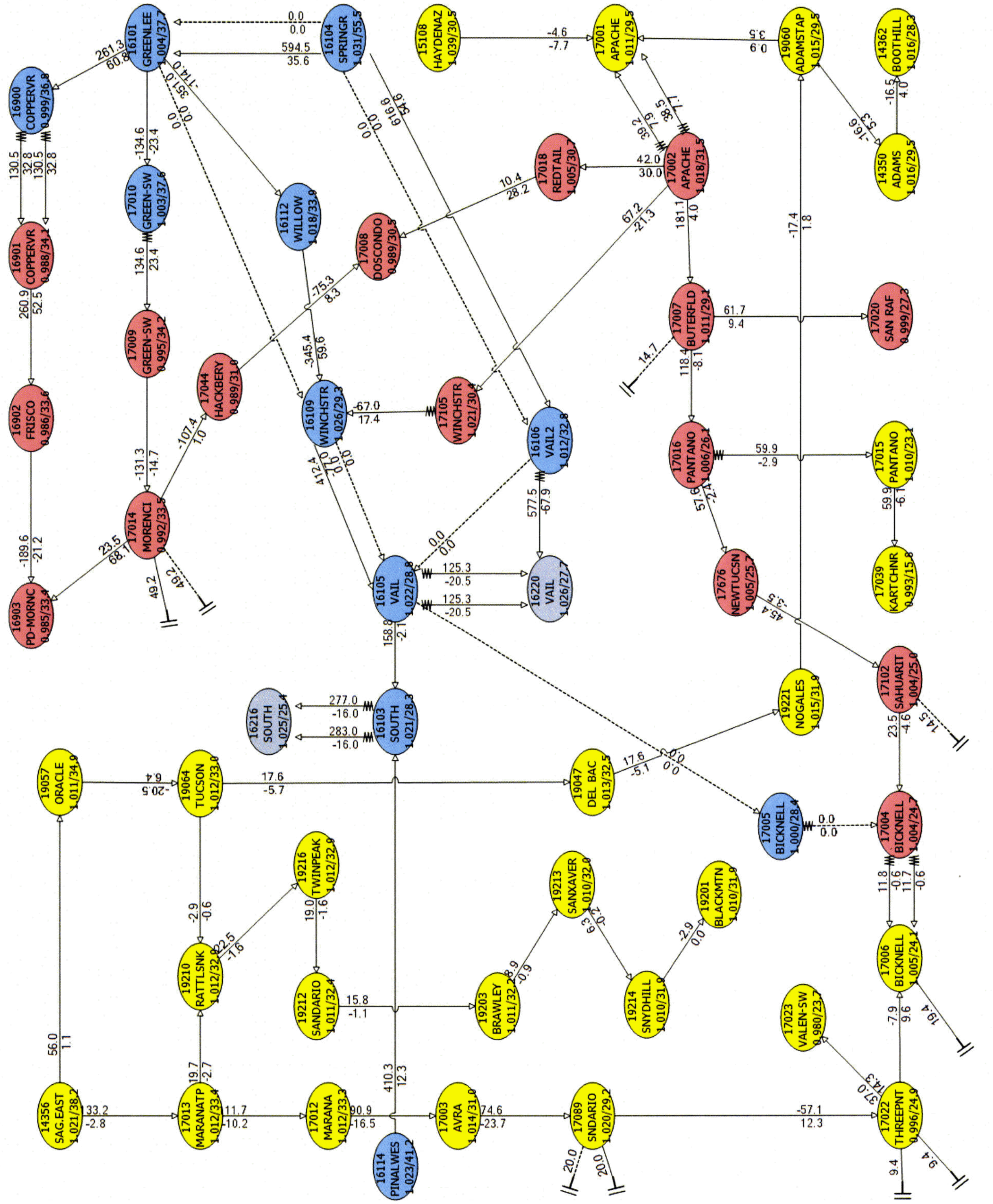
2020HS Southwest Transmission Cooperative Base System with Marana to Avra 115 kV Line out of service



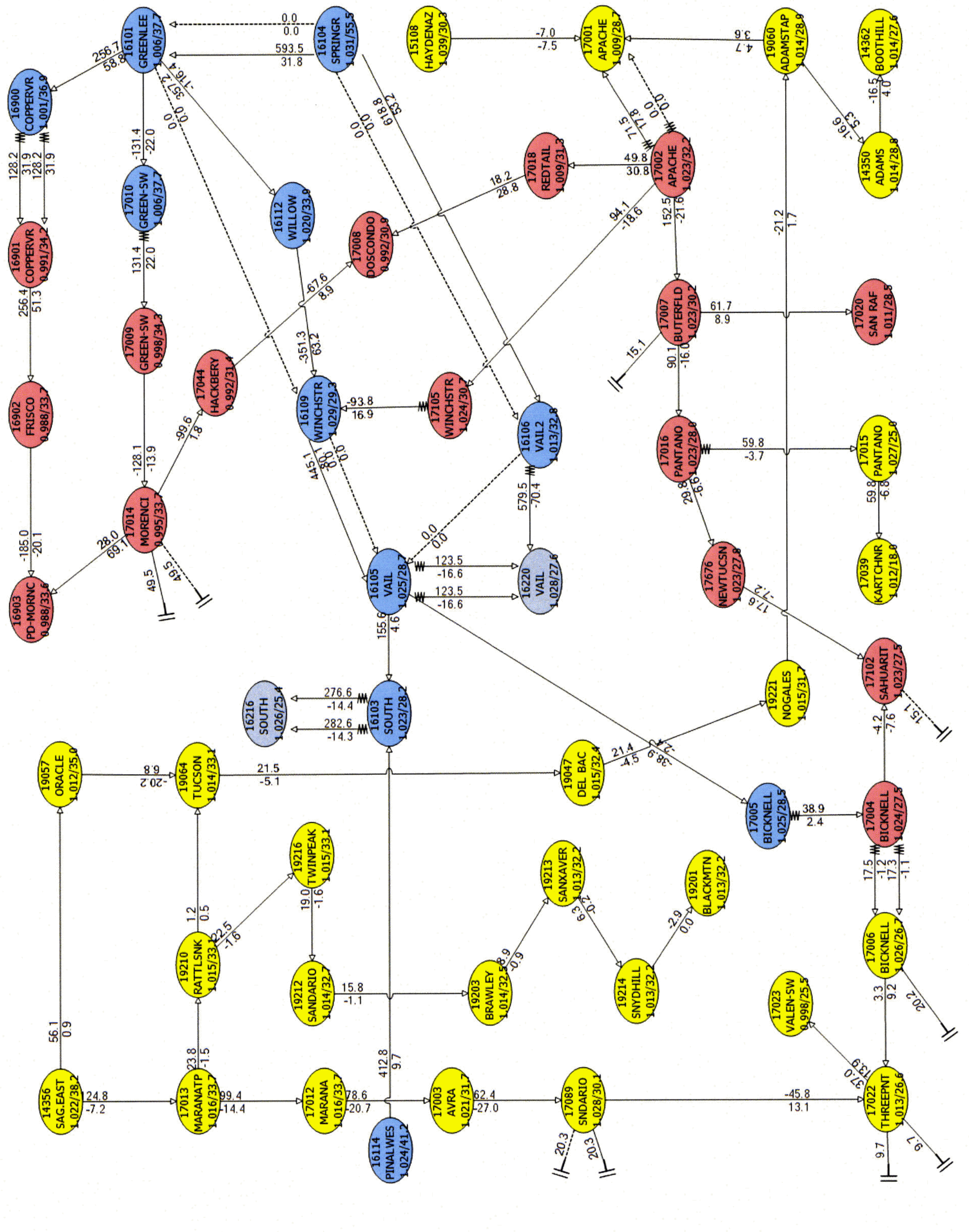
2020HS Southwest Transmission Cooperative Base System with Green-SW 345/230 kV Transformer out of service



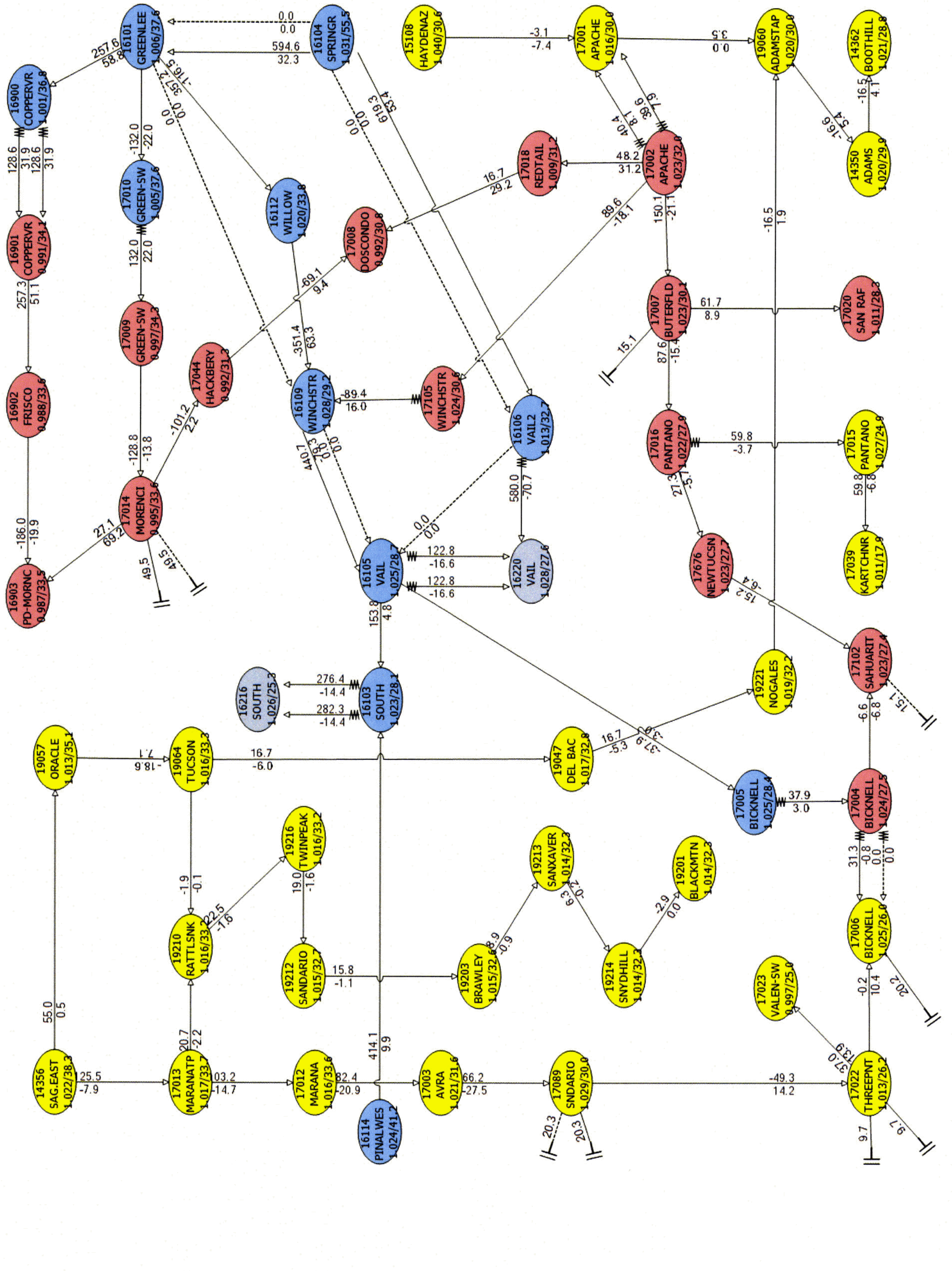
2020HS Southwest Transmission Cooperative Base System with Bicknell 345/230 kV Transformer out of service



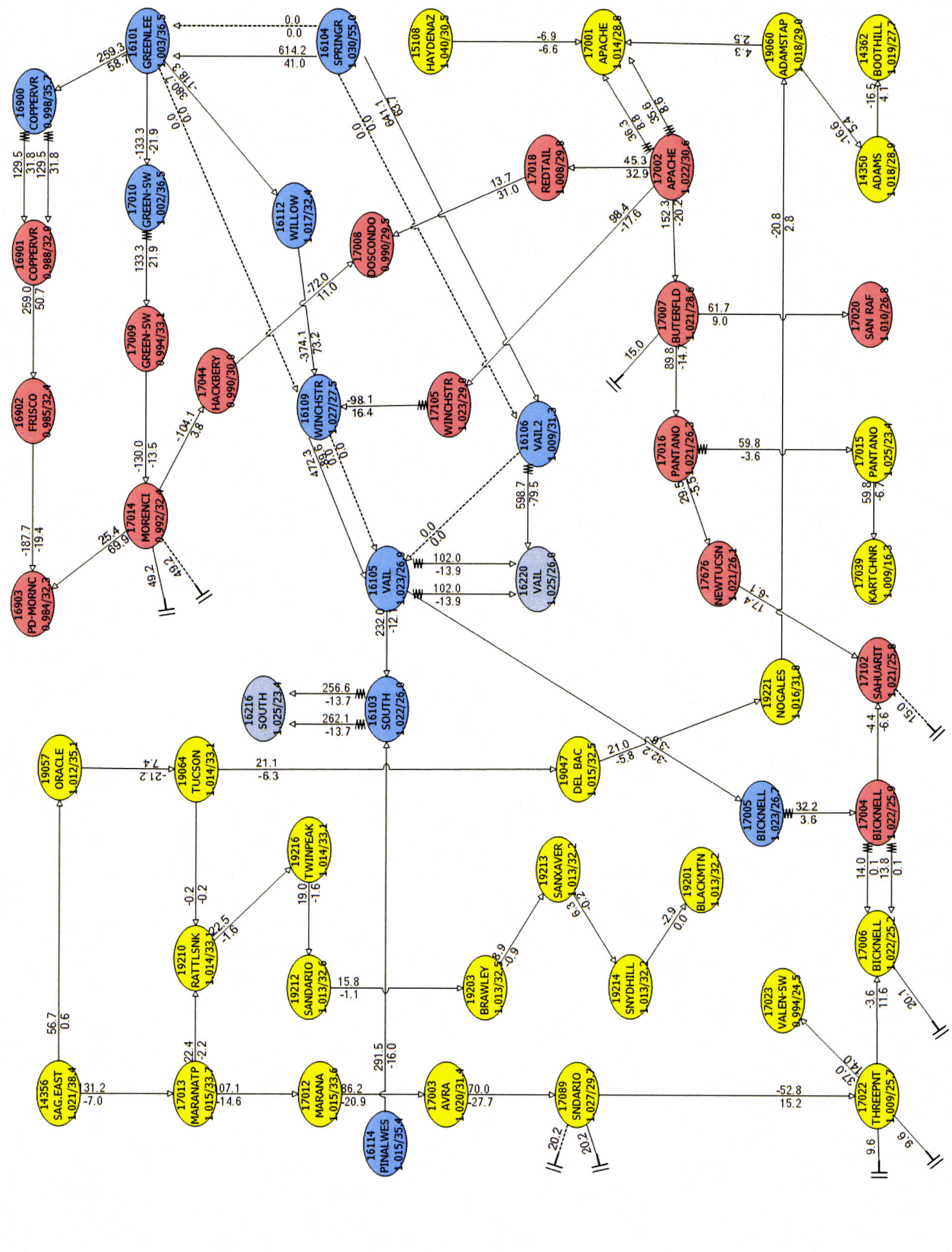
2020HS Southwest Transmission Cooperative Base System with one Apache 230/115 kV Transformer out of service



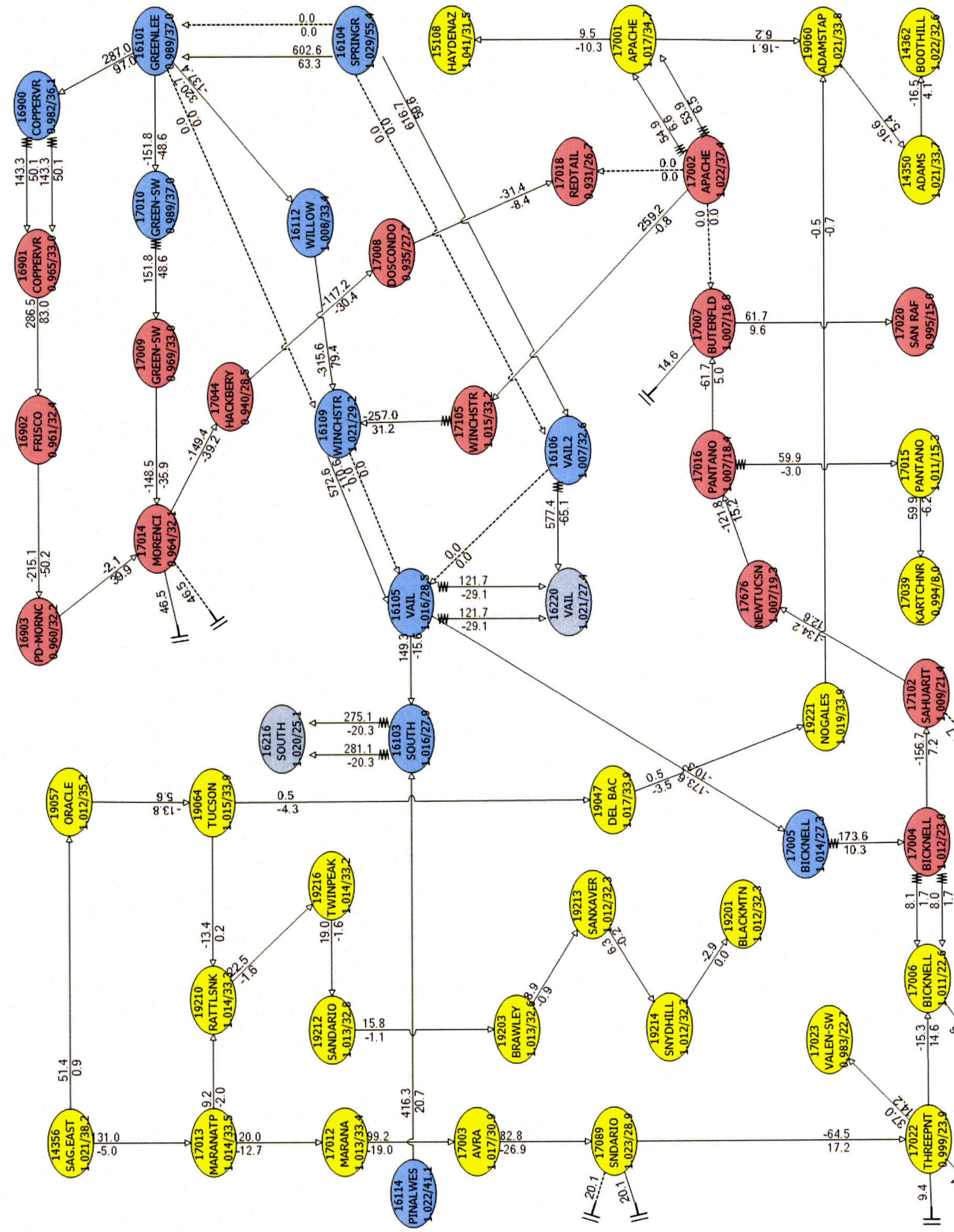
2020HS Southwest Transmission Cooperative Base System with one Bicknell 230/115 kV Transformer out of service



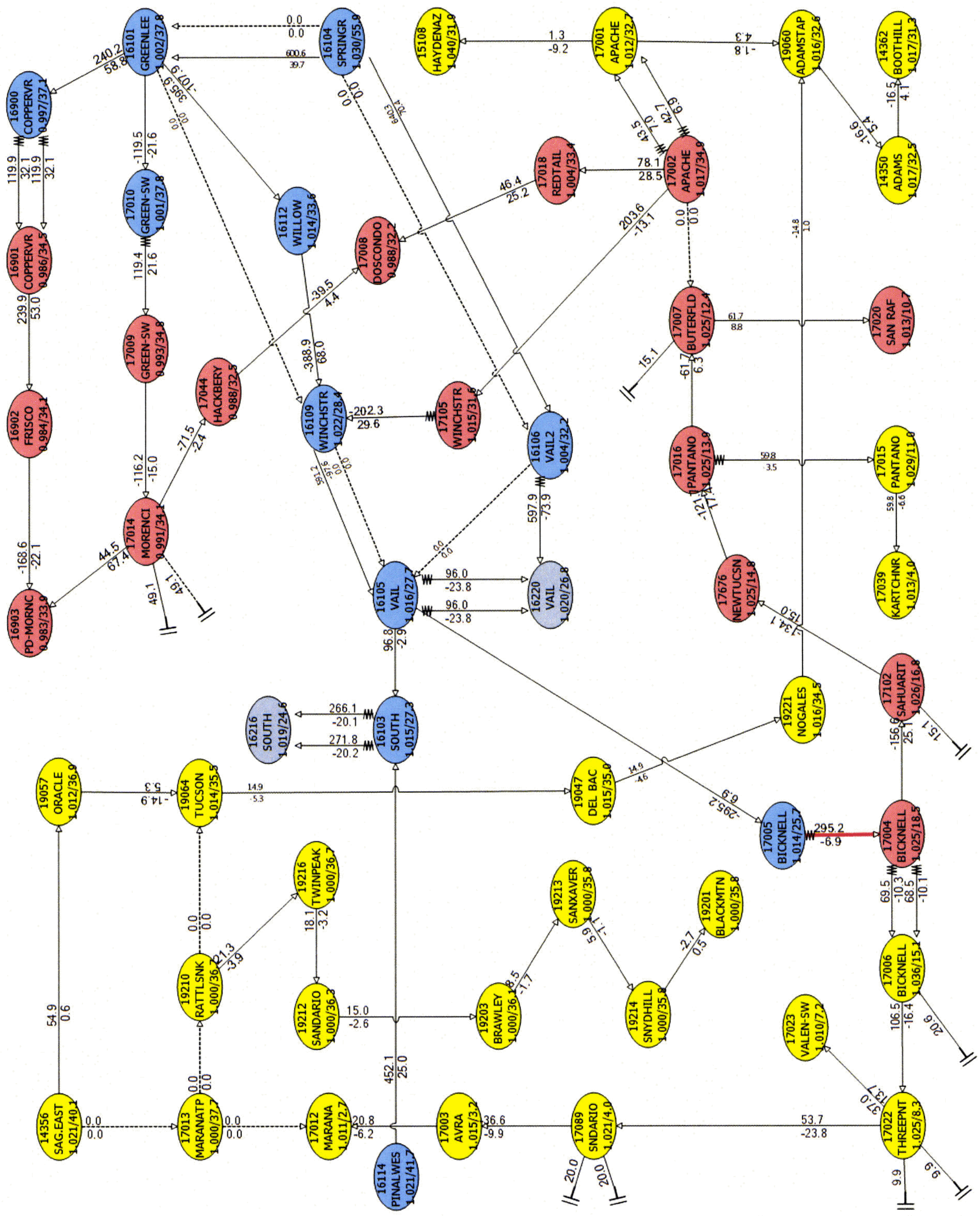
2020HS Southwest Transmission Cooperative Base System with Pinal West 500/345 kV Transformer out of service



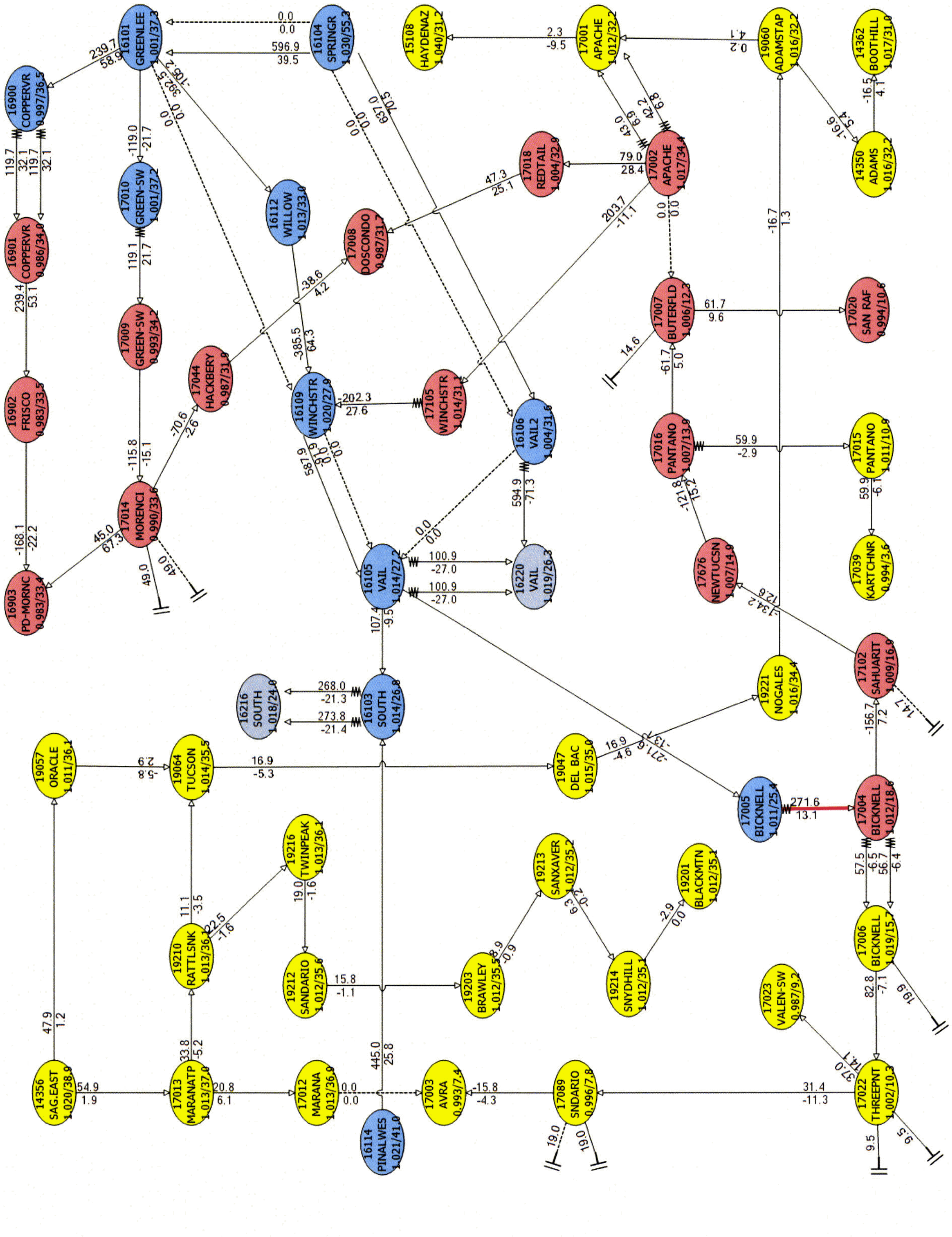
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out followed by the Apache to Redtail 230 kV Line out of service



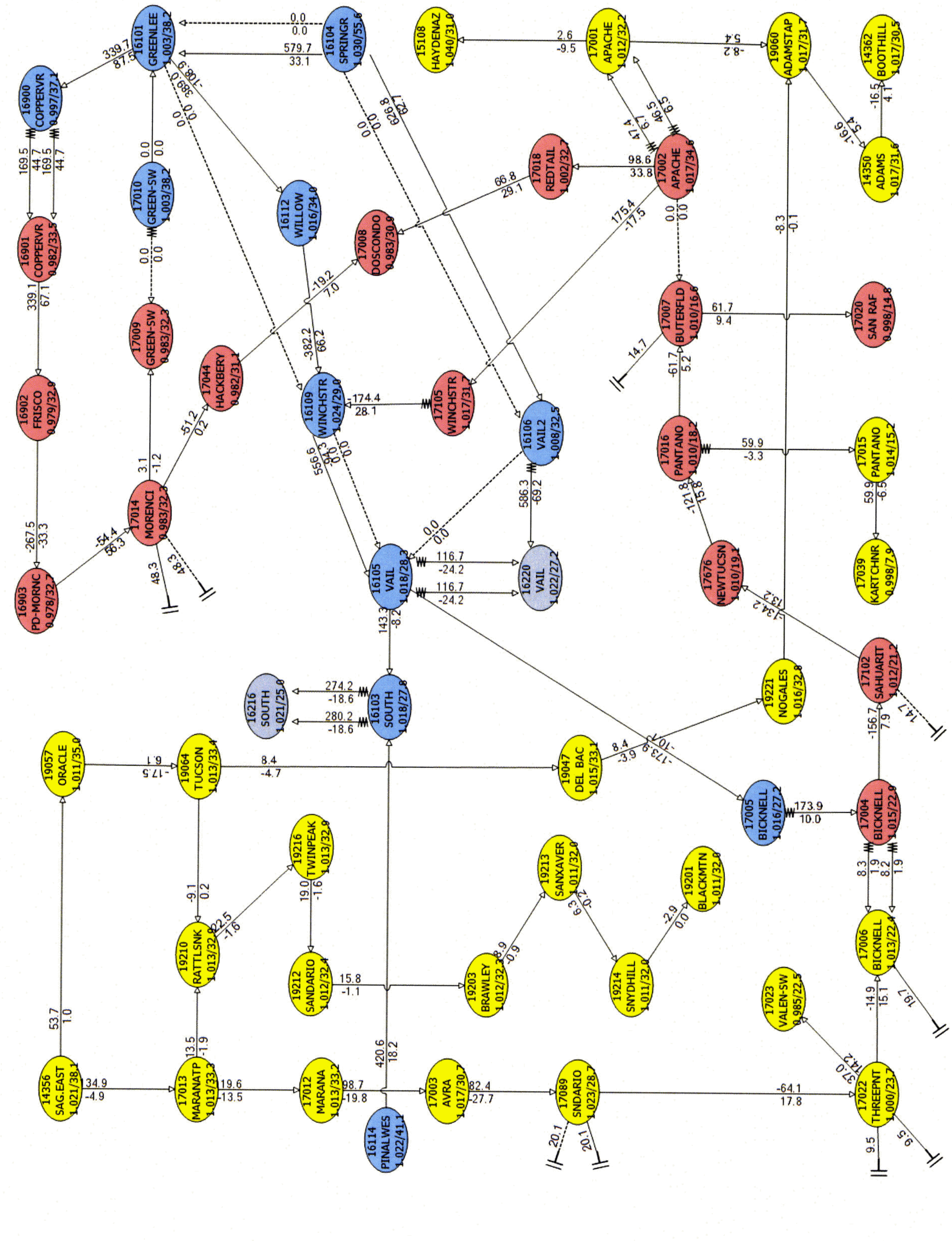
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out followed by the Saguaro East to Marana 115 kV Line out of service



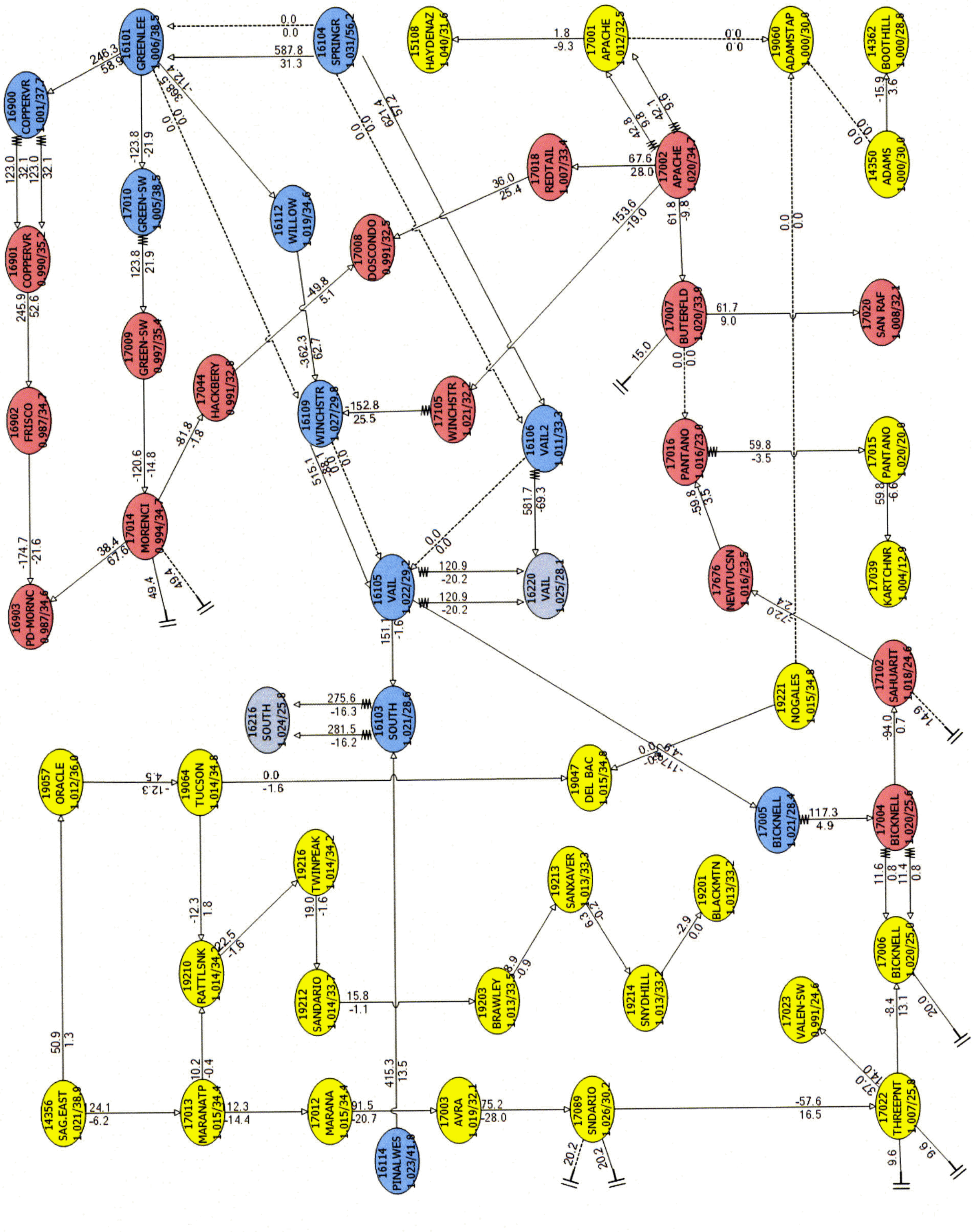
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out followed by the Marana to Avra 115 kV Line out of service



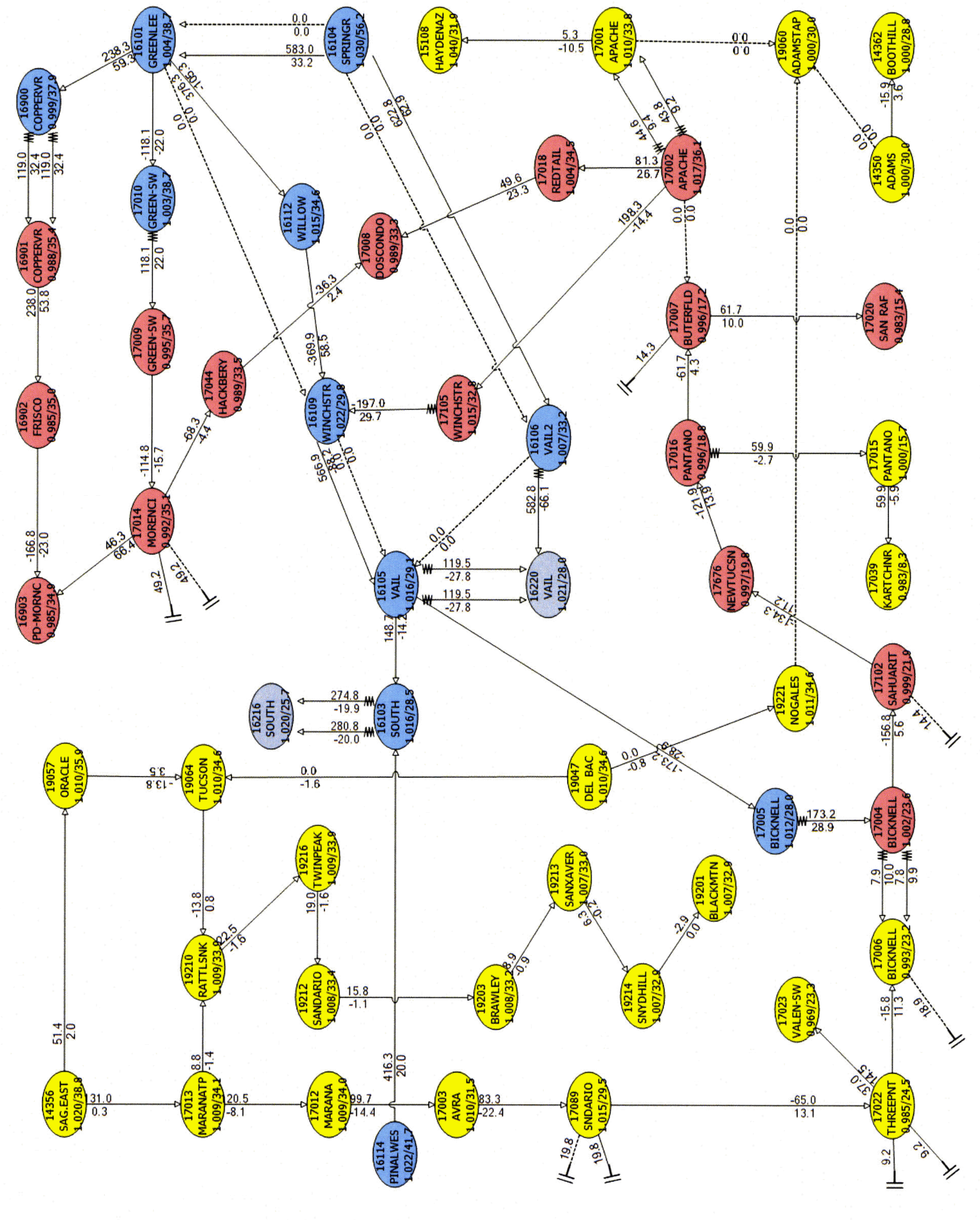
2020HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out followed by the Green-SW 345/230 kV Transformer out of service



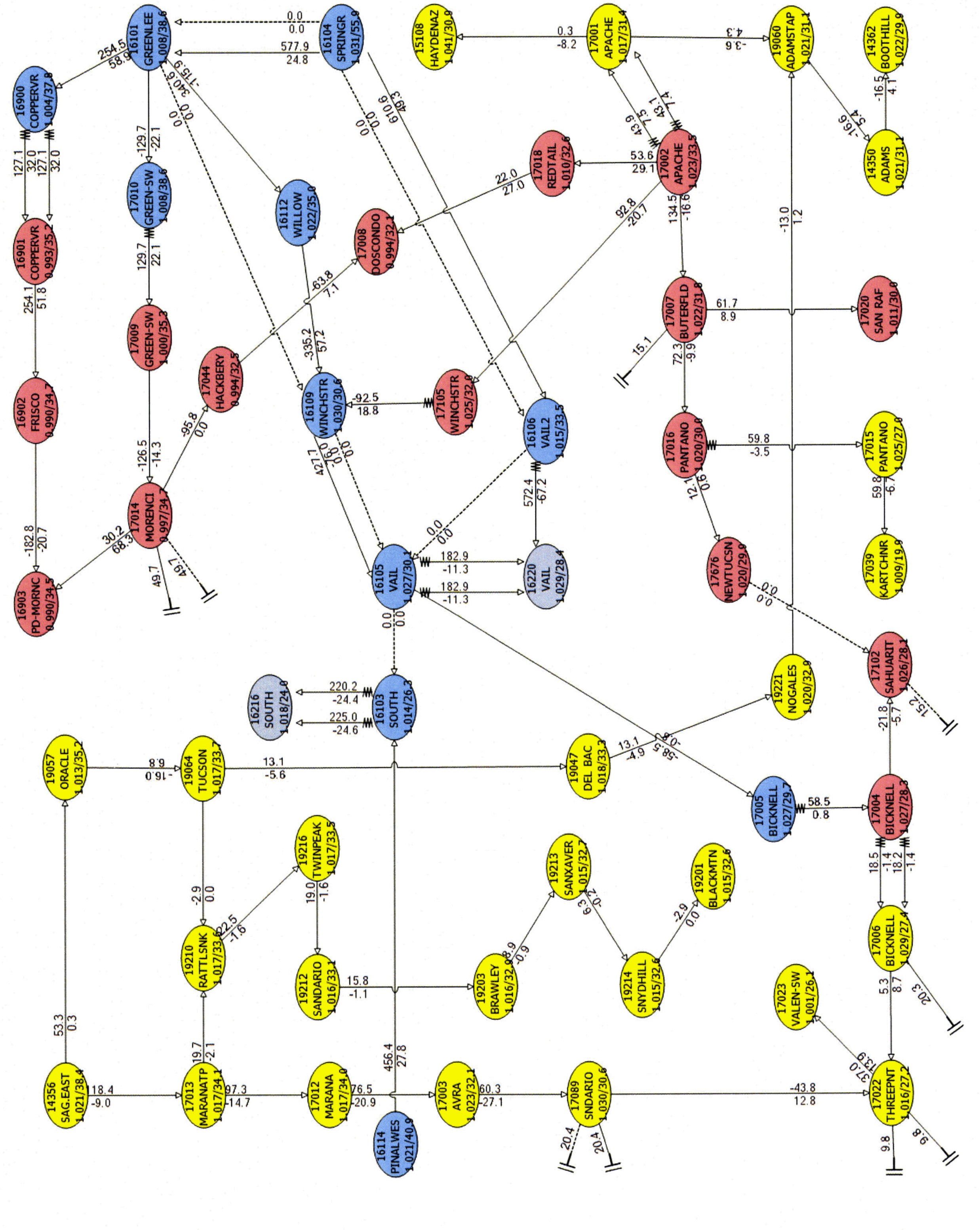
2020HS Southwest Transmission Cooperative Base System with Common Corridor #2 outage of Butterfield to Pantano 230 kV & Adams Tap to Apache 115 kV Lines



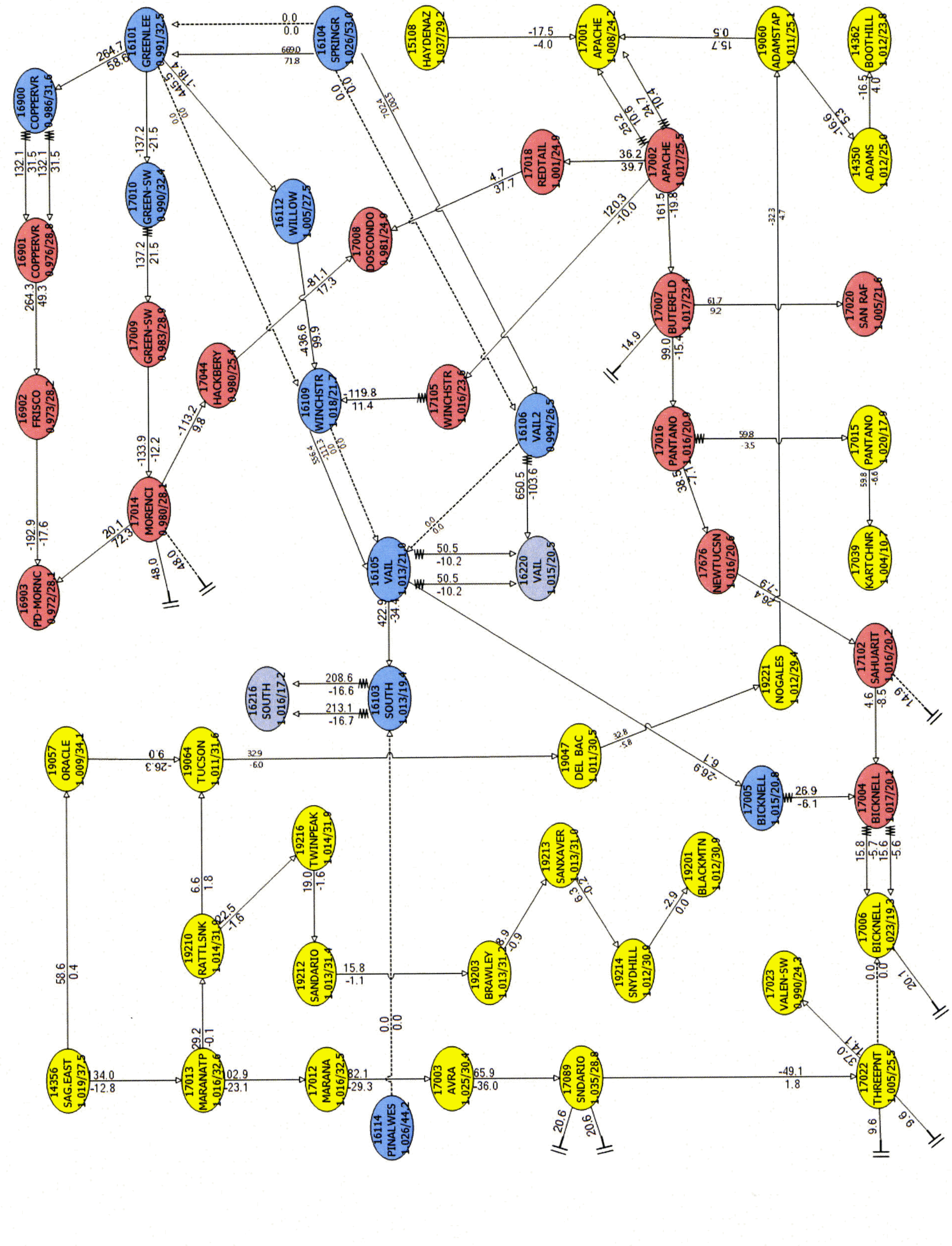
2020HS Southwest Transmission Cooperative Base System with Common Corridor #3 outage of Apache to Butterfield 230 kV & Adams Tap to Apache 115 kV Lines



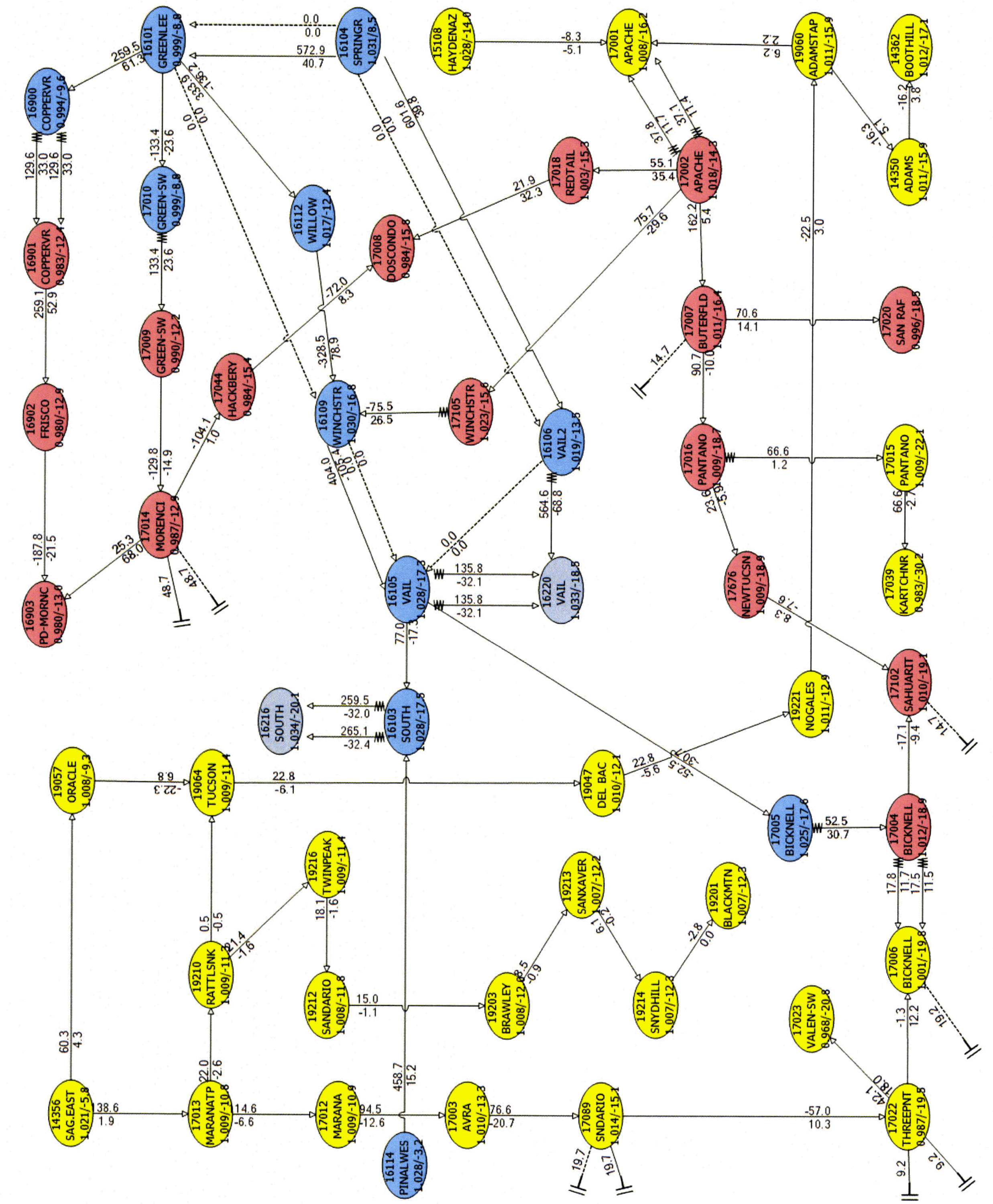
2020HS Southwest Transmission Cooperative Base System with Common Corridor #5 outage of Vail to South 345 kV & New Tucson to Sahuarita 230 kV Lines



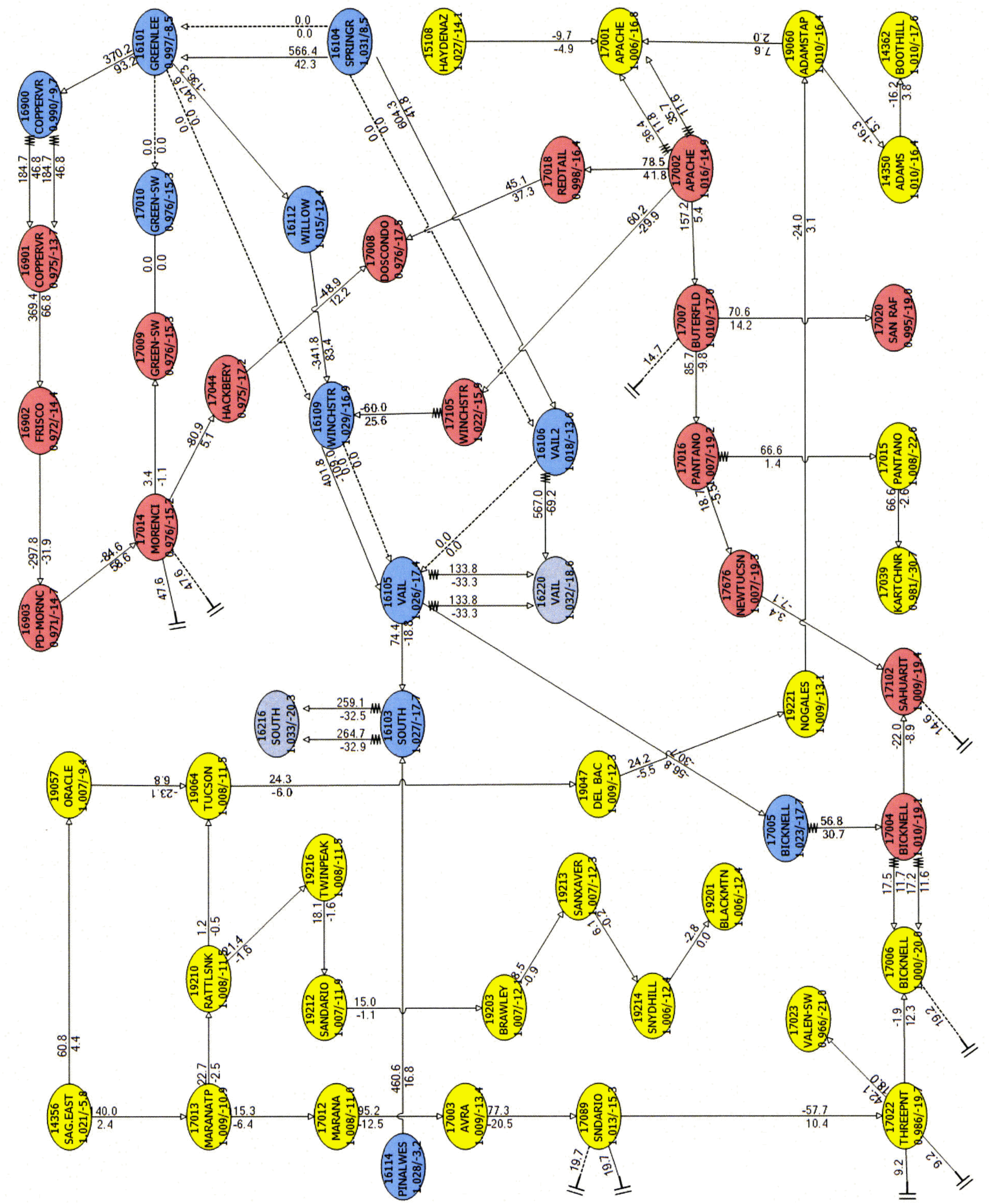
2020HS Southwest Transmission Cooperative Base System with Common Corridor #6 outage of Pinal West to South 345 kV & Bicknell to Three Points 115 kV Lines



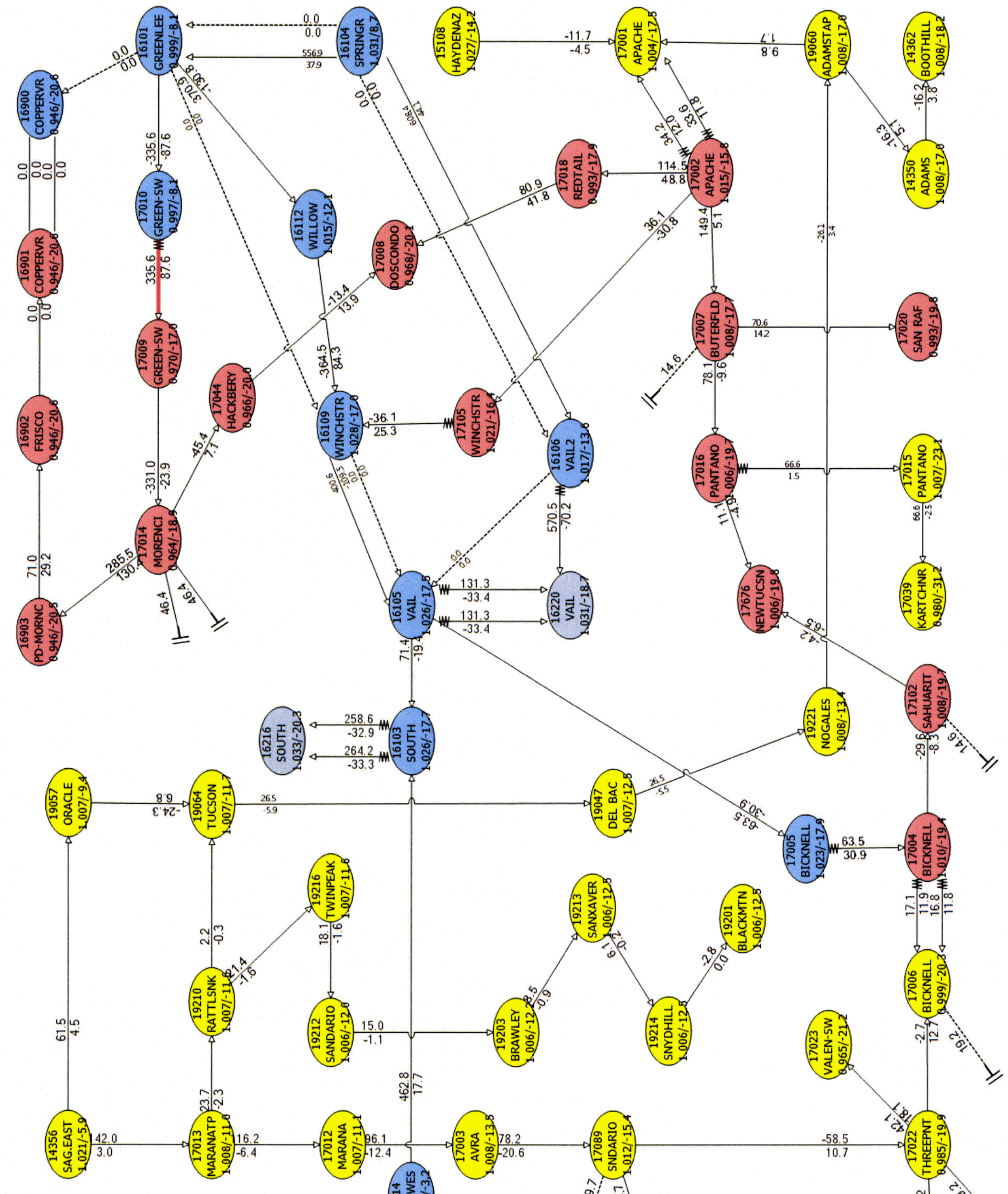
2025HS Southwest Transmission Cooperative Base System



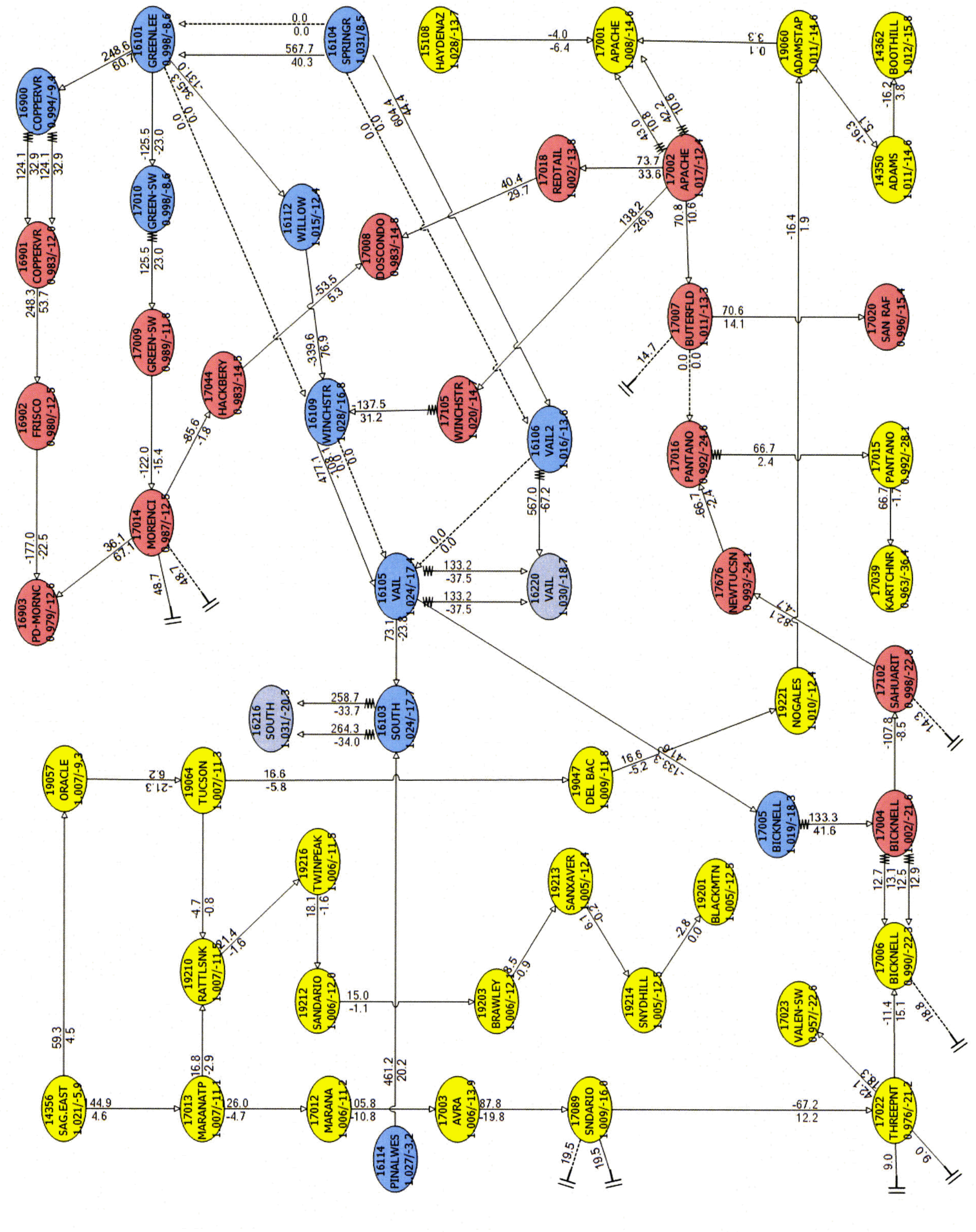
2025HS Southwest Transmission Cooperative Base System with Green-SW to Greenlee 345 kV Line out of service



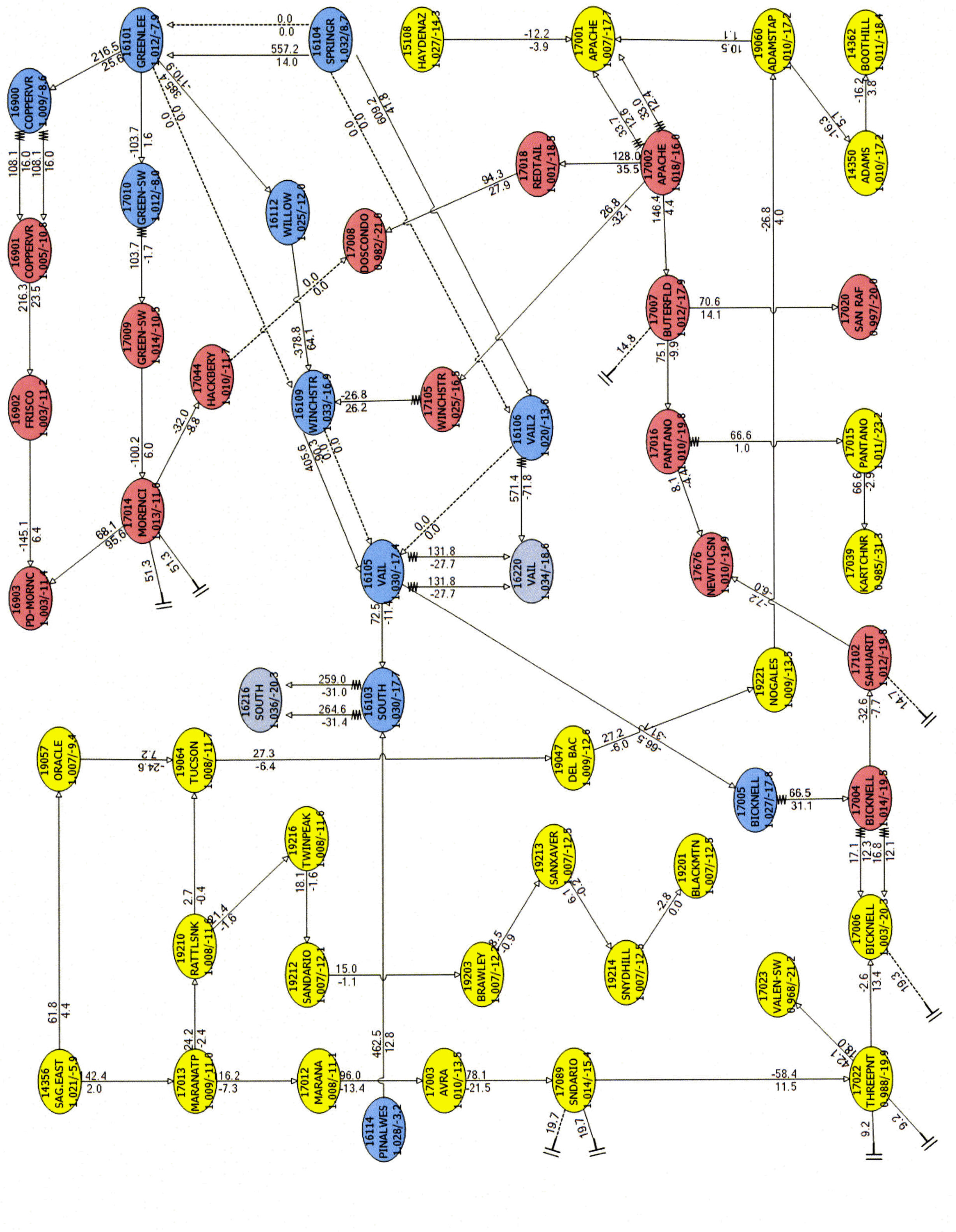
2025HS Southwest Transmission Cooperative Base System with Greenlee to Copper Verde 345 kV Line out of service



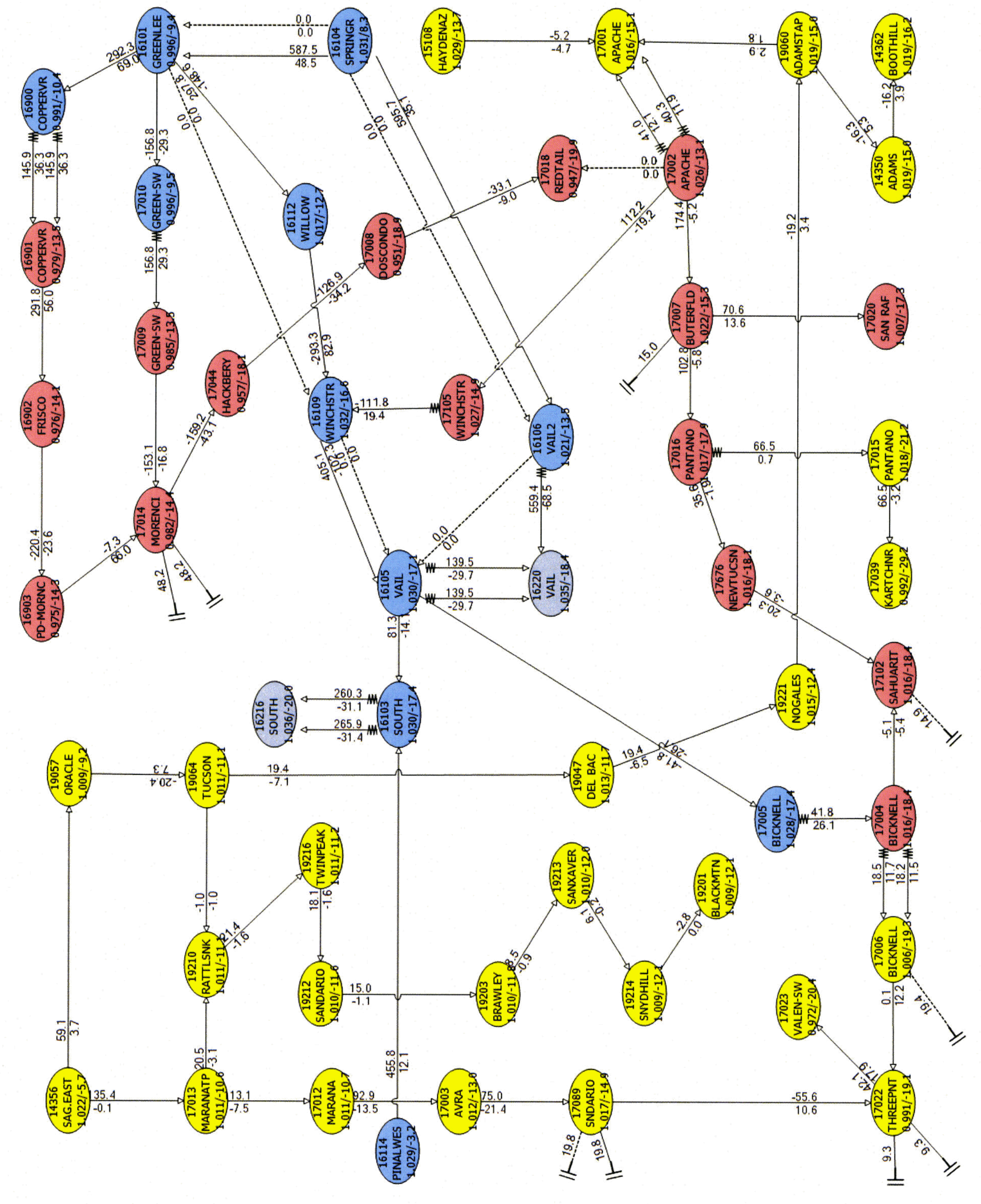
2025HS Southwest Transmission Cooperative Base System with Butterfield to Pantano 230 kV Line out of service



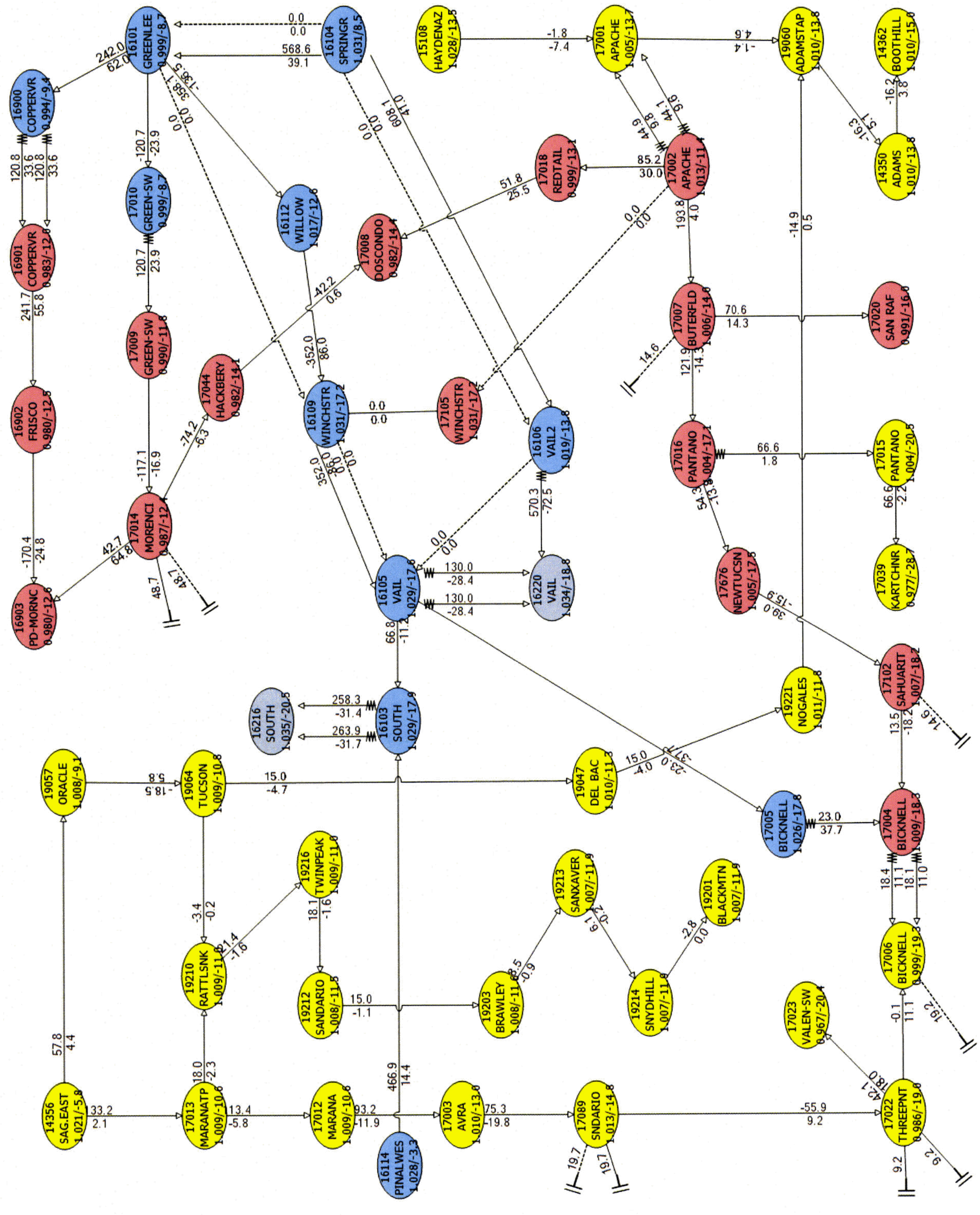
2025HS Southwest Transmission Cooperative Base System with Dos Condados to Hackberry 230 kV Line out of service



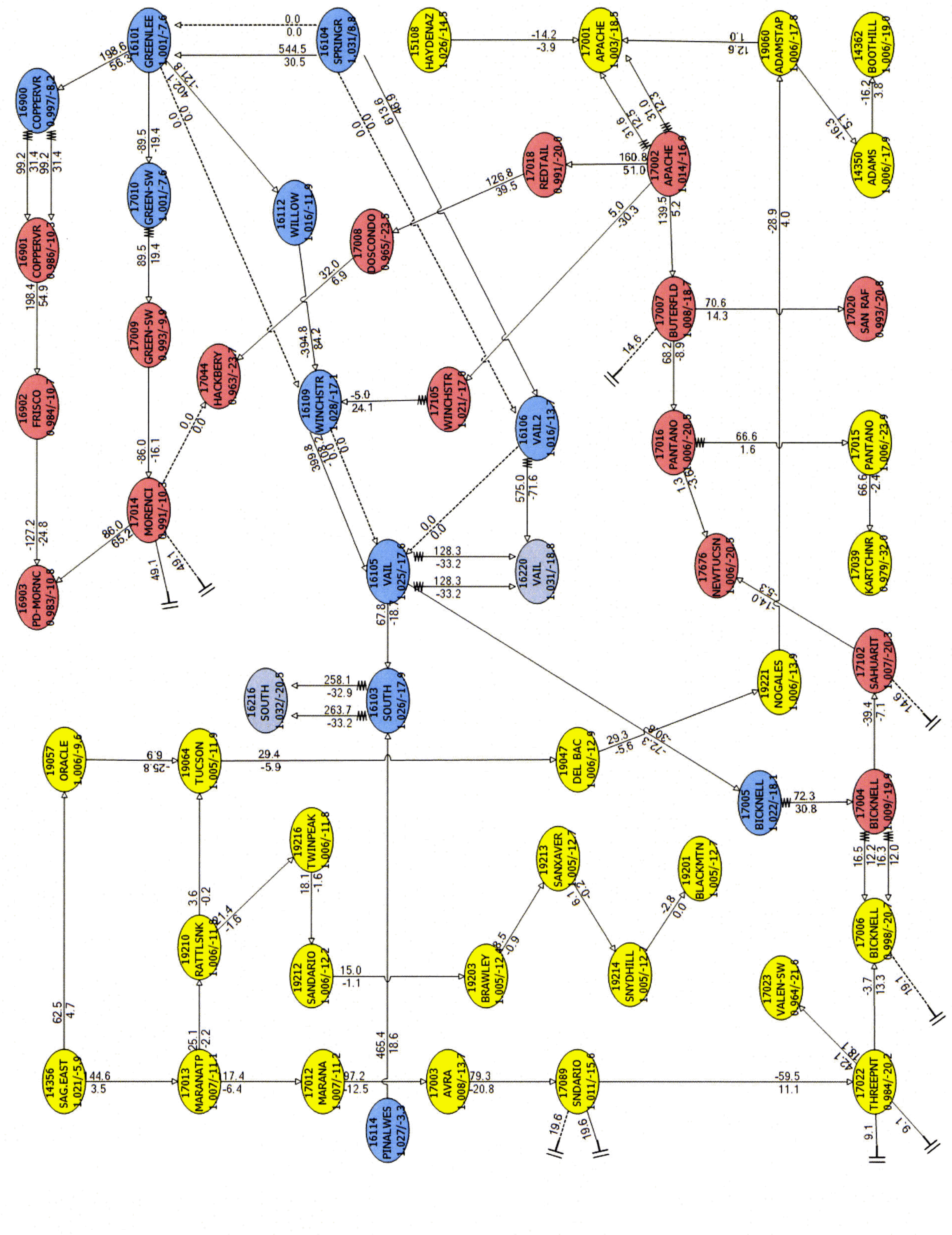
2025HS Southwest Transmission Cooperative Base System with Apache to Redtail 230 kV Line out of service



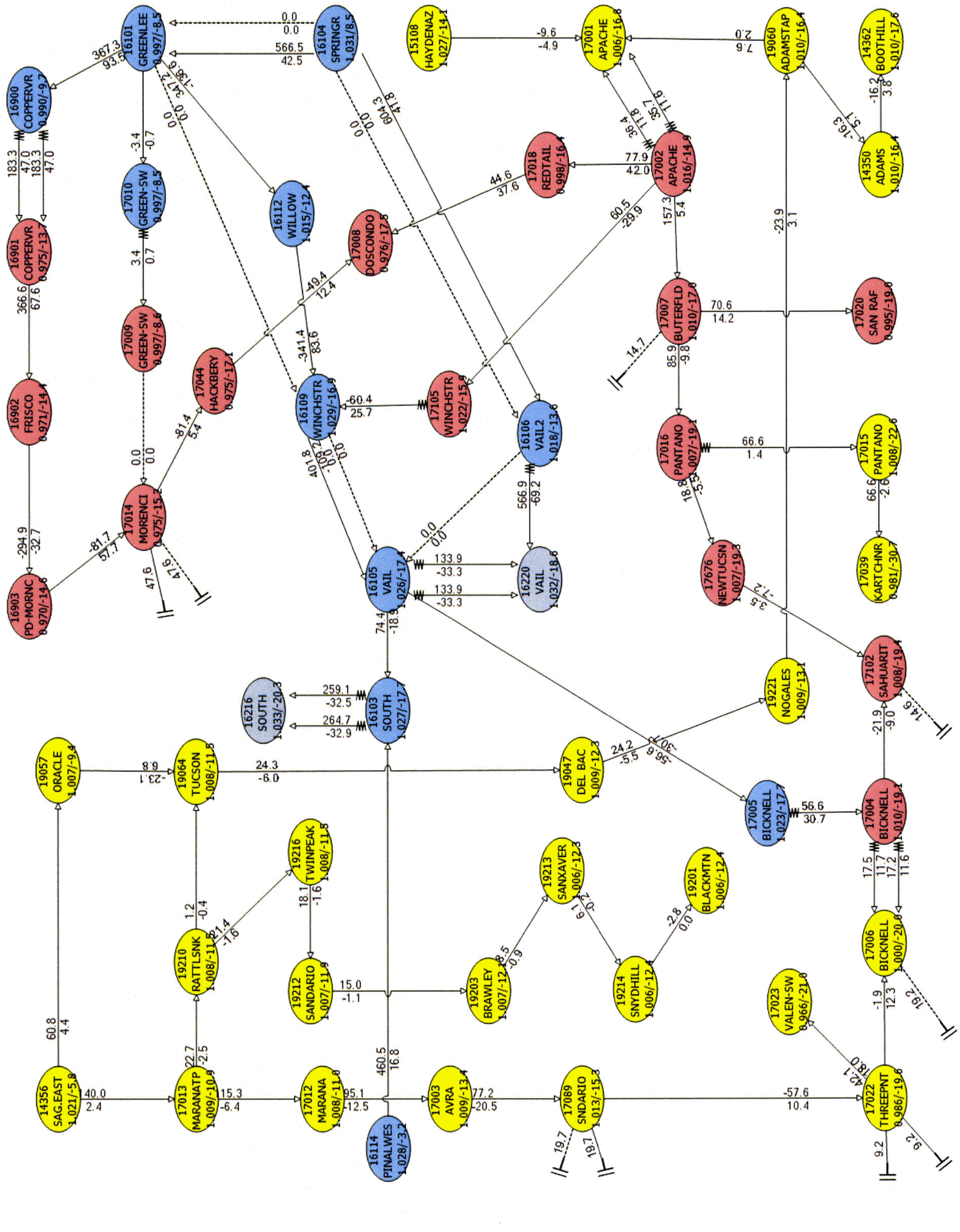
2025HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line out of service



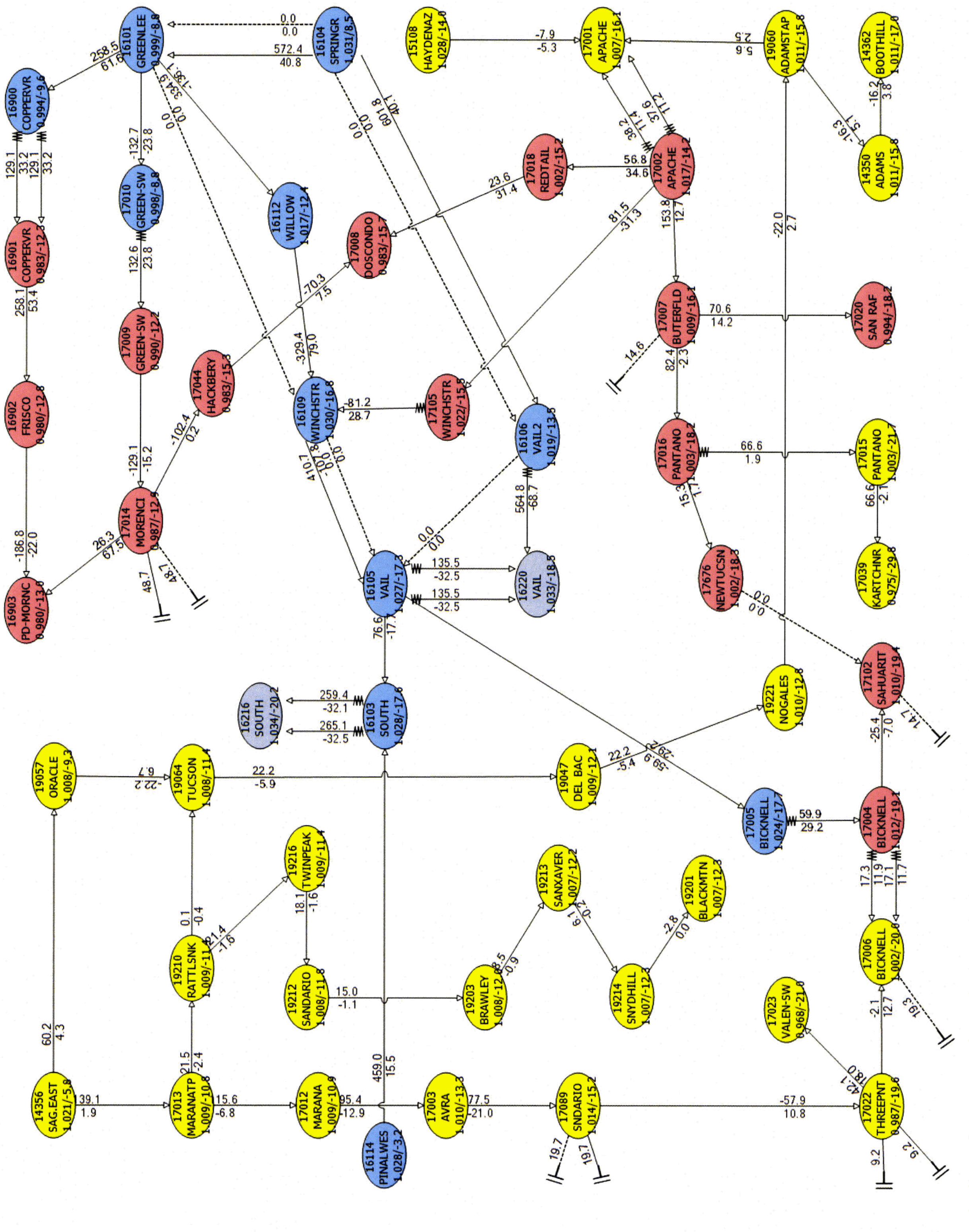
2025HS Southwest Transmission Cooperative Base System with Hackberry to Morenci 230 kV Line out of service



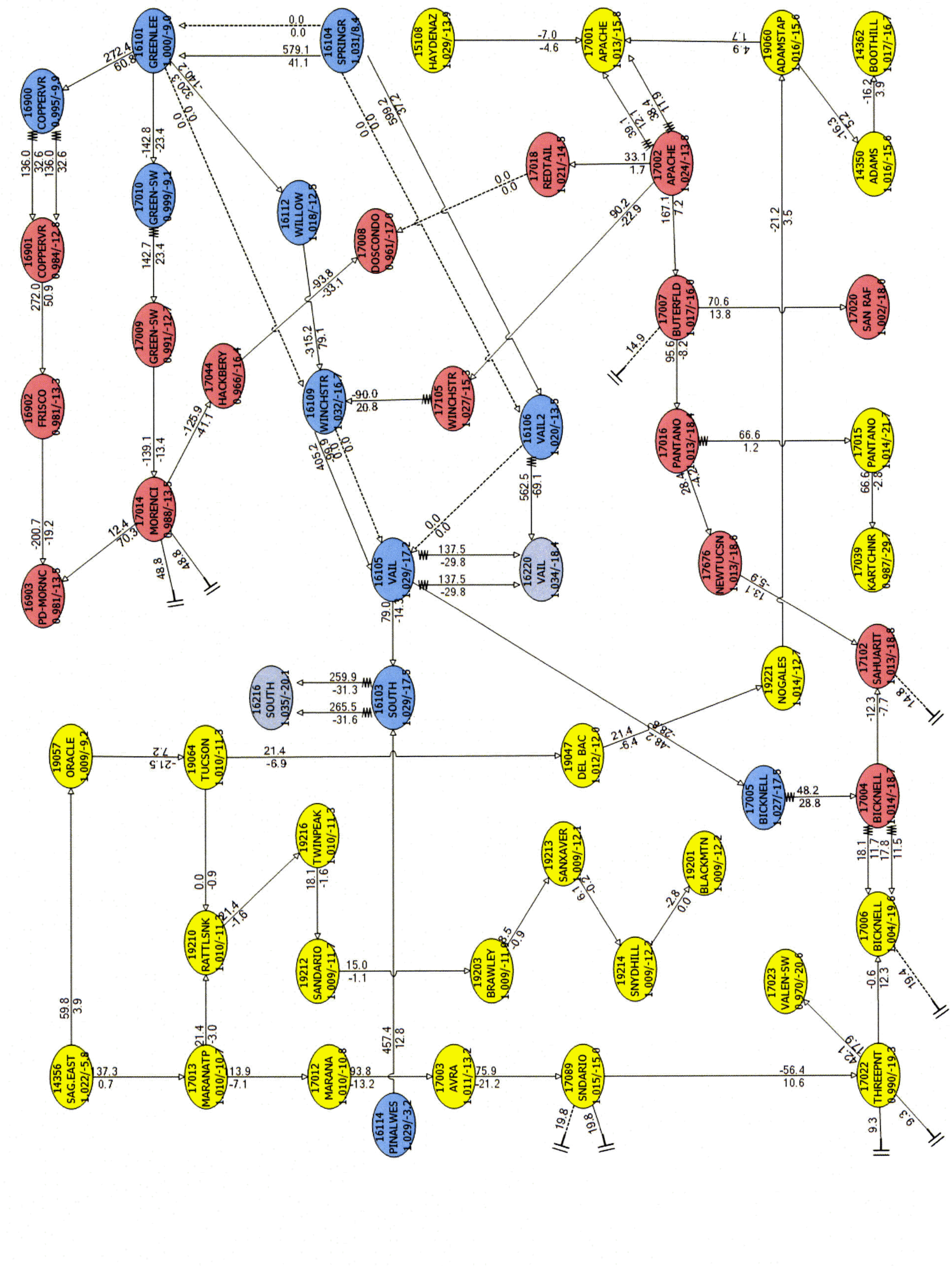
2025HS Southwest Transmission Cooperative Base System with Morenci to Green-SW 230 kV Line out of service



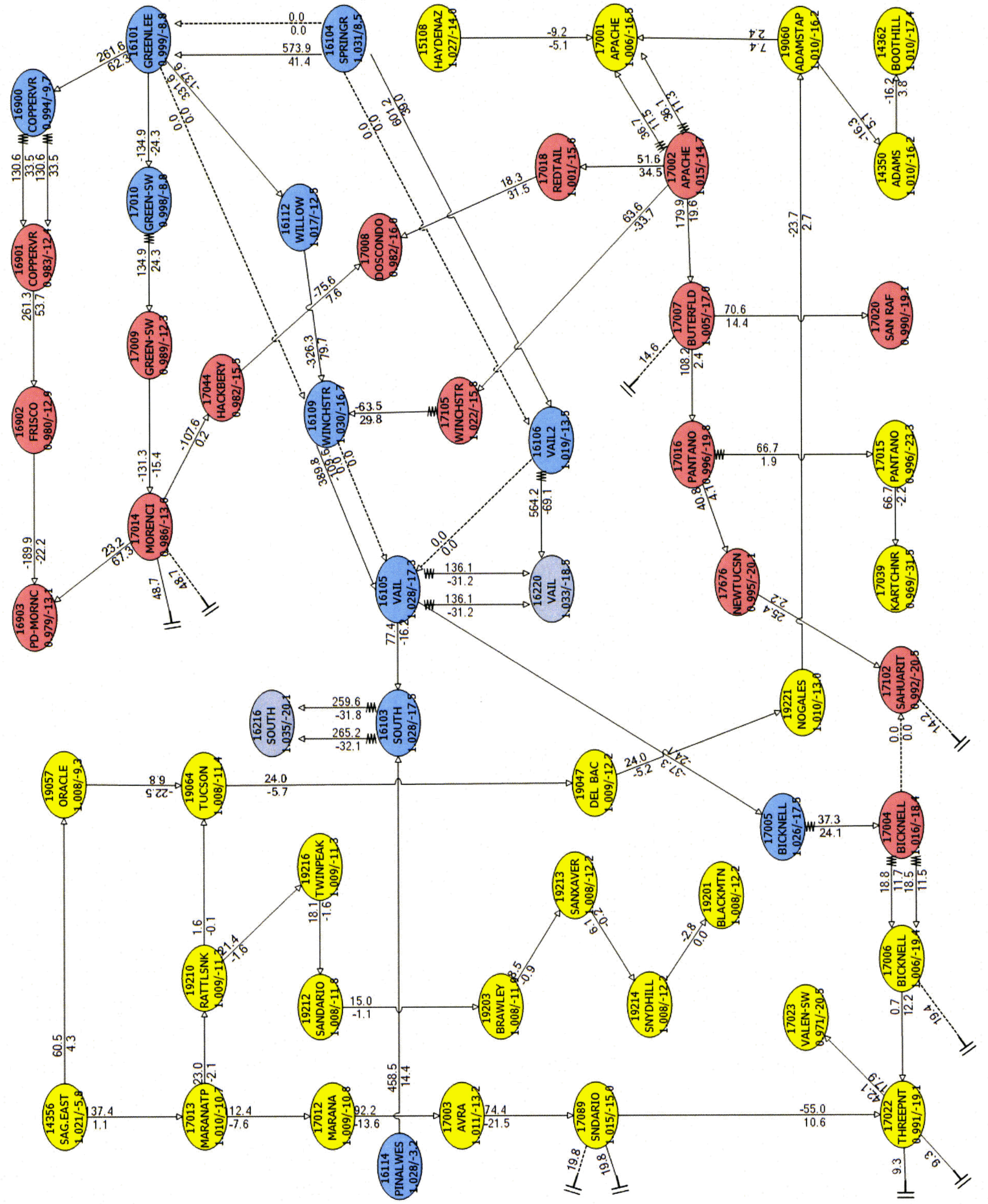
2025HS Southwest Transmission Cooperative Base System with New Tucson to Sahuarita 230 kV Line out of service



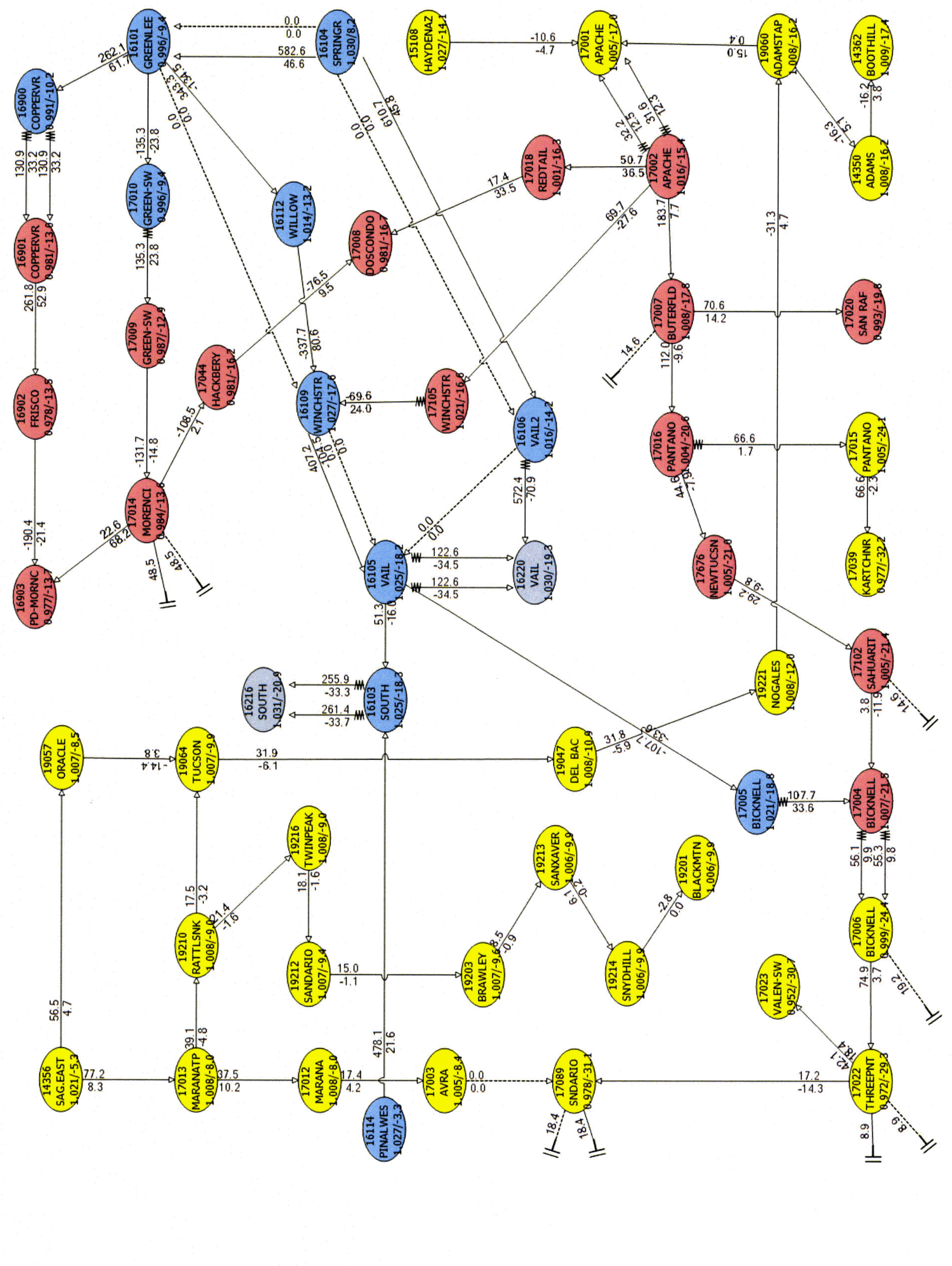
2025HS Southwest Transmission Cooperative Base System with Redtail to Dos Condados 230 kV Line out of service



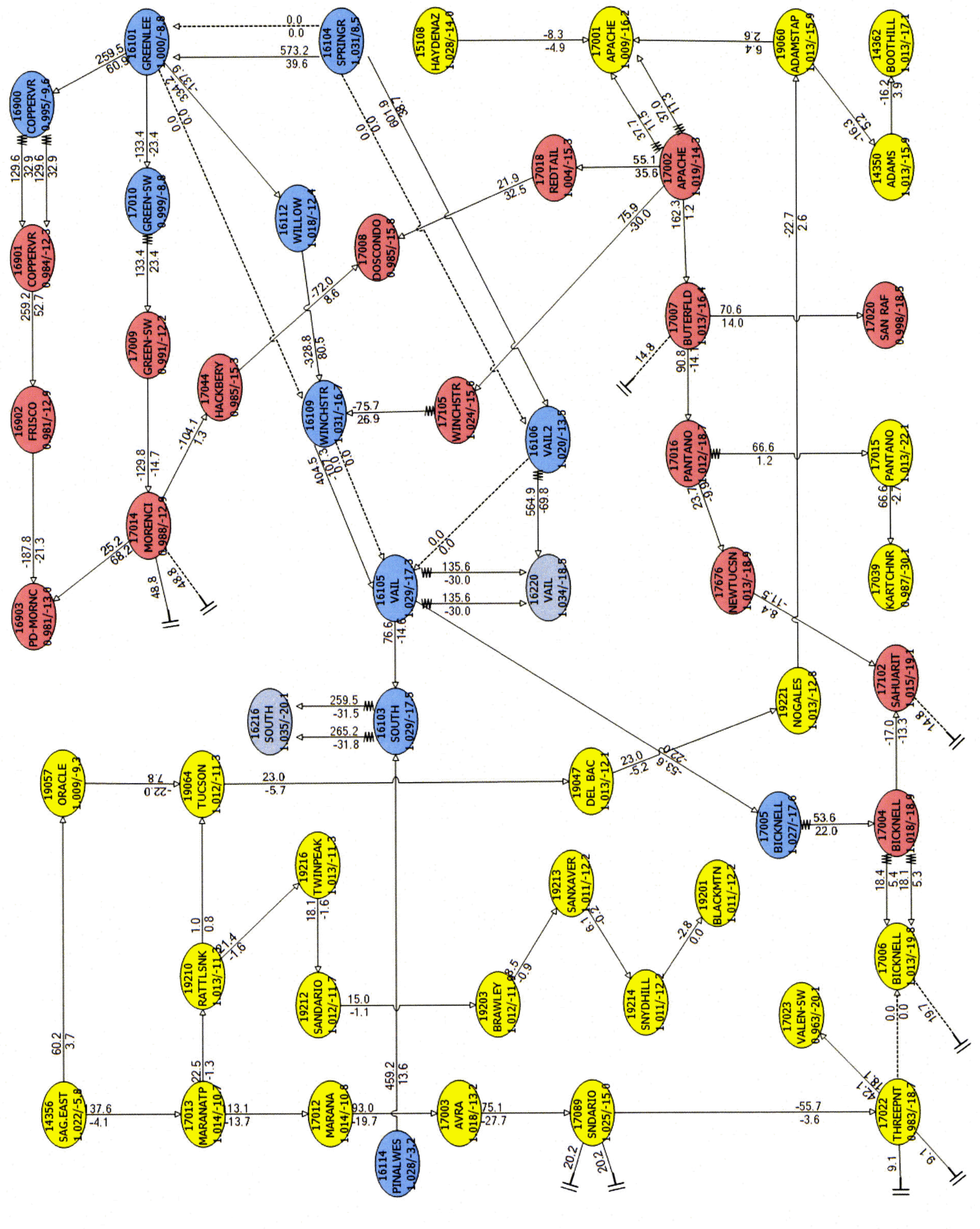
2025HS Southwest Transmission Cooperative Base System with Sahuarita to Bicknell 230 kV Line out of service



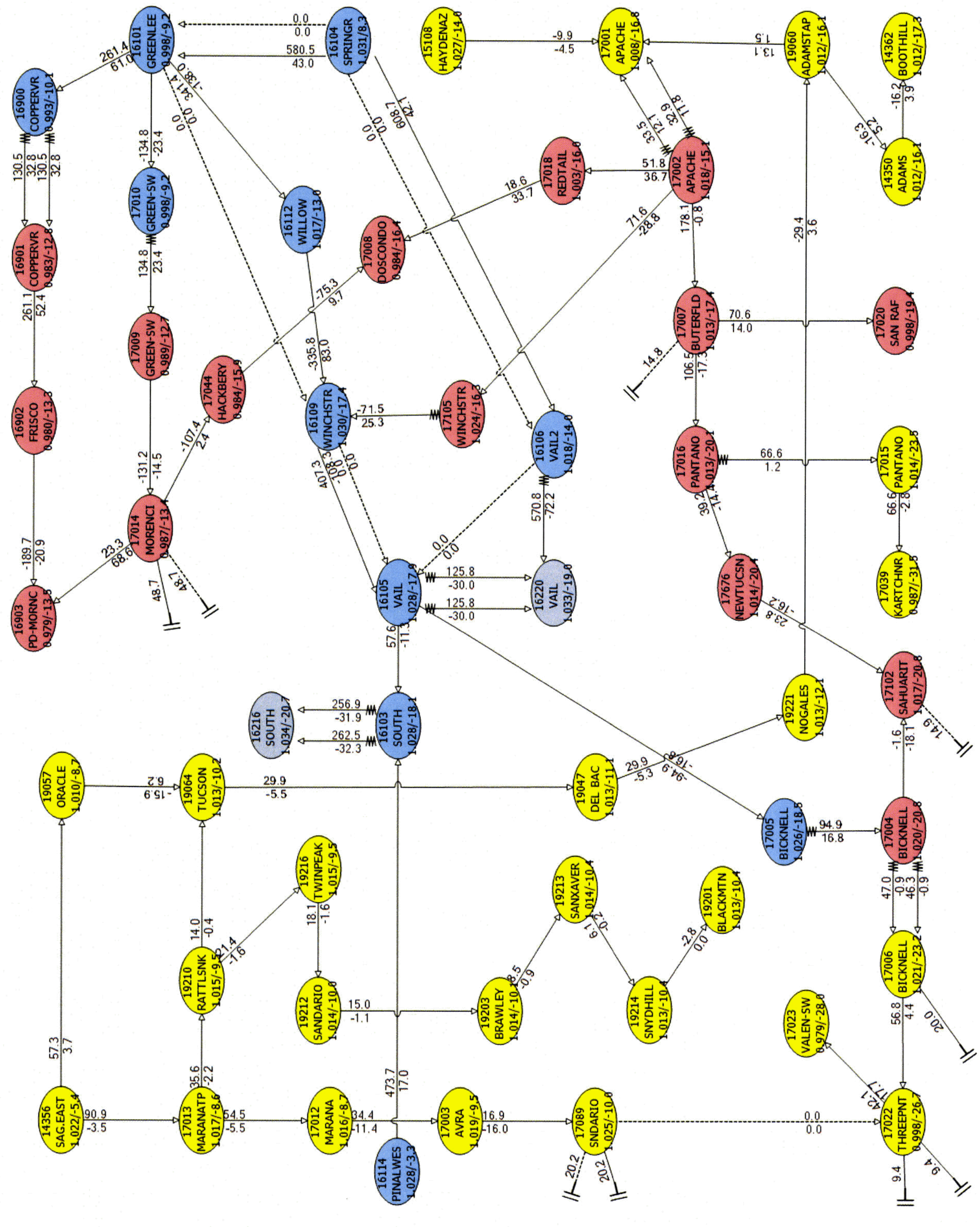
2025HS Southwest Transmission Cooperative Base System with Avra to Sandario 115 kV Line out of service



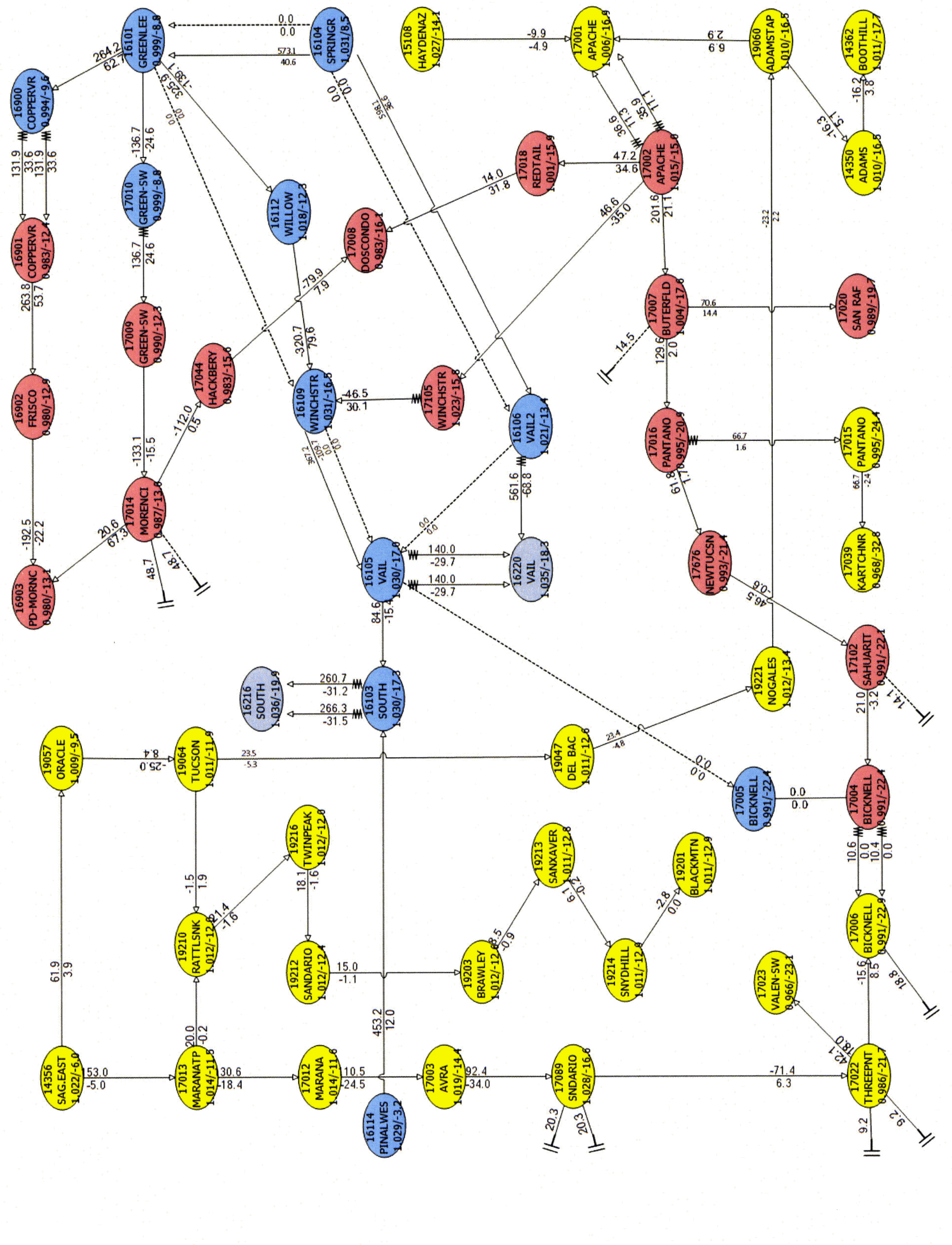
2025HS Southwest Transmission Cooperative Base System with Bicknell to Three Points 115 kV Line out of service



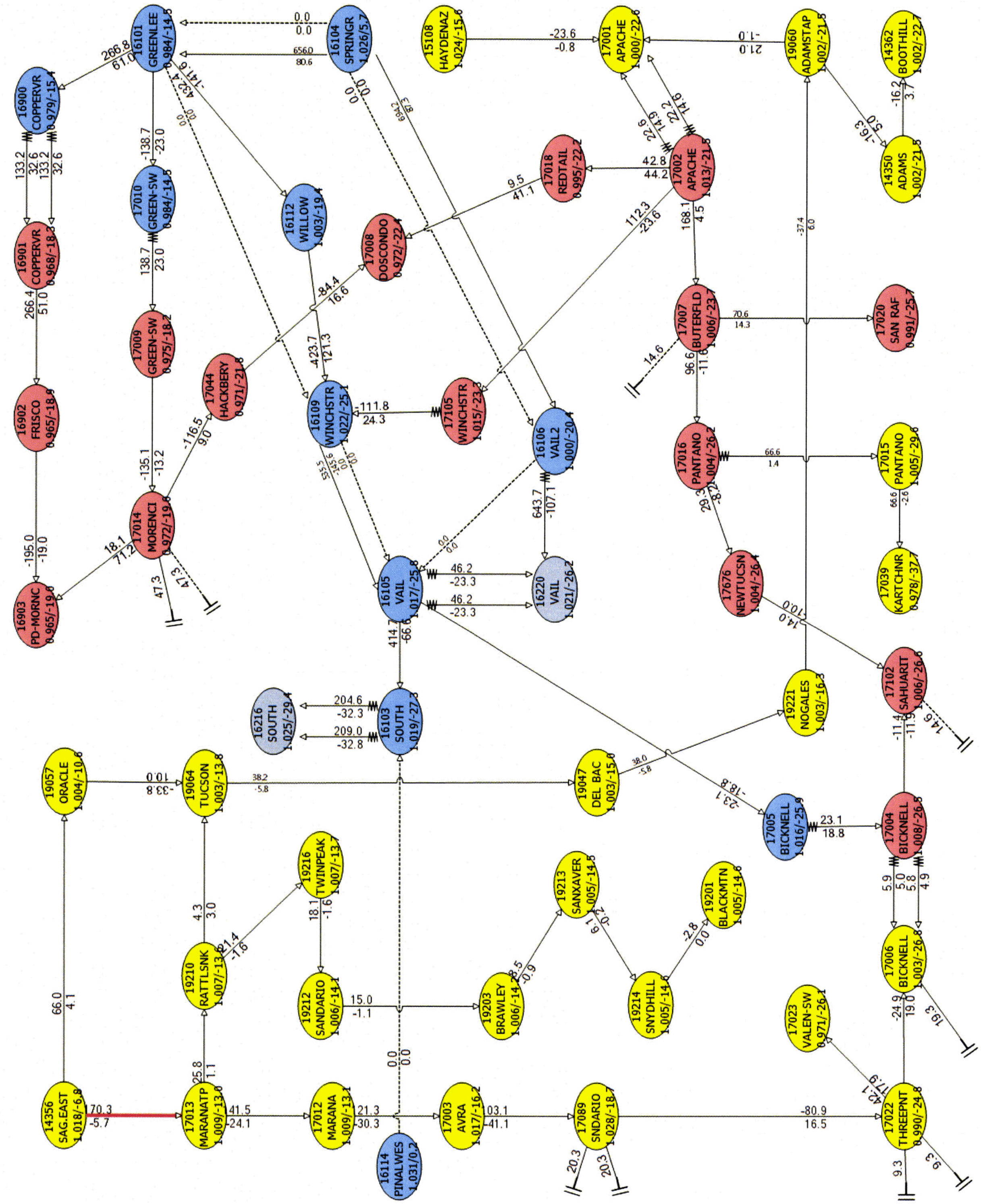
2025HS Southwest Transmission Cooperative Base System with Three Points to Sandario 115 kV Line out of service



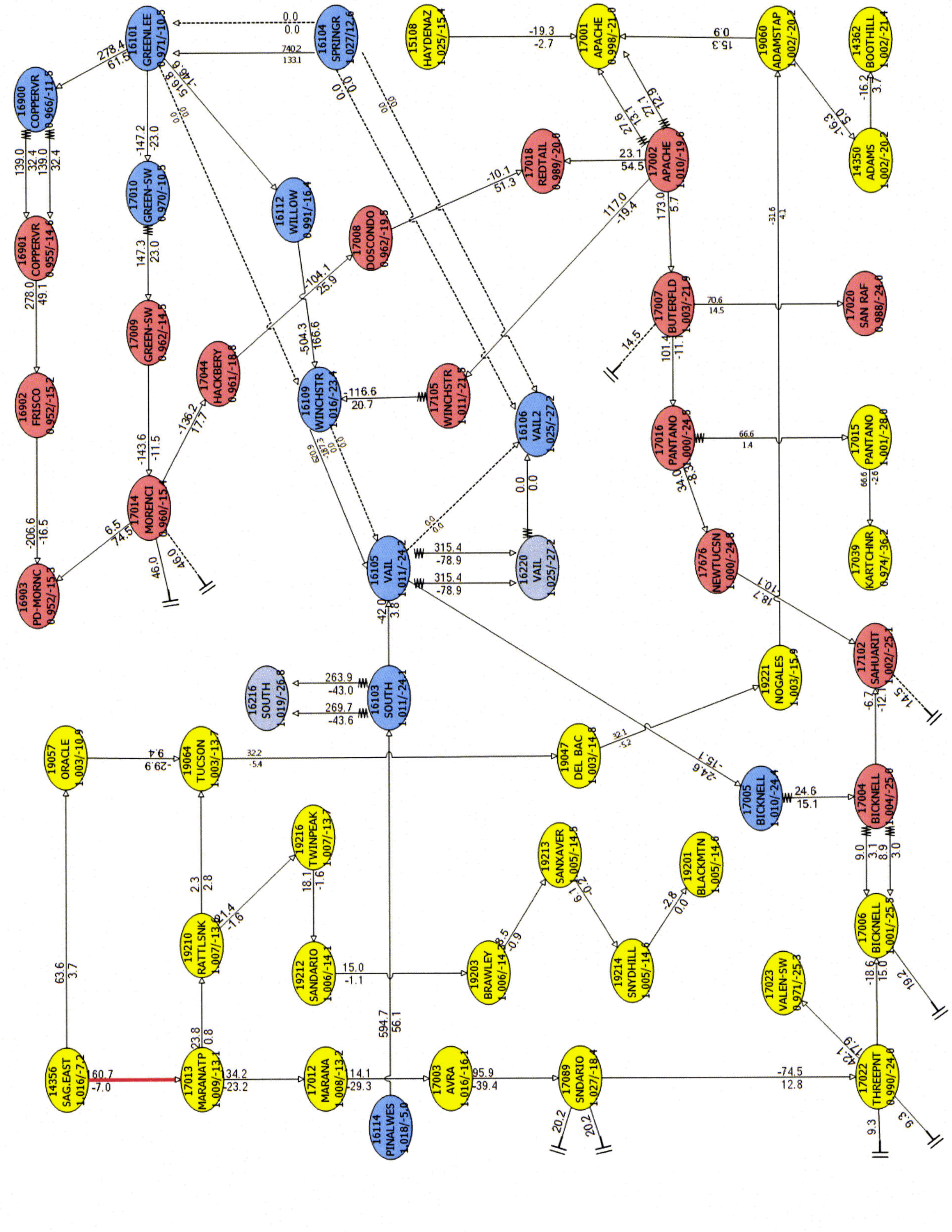
2025HS Southwest Transmission Cooperative Base System with Bicknell to Vail 345 kV Line out of service



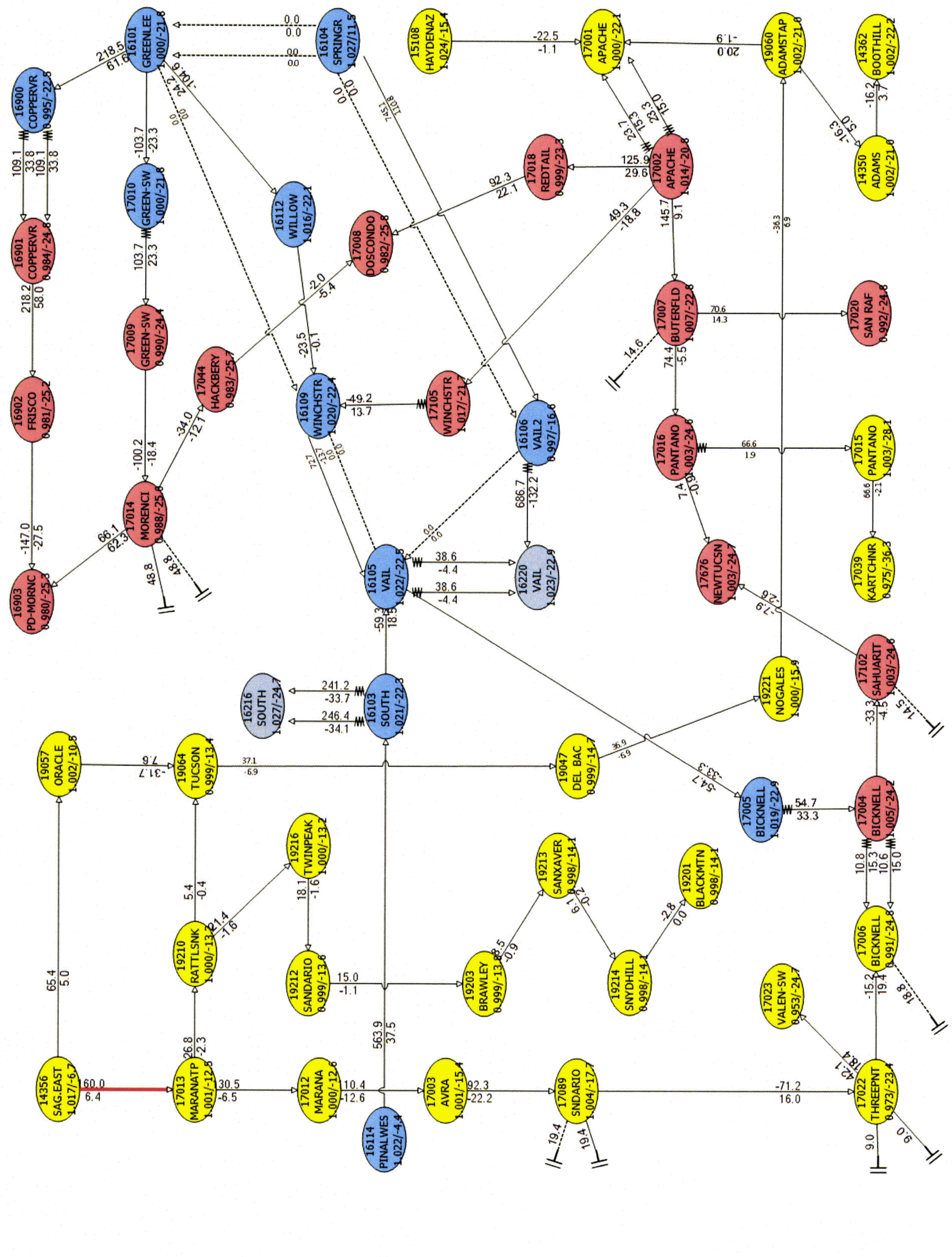
2025HS Southwest Transmission Cooperative Base System with Pinal West to South 345 kV Line out of service



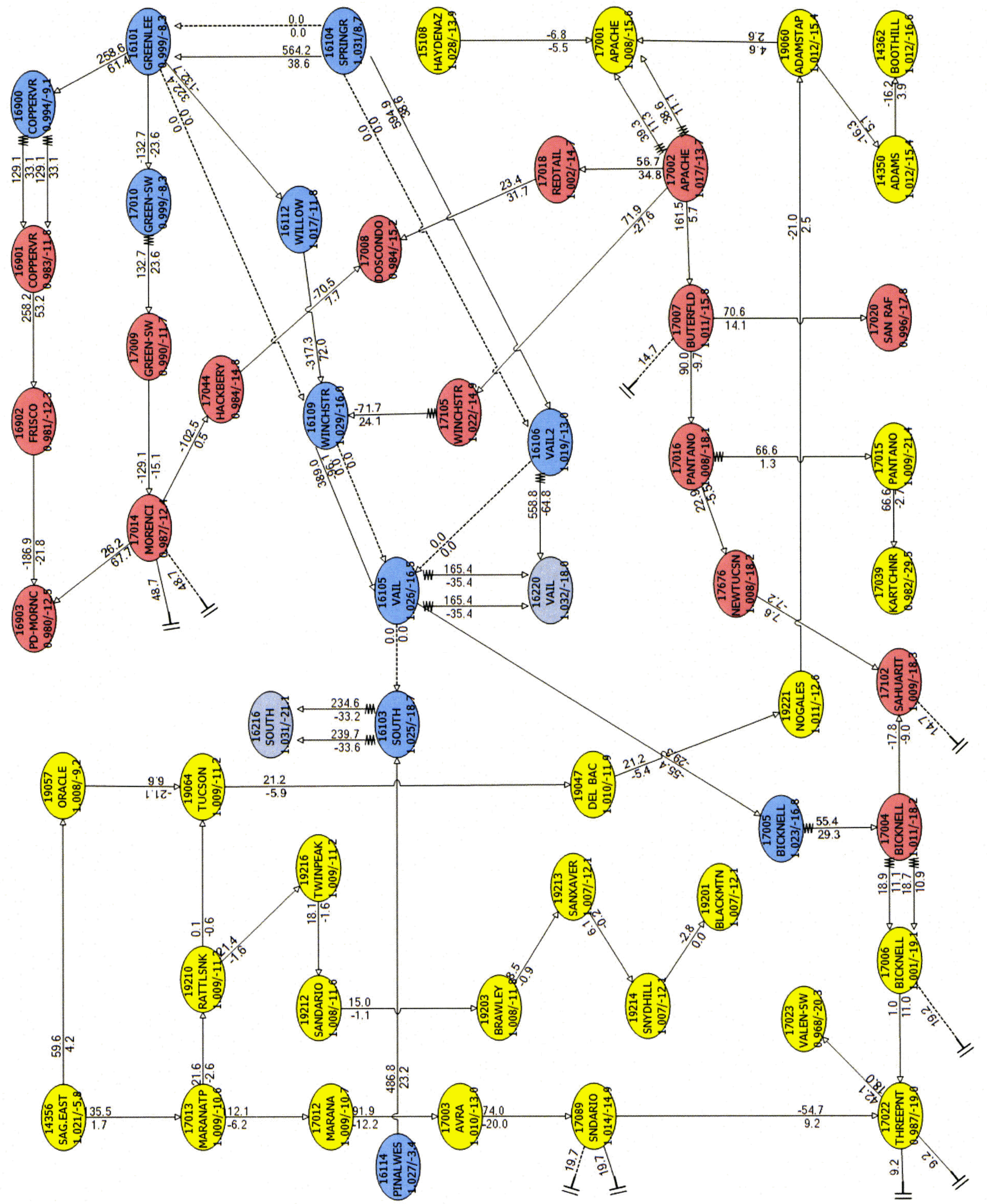
2025HS Southwest Transmission Cooperative Base System with Springerville to Vail2 345 kV Line out of service



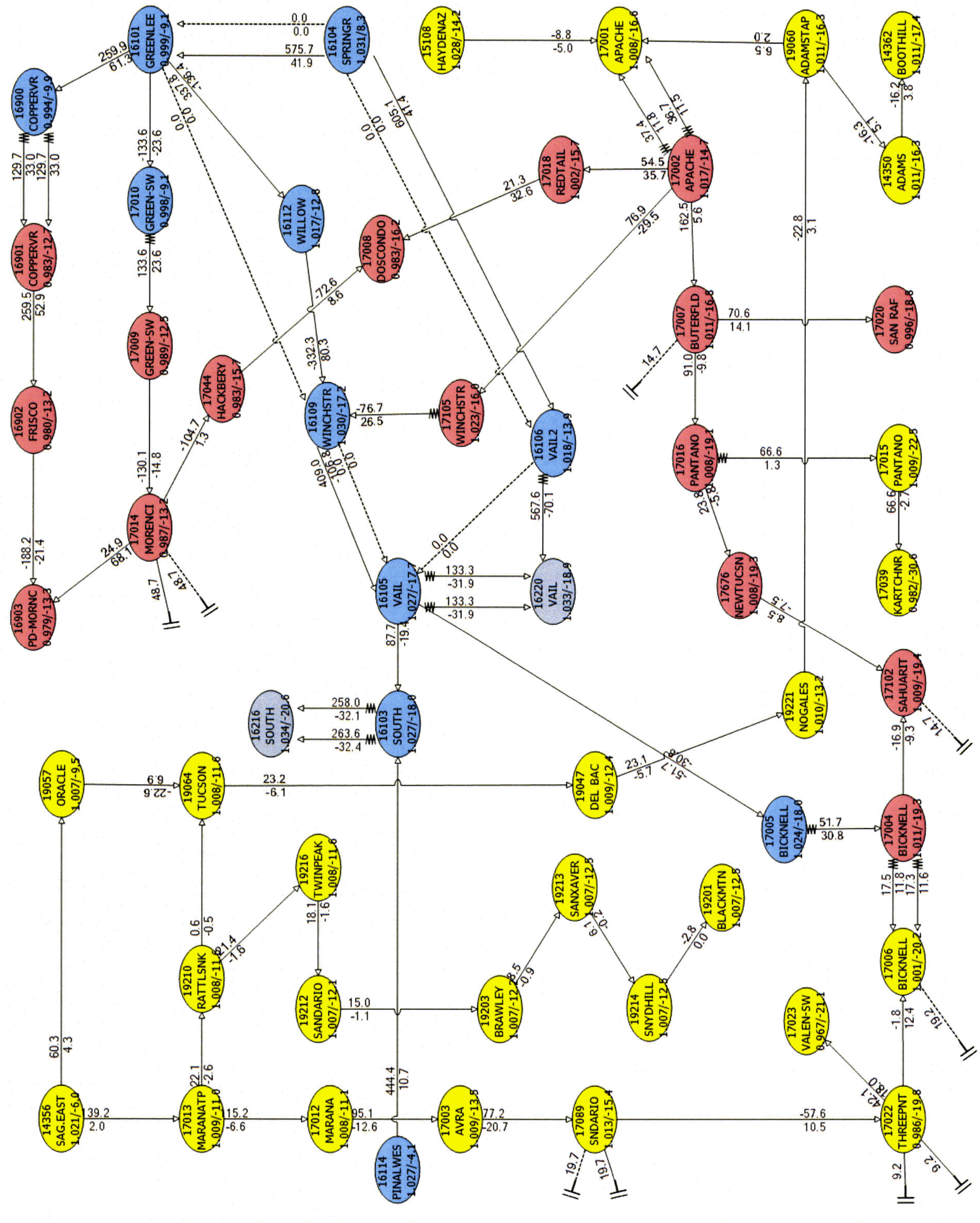
2025HS Southwest Transmission Cooperative Base System with Springerville to Greenlee 345 kV Line out of service



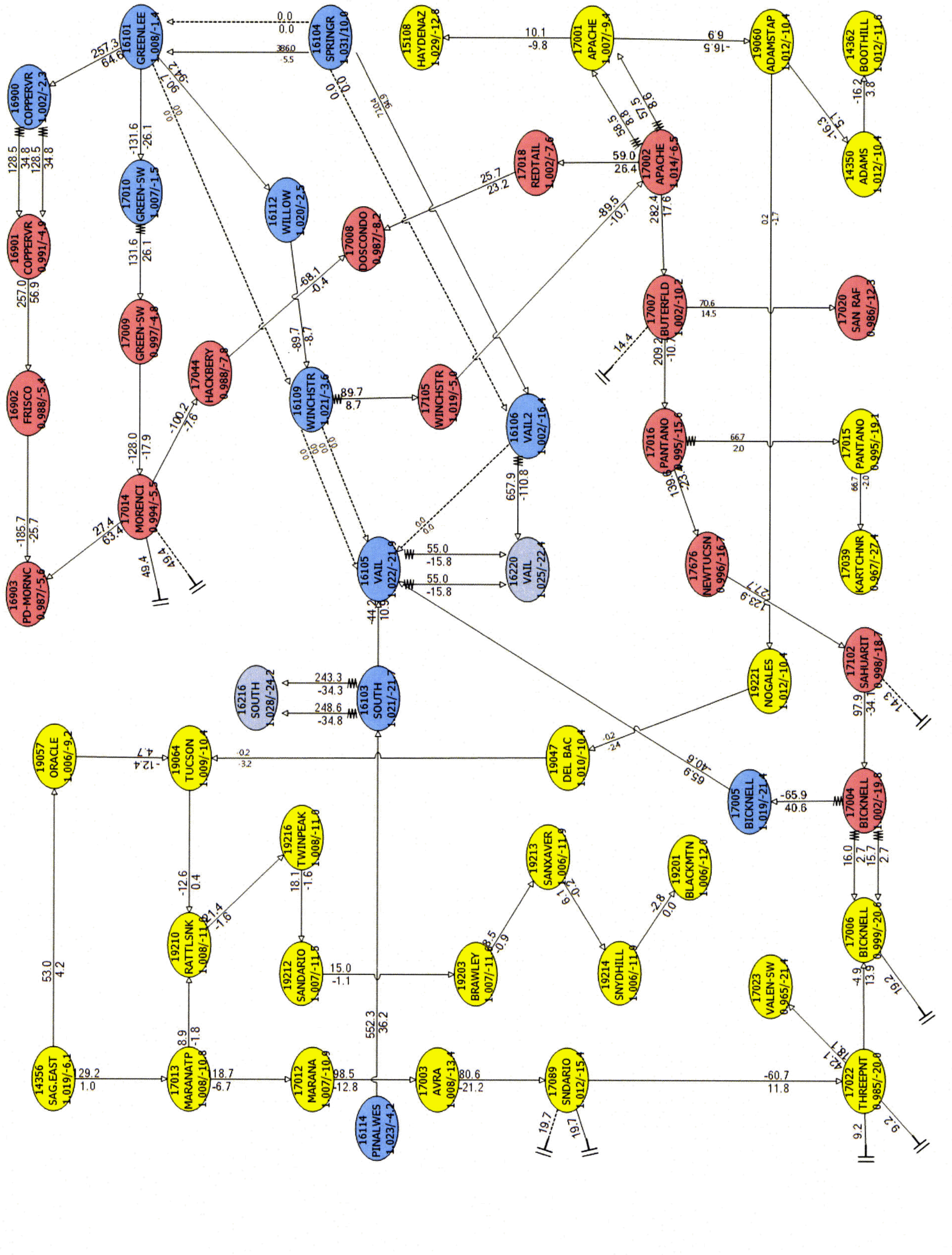
2025HS Southwest Transmission Cooperative Base System with Vail to South 345 kV Line out of service



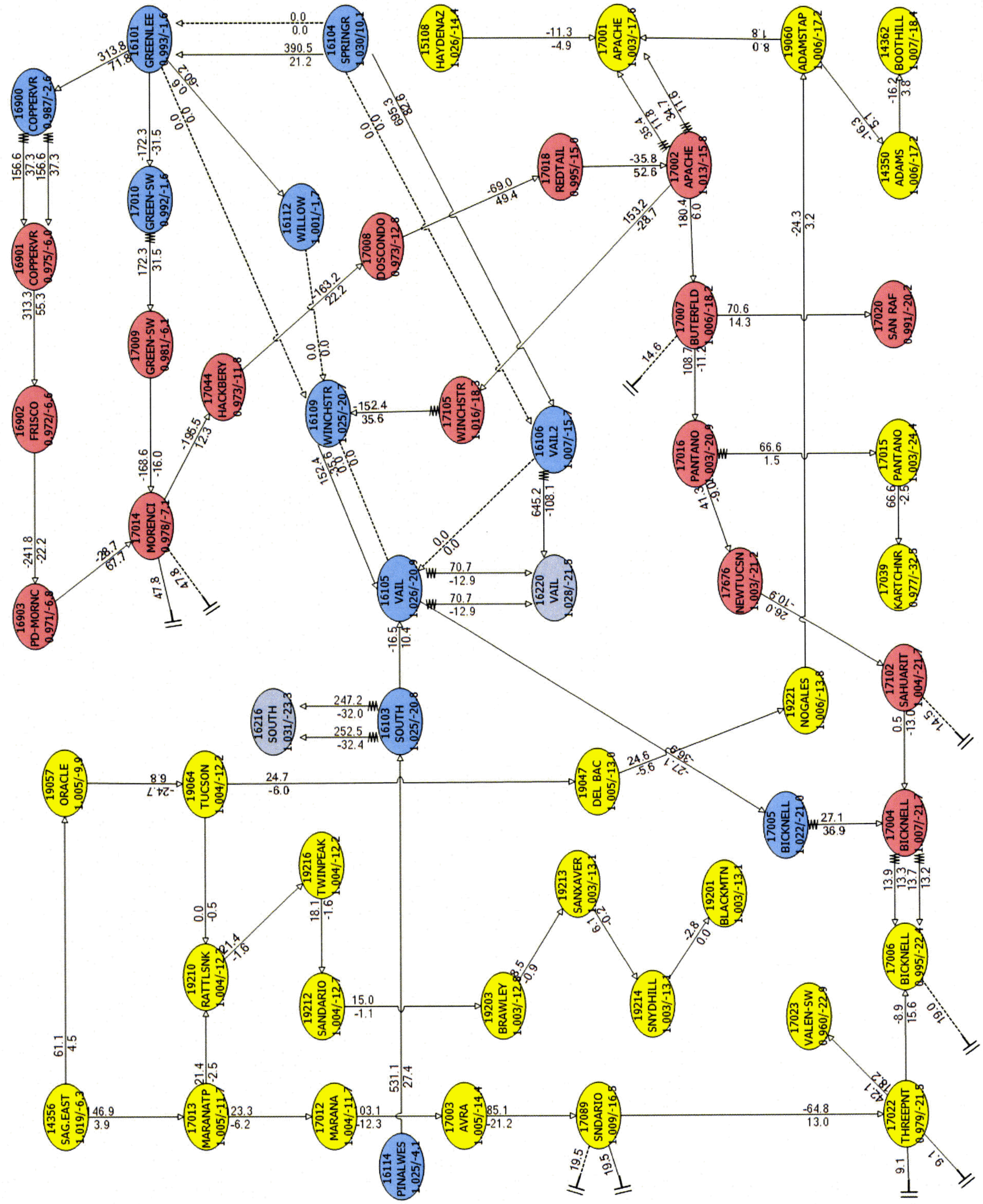
2025HS Southwest Transmission Cooperative Base System with Westwing to Pinal West 345 kV Line out of service



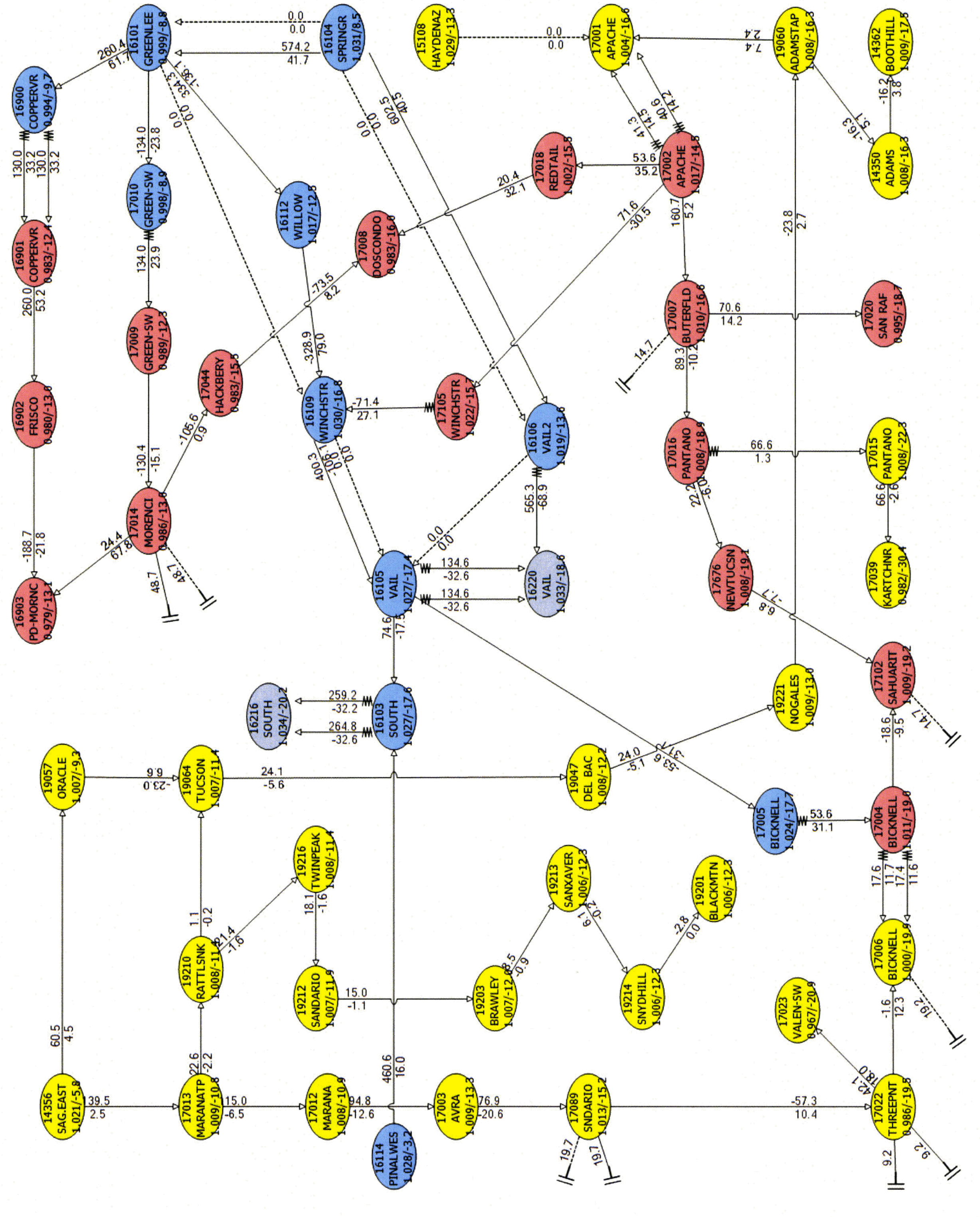
2025HS Southwest Transmission Cooperative Base System with Winchester to Vail 345 kV Line out of service



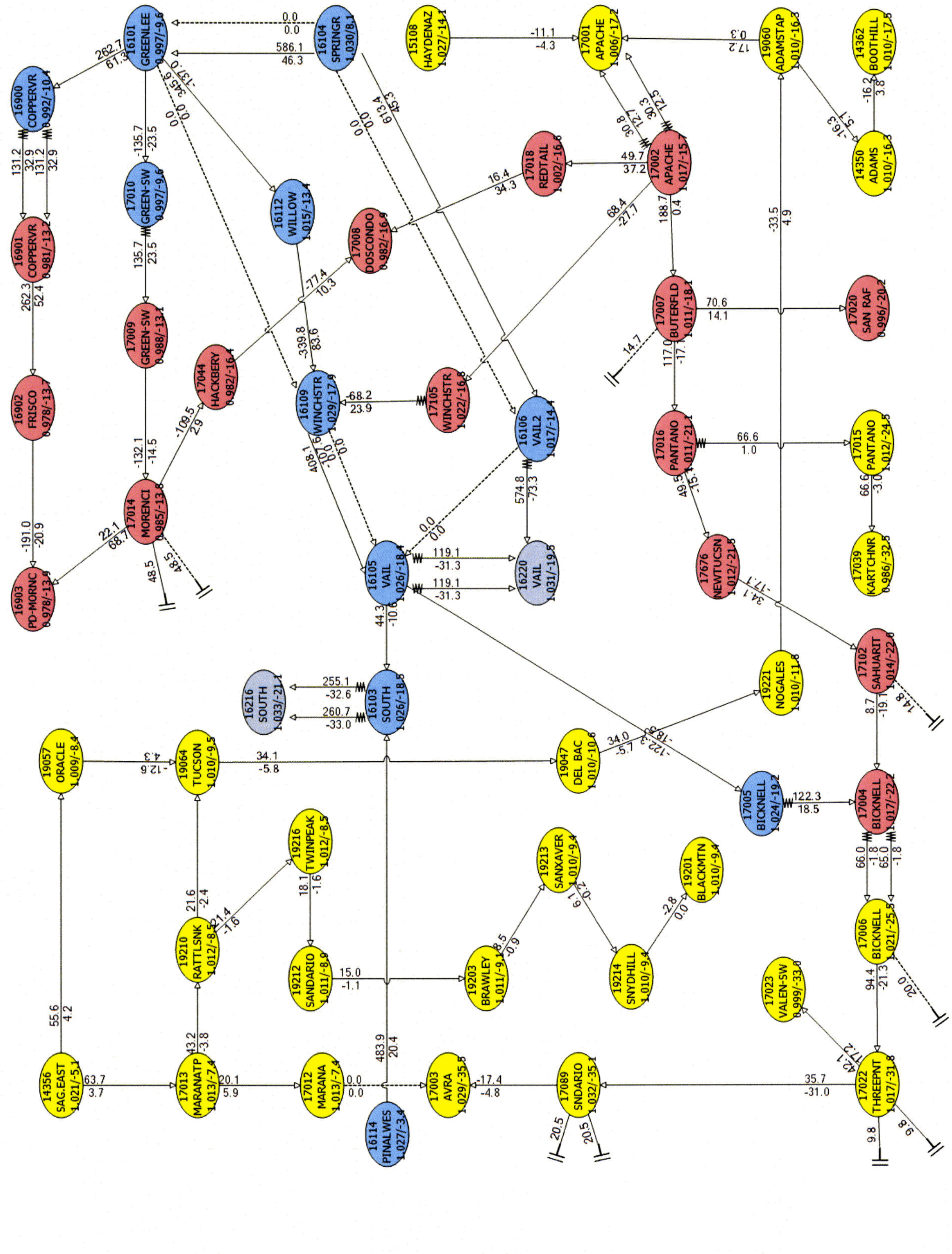
2025HS Southwest Transmission Cooperative Base System with Winchester to Willow 345 kV Line out of service



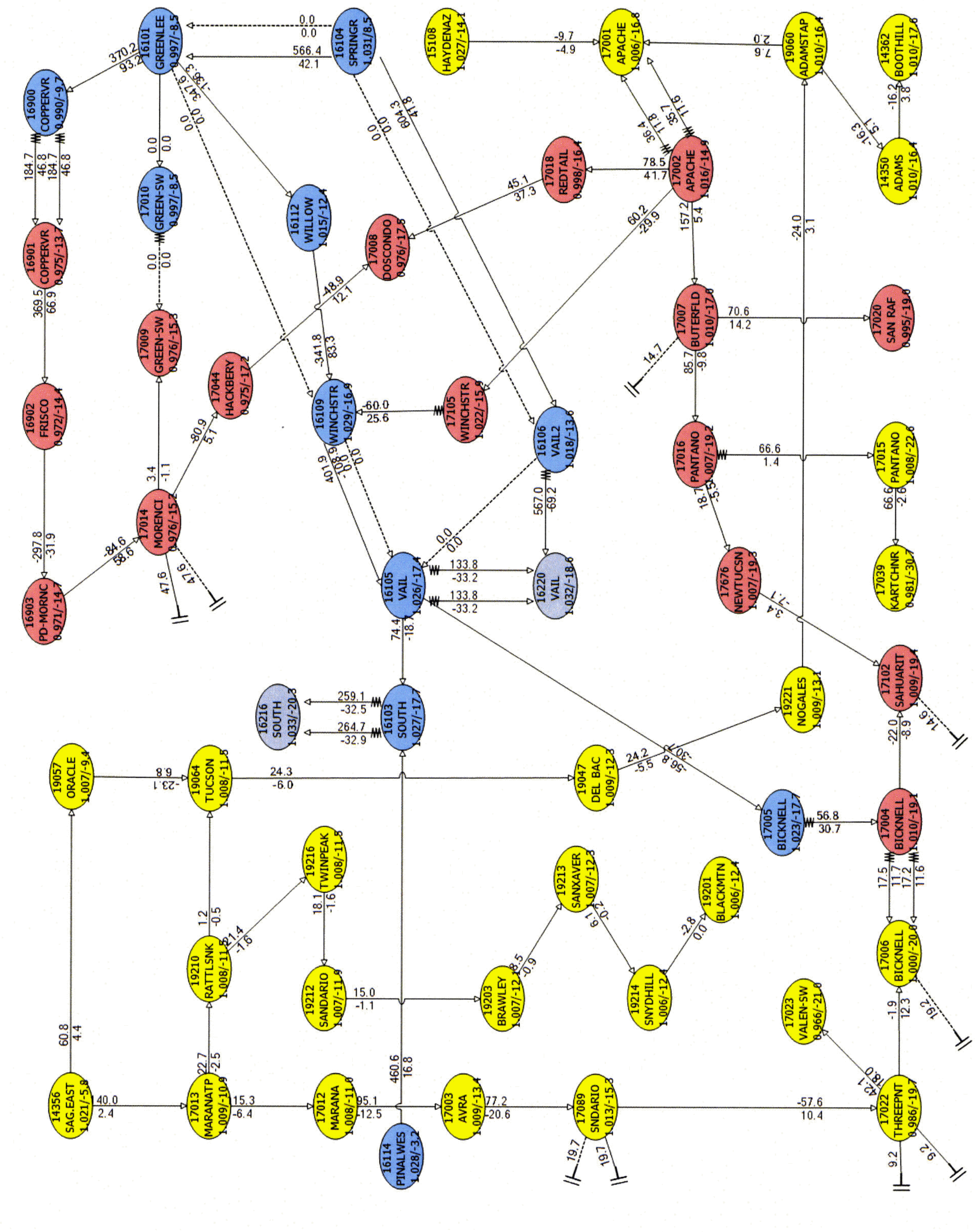
2025HS Southwest Transmission Cooperative Base System with Apache to Hayden 115 kV Line out of service



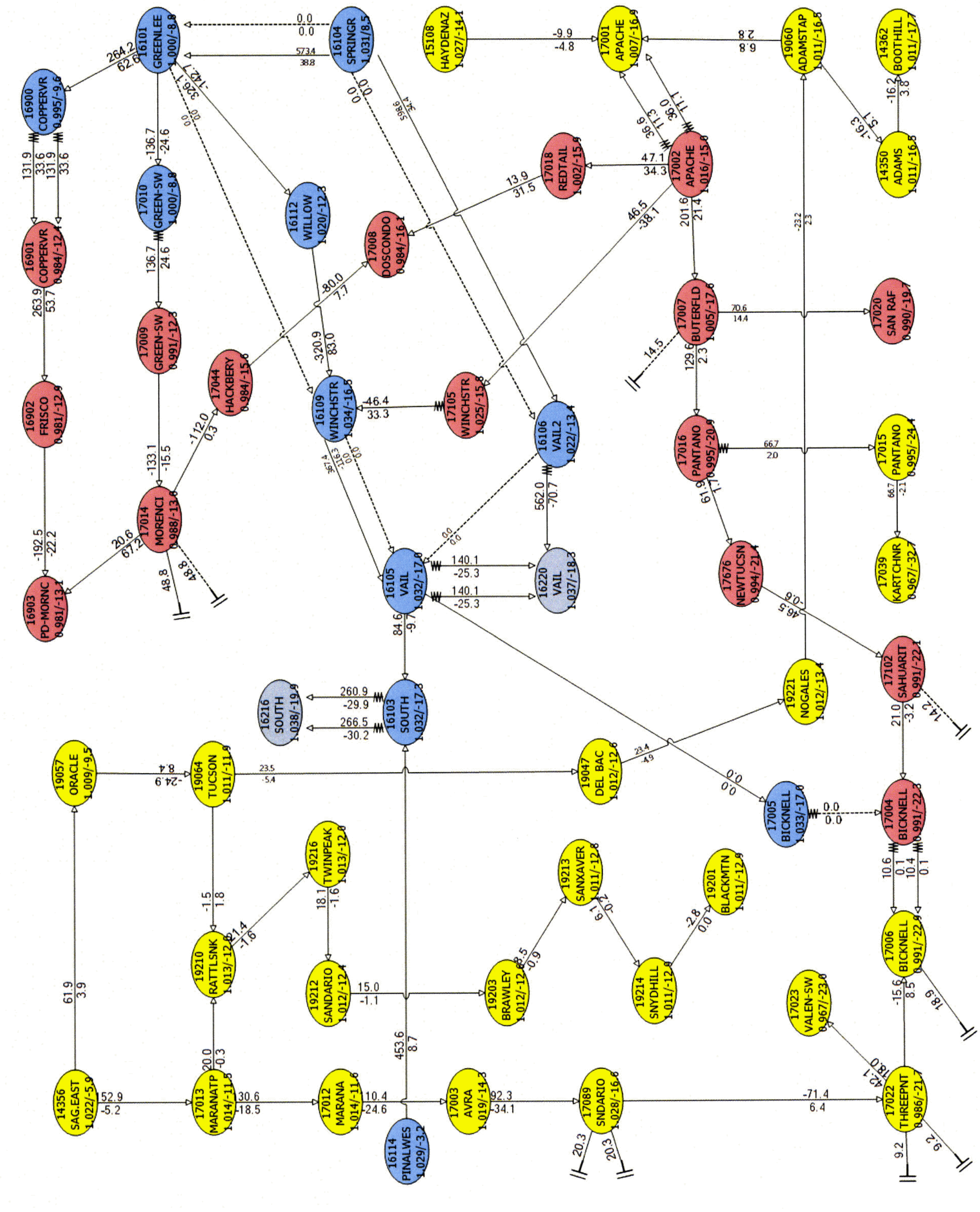
2025HS Southwest Transmission Cooperative Base System with Marana to Avra 115 kV Line out of service



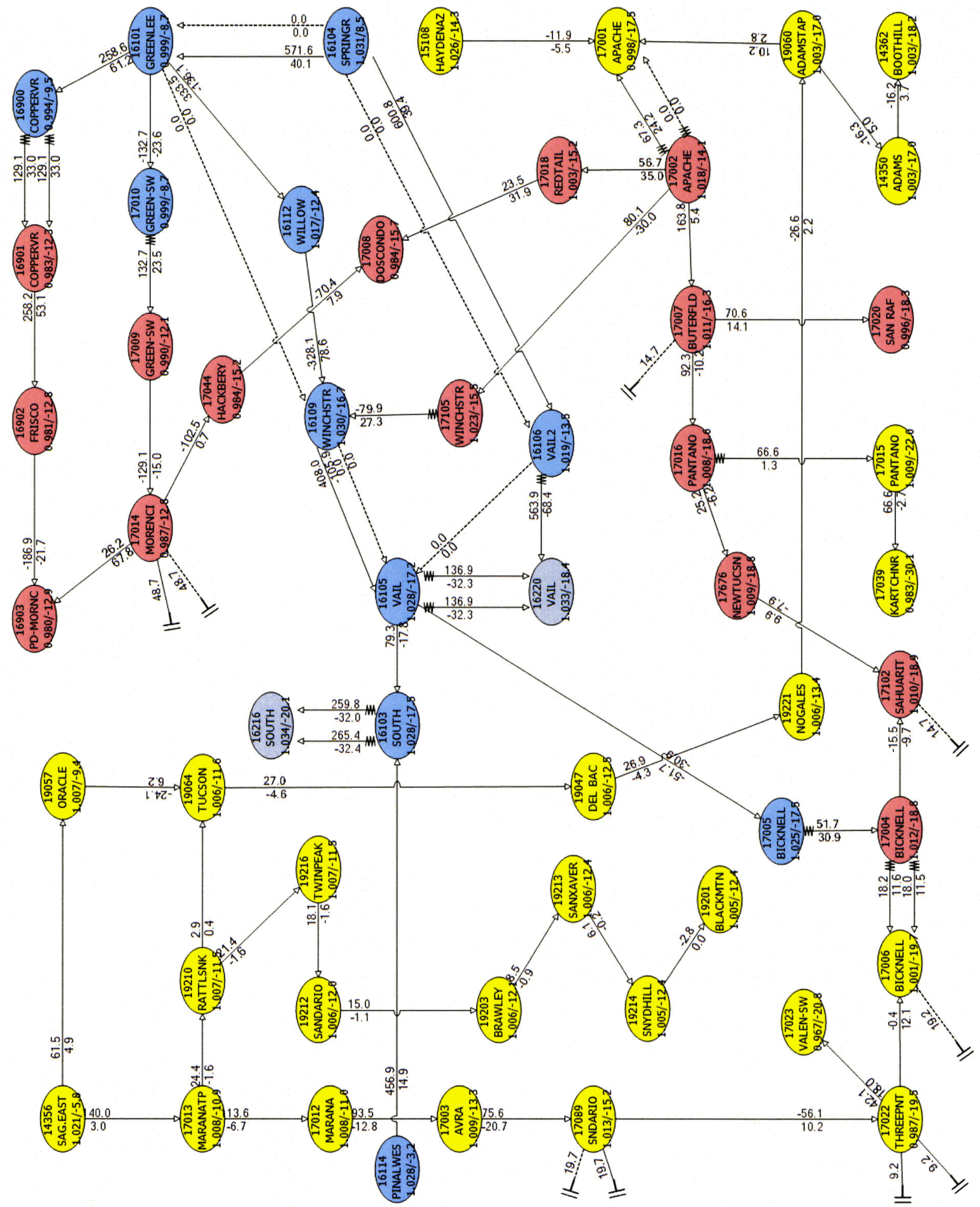
2025HS Southwest Transmission Cooperative Base System with Green-SW 345/230 kV Transformer out of service



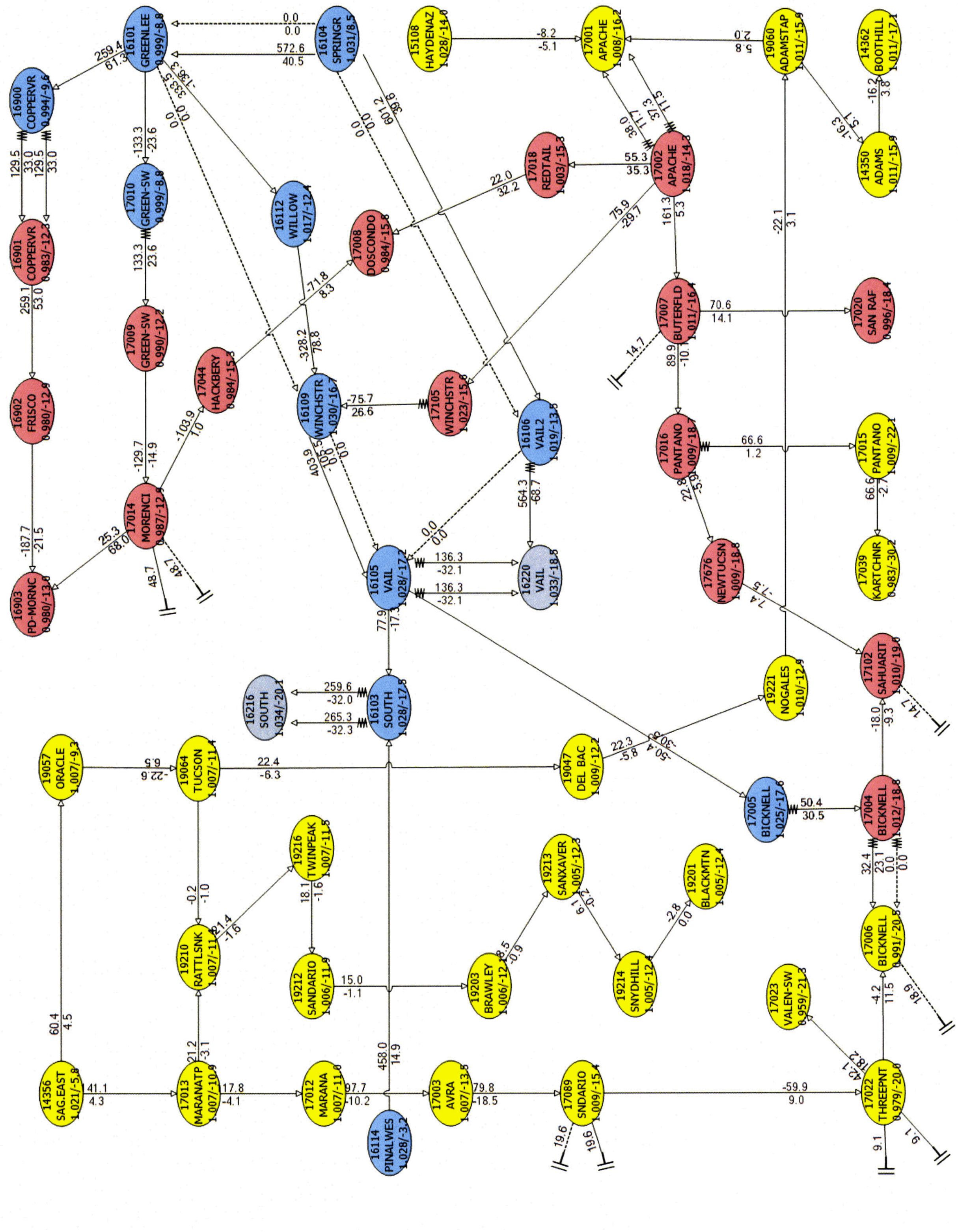
2025HS Southwest Transmission Cooperative Base System with Bicknell 345/230 kV Transformer out of service



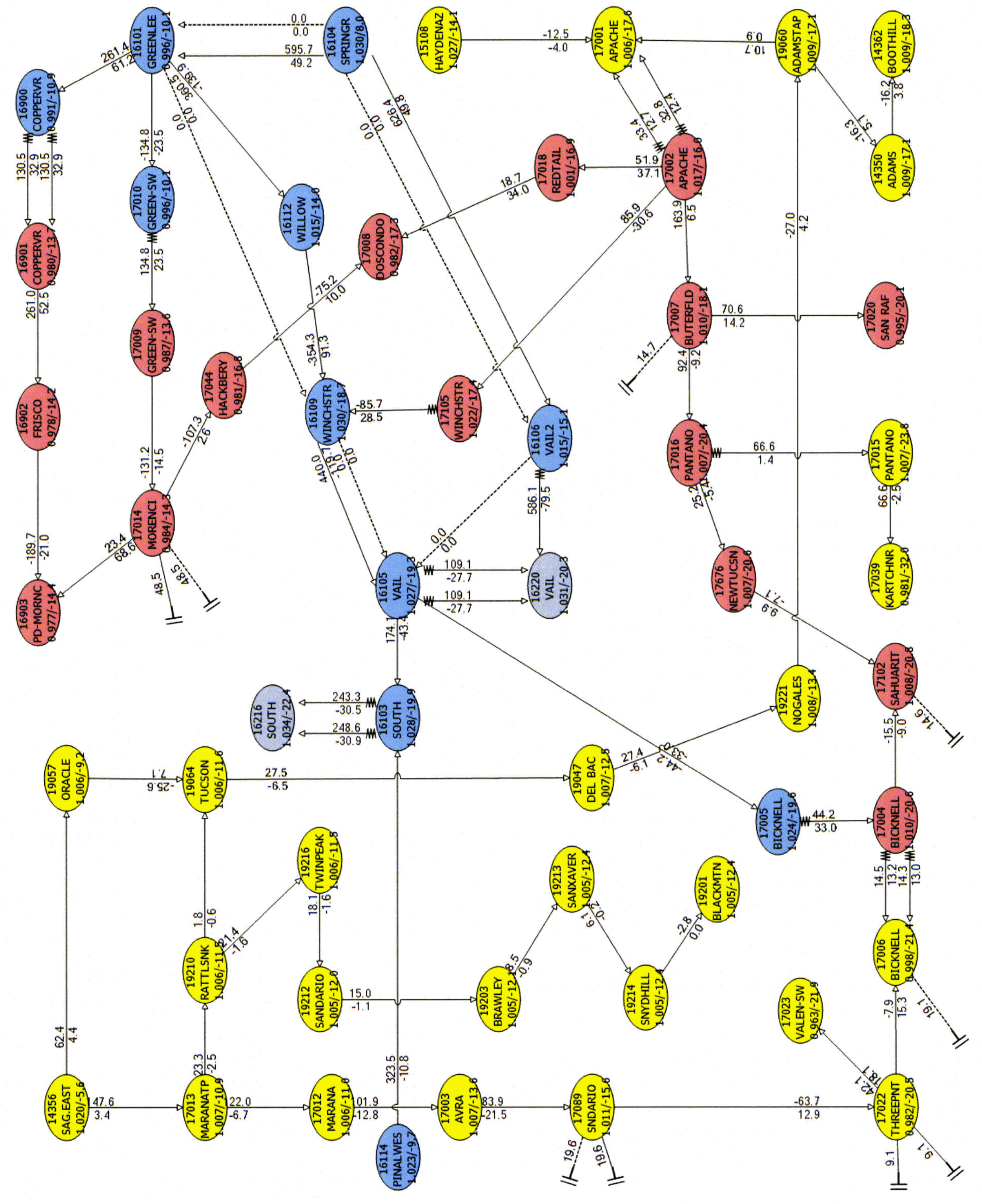
2025HS Southwest Transmission Cooperative Base System with one Apache 230/115 kV Transformer out of service



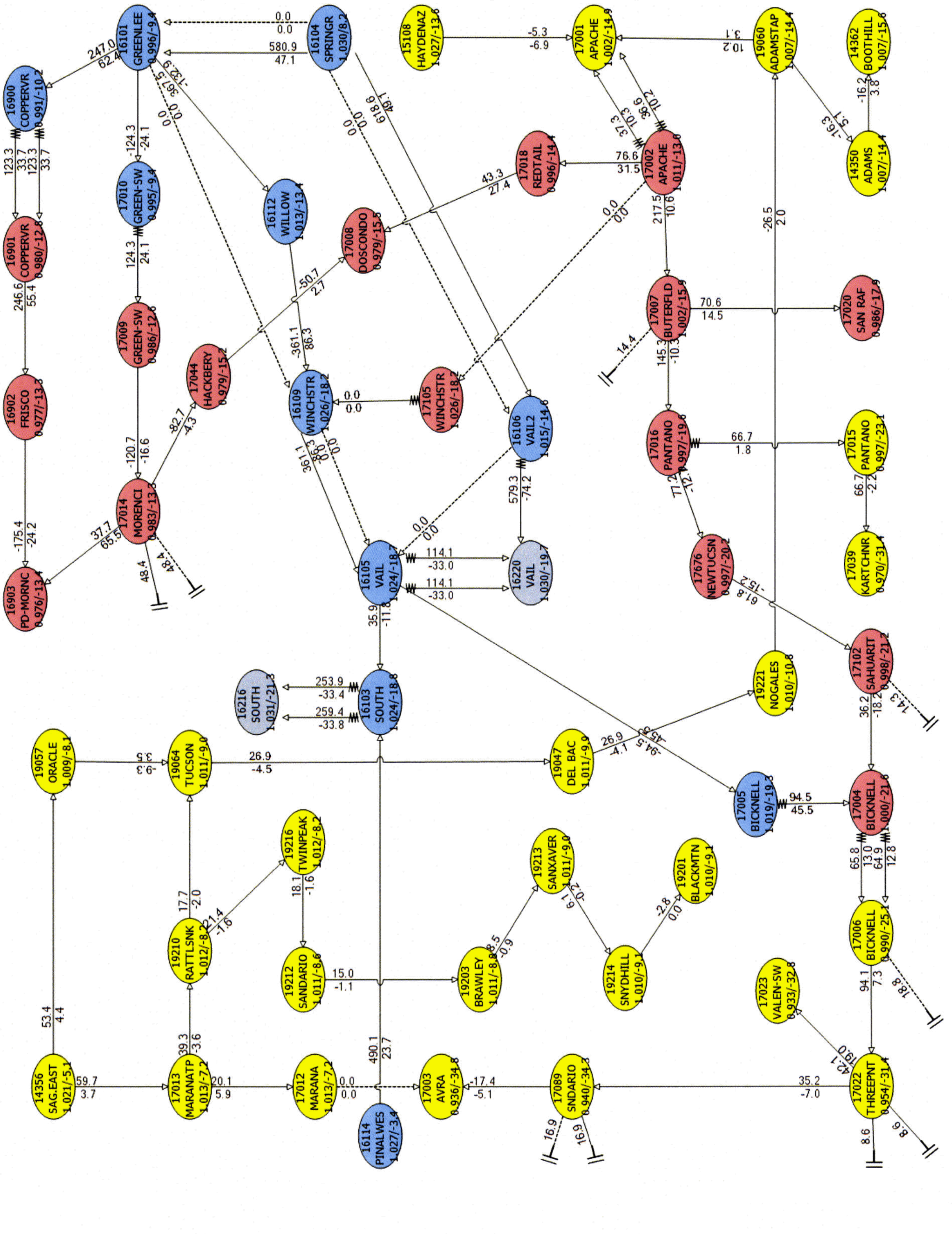
2025HS Southwest Transmission Cooperative Base System with one Bicknell 230/115 kV Transformer out of service



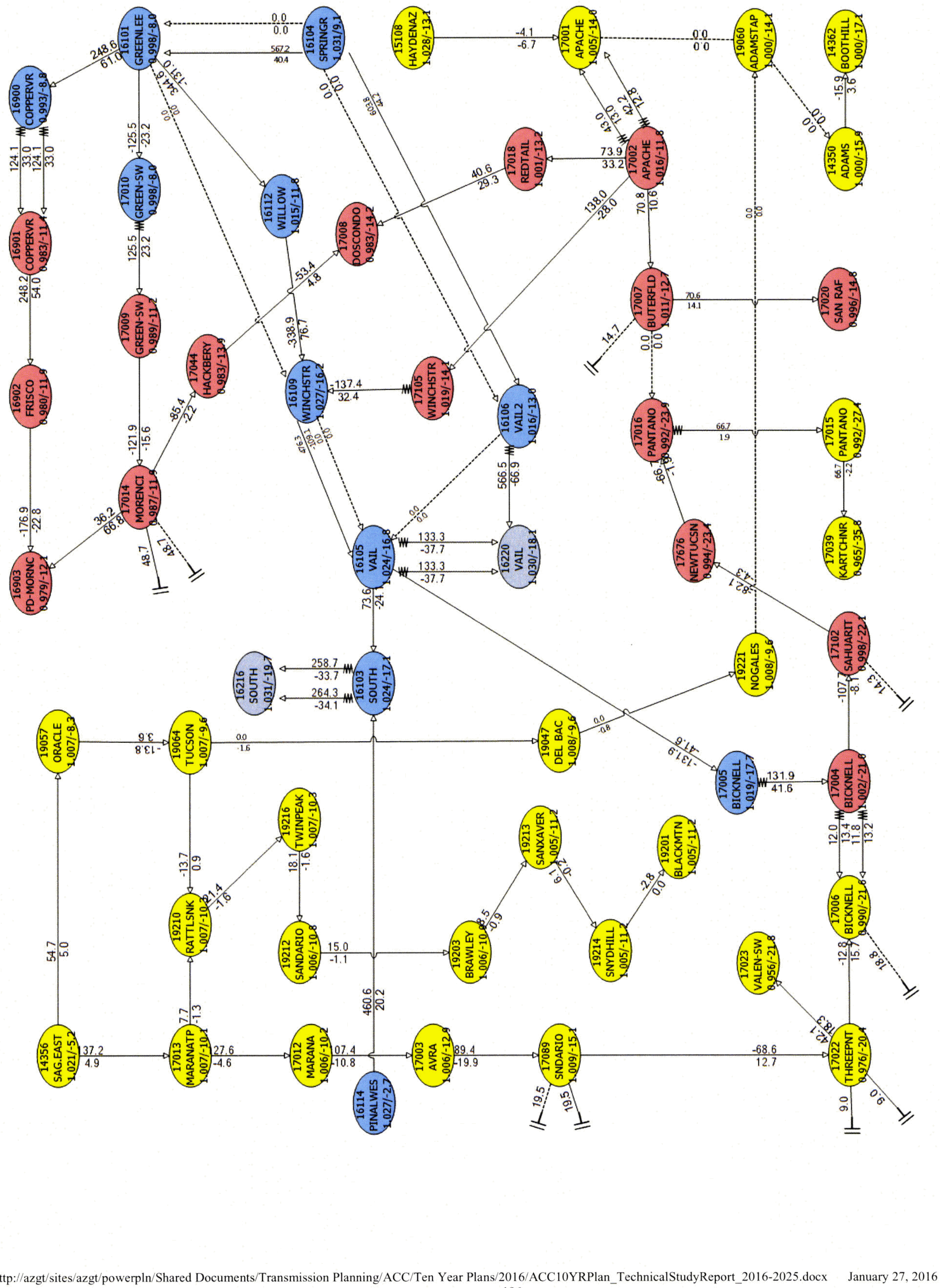
2025HS Southwest Transmission Cooperative Base System with Pinal West 500/345 kV Transformer out of service



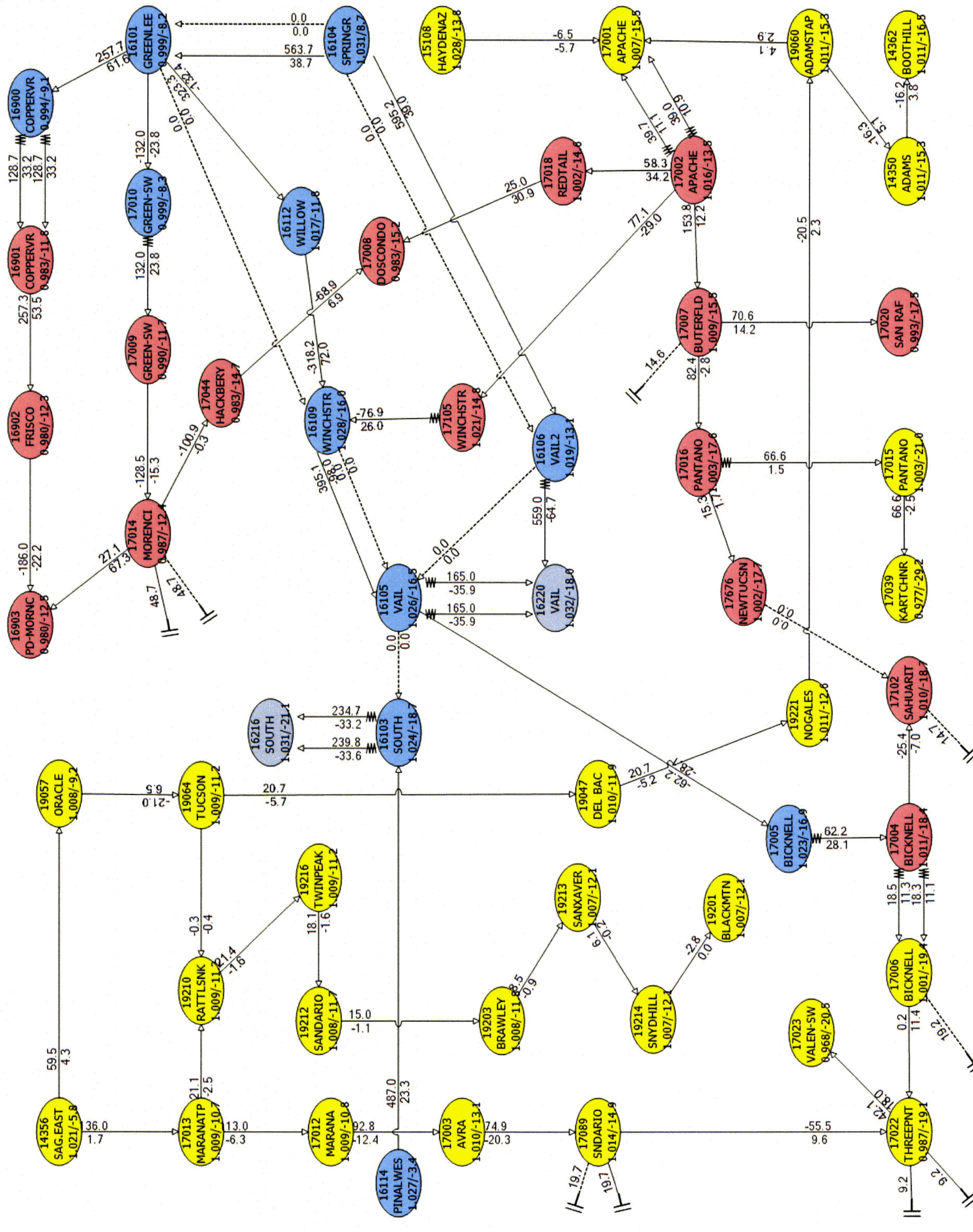
2025HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line out followed by the Marana to Avra 115 kV Line out of service



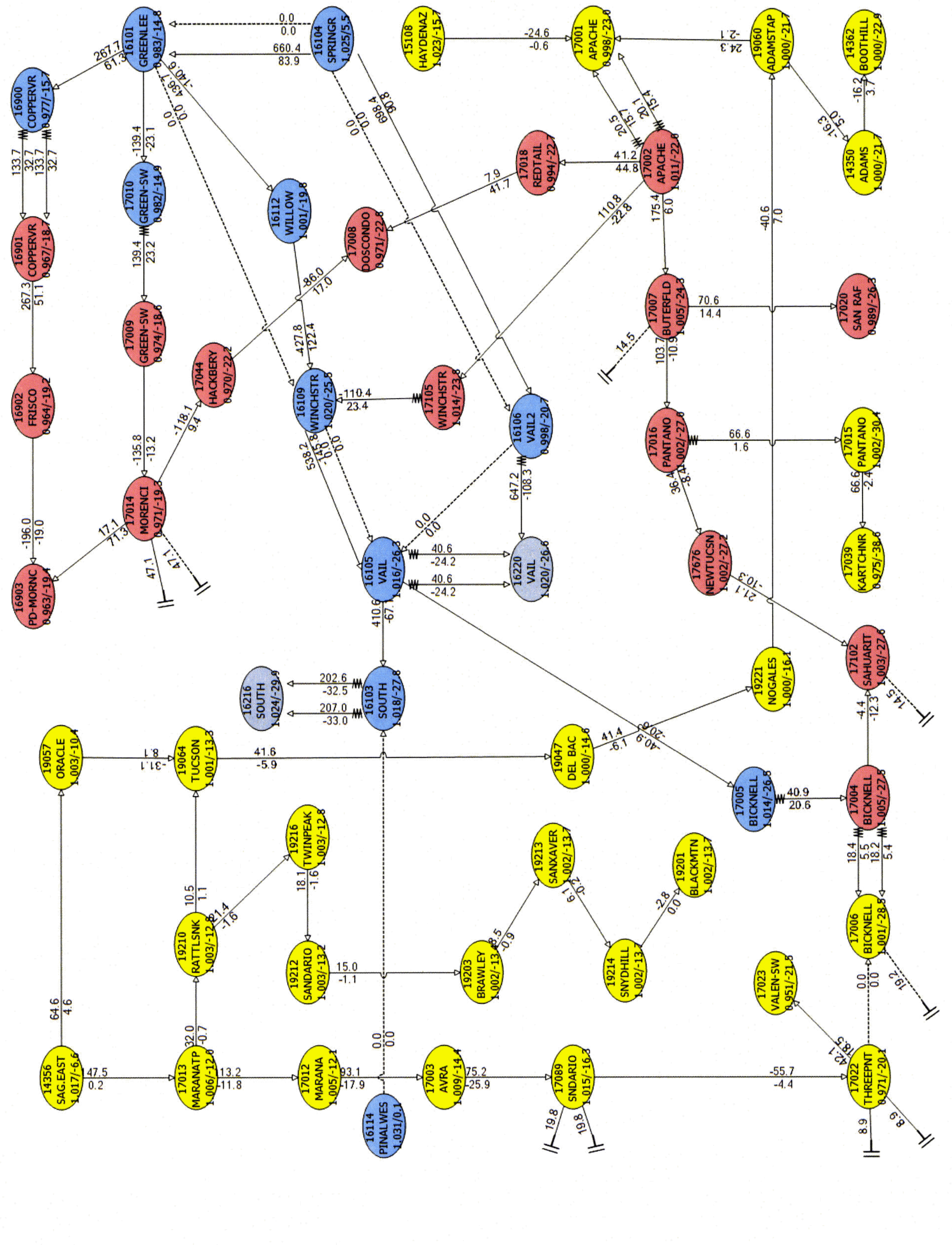
2025HS Southwest Transmission Cooperative Base System with Common Corridor #2 outage of the Butterfield to Pantano 230 kV & Adams Tap to Apache 115 kV Lines



2025HS Southwest Transmission Cooperative Base System with Common Corridor #5 outage of the Vail to South 345 kV & New Tucson to Sahuarita 230 kV Lines



2025HS Southwest Transmission Cooperative Base System with Common Corridor #6 outage of the Pinal West to South 345 kV & Bicknell to Three Points 115 kV Lines

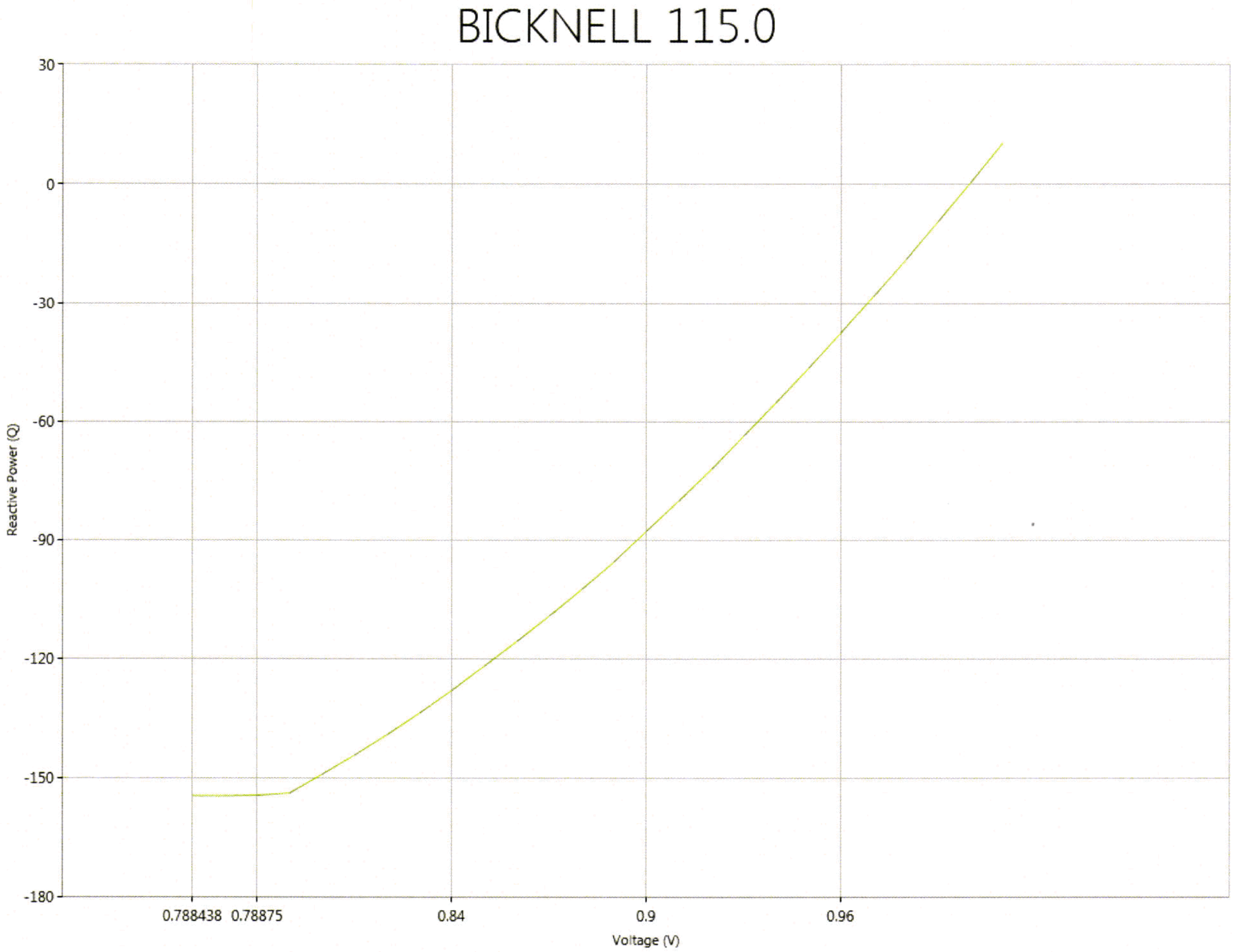


APPENDIX D: Reactive Margin Q-V Plots

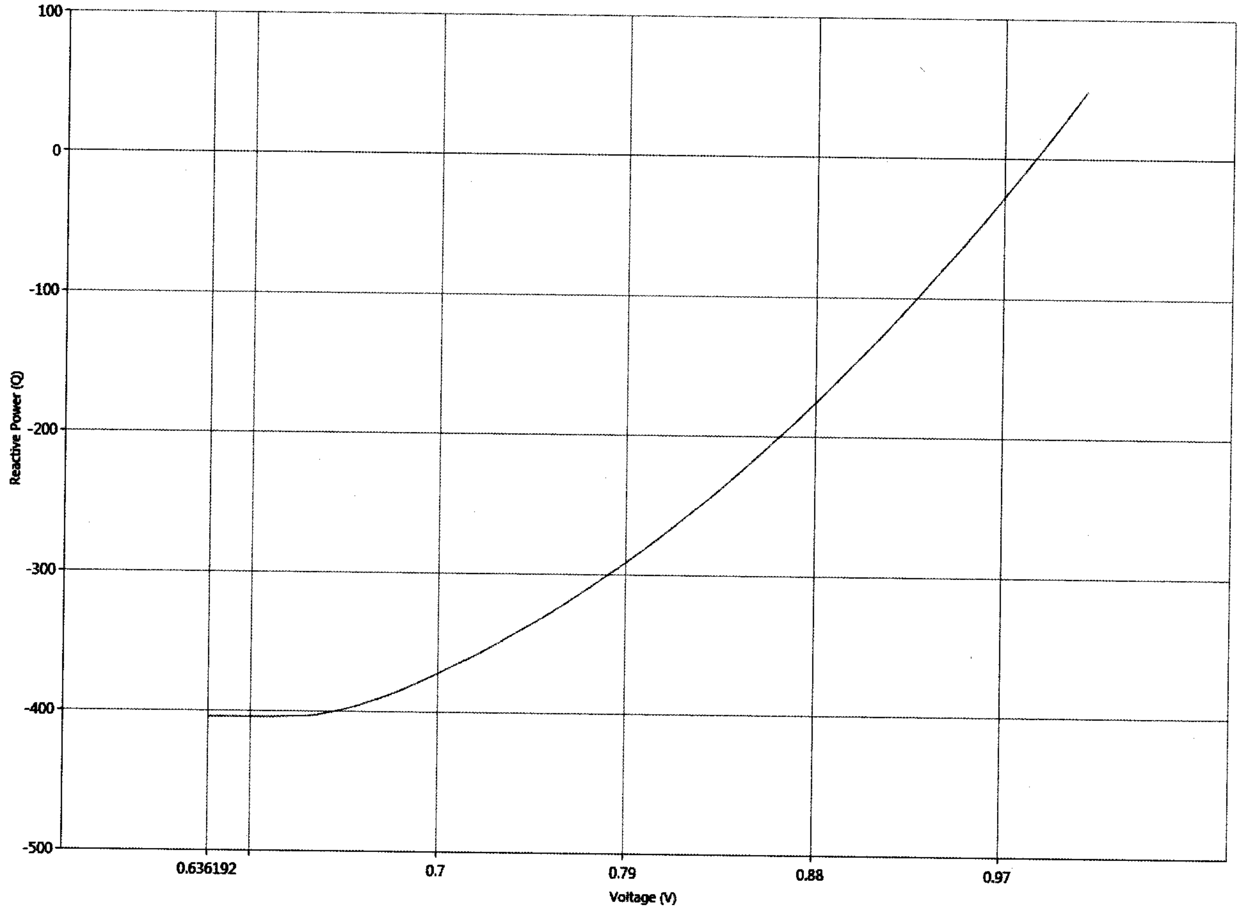
2016HS Plots:

2016HS Apache – Butterfield 230 kV Outage

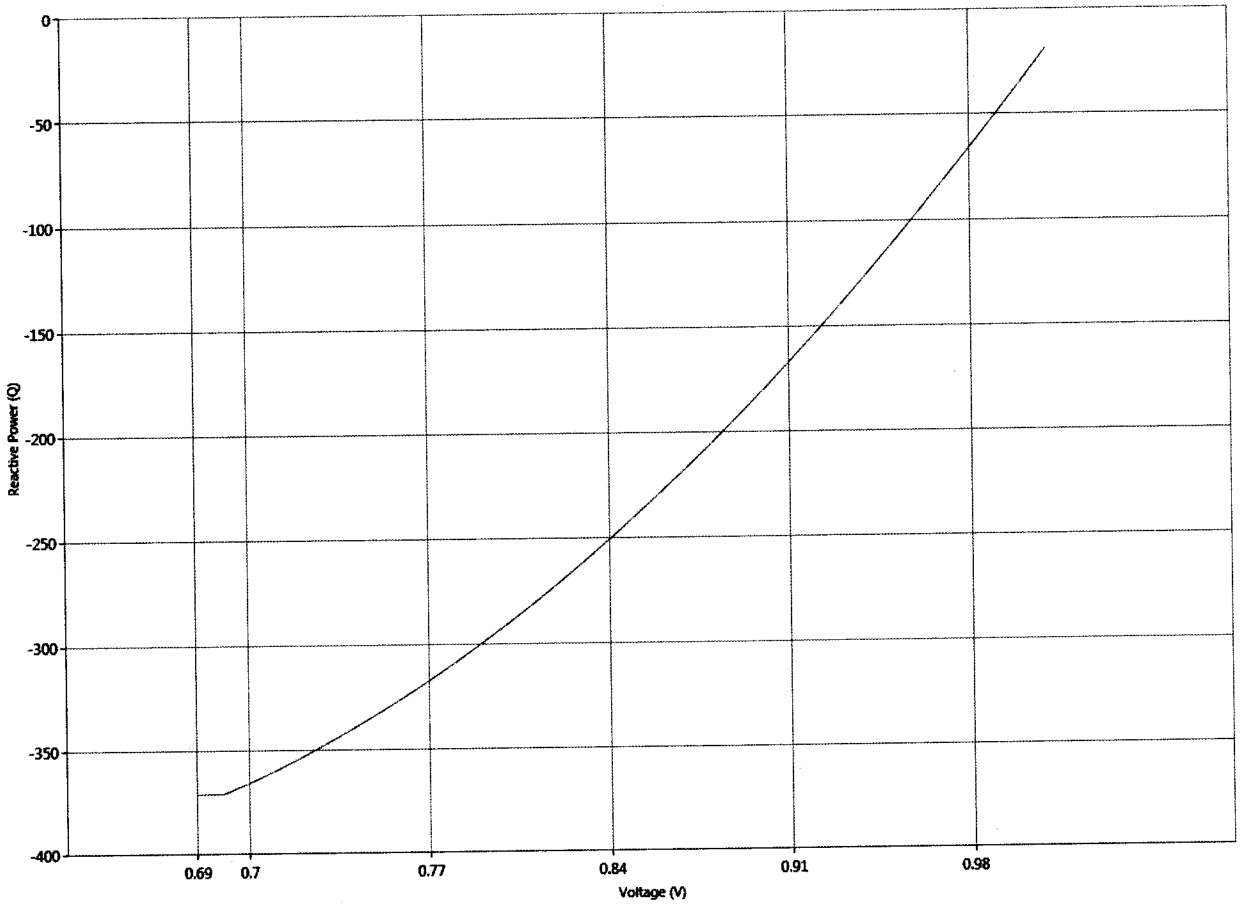
2016HS – Apache to Butterfield 230 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV, and Redtail 230 kV buses



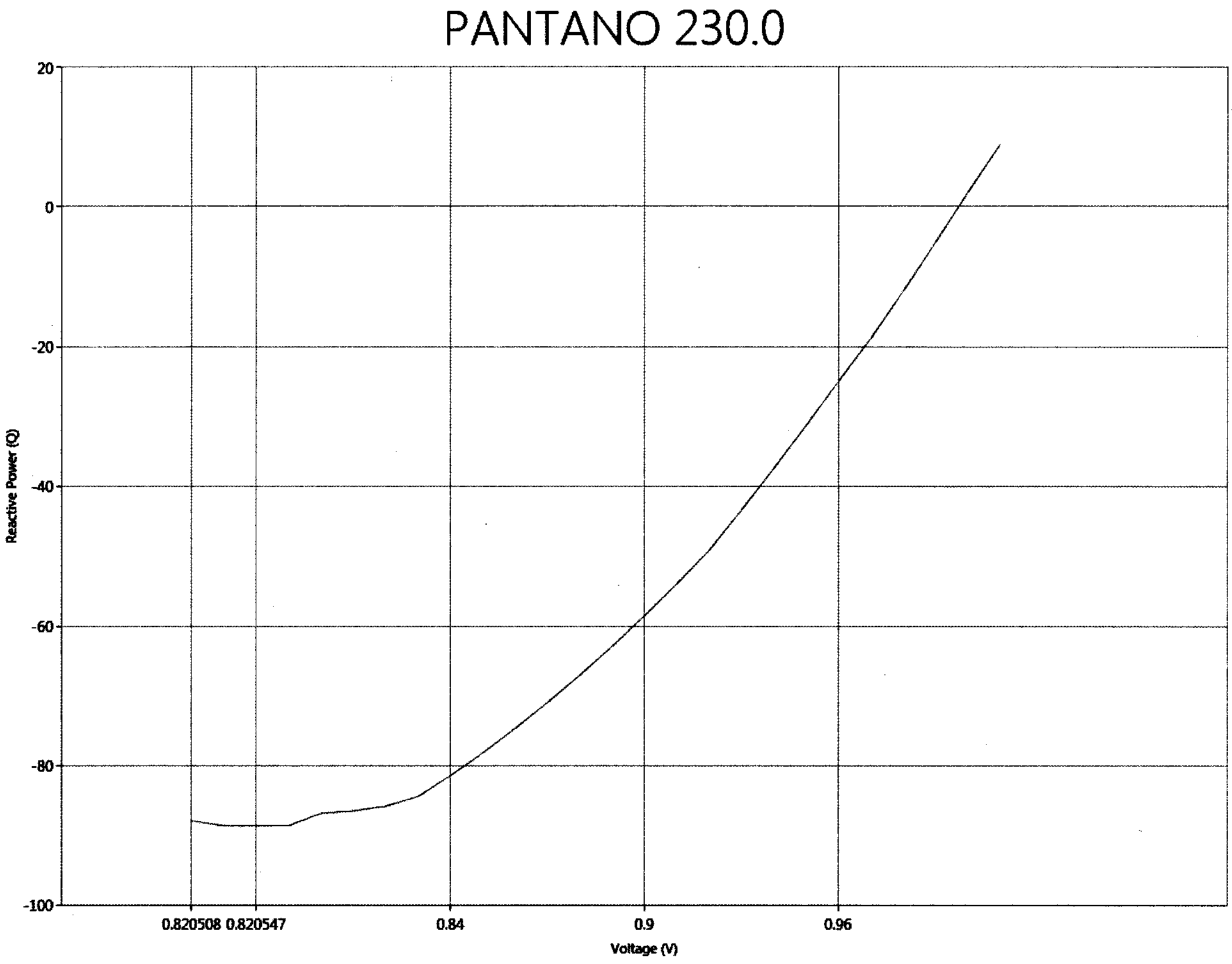
HACKBERY 230.0



MARANA 115.0

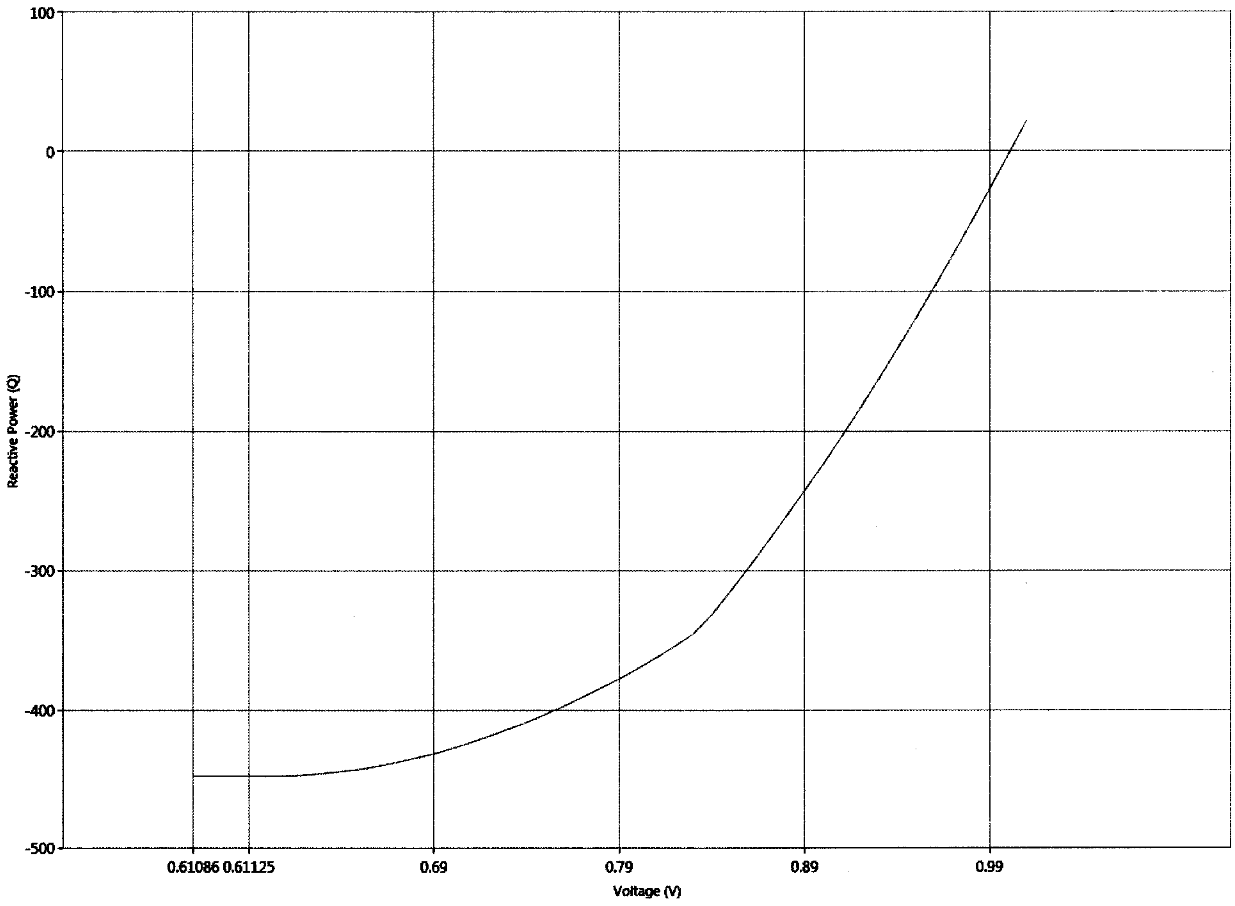


0
-50
-100
-150
-200
-250
-300
-350
-400
Reactive Power (Q)
0.69
0.7
0.77
0.84
0.91
0.98
Voltage (V)



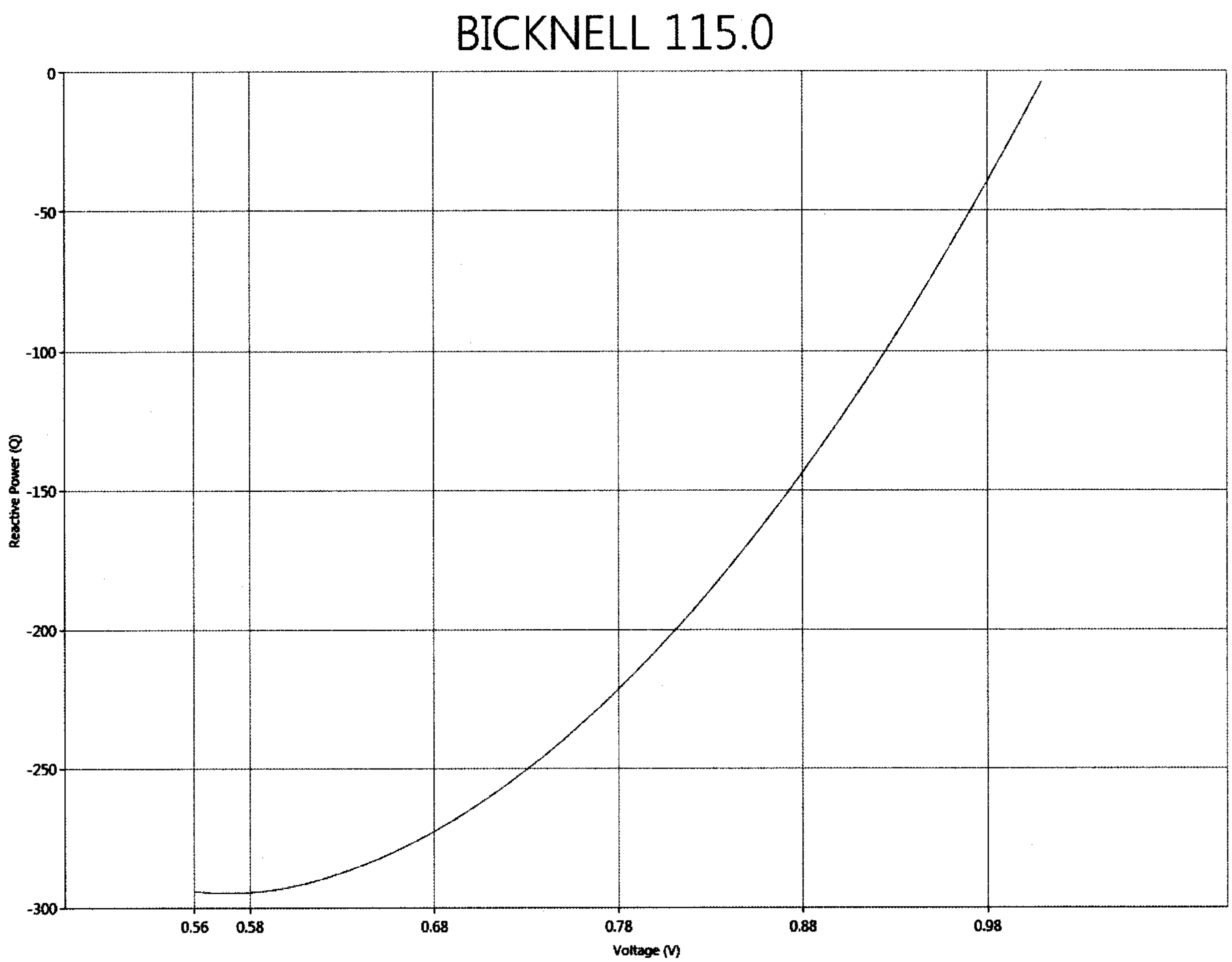
PANTANO 230.0
20
0
-20
-40
-60
-80
-100
Reactive Power (Q)
0.820508 0.820547
0.84
0.9
0.96
Voltage (V)

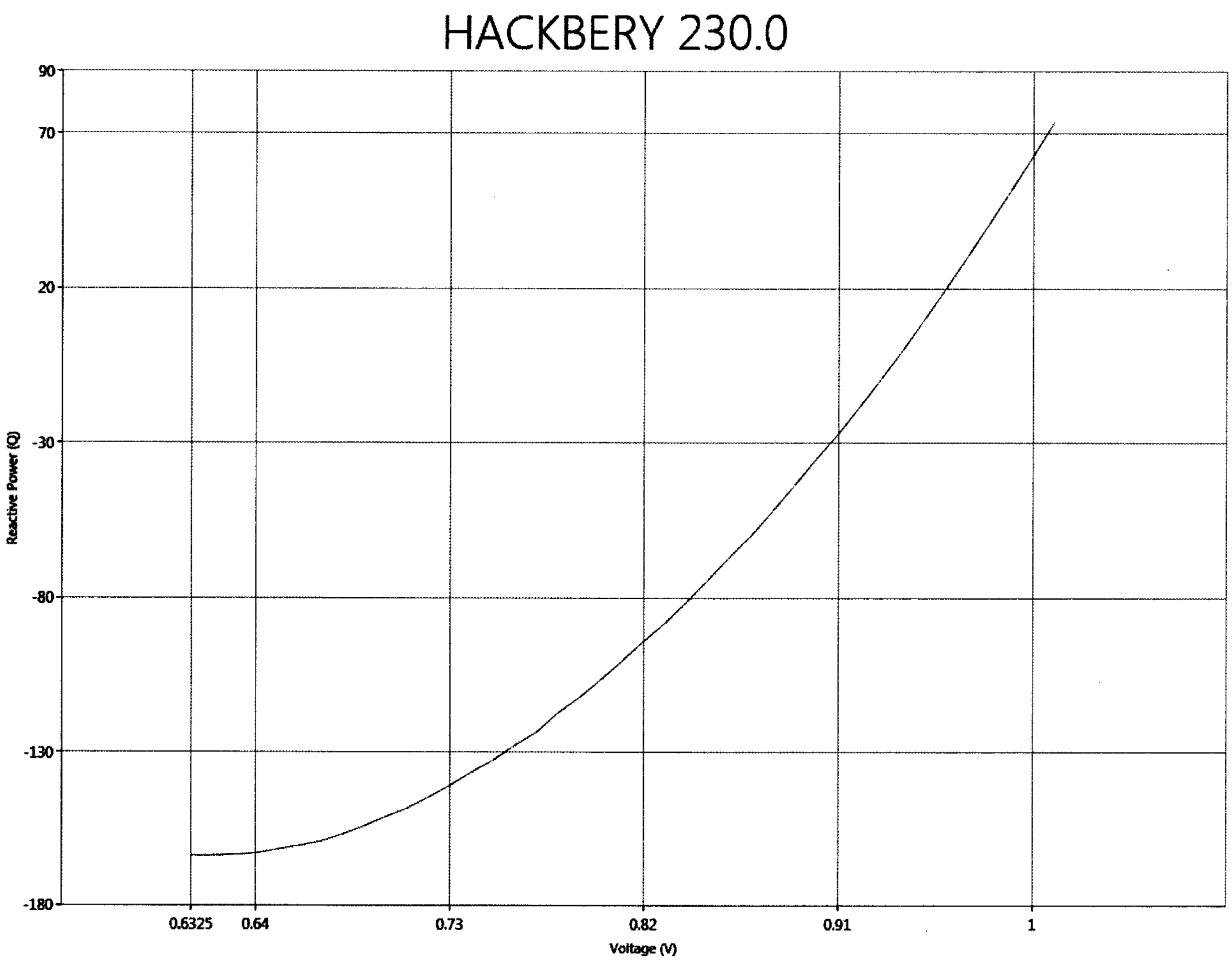
REDTAIL 230.0

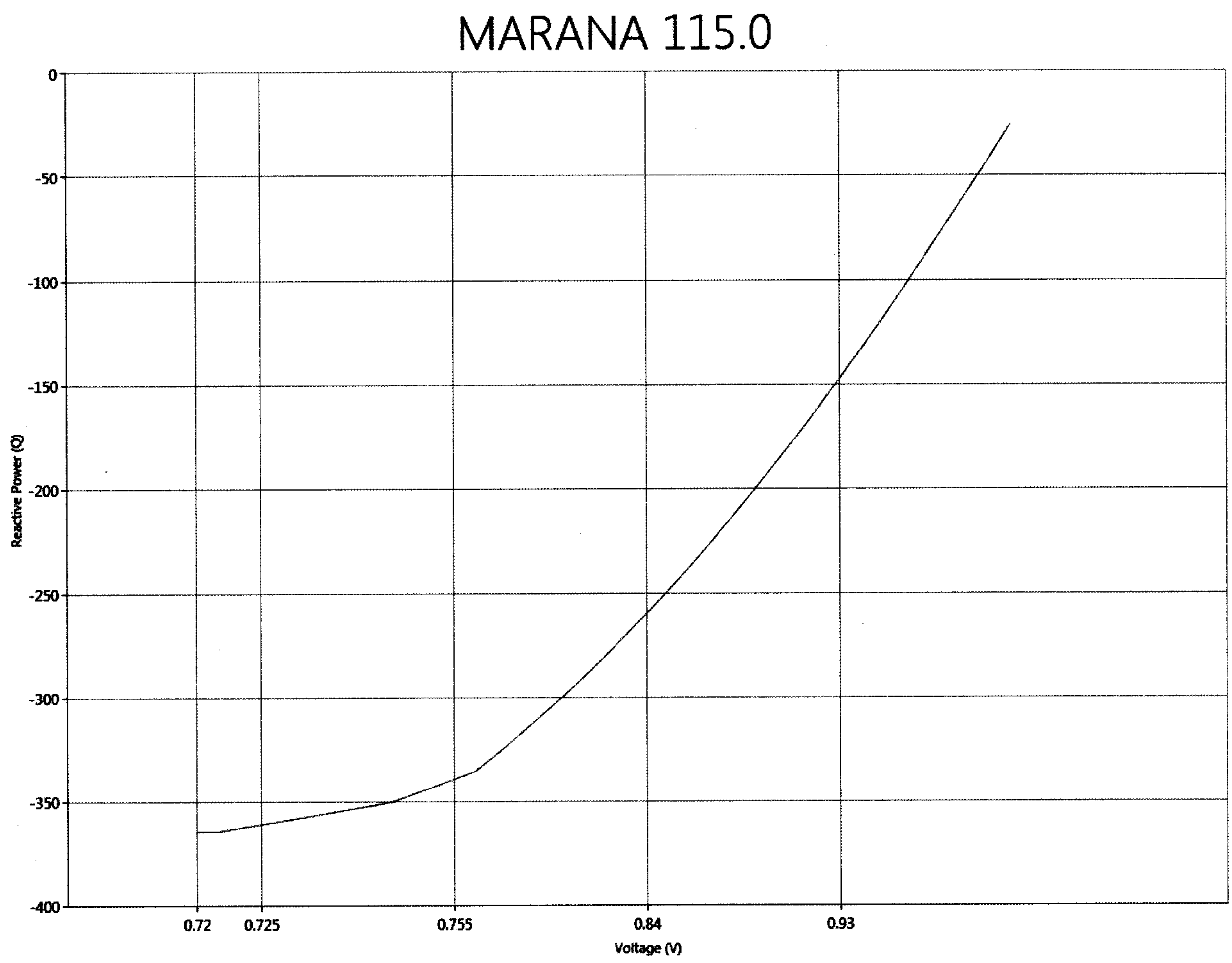


2016HS Apache – Redtail 230 kV Outage

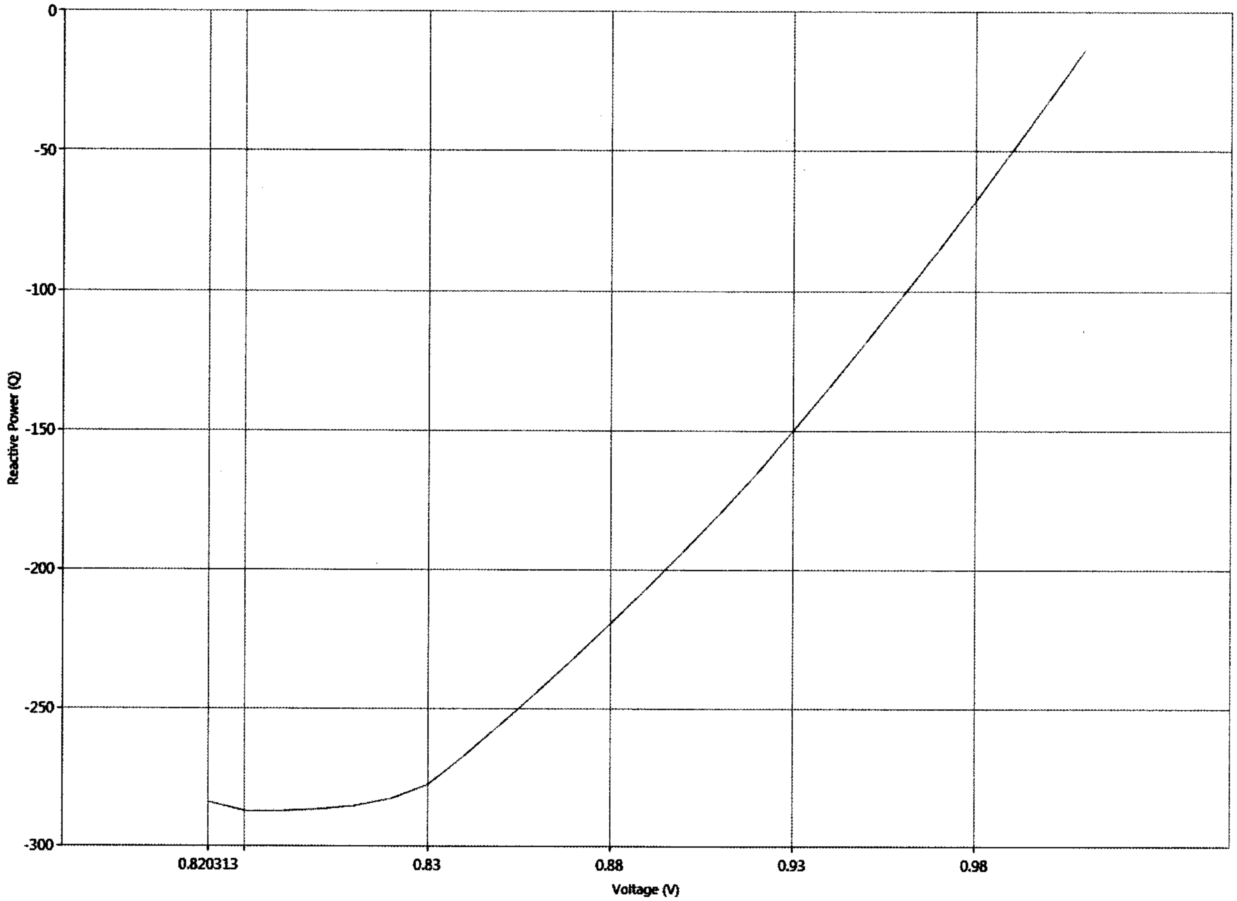
2016HS – Apache to Redtail 230 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses

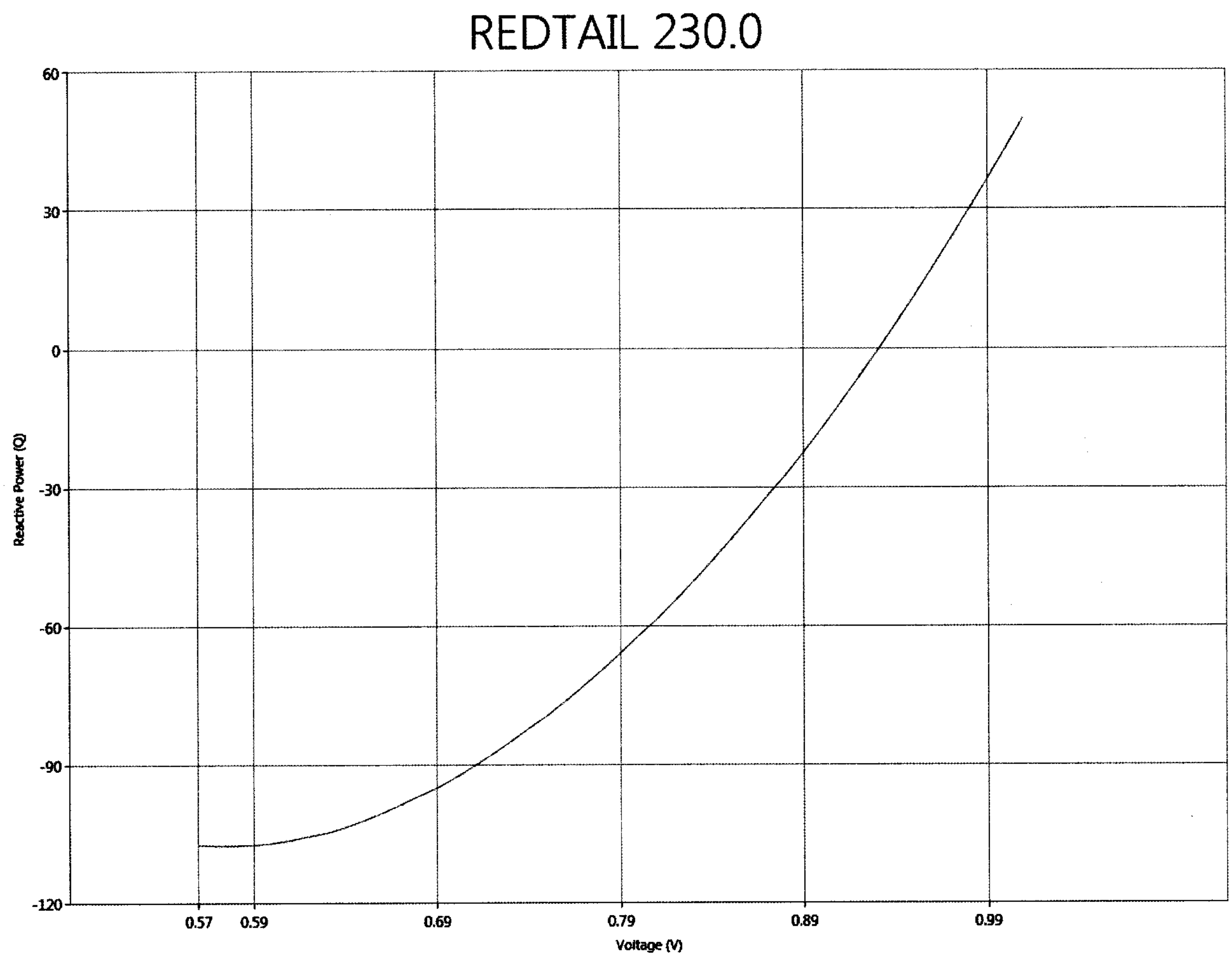



HACKBERY 230.0
90
70
20
-30
-80
-130
-180
Reactive Power (Q)
0.6325
0.64
0.73
0.82
0.91
1
Voltage (V)


MARANA 115.0
0
-50
-100
-150
-200
-250
-300
-350
-400
Reactive Power (Q)
0.72
0.725
0.755
0.84
0.93
Voltage (V)

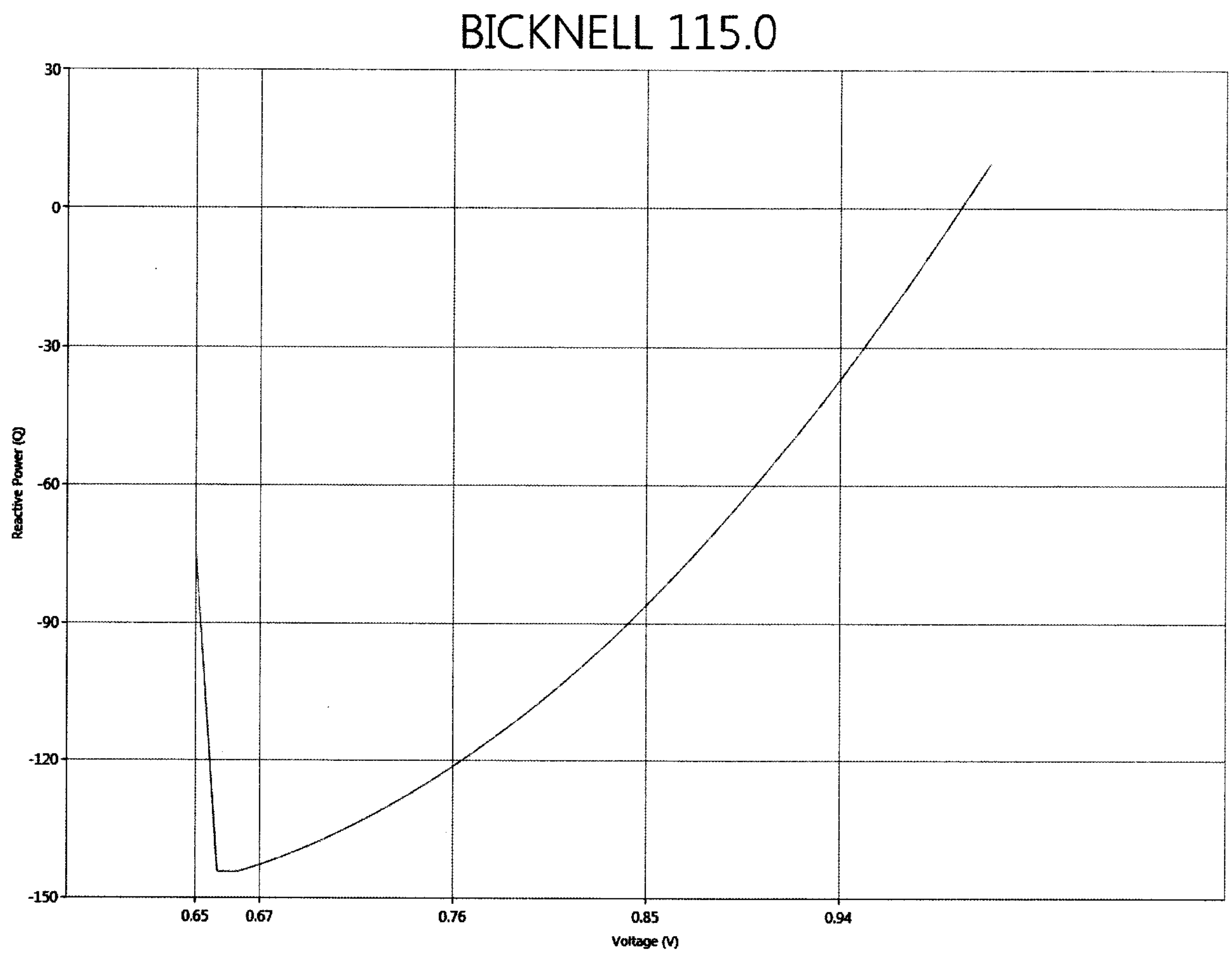
PANTANO 230.0

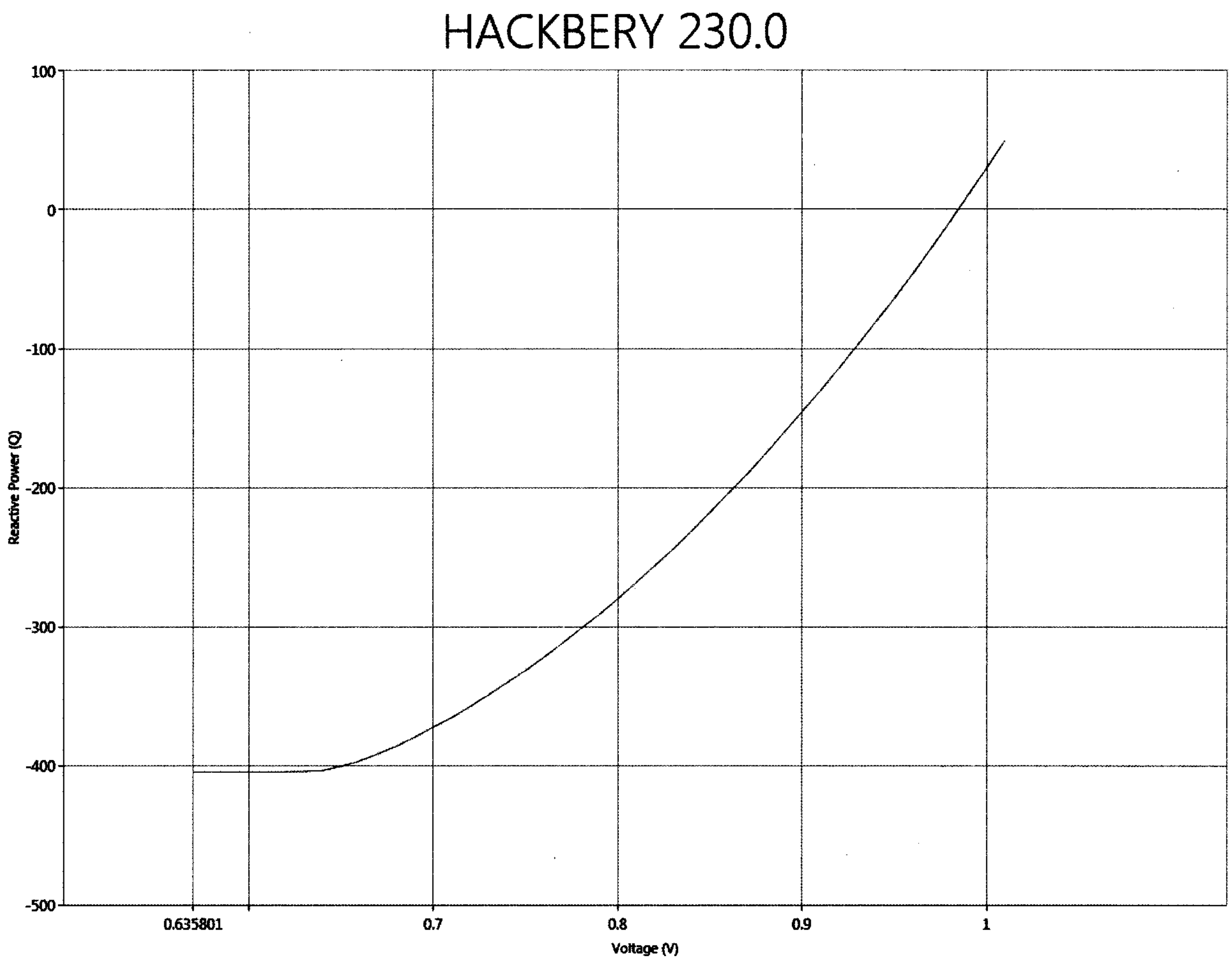


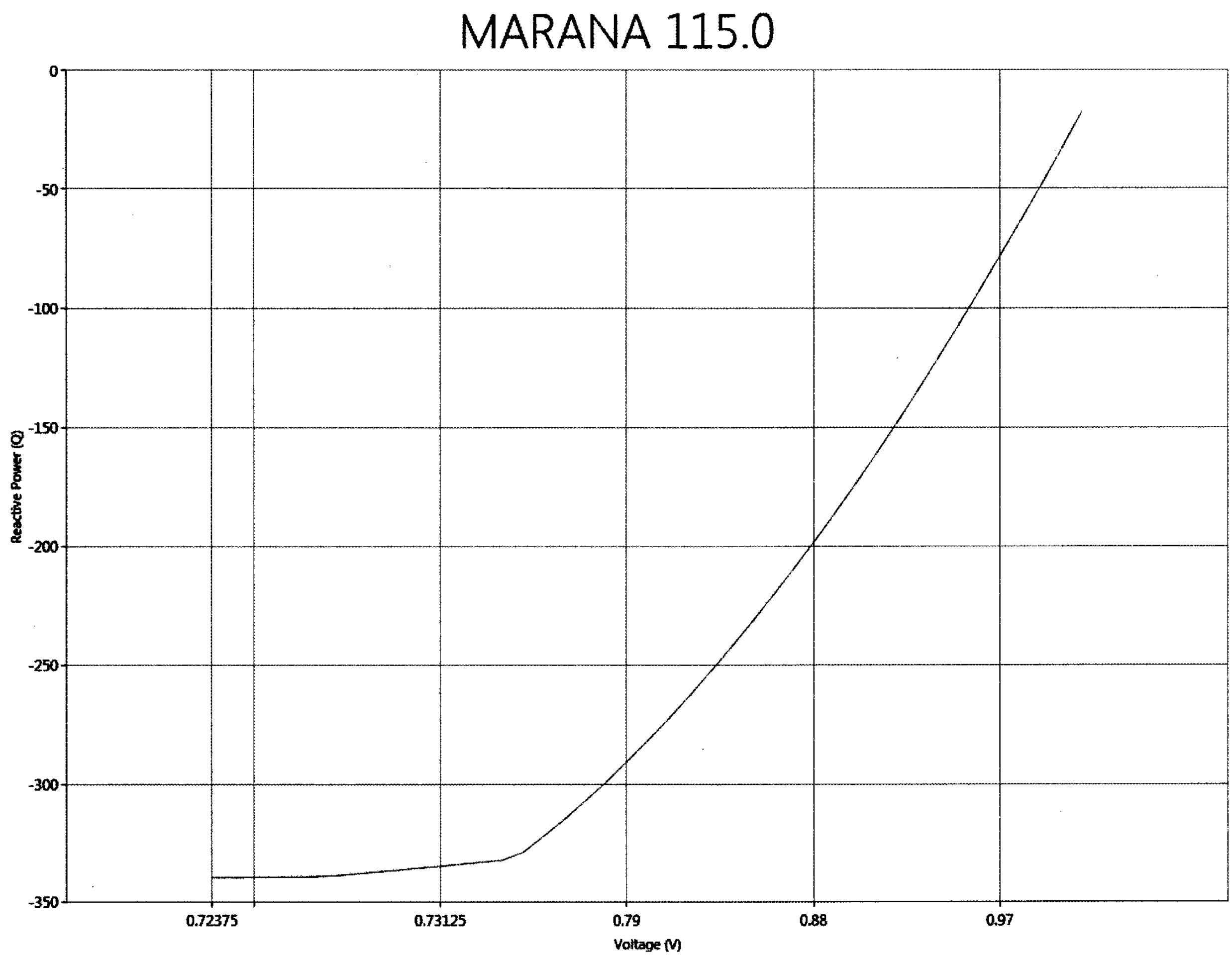

REDTAIL 230.0
60
30
0
-30
-60
-90
-120
Reactive Power (Q)
0.57
0.59
0.69
0.79
0.89
0.99
Voltage (V)

2016HS Bicknell – Vail 345 kV Outage

2016HS – Bicknell to Vail 345 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses

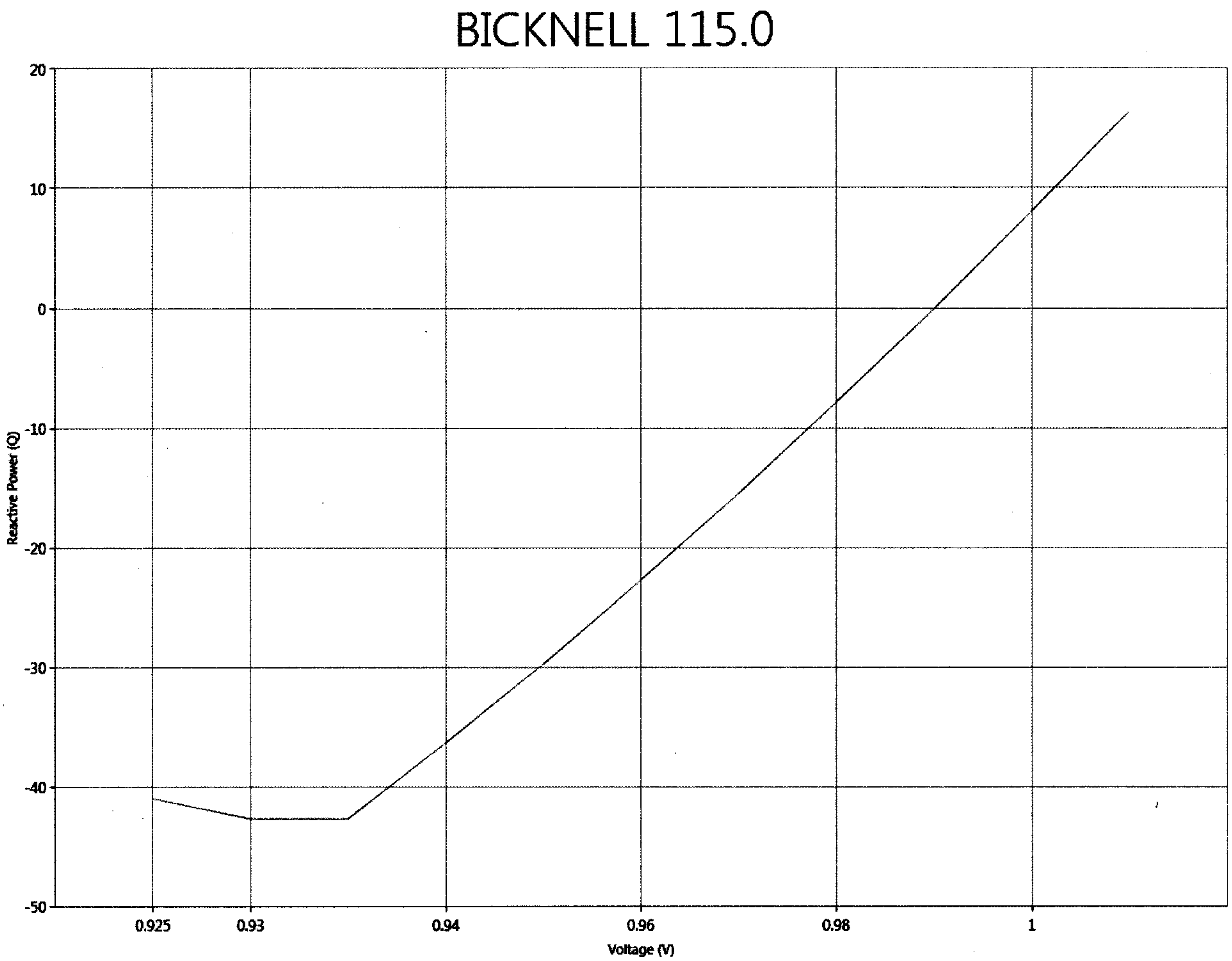


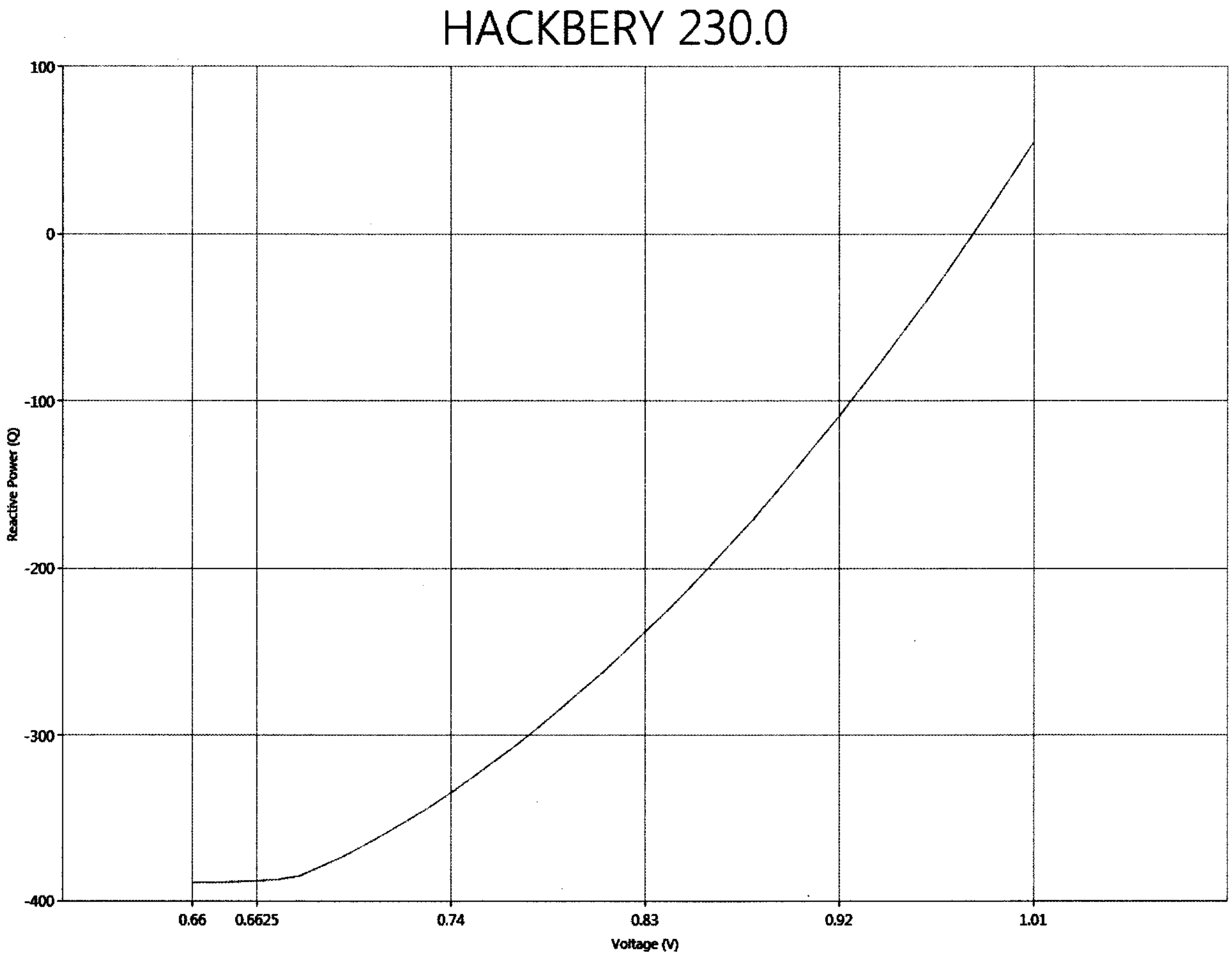

HACKBERY 230.0
100
0
-100
-200
-300
-400
-500
Reactive Power (Q)
0.635801
0.7
0.8
0.9
1
Voltage (V)

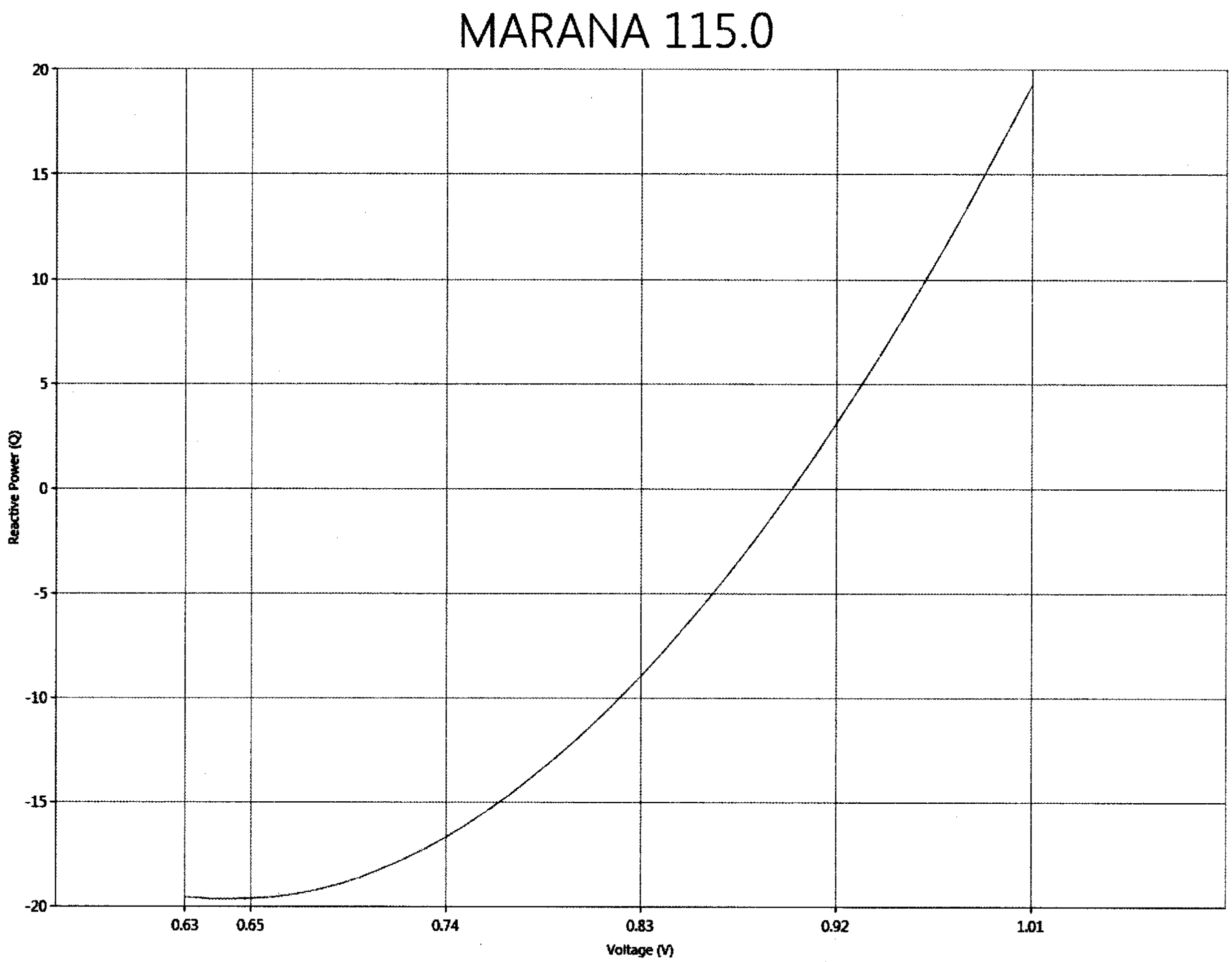

MARANA 115.0
Reactive Power (Q)
0
-50
-100
-150
-200
-250
-300
-350
0.72375
0.73125
0.79
0.88
0.97
Voltage (V)

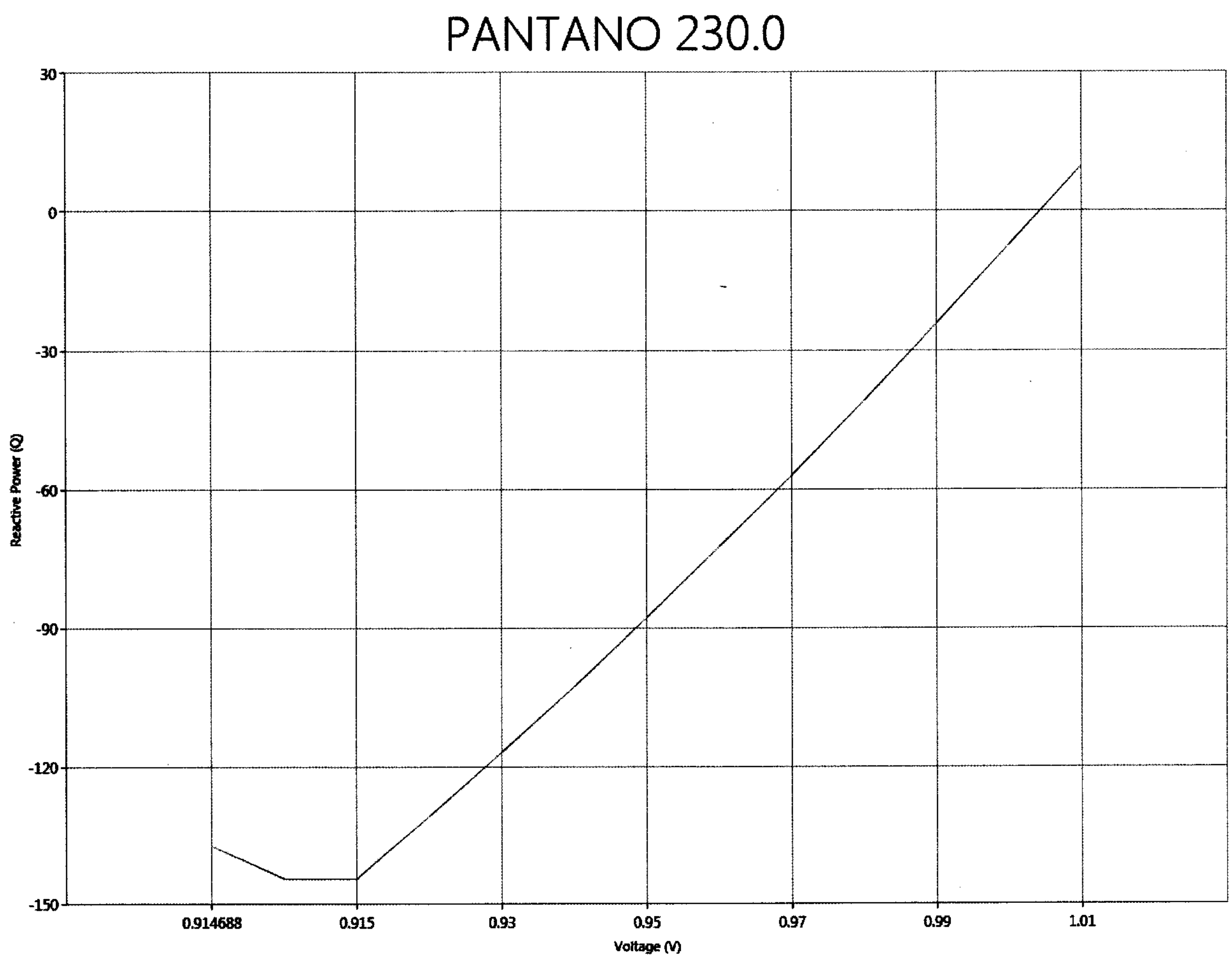
2016HS Marana Group 115 kV Outage

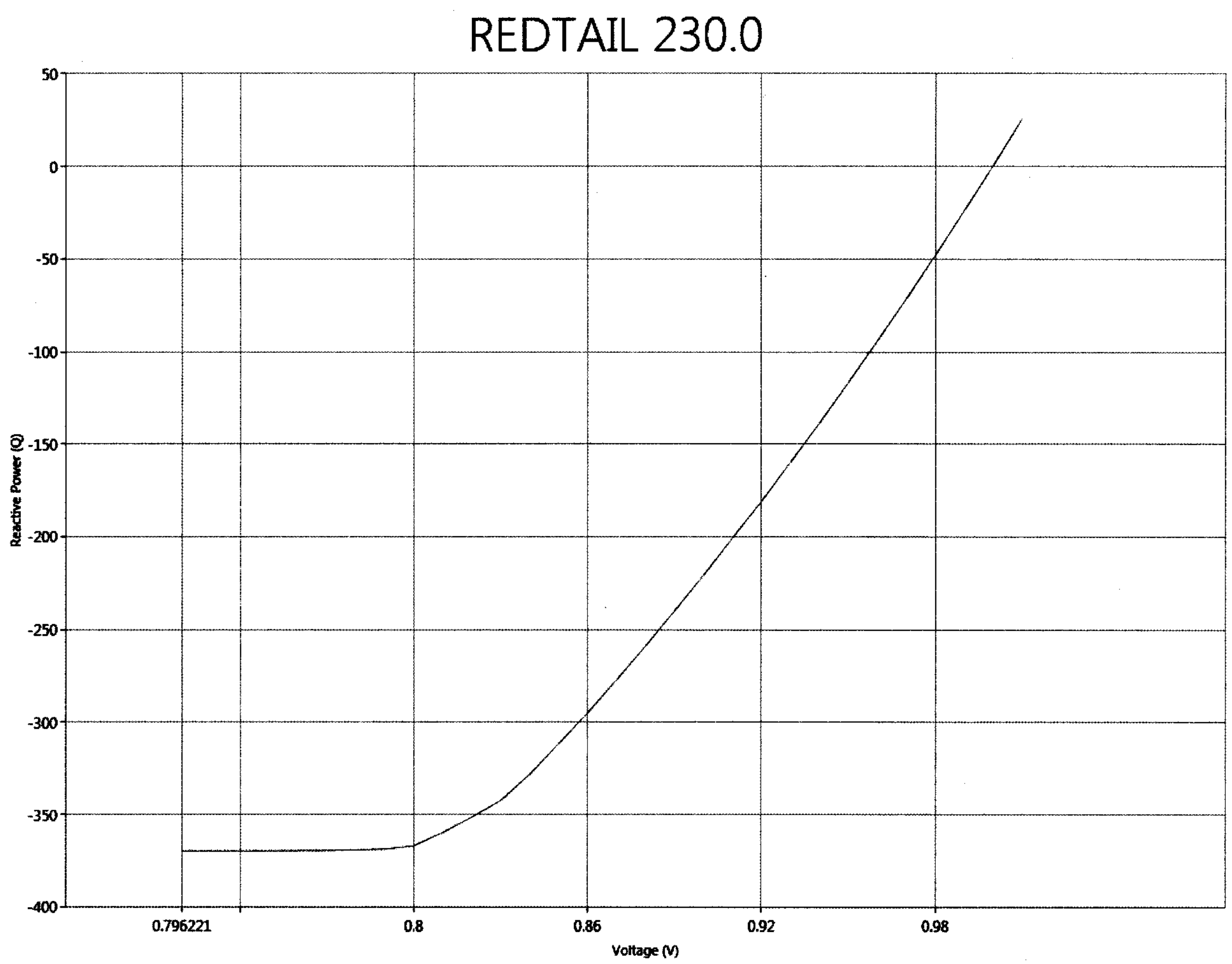
2016HS – Marana Group 115 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses




HACKBERY 230.0
100
0
-100
-200
-300
-400
Reactive Power (Q)
0.66
0.6625
0.74
0.83
0.92
1.01
Voltage (V)


MARANA 115.0
Reactive Power (Q)
Voltage (V)
20
15
10
5
0
-5
-10
-15
-20
0.63
0.65
0.74
0.83
0.92
1.01

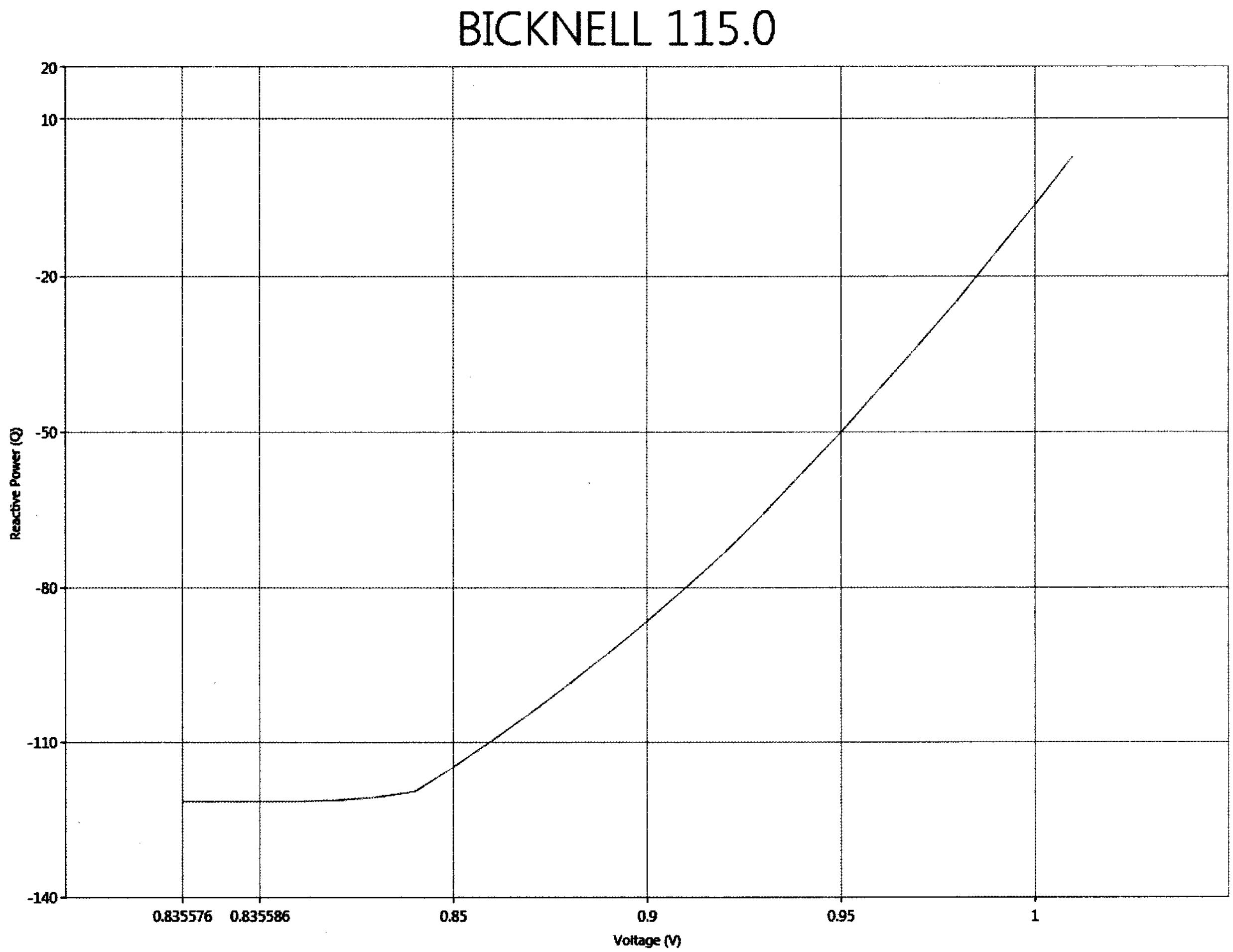

PANTANO 230.0
30
0
-30
-60
-90
-120
-150
Reactive Power (Q)
0.914688
0.915
0.93
0.95
0.97
0.99
1.01
Voltage (V)

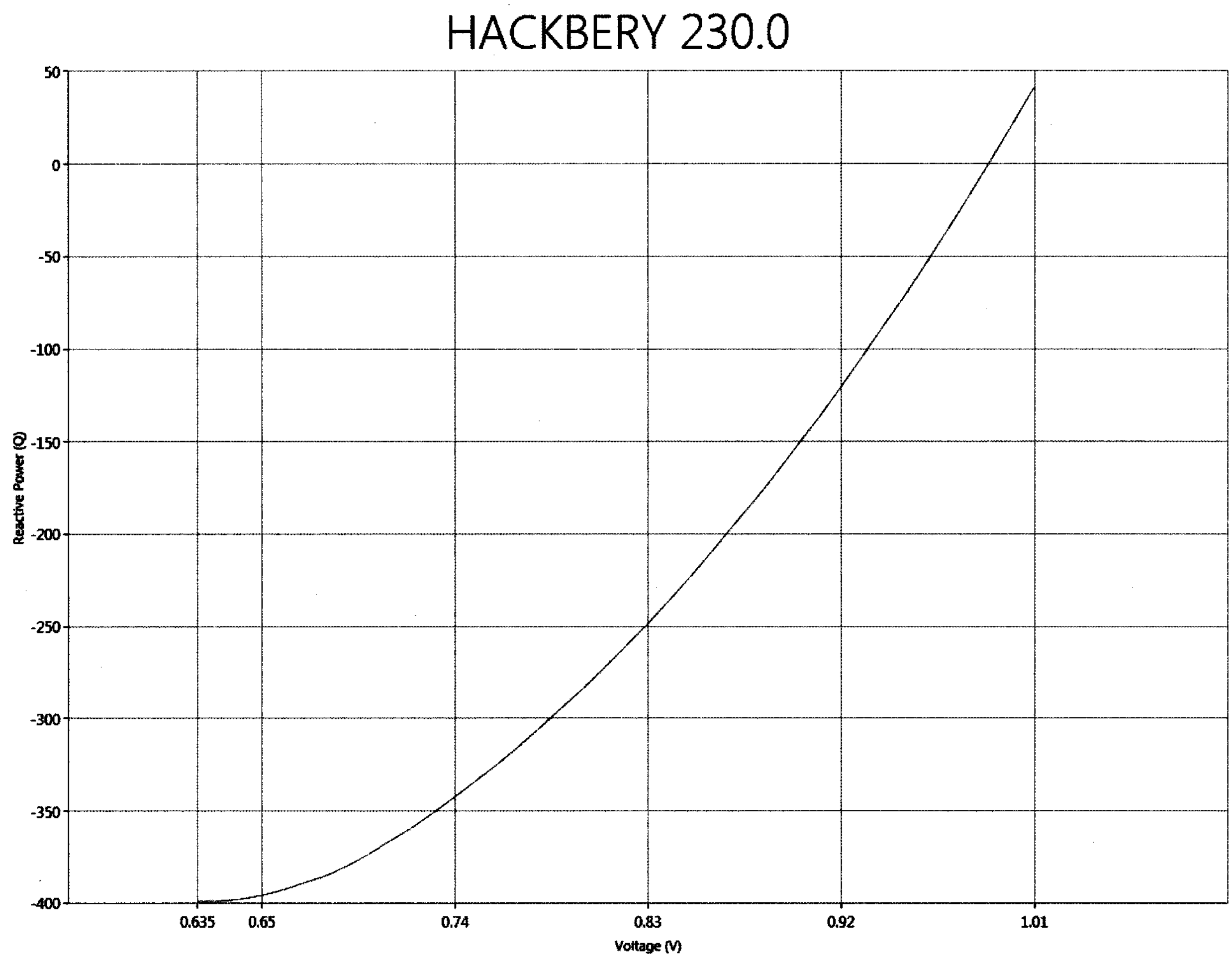

REDTAIL 230.0
50
0
-50
-100
-150
-200
-250
-300
-350
-400
Reactive Power (Q)
0.796221
0.8
0.86
0.92
0.98
Voltage (V)

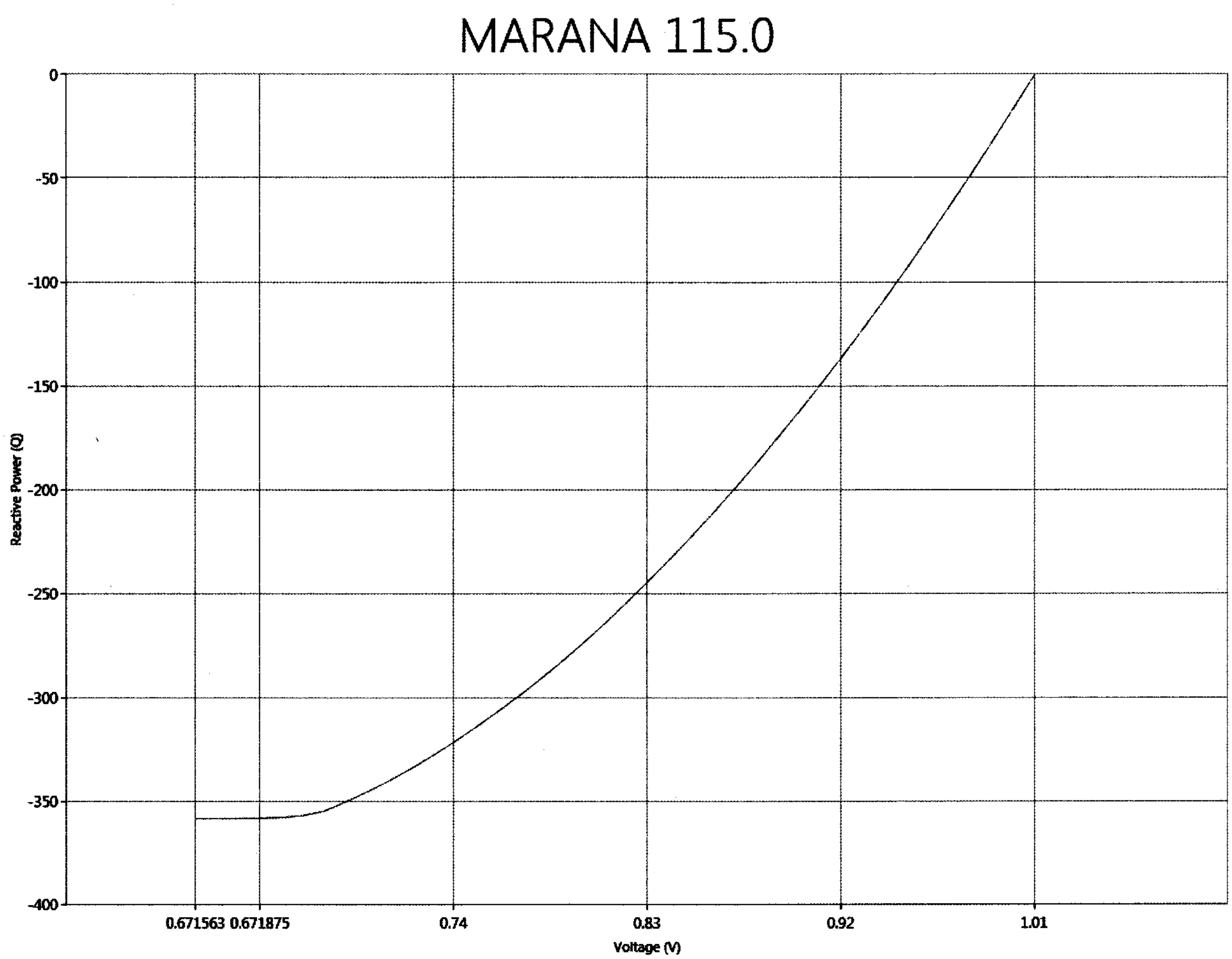
2020HS Plots:

2020HS Apache – Butterfield 230 kV Outage

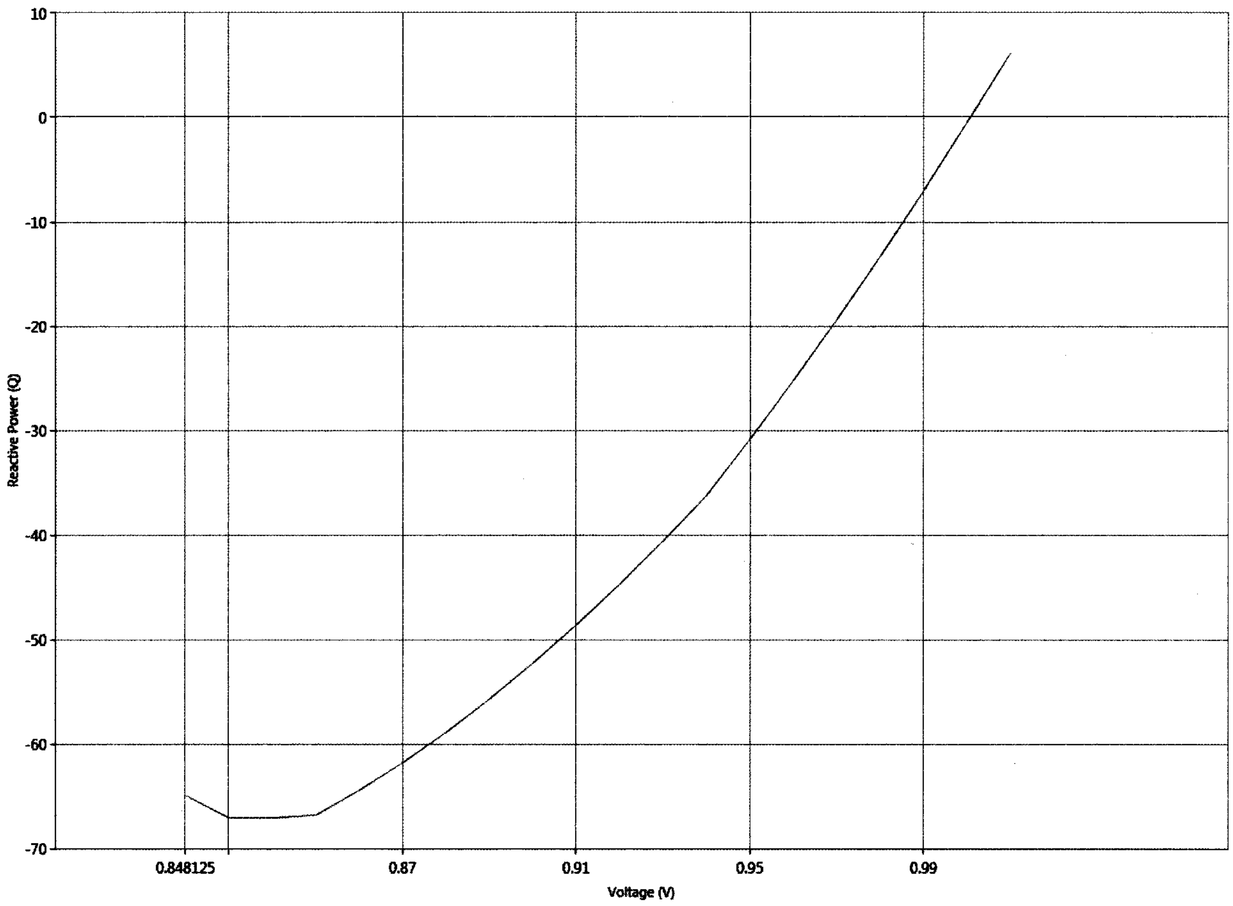
2020HS – Apache to Butterfield 230 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses

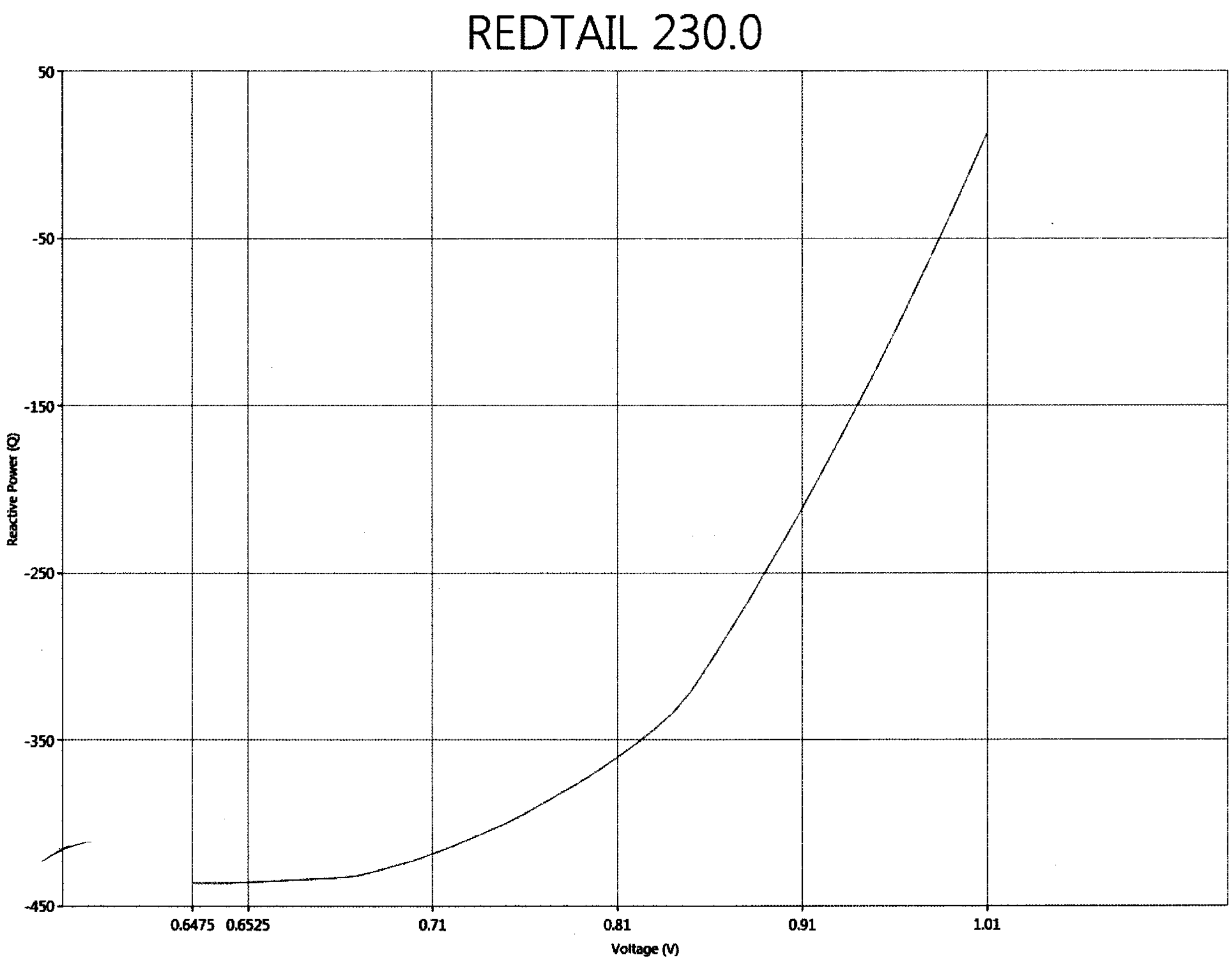



HACKBERY 230.0
Reactive Power (Q)
50
0
-50
-100
-150
-200
-250
-300
-350
-400
0.635
0.65
0.74
0.83
0.92
1.01
Voltage (V)


MARANA 115.0
0
-50
-100
-150
-200
-250
-300
-350
-400
Reactive Power (Q)
0.671563
0.671875
0.74
0.83
0.92
1.01
Voltage (V)

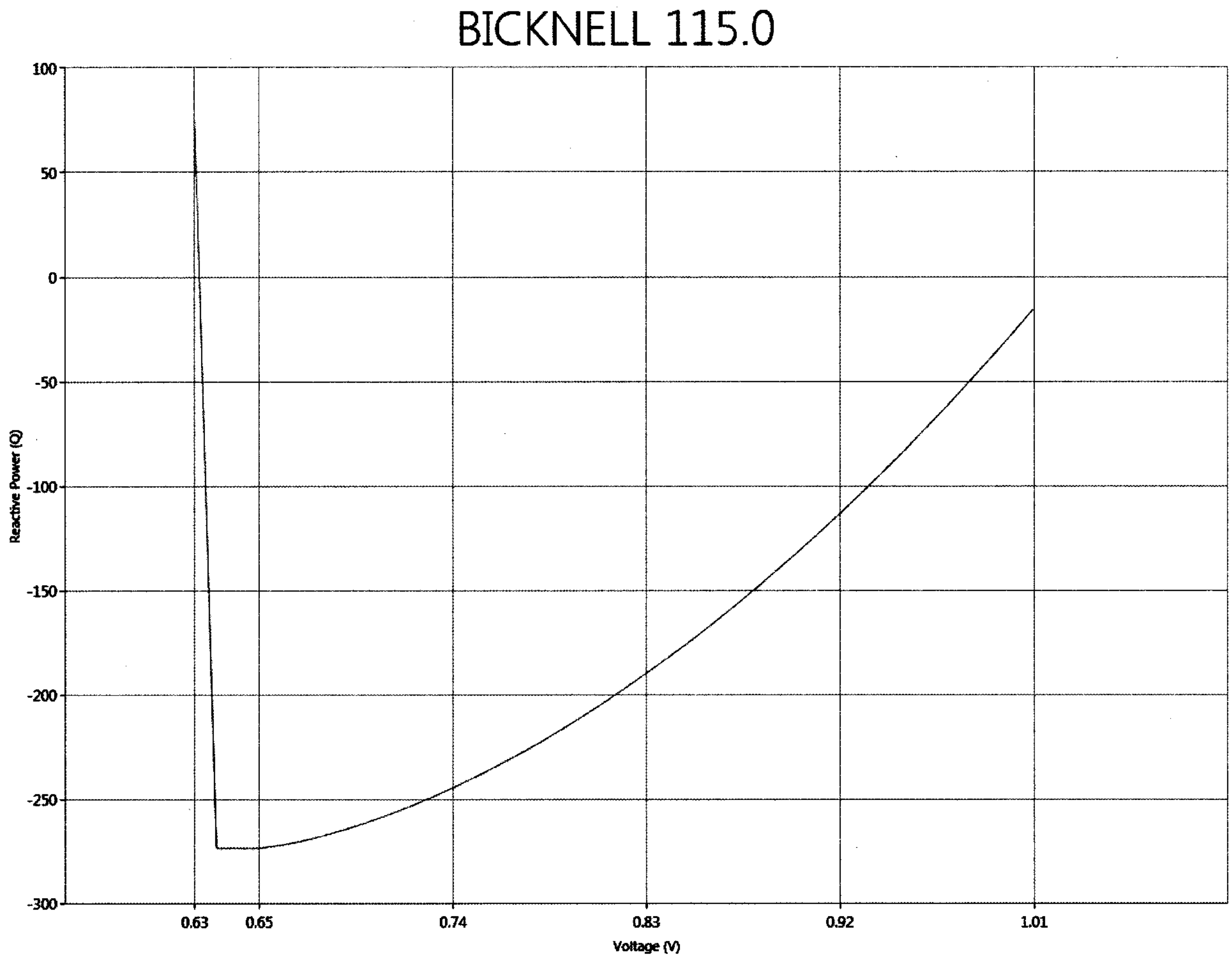
PANTANO 230.0

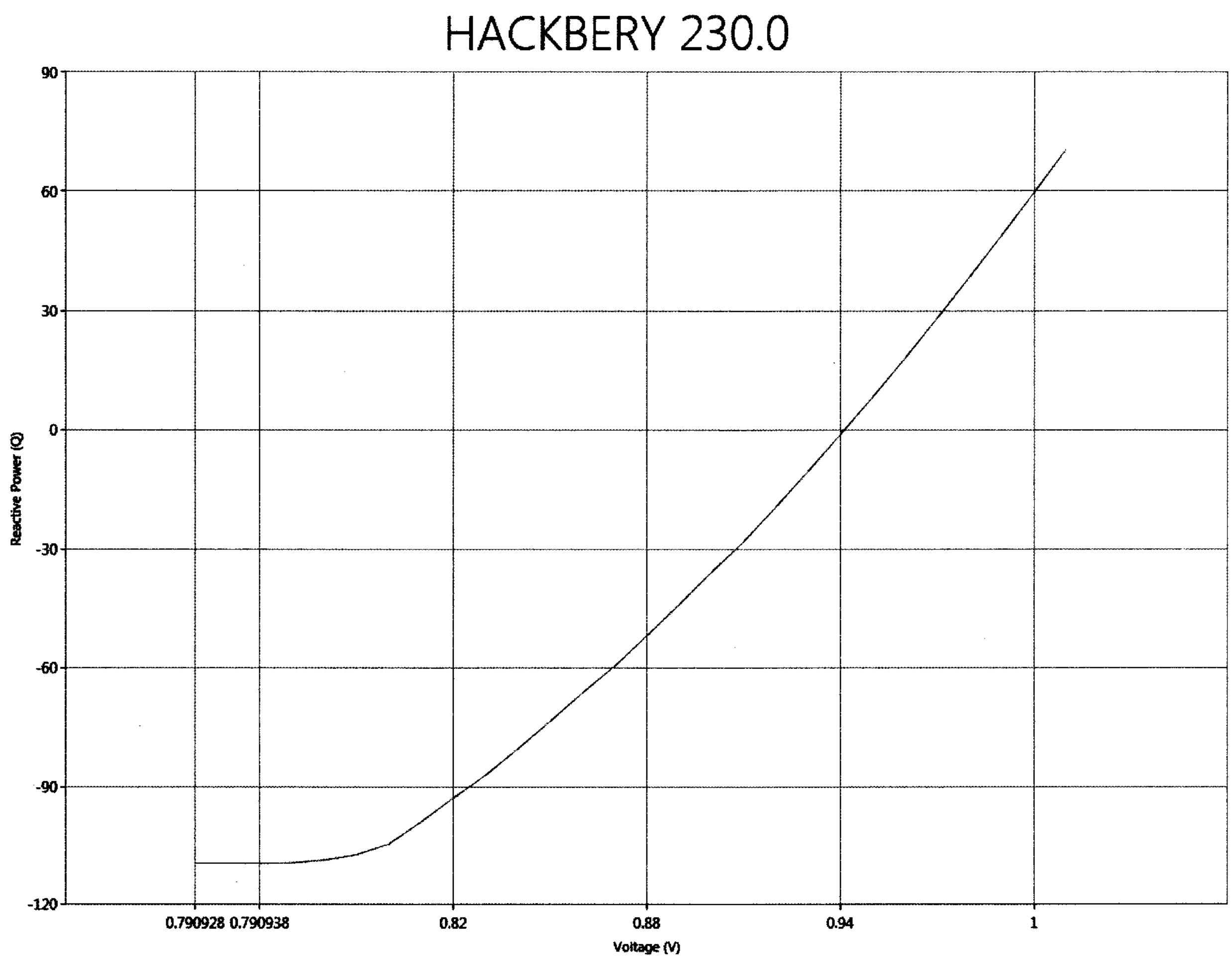



REDTAIL 230.0
50
-50
-150
-250
-350
-450
Reactive Power (Q)
0.6475
0.6525
0.71
0.81
0.91
1.01
Voltage (V)

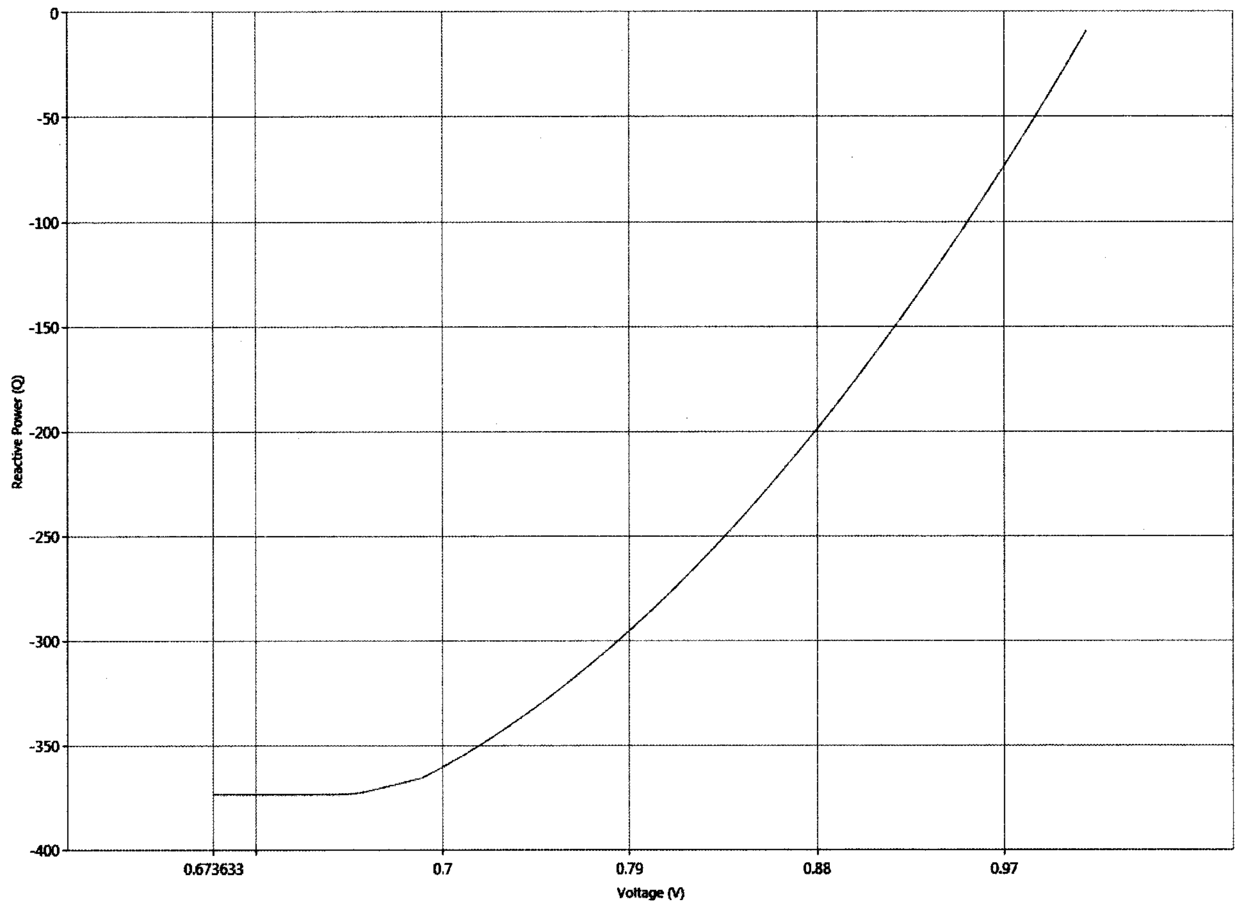
2020HS Apache – Redtail 230 kV Outage

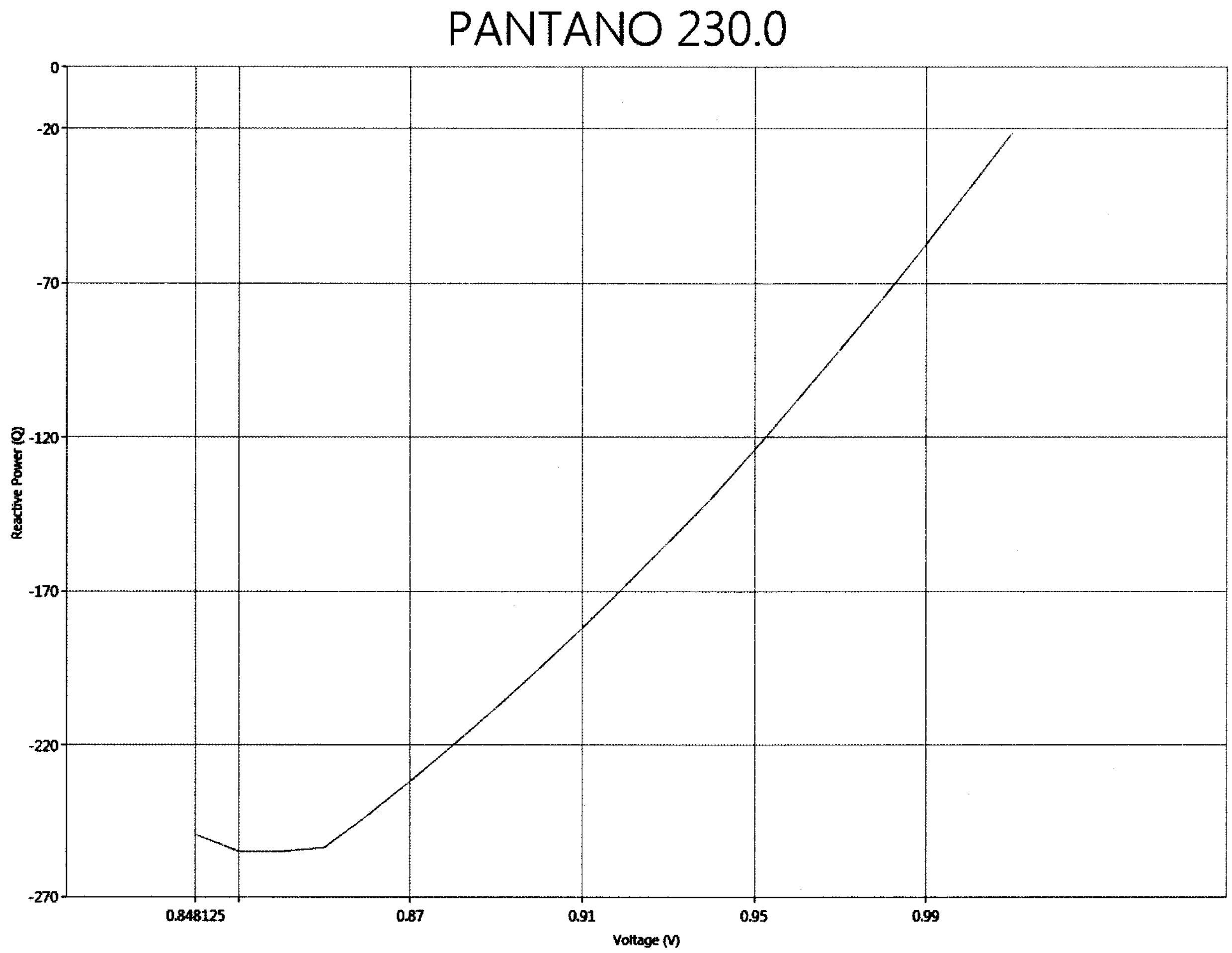
2020HS – Apache to Redtail 230 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses



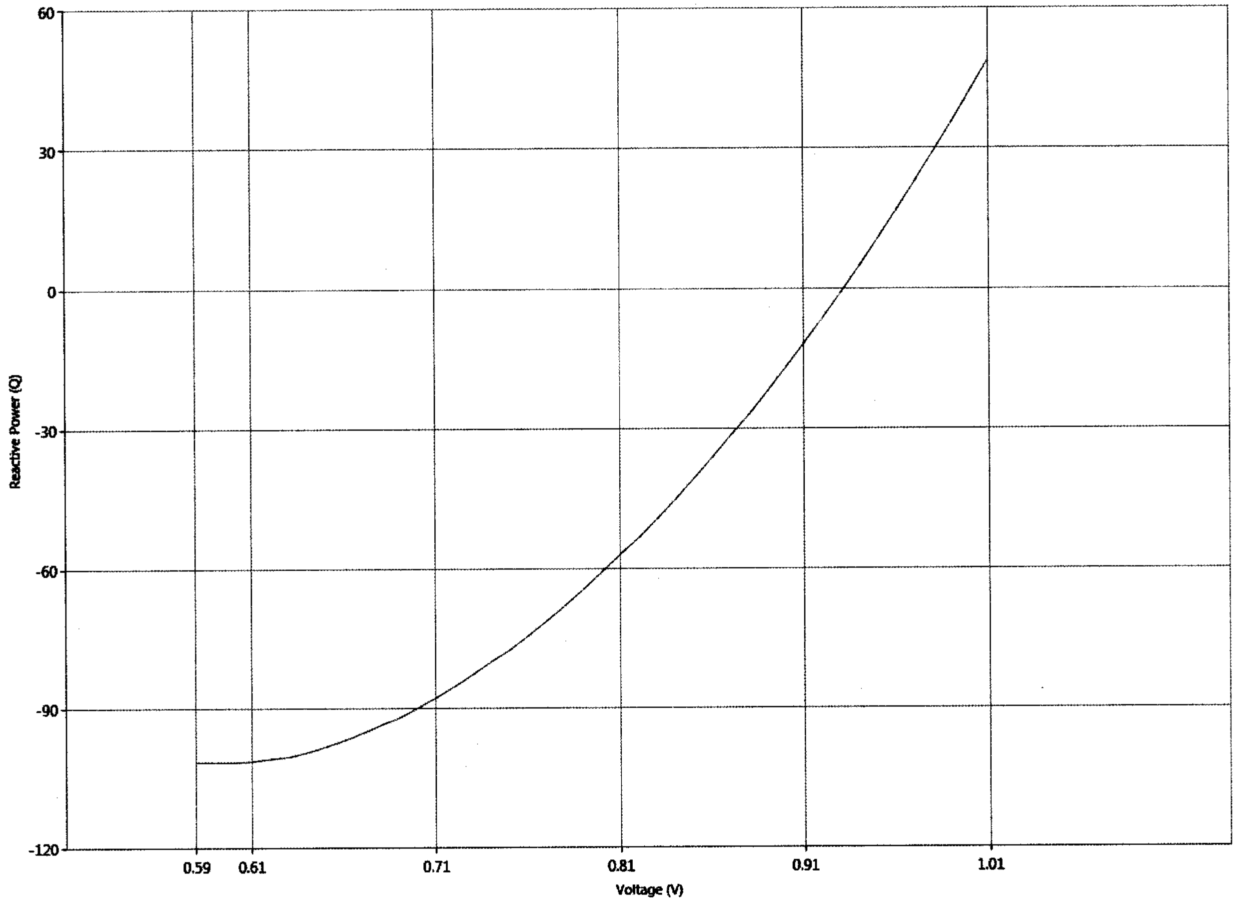

HACKBERY 230.0
90
60
30
0
-30
-60
-90
-120
Reactive Power (Q)
0.790928 0.790938
0.82
0.88
0.94
1
Voltage (V)

MARANA 115.0


0
-50
-100
-150
-200
-250
-300
-350
-400
Reactive Power (Q)
0.673633
0.7
0.79
0.88
0.97
Voltage (V)

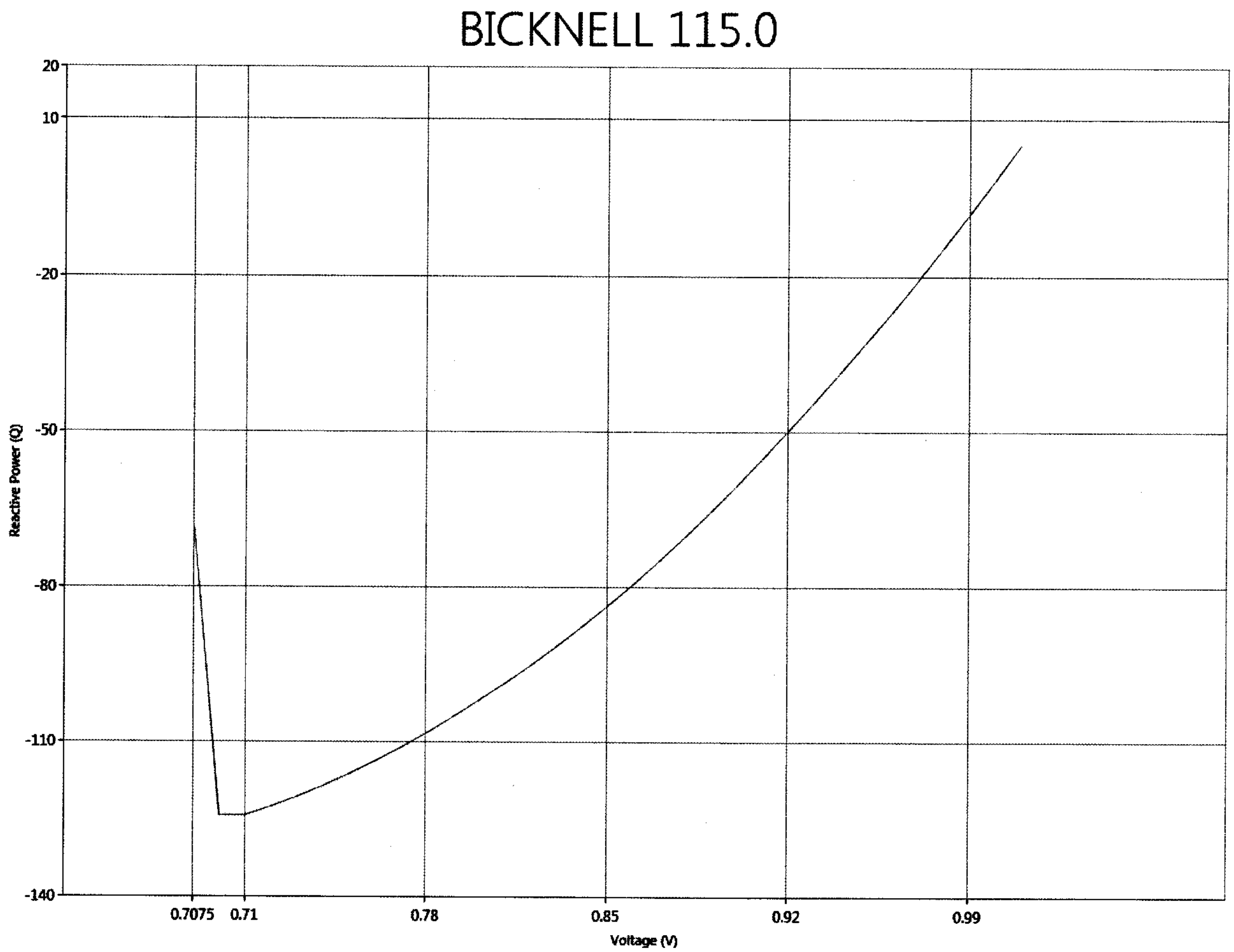

PANTANO 230.0
0
-20
-70
-120
-170
-220
-270
Reactive Power (Q)
0.848125
0.87
0.91
0.95
0.99
Voltage (V)

REDTAIL 230.0

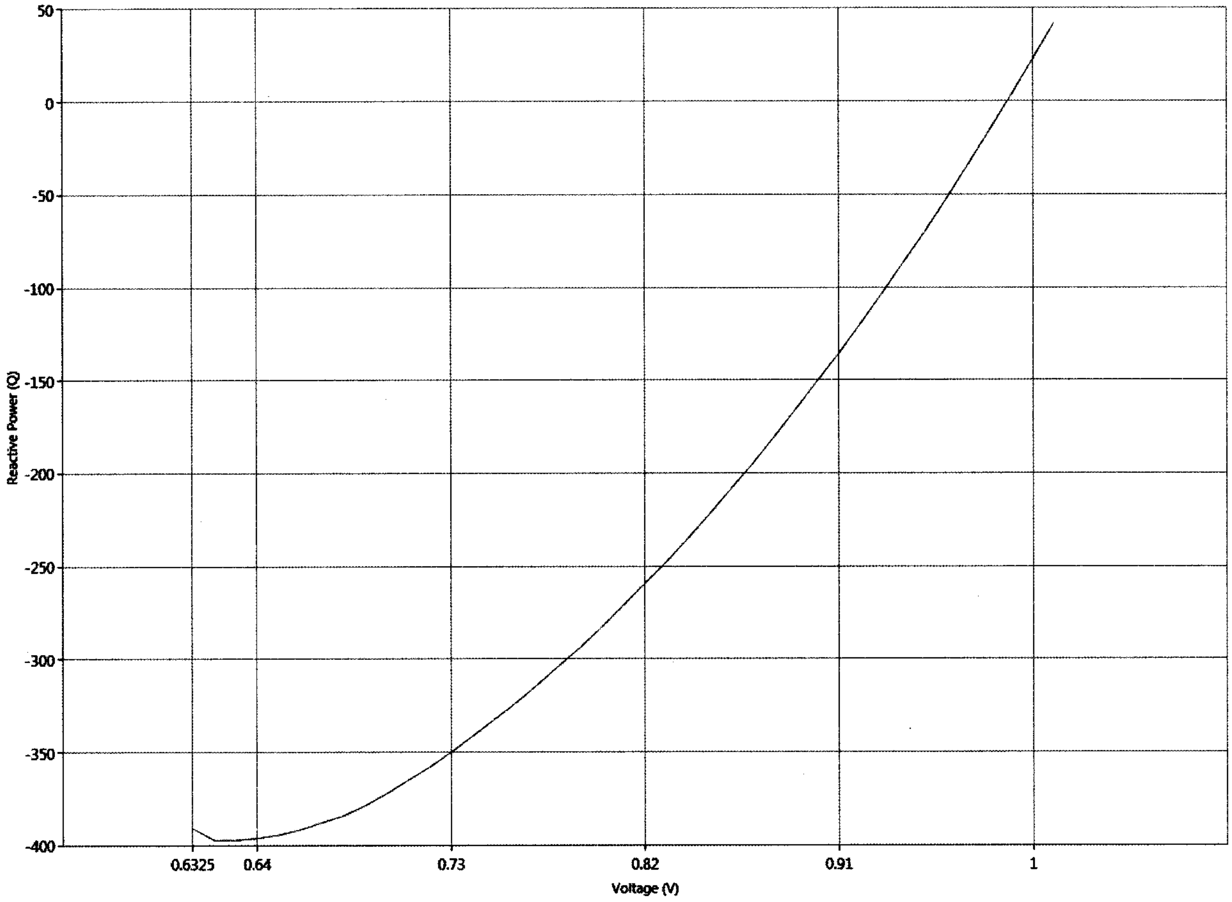


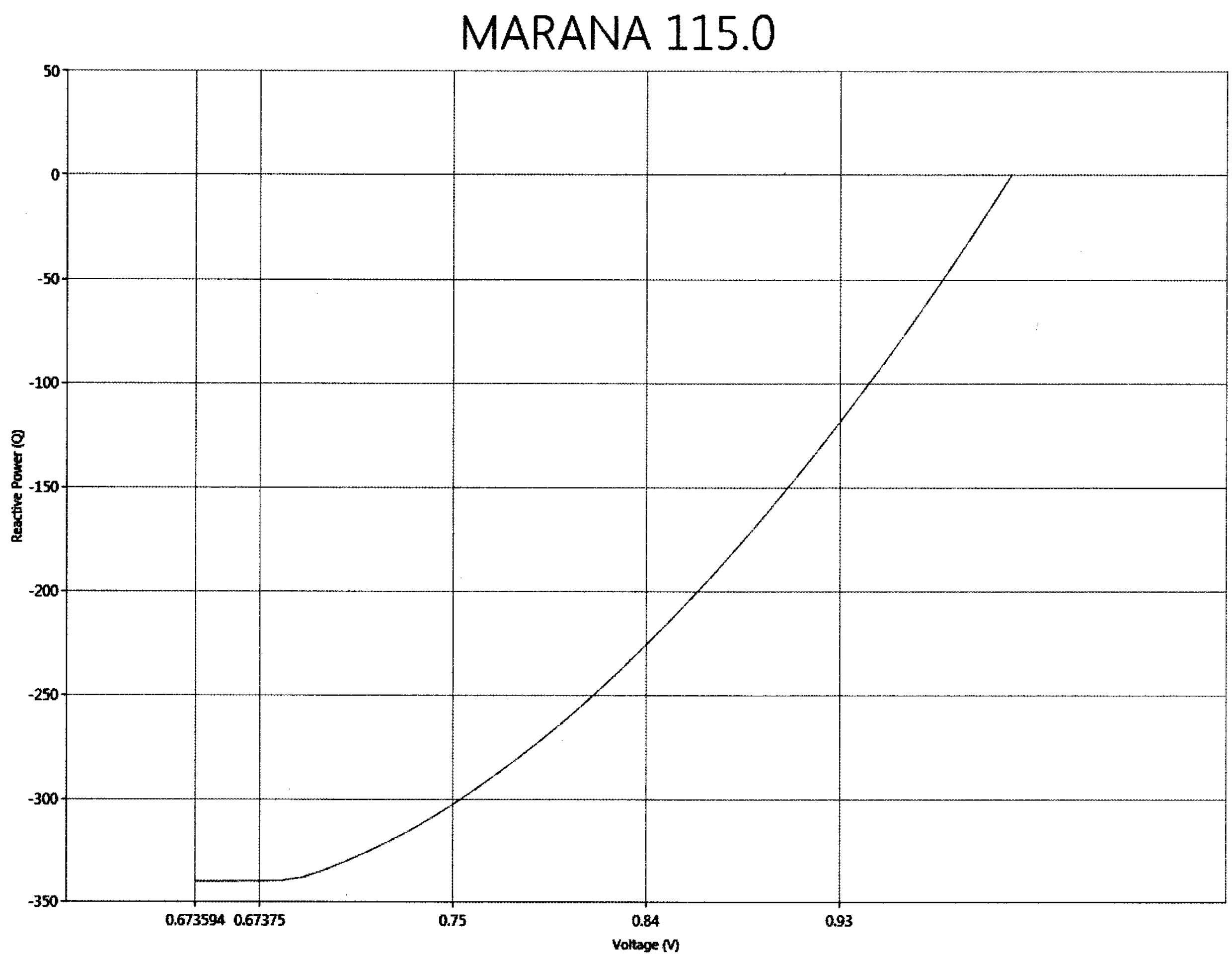
2020HS Bicknell – Vail 345 kV Outage

2020HS – Bicknell to Vail 345 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses

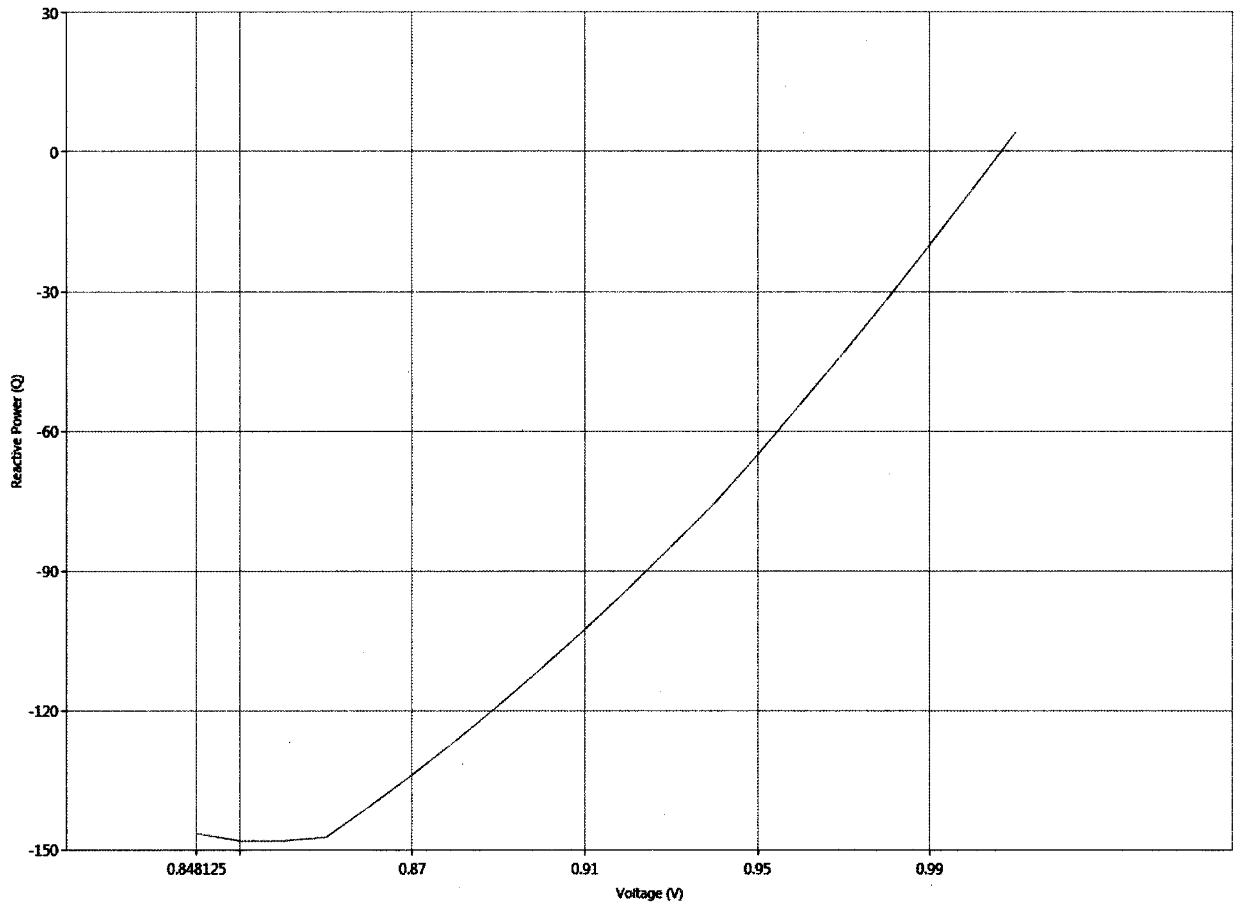


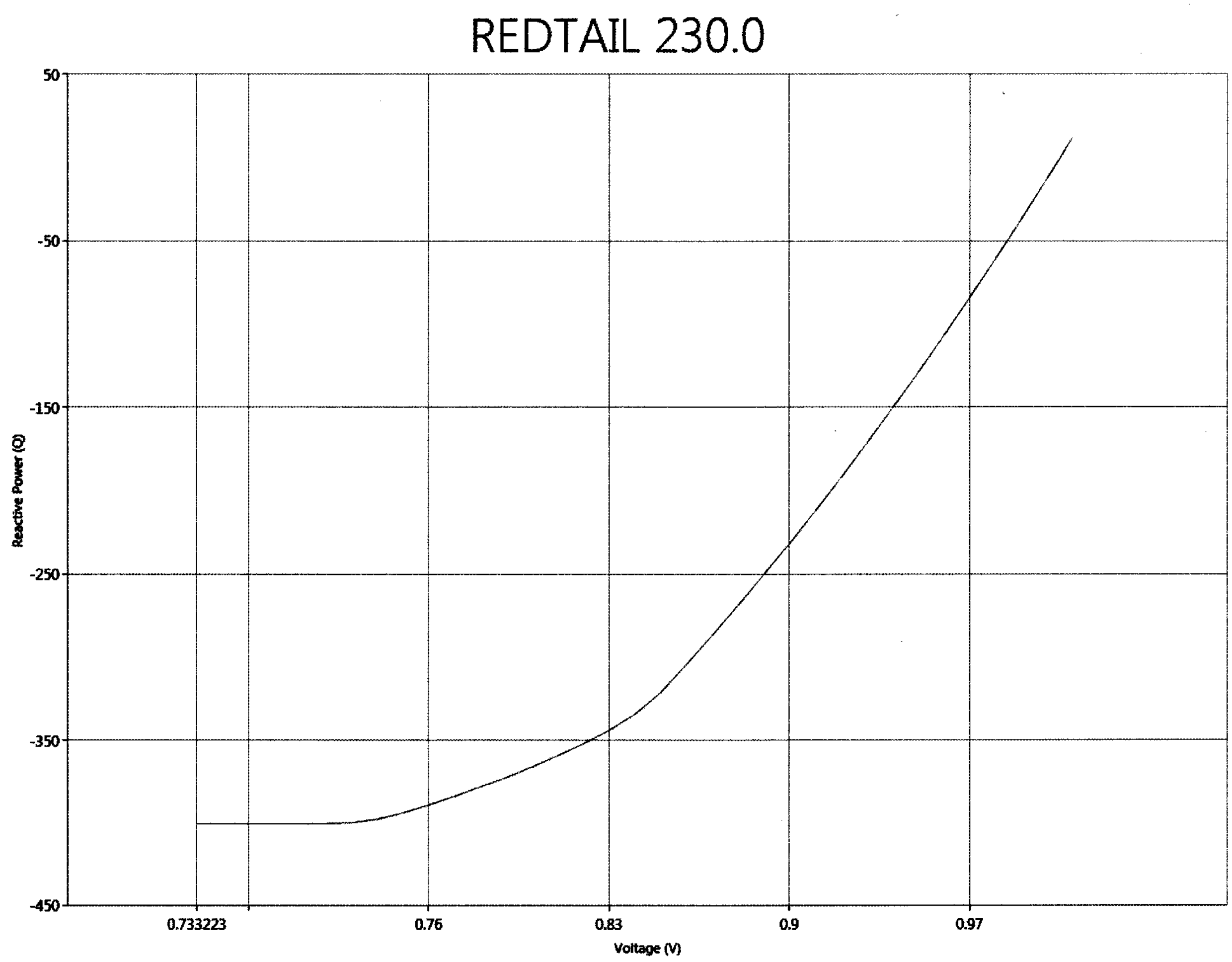
HACKBERY 230.0




MARANA 115.0
Reactive Power (Q)
50
0
-50
-100
-150
-200
-250
-300
-350
0.673594
0.67375
0.75
0.84
0.93
Voltage (V)

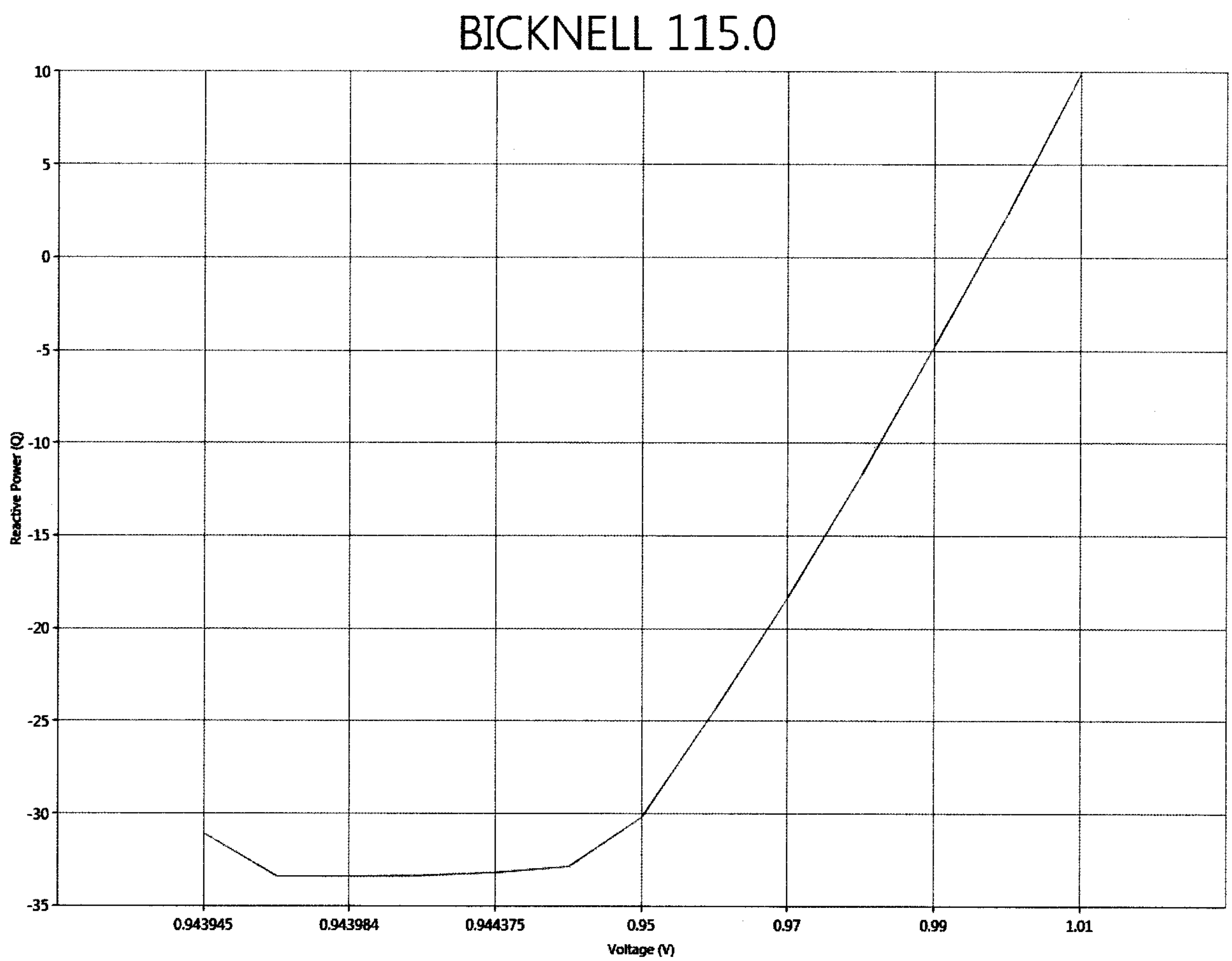
PANTANO 230.0

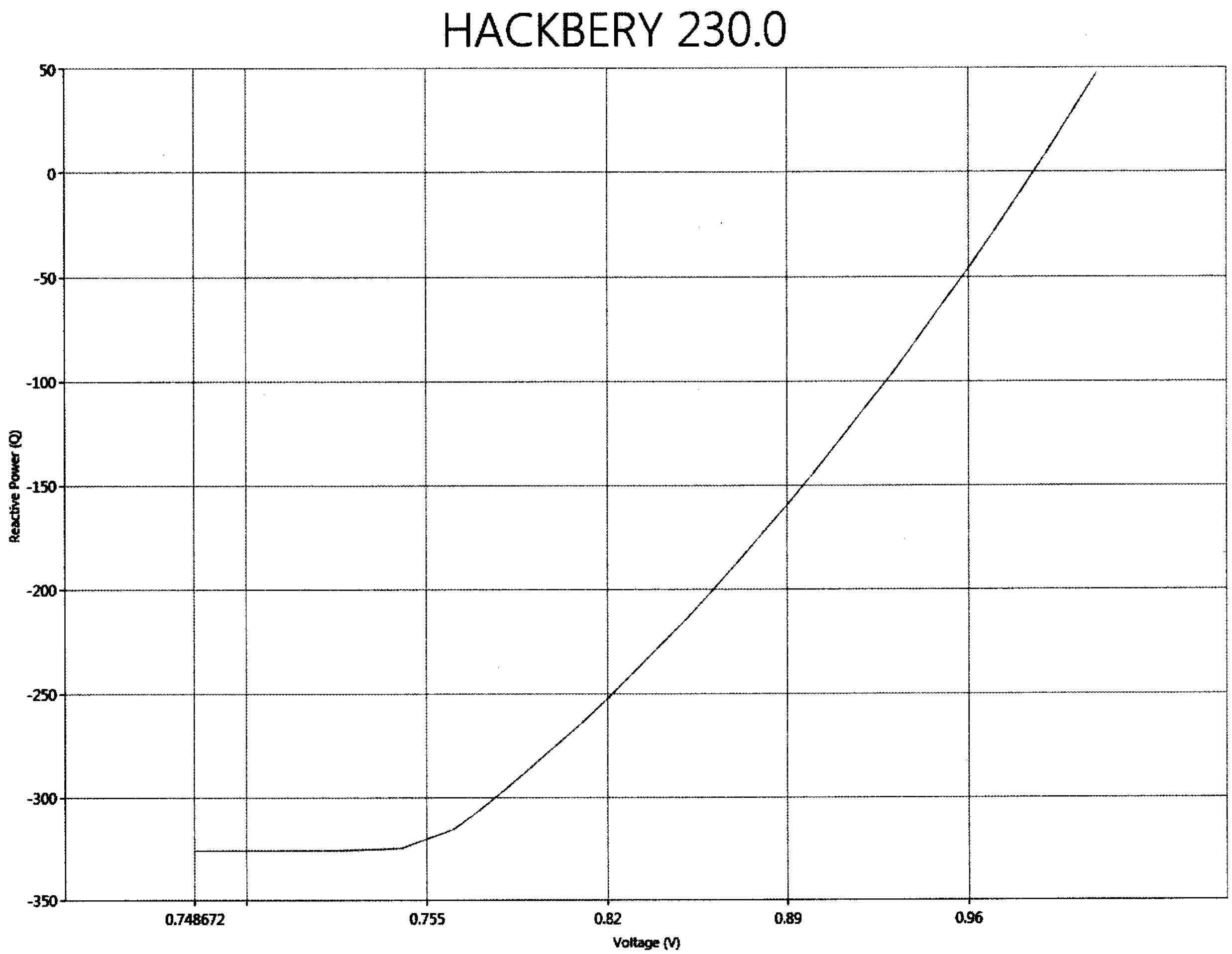



REDTAIL 230.0
50
-50
-150
-250
-350
-450
Reactive Power (Q)
0.733223
0.76
0.83
0.9
0.97
Voltage (V)

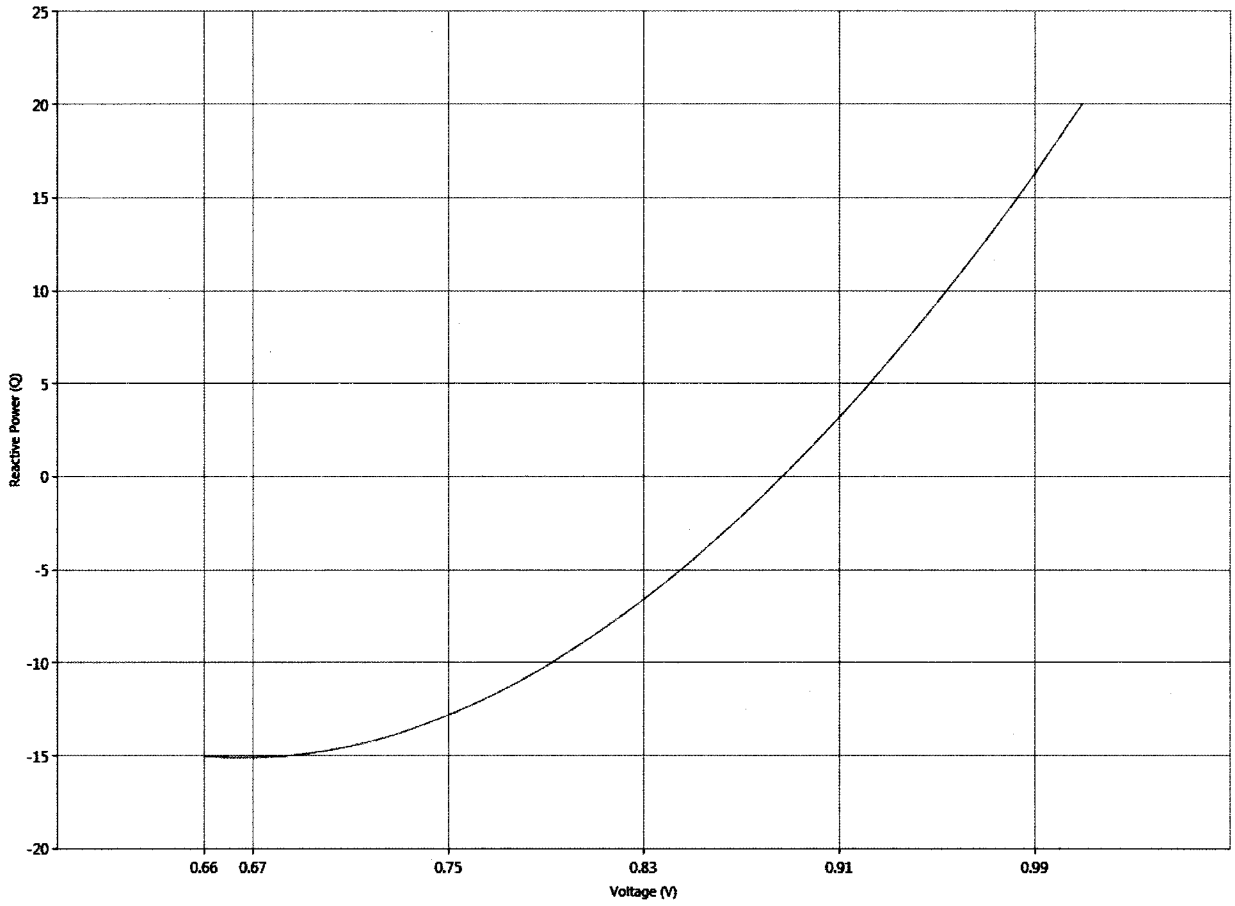
2020HS Marana Group 115 kV Outage

2020HS – Marana Group 115V Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses

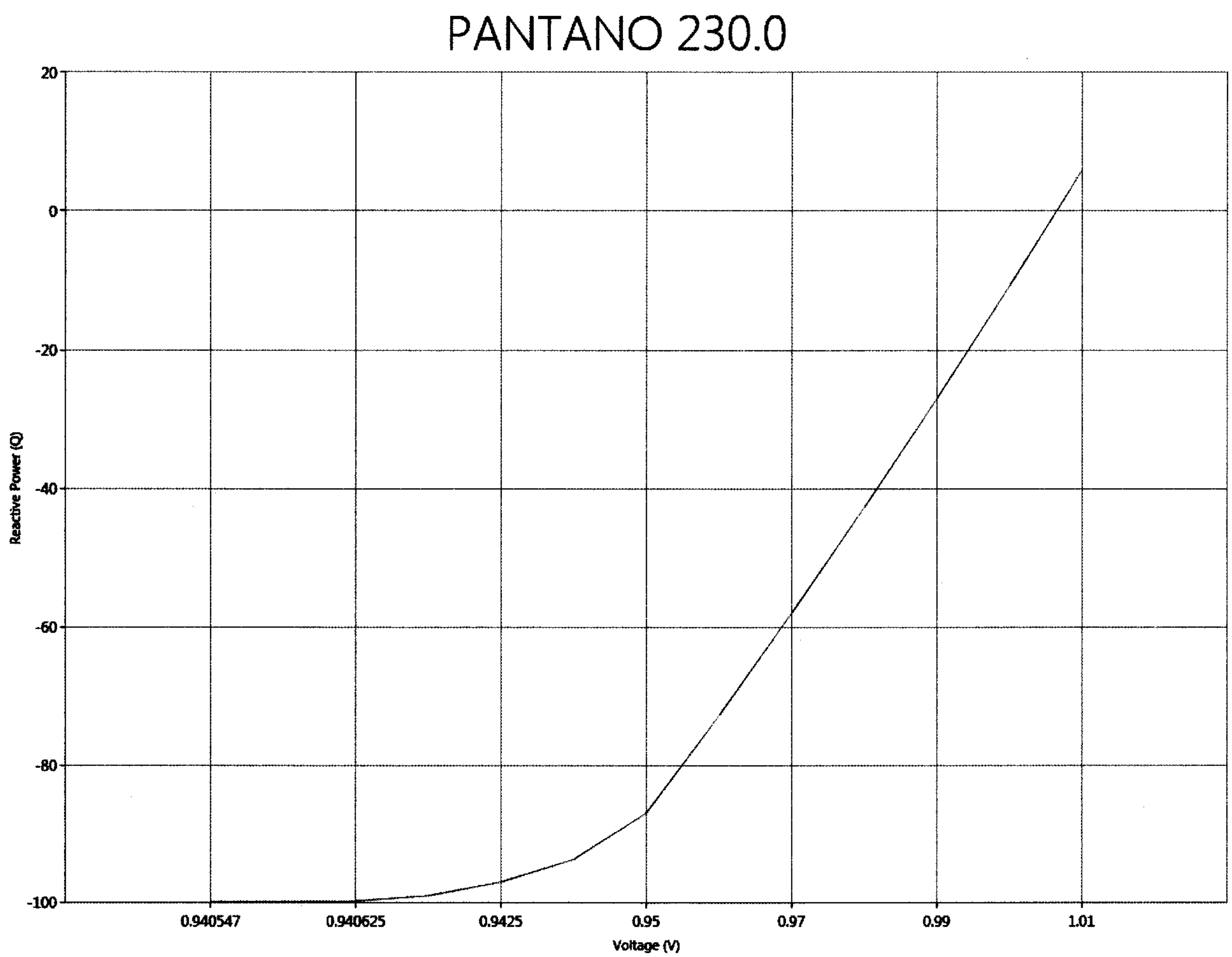


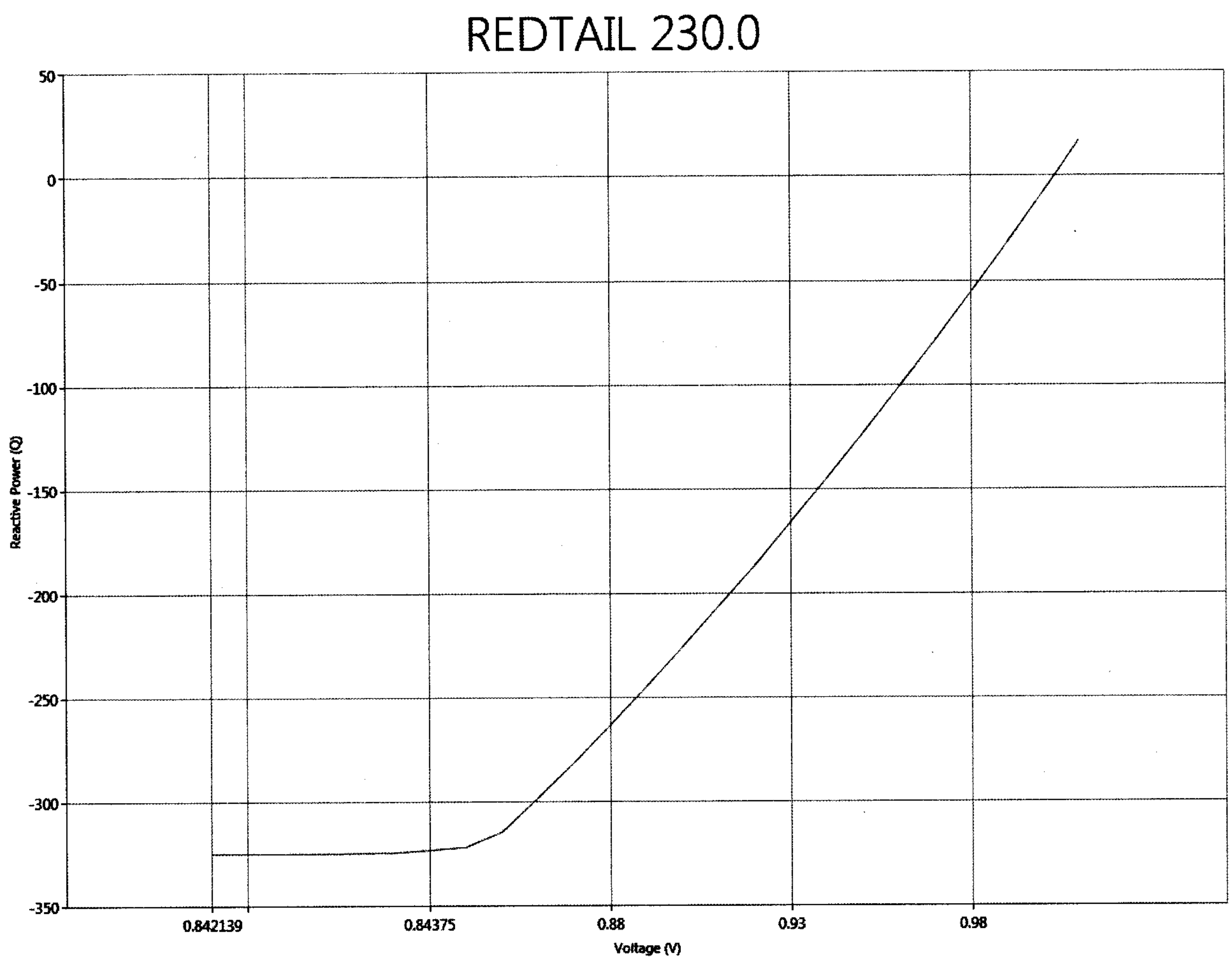

HACKBERY 230.0
50
0
-50
-100
-150
-200
-250
-300
-350
Reactive Power (Q)
0.748672
0.755
0.82
0.89
0.96
Voltage (V)

MARANA 115.0



25
20
15
10
5
0
-5
-10
-15
-20
Reactive Power (Q)
0.66
0.67
0.75
0.83
0.91
0.99
Voltage (V)

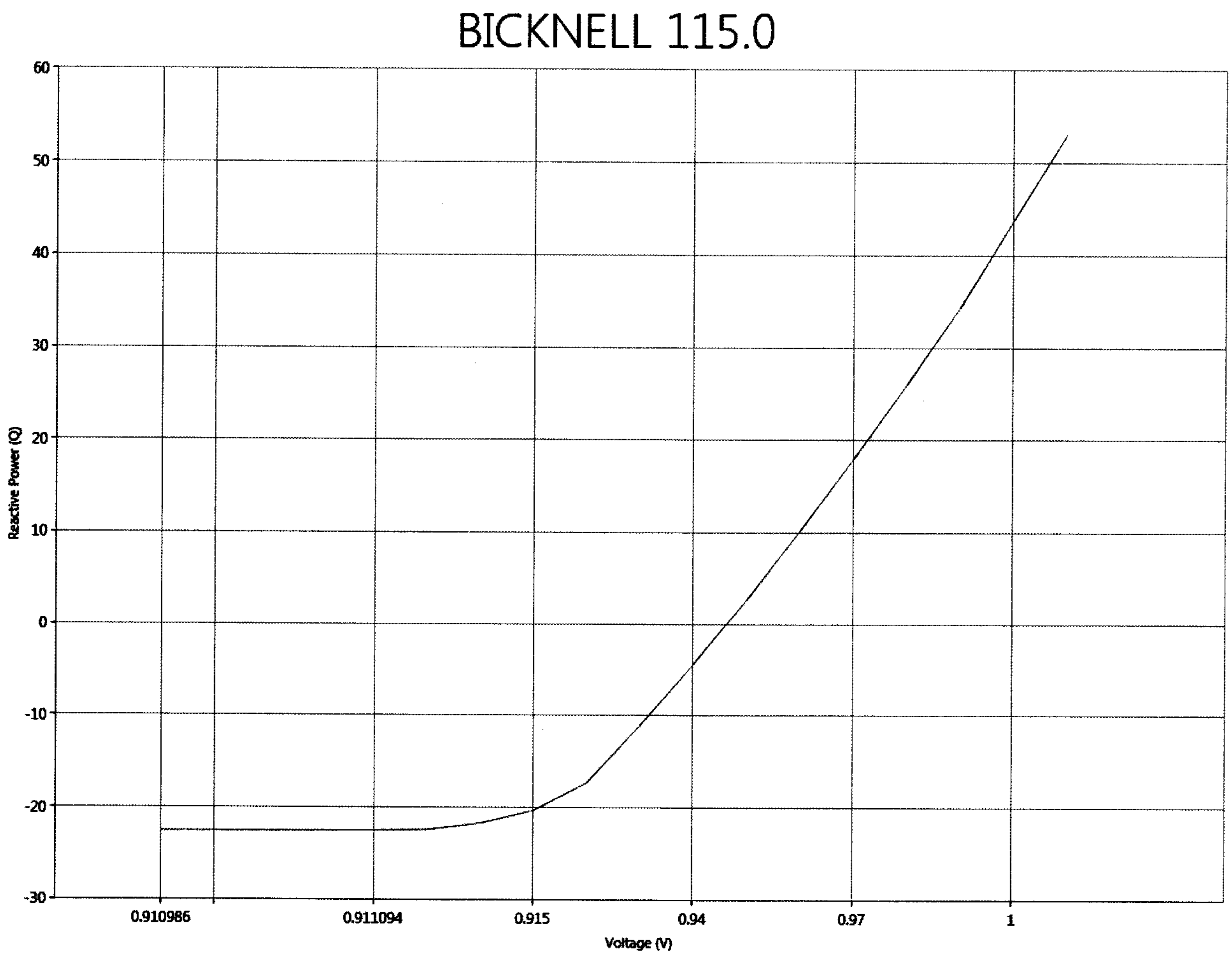

PANTANO 230.0
20
0
-20
-40
-60
-80
-100
Reactive Power (Q)
0.940547
0.940625
0.9425
0.95
0.97
0.99
1.01
Voltage (V)

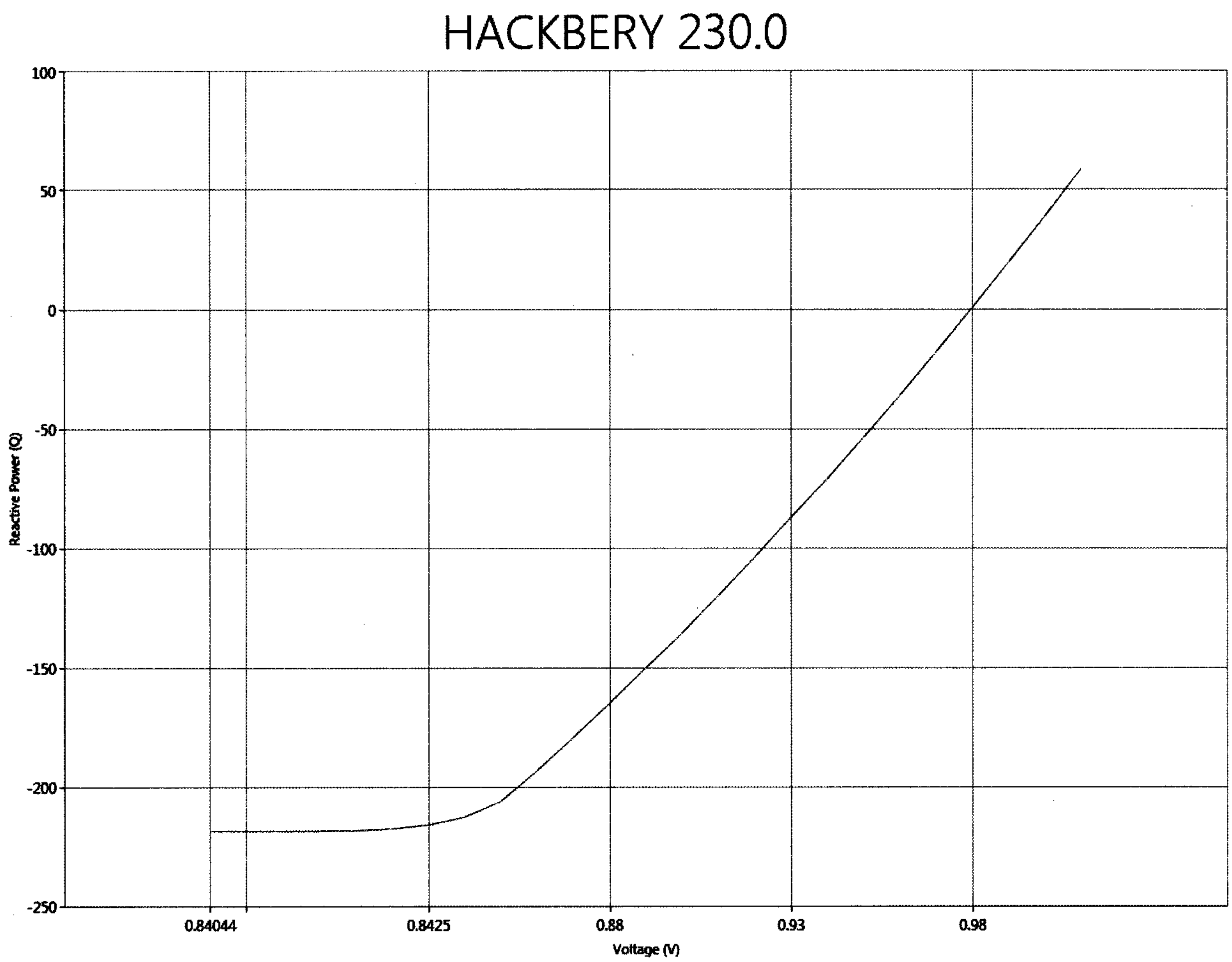

REDTAIL 230.0
50
0
-50
-100
-150
-200
-250
-300
-350
Reactive Power (Q)
0.842139
0.84375
0.88
0.93
0.98
Voltage (V)

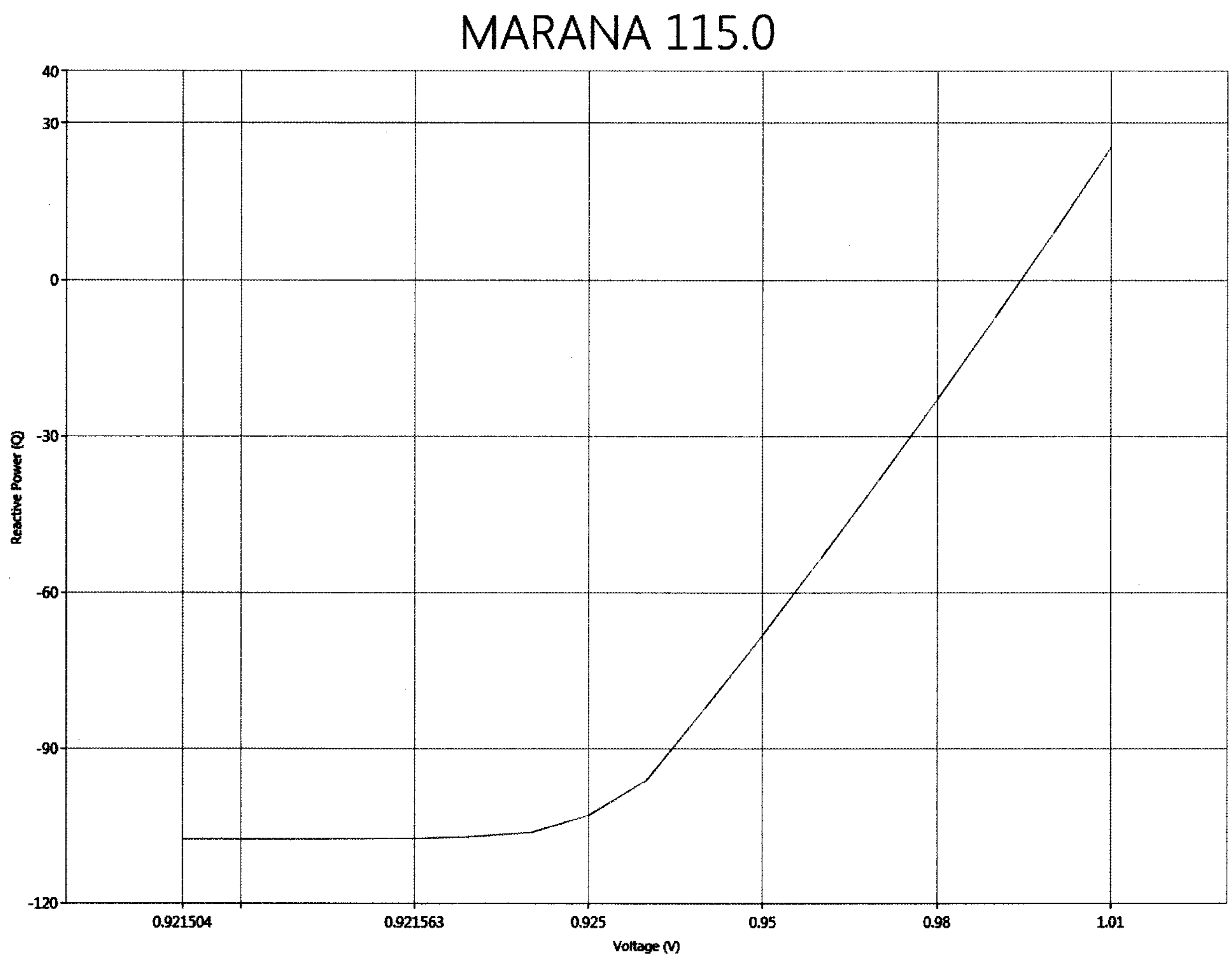
2025HS Plots:

2025HS Apache –Butterfield 230 kV Outage

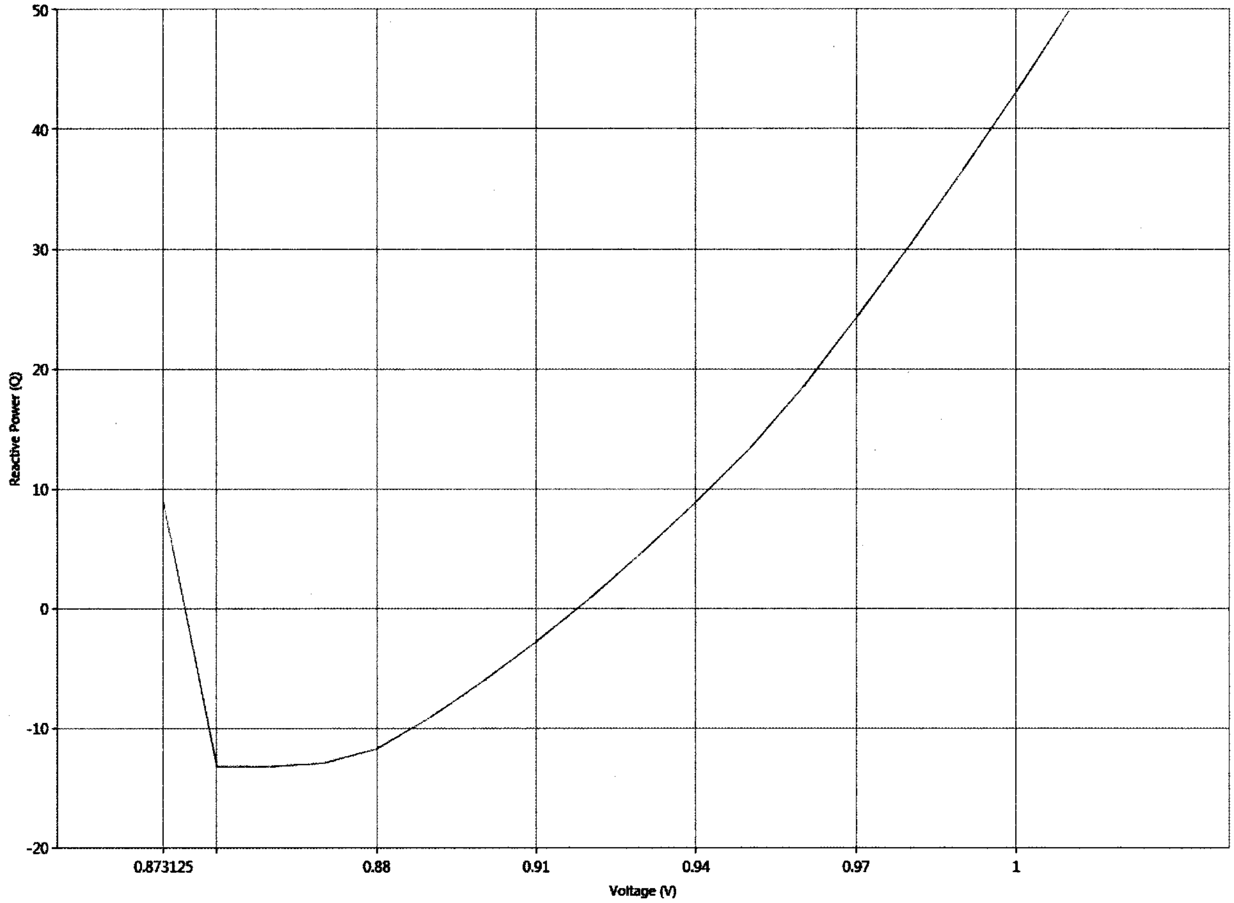
2025HS – Apache to Redtail 230 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses

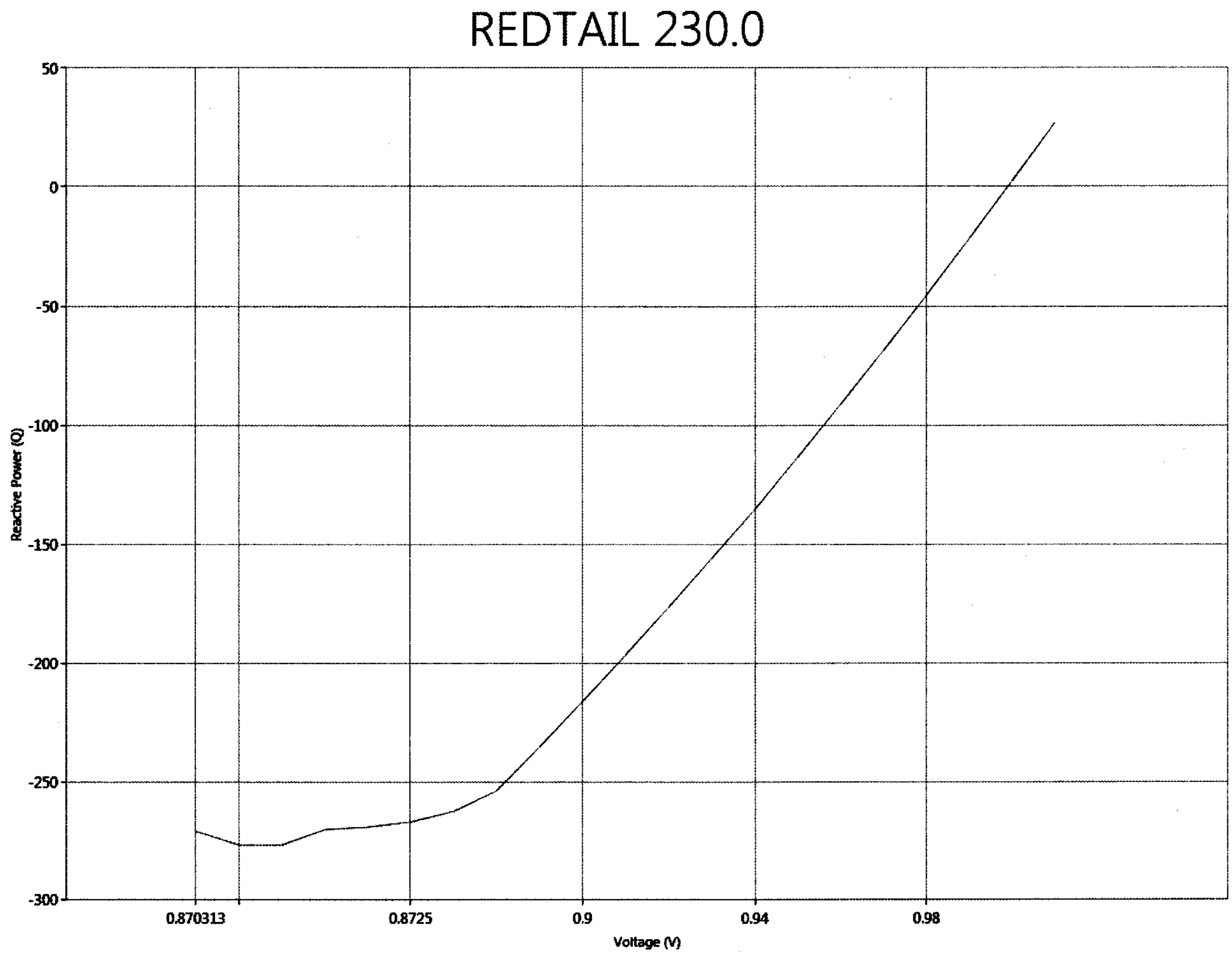



HACKBERY 230.0
100
50
0
-50
-100
-150
-200
-250
Reactive Power (Q)
0.84044
0.8425
0.88
0.93
0.98
Voltage (V)


MARANA 115.0
40
30
0
-30
-60
-90
-120
Reactive Power (Q)
0.921504
0.921563
0.925
0.95
0.98
1.01
Voltage (V)

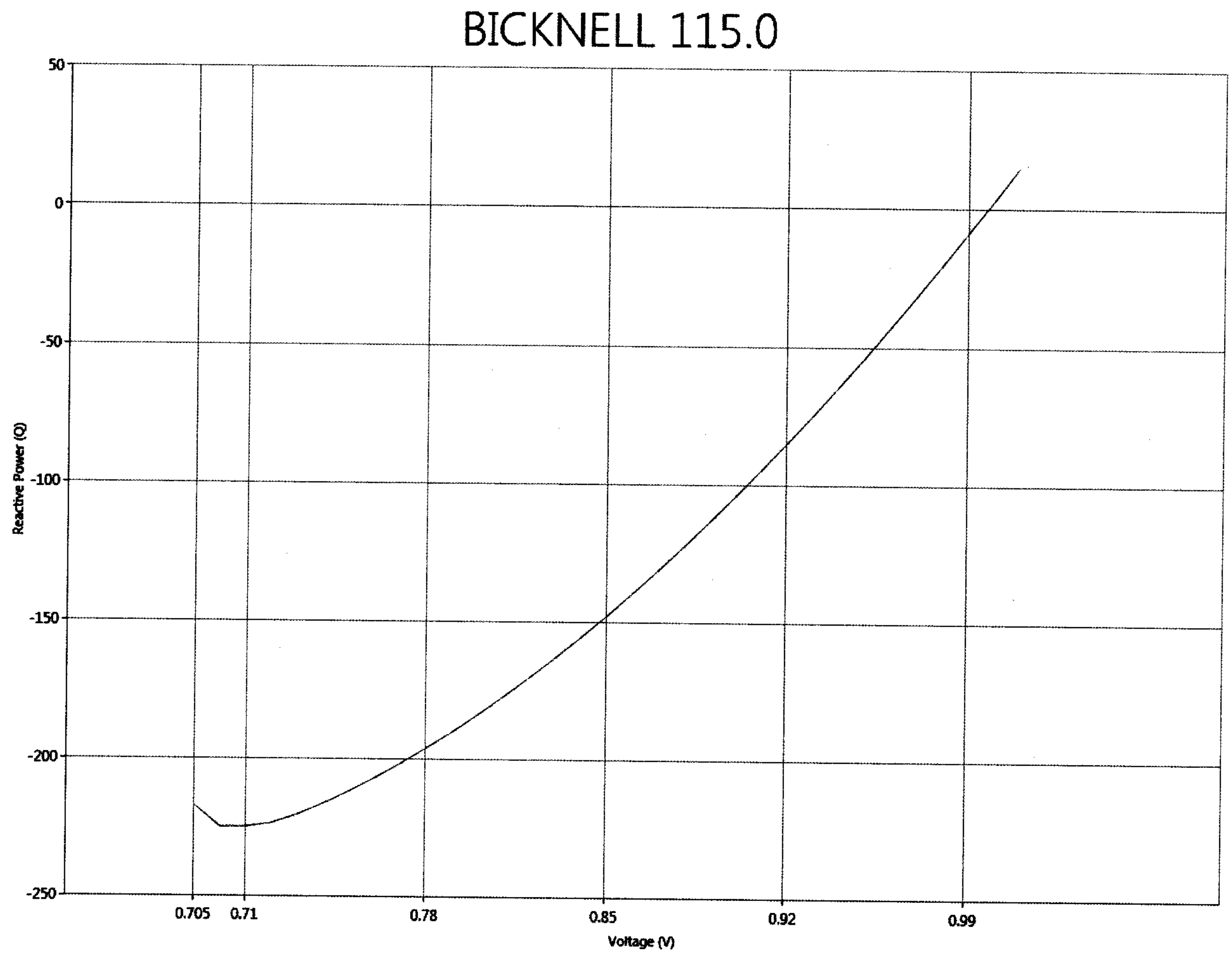
PANTANO 230.0

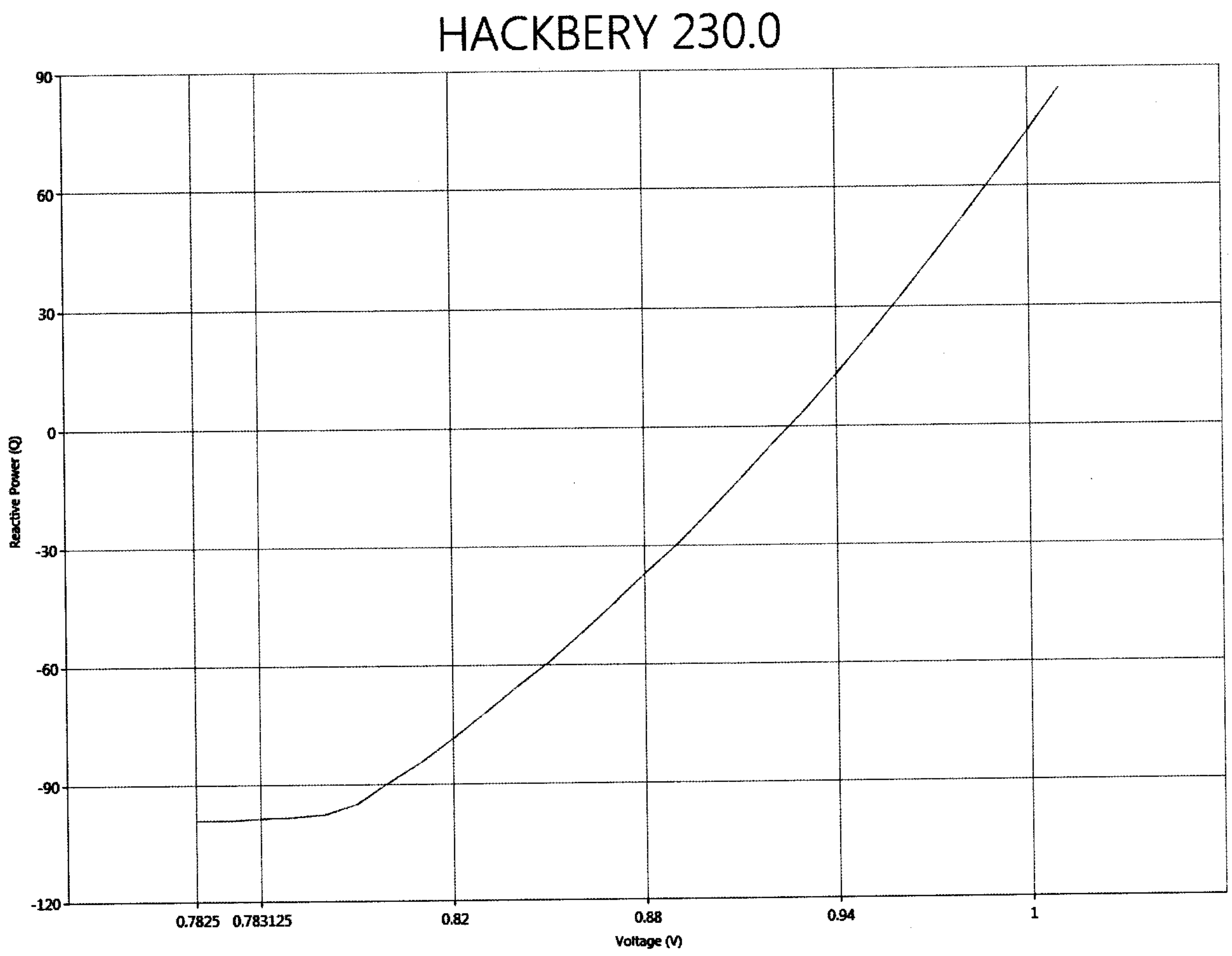



REDTAIL 230.0
Reactive Power (Q)
50
0
-50
-100
-150
-200
-250
-300
0.870313
0.8725
0.9
0.94
0.98
Voltage (V)

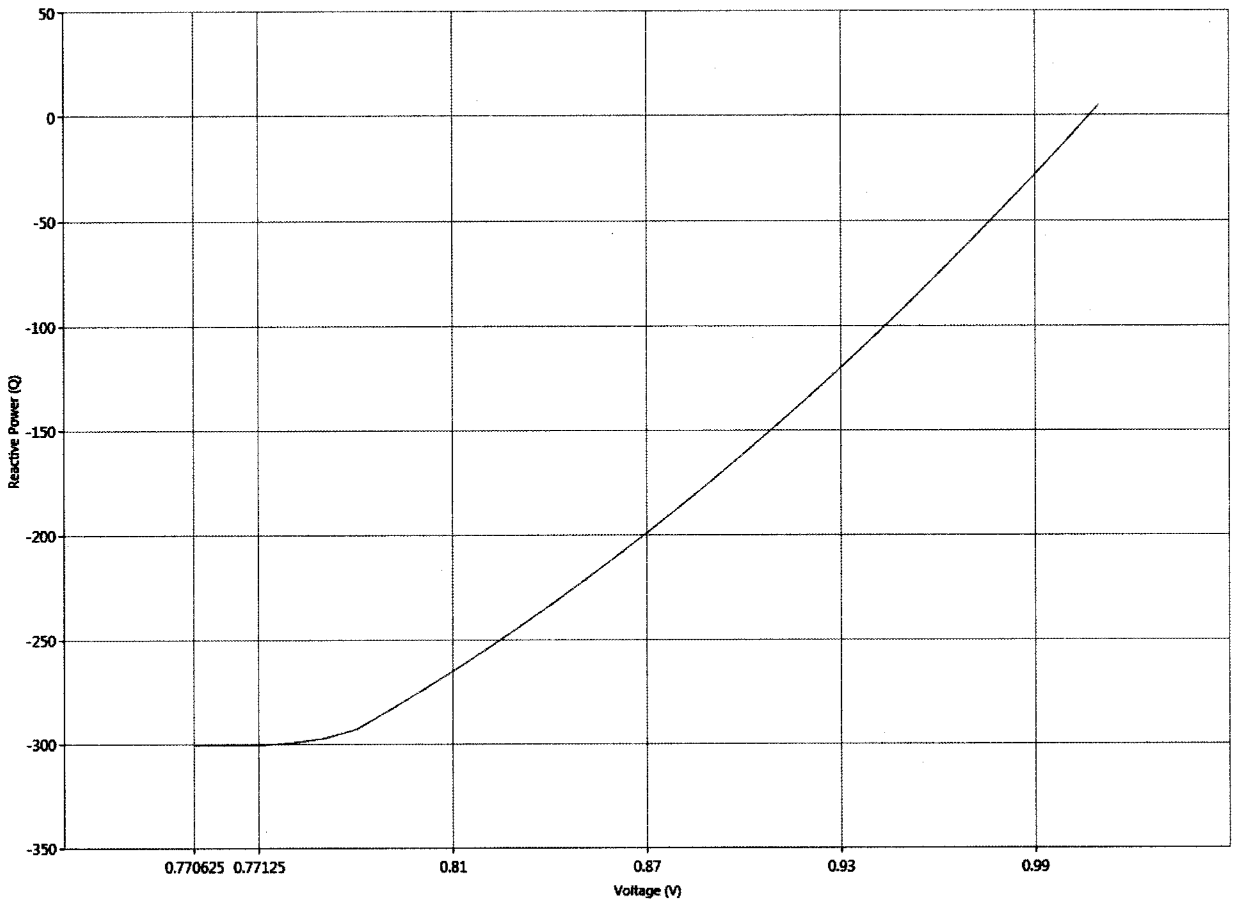
2025HS Apache – Redtail 230 kV Outage

2025HS – Apache to Redtail 230 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses



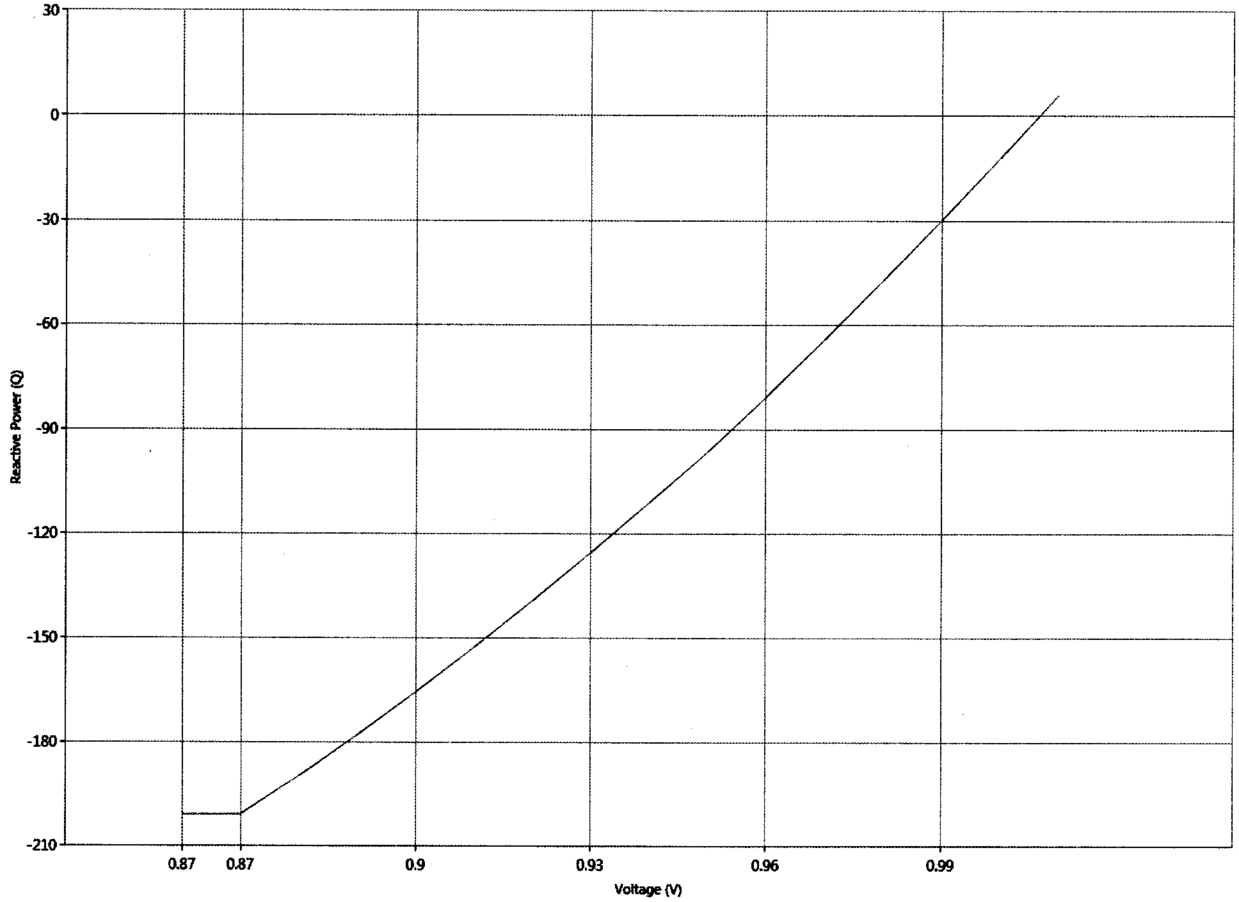

HACKBERY 230.0
90
60
30
0
-30
-60
-90
-120
Reactive Power (Q)
0.7825
0.783125
0.82
0.88
0.94
1
Voltage (V)

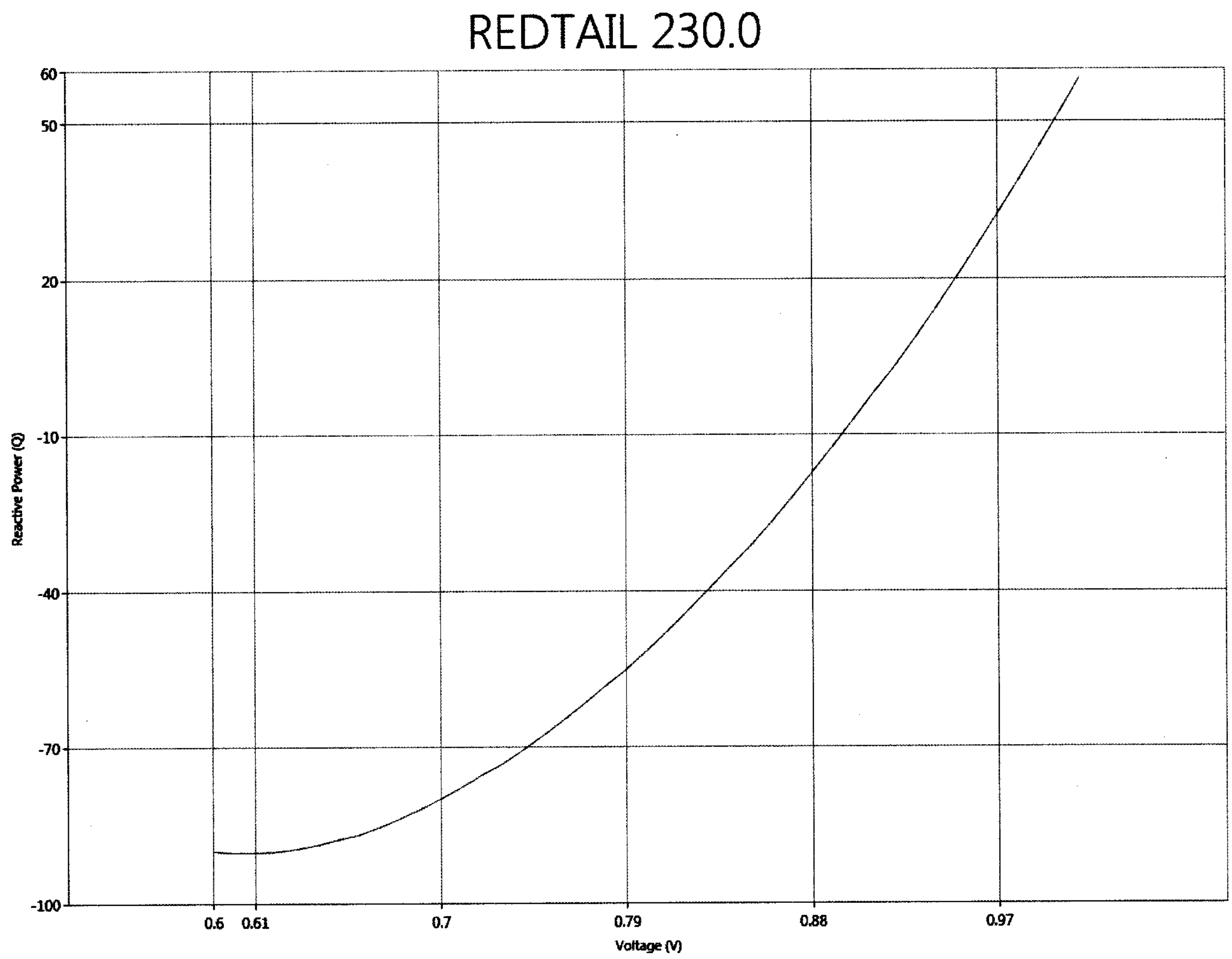
MARANA 115.0



50
0
-50
-100
-150
-200
-250
-300
-350
Reactive Power (Q)
0.770625
0.77125
0.81
0.87
0.93
0.99
Voltage (V)

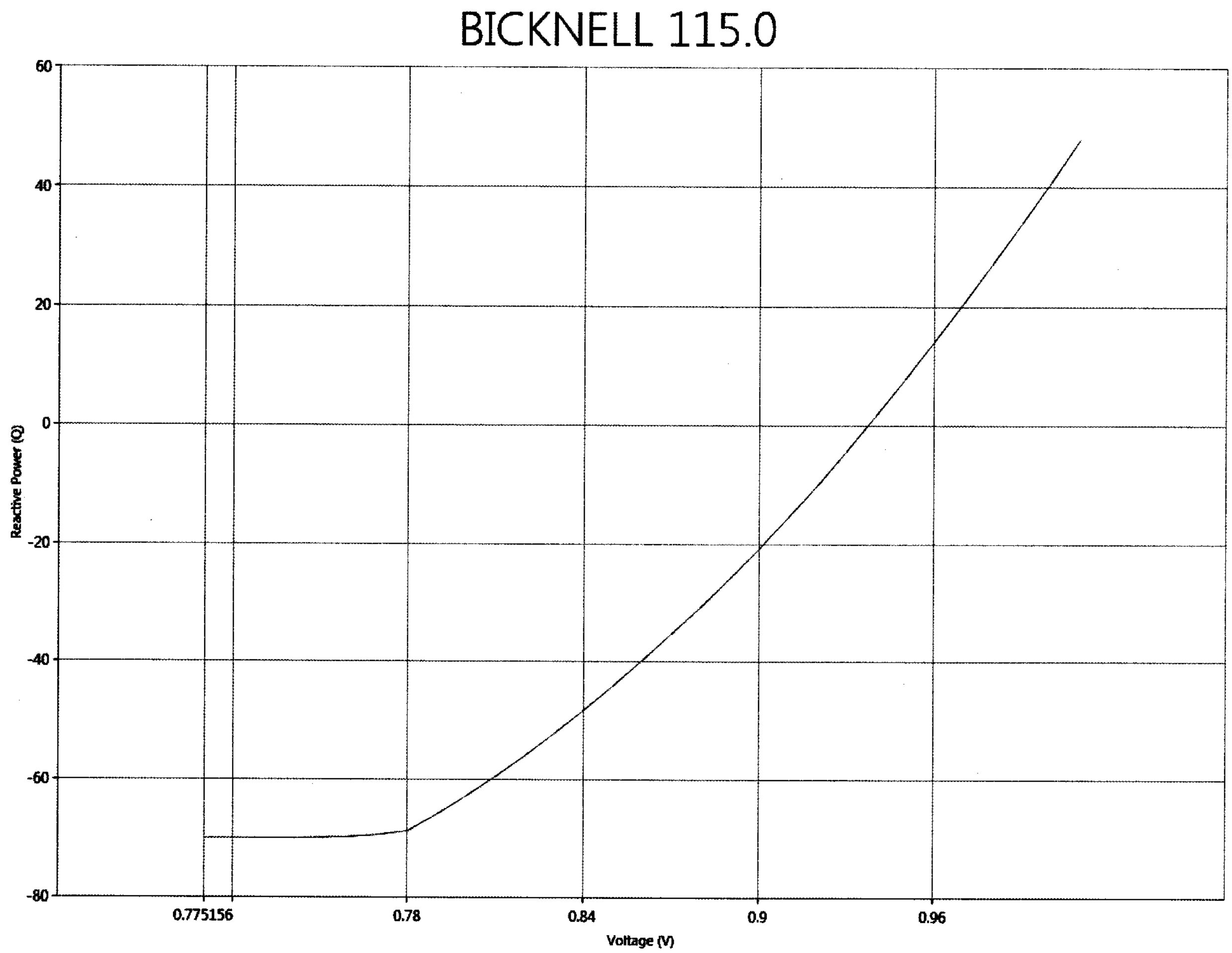
PANTANO 230.0



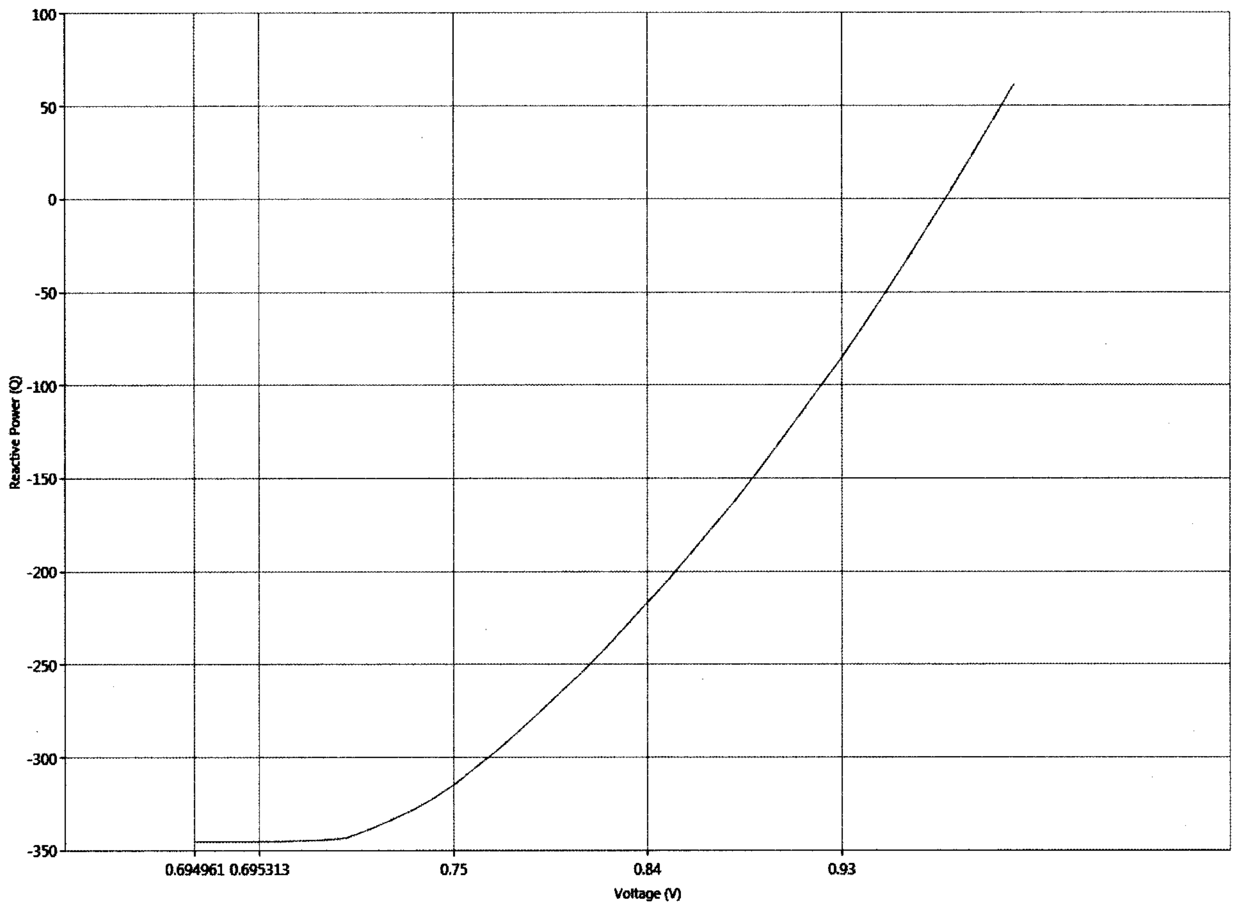

REDTAIL 230.0
60
50
20
-10
-40
-70
-100
Reactive Power (Q)
0.6
0.61
0.7
0.79
0.88
0.97
Voltage (V)

2025HS Bicknell – Vail 345 kV Outage

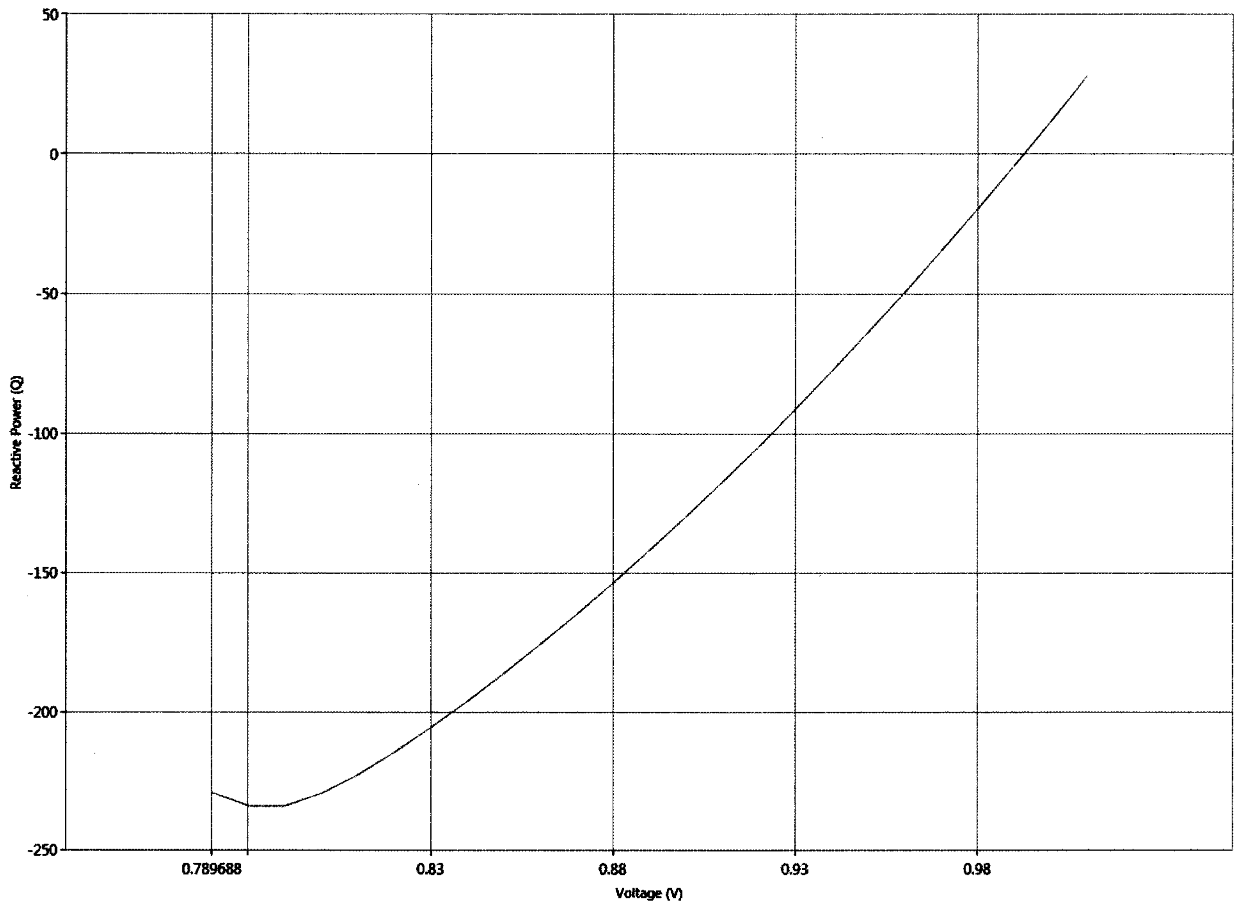
2025HS – Bicknell to Vail 345 kV Line Outage with plots of Bicknell 115 kV, Hackberry 230 kV, Marana 115 kV, Pantano 230 kV and Redtail 230 kV buses



HACKBERY 230.0

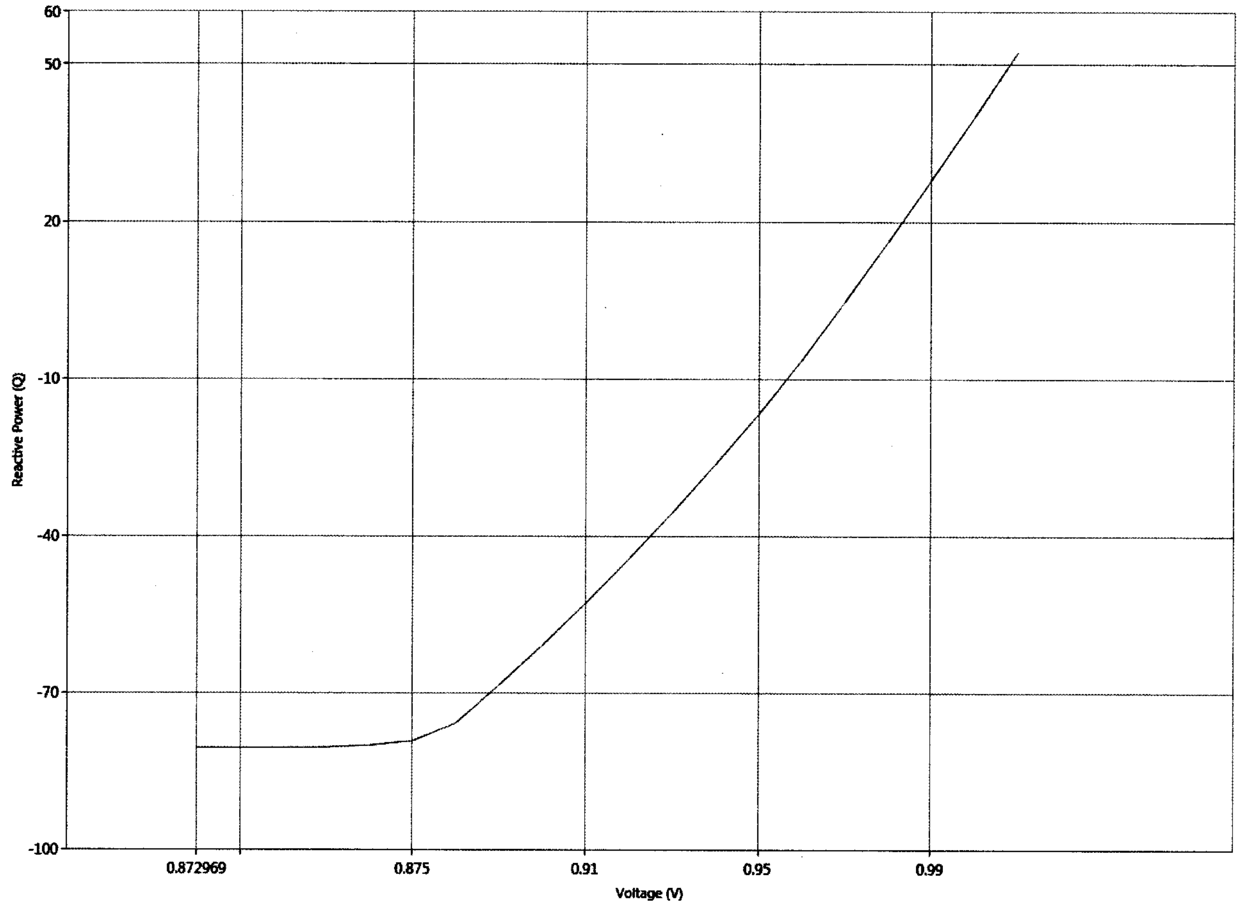


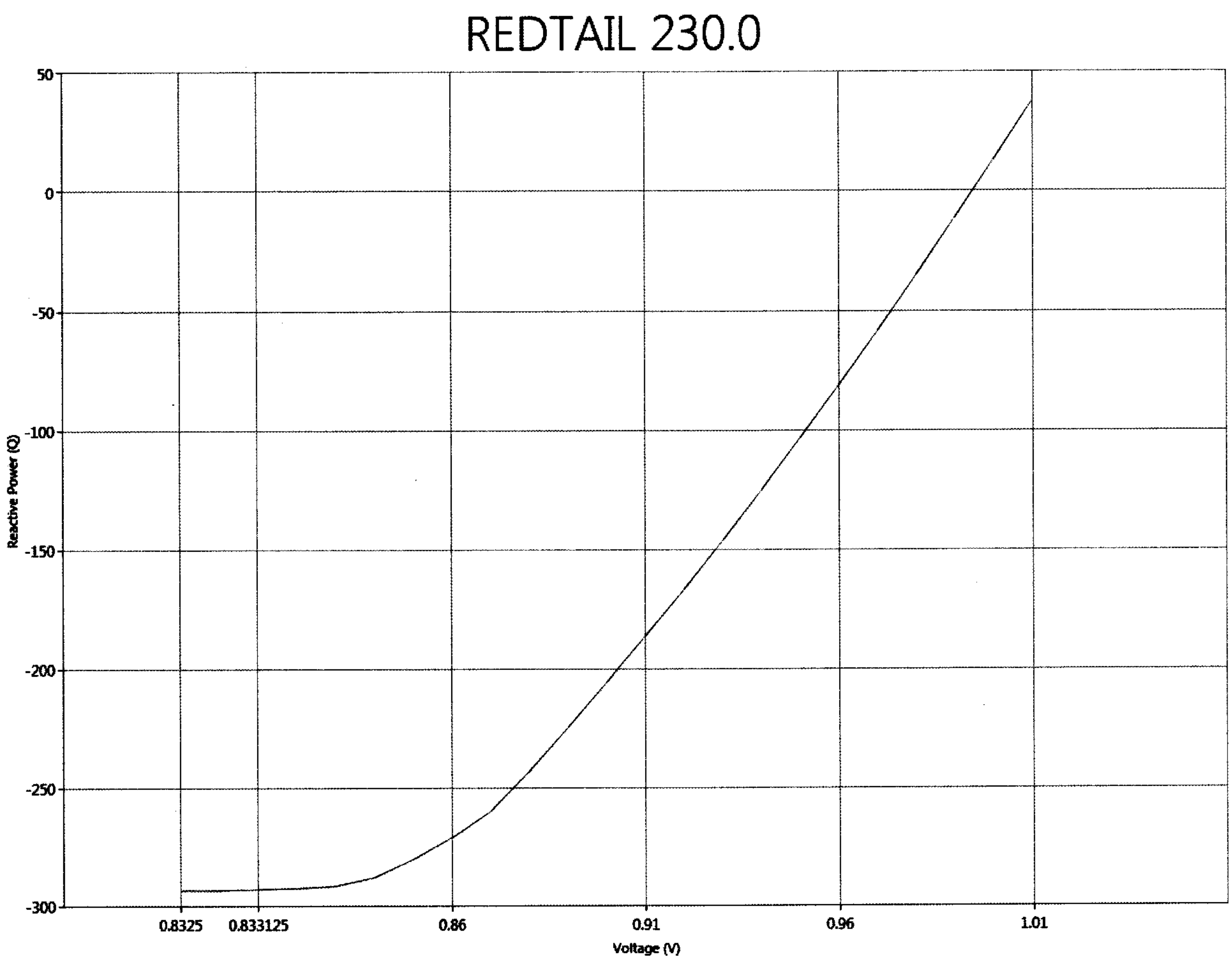
MARANA 115.0



50
0
-50
-100
-150
-200
-250
Reactive Power (Q)
0.789688
0.83
0.88
0.93
0.98
Voltage (V)

PANTANO 230.0



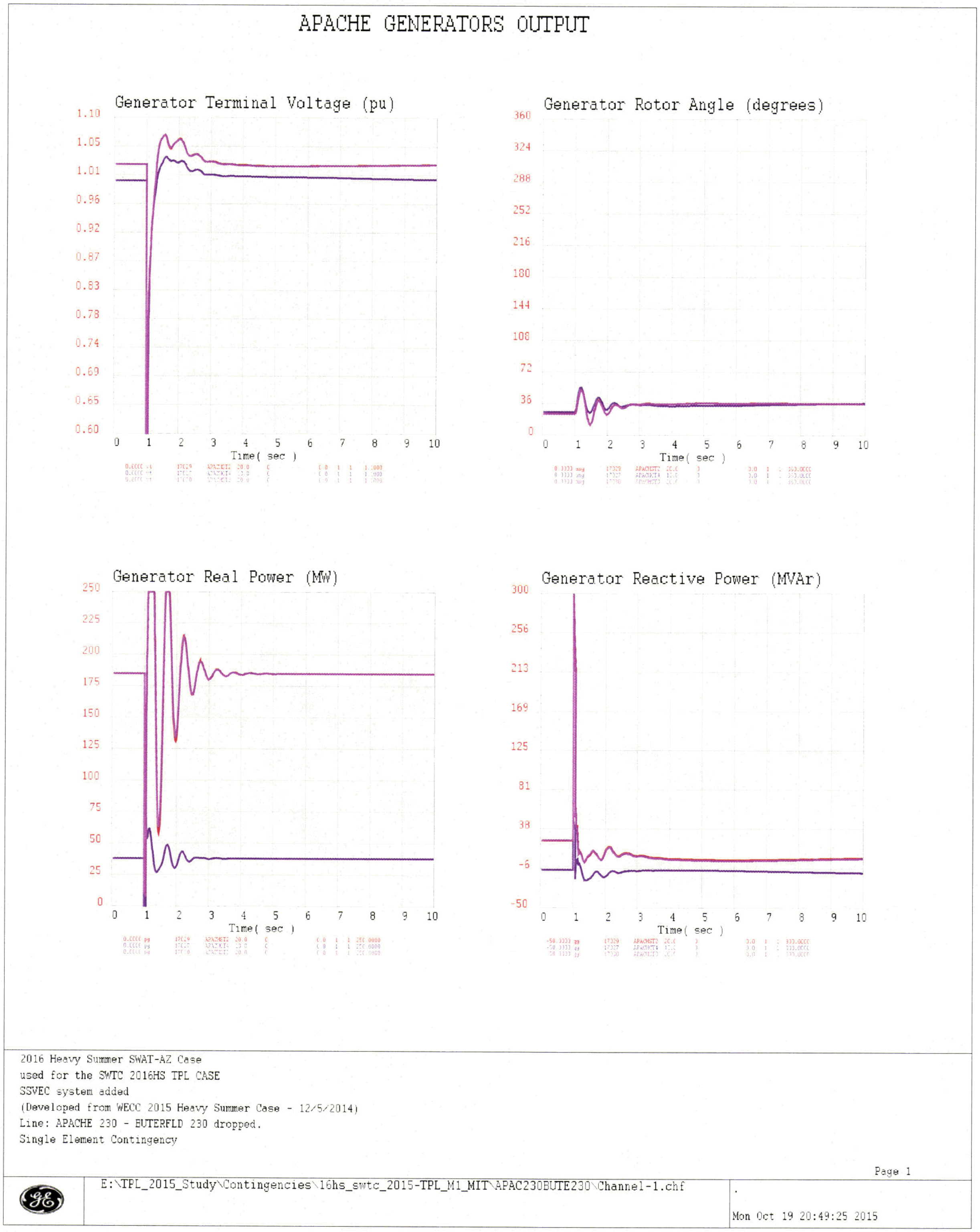

REDTAIL 230.0
50
0
-50
-100
-150
-200
-250
-300
Reactive Power (Q)
0.8325
0.833125
0.86
0.91
0.96
1.01
Voltage (V)

APPENDIX E: Transient Stability Plots

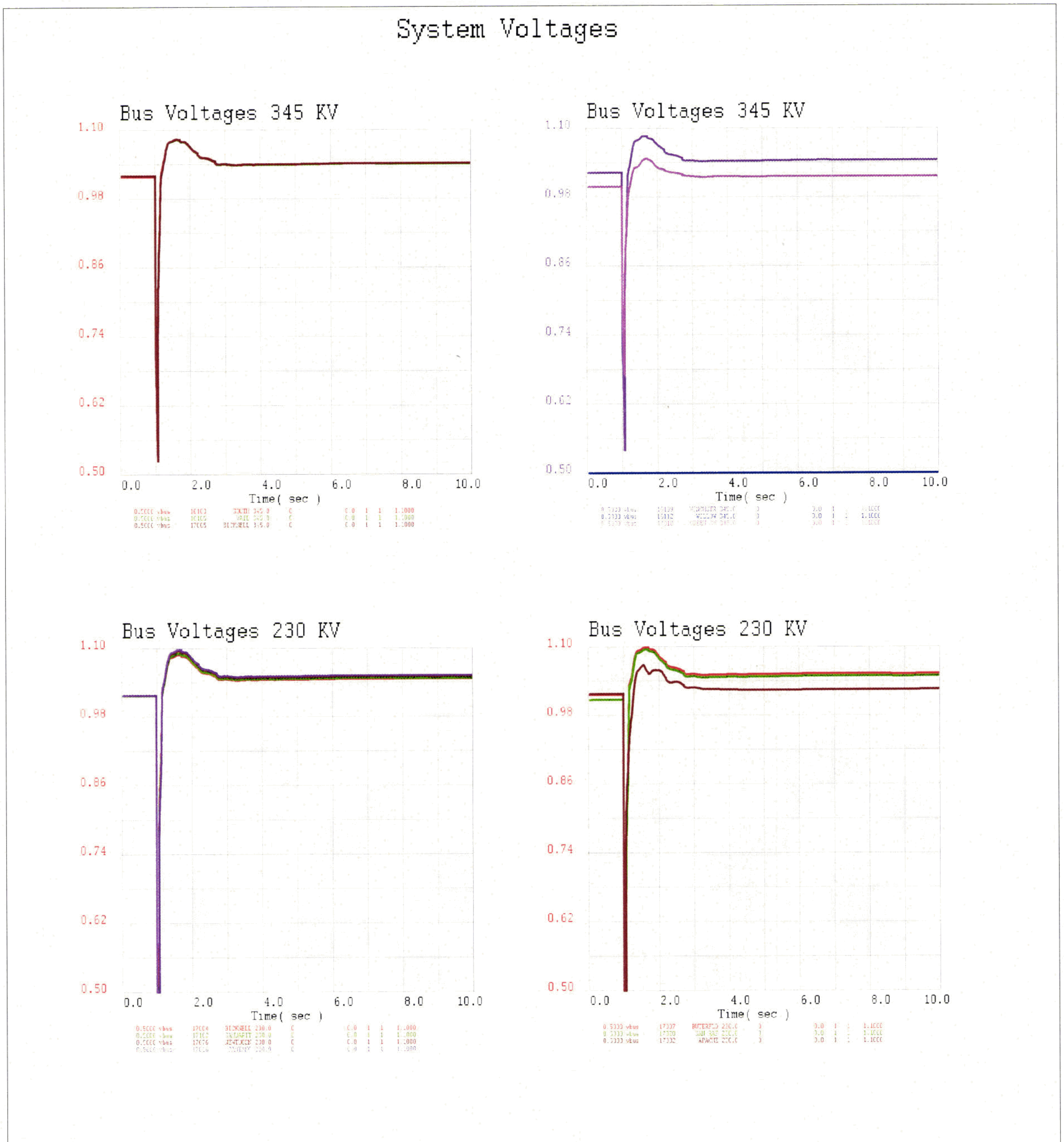
2016HS Plots:

Apache – Butterfield 230 kV Outage

2016HS – Apache to Butterfield 230 kV Line Outage – Apache Generators Output



2016HS – Apache to Butterfield 230 kV Line Outage – 345 kV & 230 kV Bus Voltages



2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: APACHE 230 - BUTERFLD 230 dropped.
Single Element Contingency

Page 2

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MIT\APAC230BUTE230\Channel-1.chf

Mon Oct 19 20:49:26 2015

2016HS – Apache to Butterfield 230 kV Line Outage – 230 kV & 115 kV Bus Voltages

2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: APACHE 230 - BUTERFLD 230 dropped.
Single Element Contingency

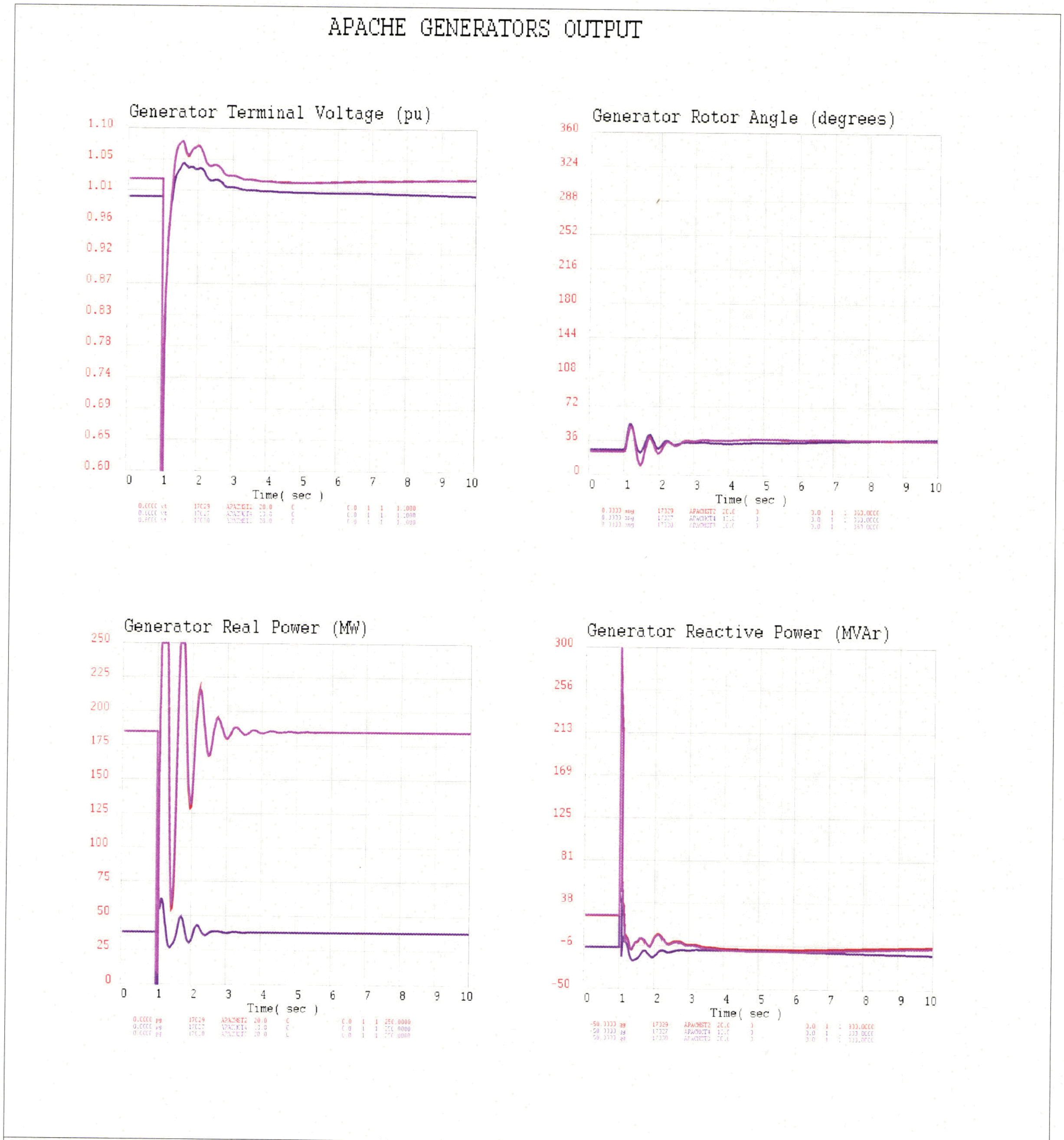
Page 3

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MIT\APAC230BUTE230\Channel-1.chf

Mon Oct 19 20:49:26 2015

Apache – Redtail 230 kV Outage

2016HS – Apache to Redtail 230 kV Line Outage – Apache Generators Output



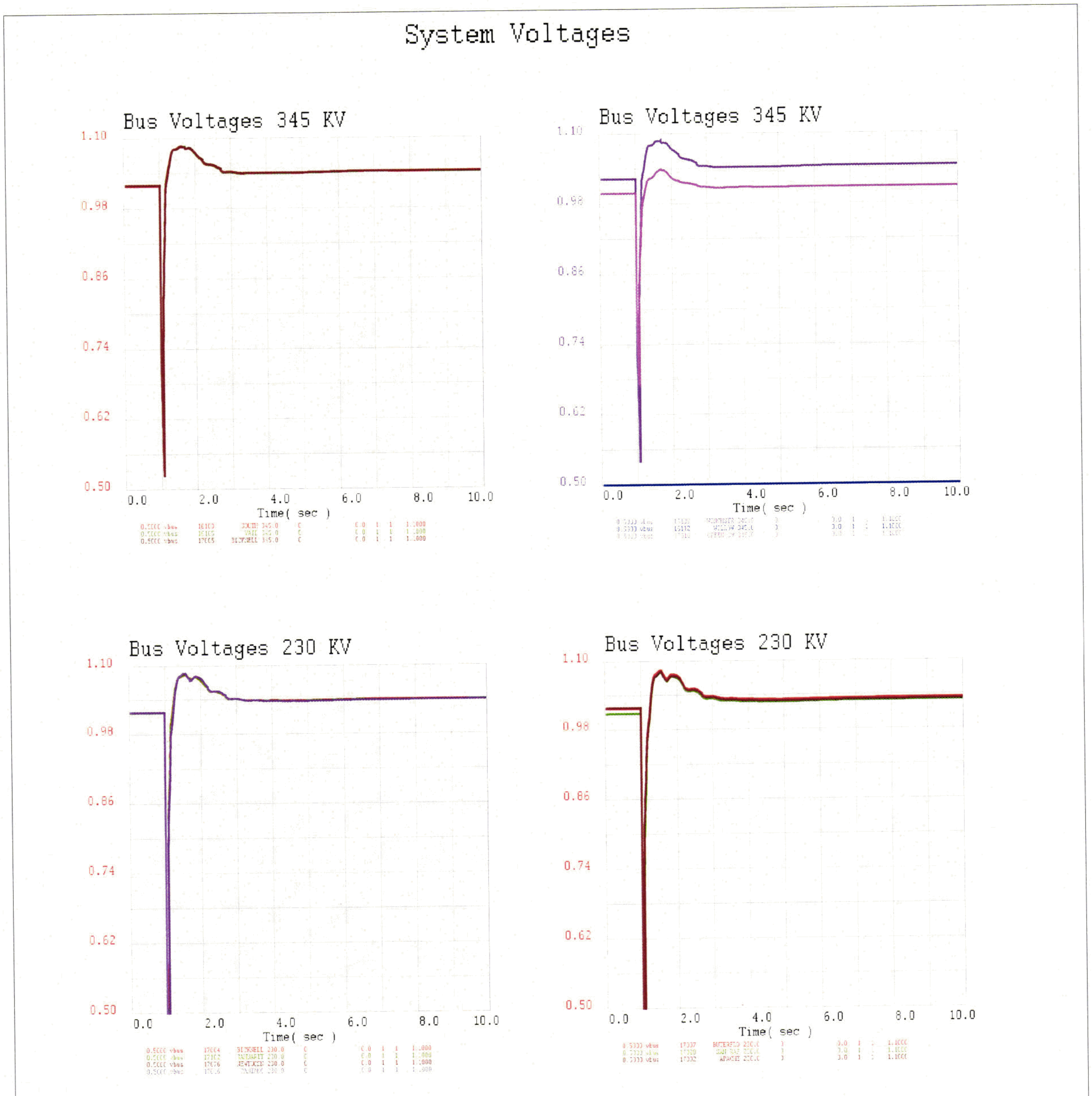
2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: APACHE 230 - REDTAIL 230 dropped.
Single Element Contingency

Page 1

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MIT\APAC230RED230\Channel-2.chf

Mon Oct 19 20:55:42 2015

2016HS – Apache to Redtail 230 kV Line Outage – 345 kV & 230 kV Bus Voltages



2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: APACHE 230 - REDTAIL 230 dropped.
Single Element Contingency

Page 2

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MIT\APAC230RED230\Channel-2.chf

Mon Oct 19 20:55:42 2015

2016HS – Apache to Redtail 230 kV Line Outage – 230 kV & 115 kV Bus Voltages

2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: APACHE 230 - REDTAIL 230 dropped.
Single Element Contingency

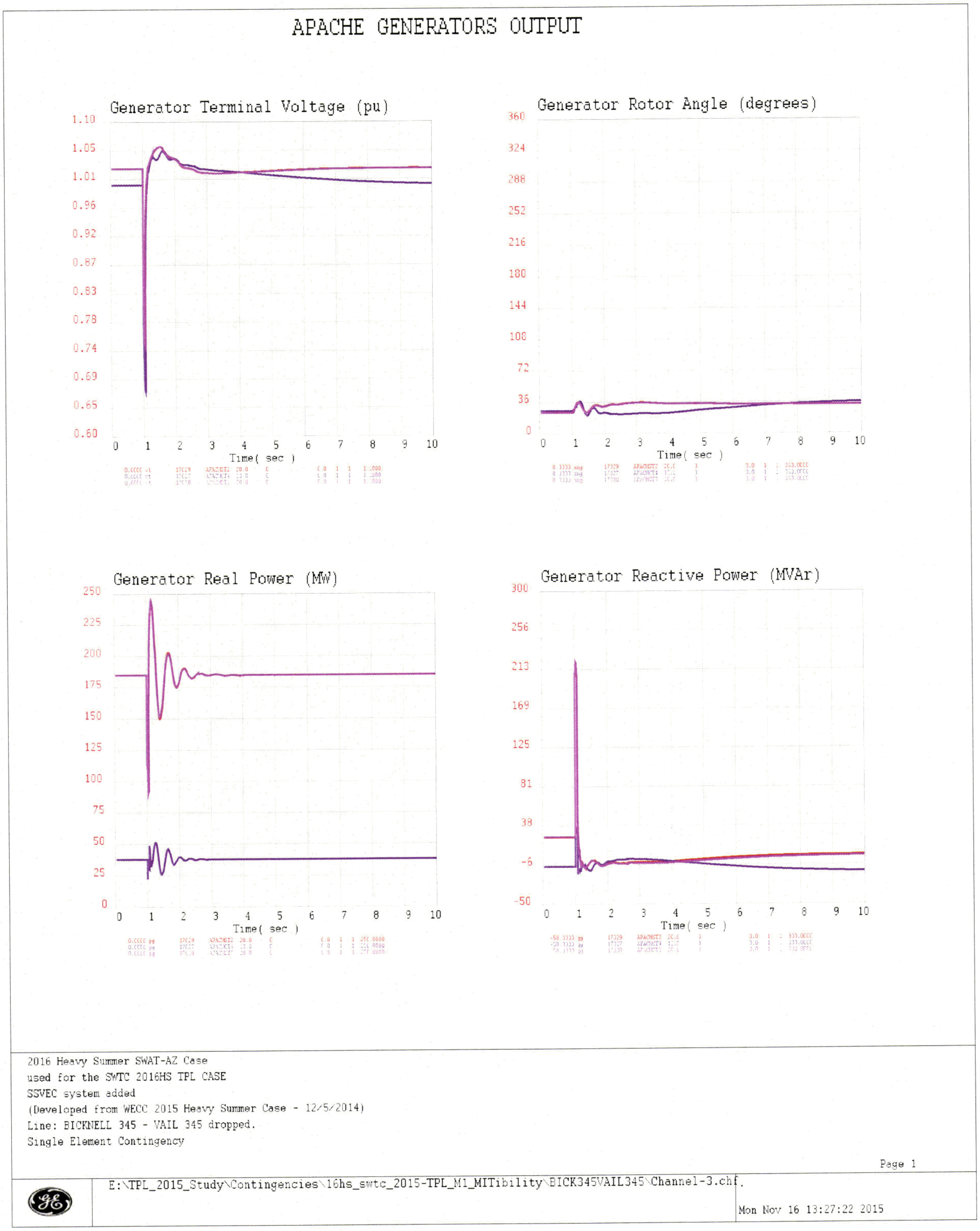
Page 3

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MIT\APAC230RED230\Channel-2.chf

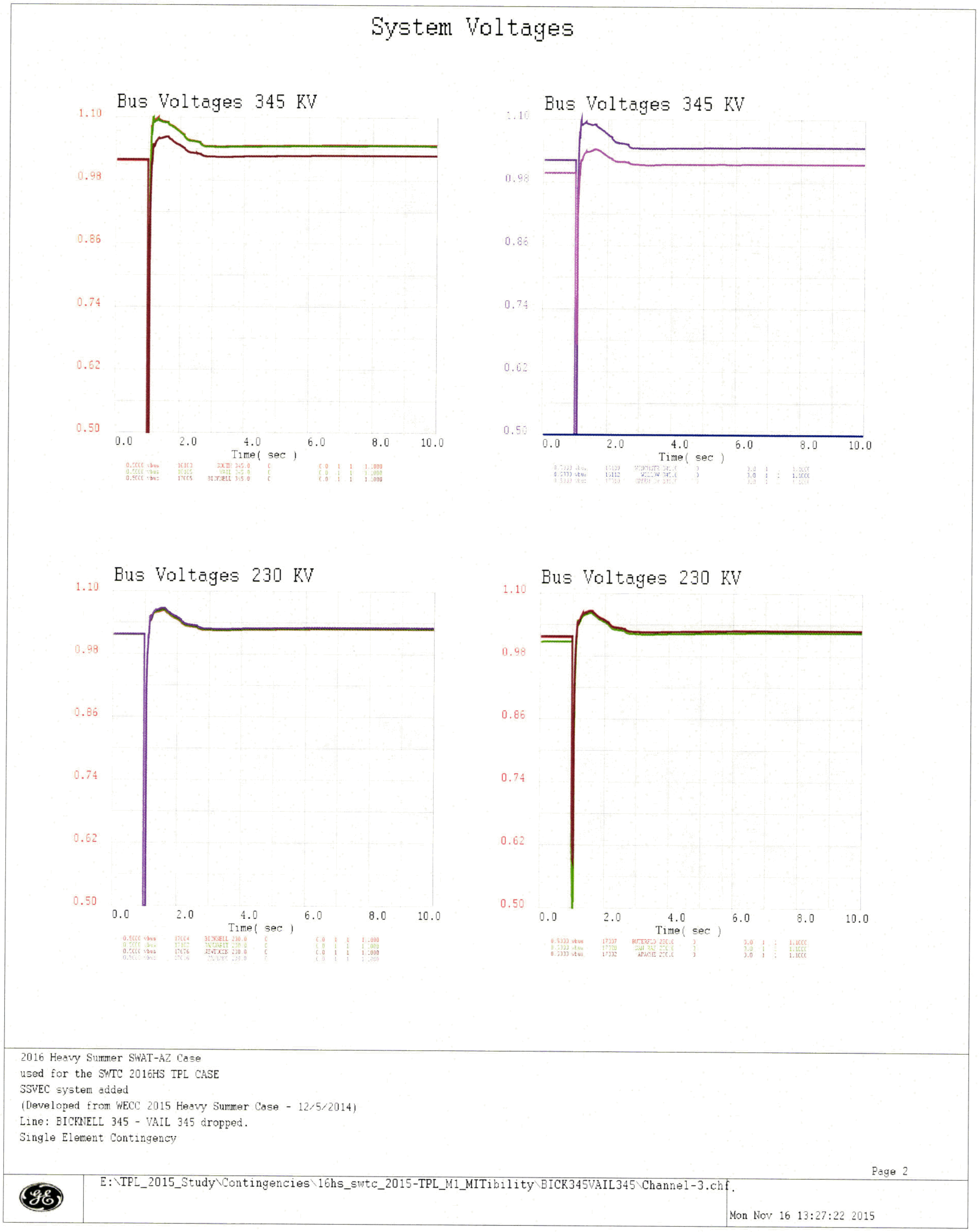
Mon Oct 19 20:55:42 2015

Bicknell – Vail 345 kV Outage

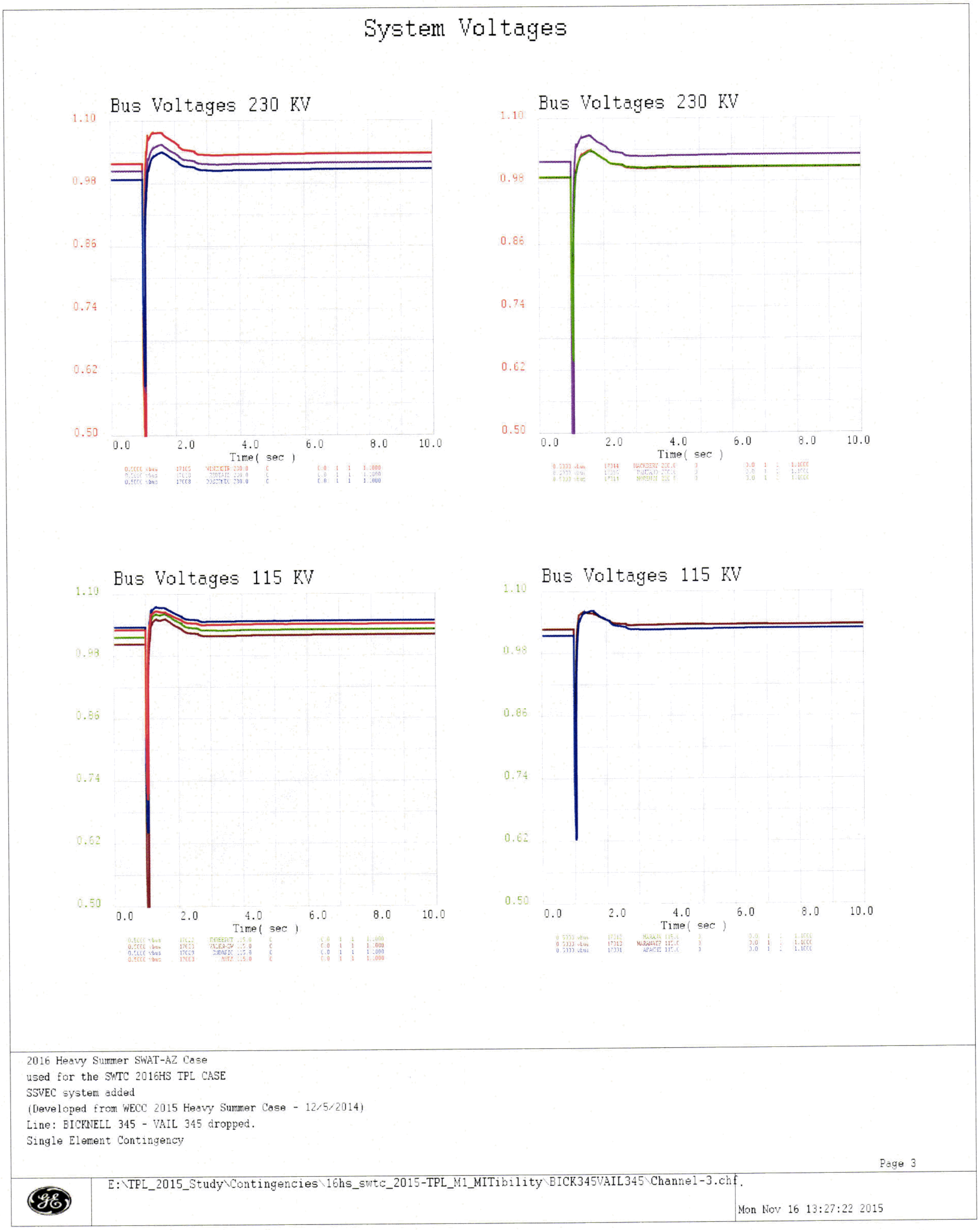
2016HS – Bicknell to Vail 345 kV Line Outage – Apache Generators Output



2016HS – Bicknell to Vail 345 kV Line Outage – 345 kV & 230 kV Bus Voltages

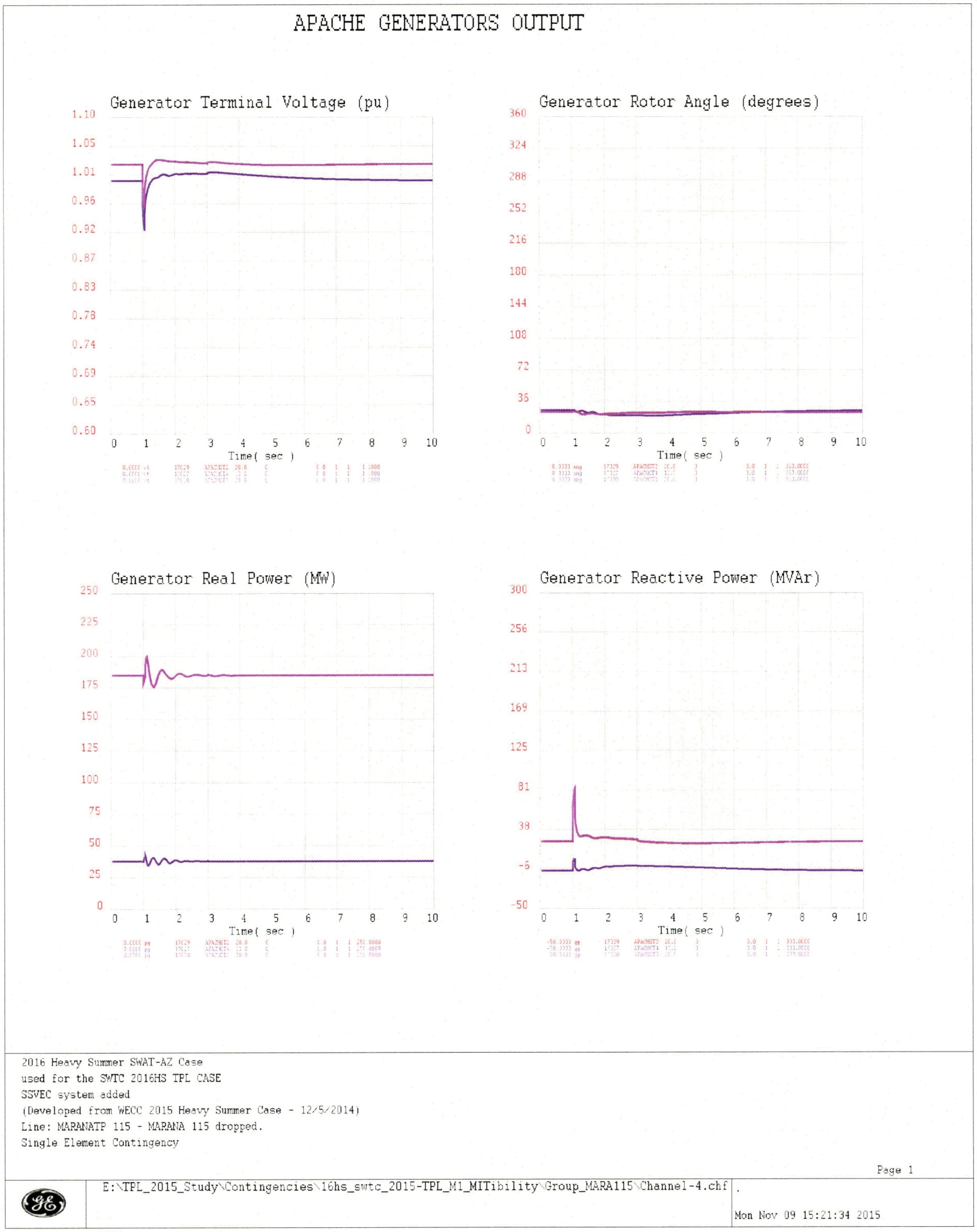


2016HS – Bicknell to Vail 345 kV Line Outage – 230 kV & 115 kV Bus Voltages

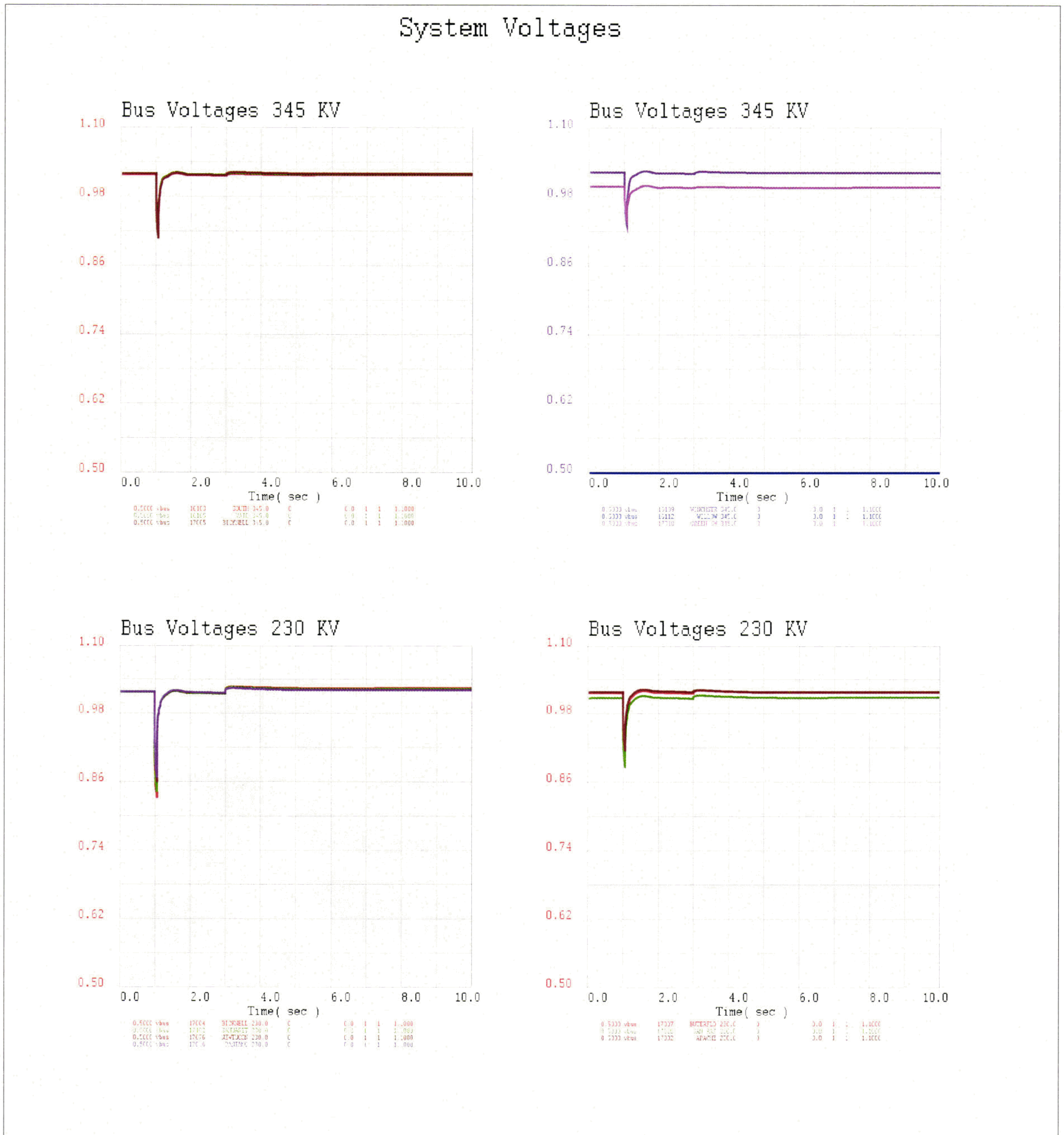


Marana Group 115 kV Outage

2016HS – Marana Group 115 kV Line Outage – Apache Generators Output



2016HS – Marana Group kV Line Outage – 345 kV & 230 kV Bus Voltages



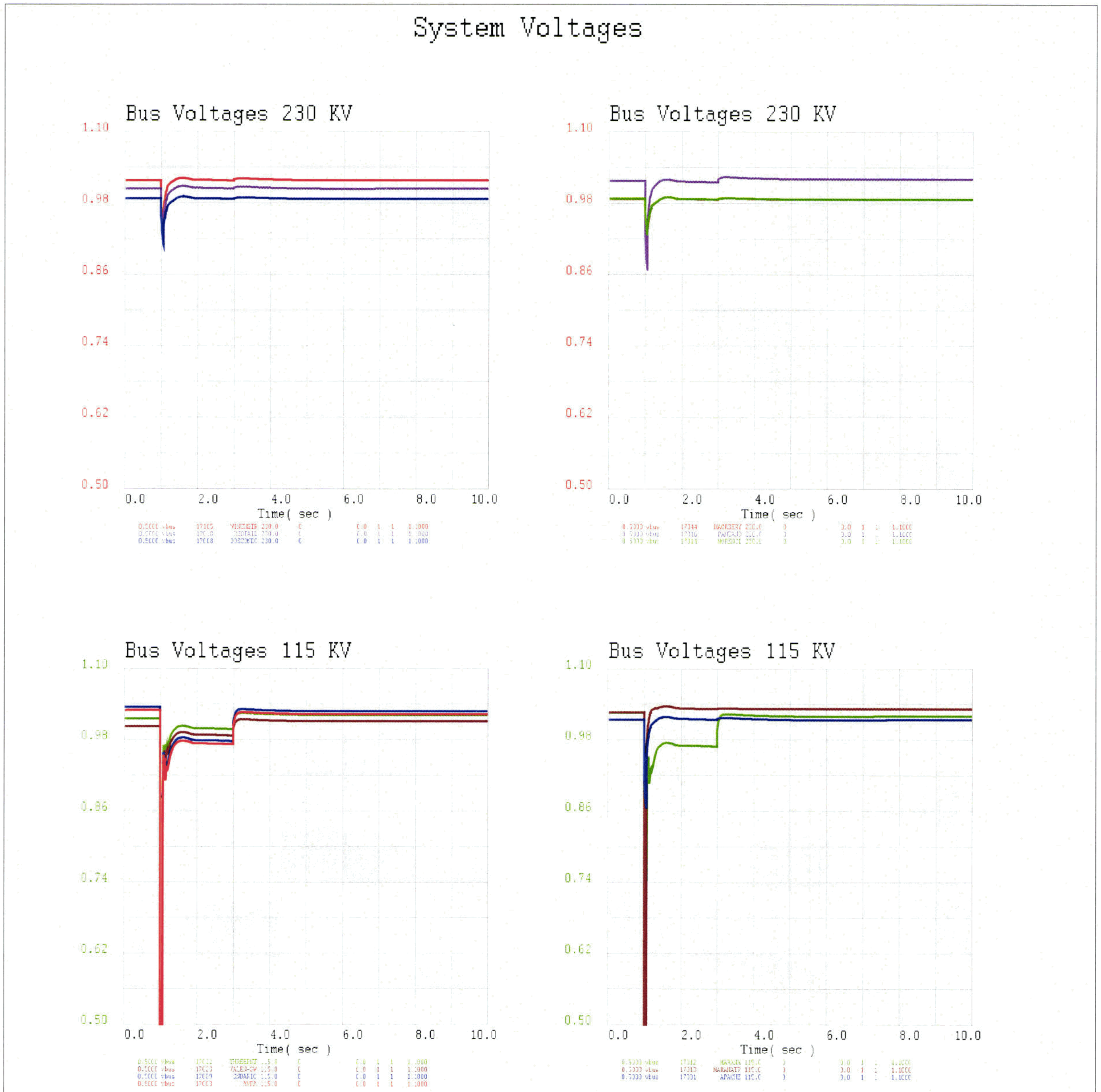
2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: MARANATP 115 - MARANA 115 dropped.
Single Element Contingency

Page 2

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MITibility\Group_MARA115\Channel-4.chf

Mon Nov 09 15:21:34 2015

2016HS – Marana Group kV Line Outage – 230 kV & 115 kV Bus Voltages



2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: MARANATP 115 - MARANA 115 dropped.
Single Element Contingency

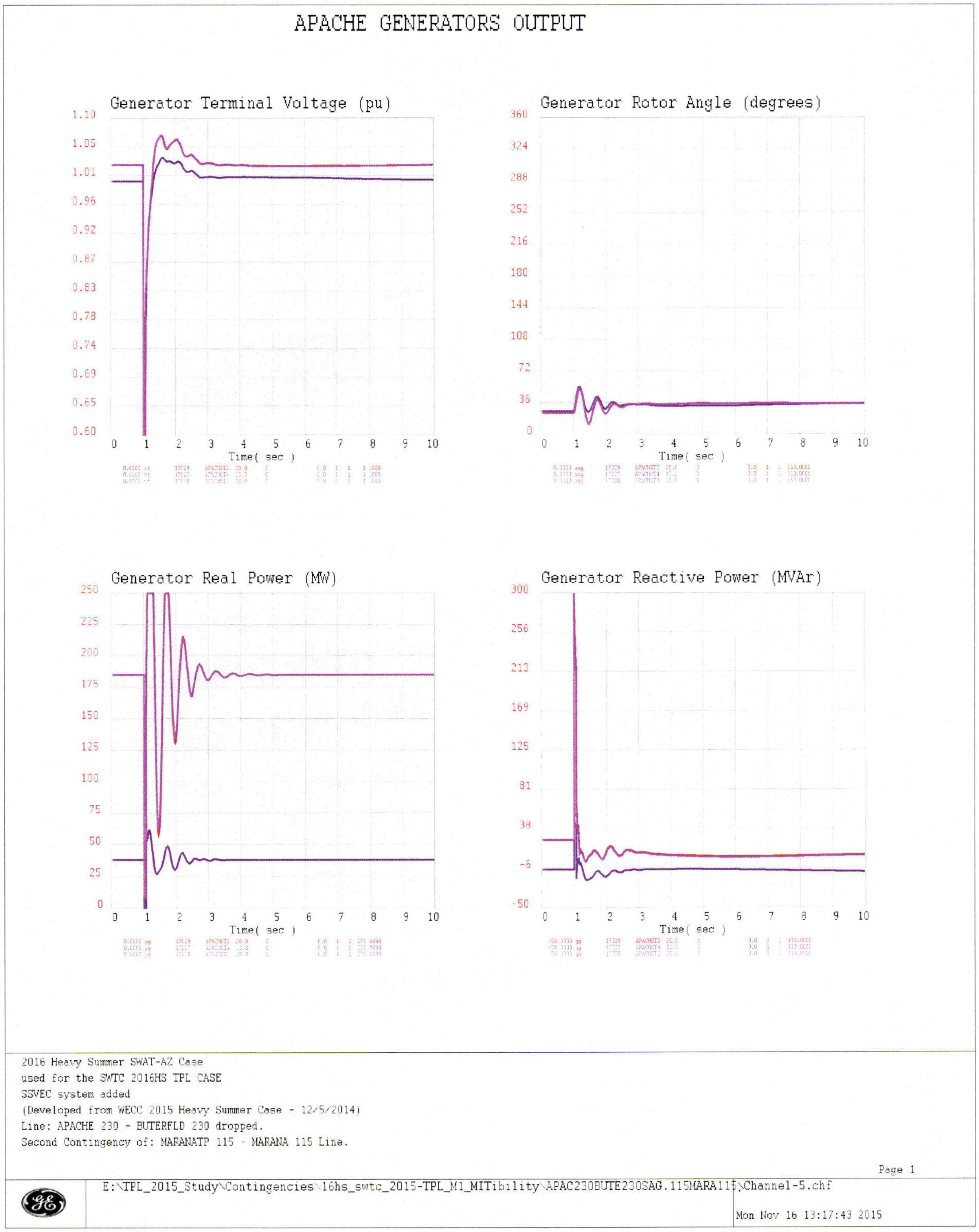
Page 3

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MITibility\Group_MARA115\Channel-4.chf

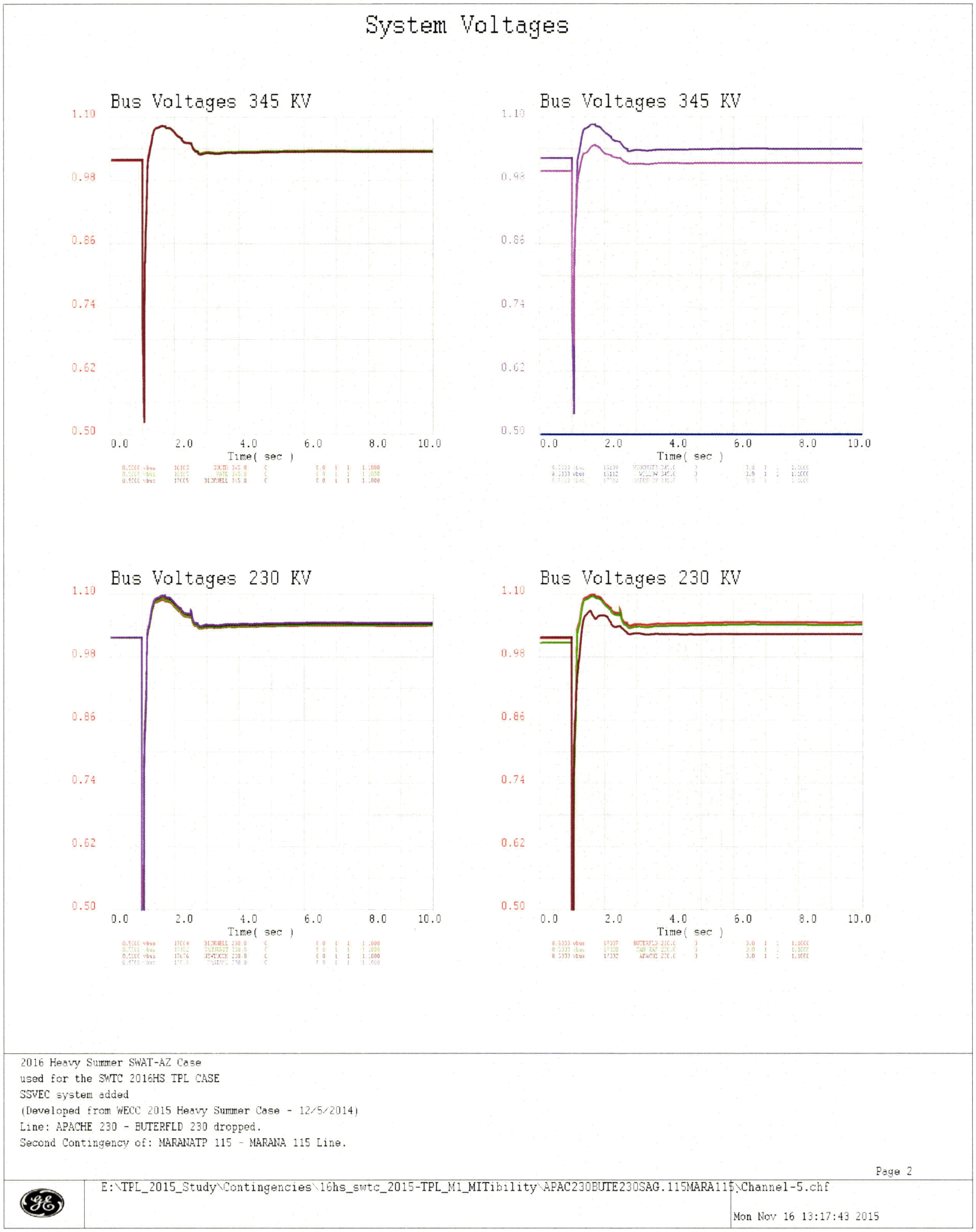
Mon Nov 09 15:21:34 2015

Apache – Butterfield 230 kV & Saguaro East – Marana Tap 115 kV Outage

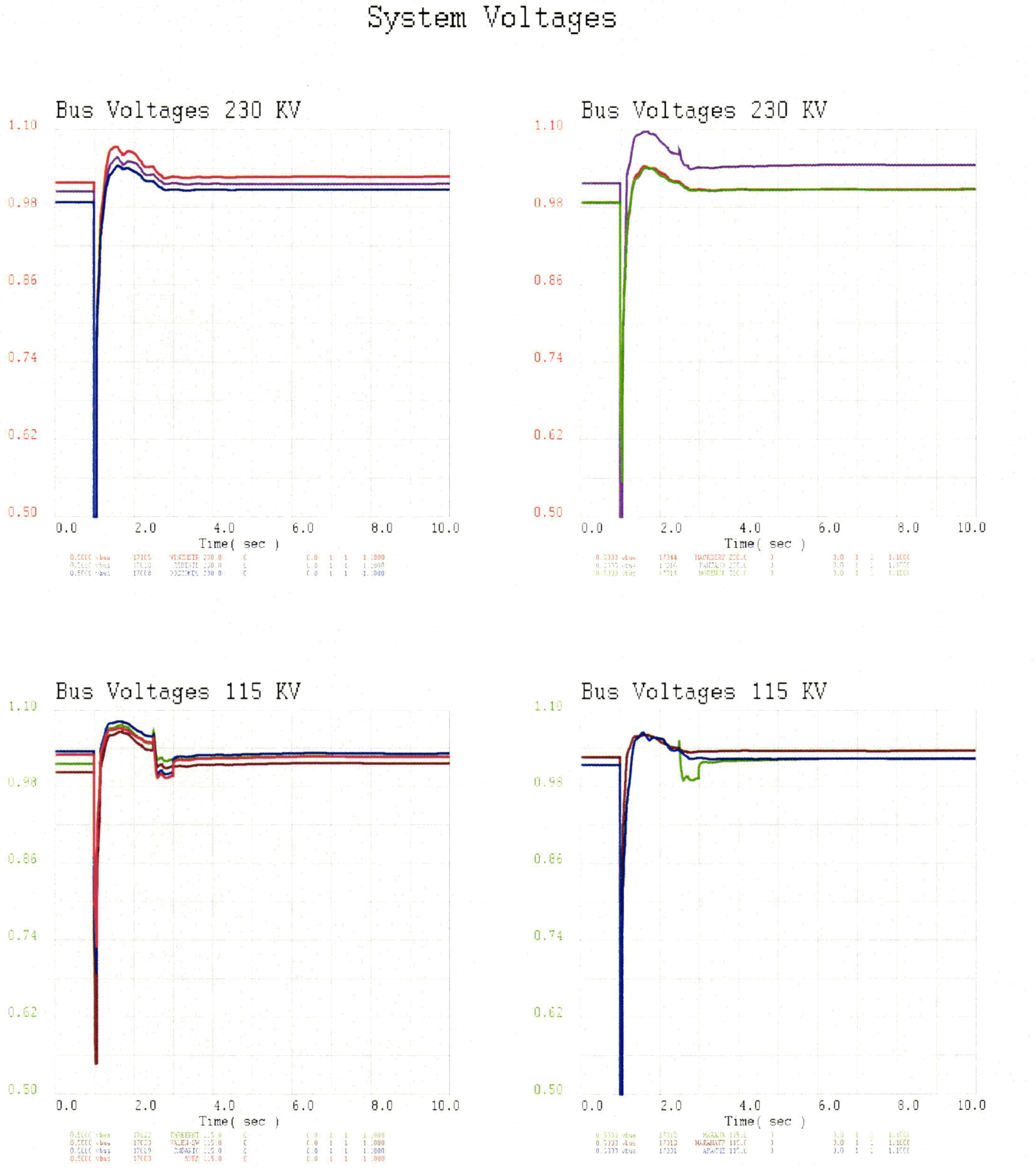
2016HS – Apache to Butterfield 230 kV & Saguaro East to Marana Tap kV Line Outages – Apache Generators Output



2016HS – Apache to Butterfield 230 kV & Saguaro East to Marana Tap kV Line Outages – 345 kV & 230 kV Bus Voltages



2016HS – Apache to Butterfield 230 kV & Saguaro East to Marana Tap kV Line Outages – 230 kV & 115 kV Bus Voltages



2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: APACHE 230 - BUTERFLD 230 dropped.
Second Contingency of: MARANATP 115 - MARANA 115 Line.

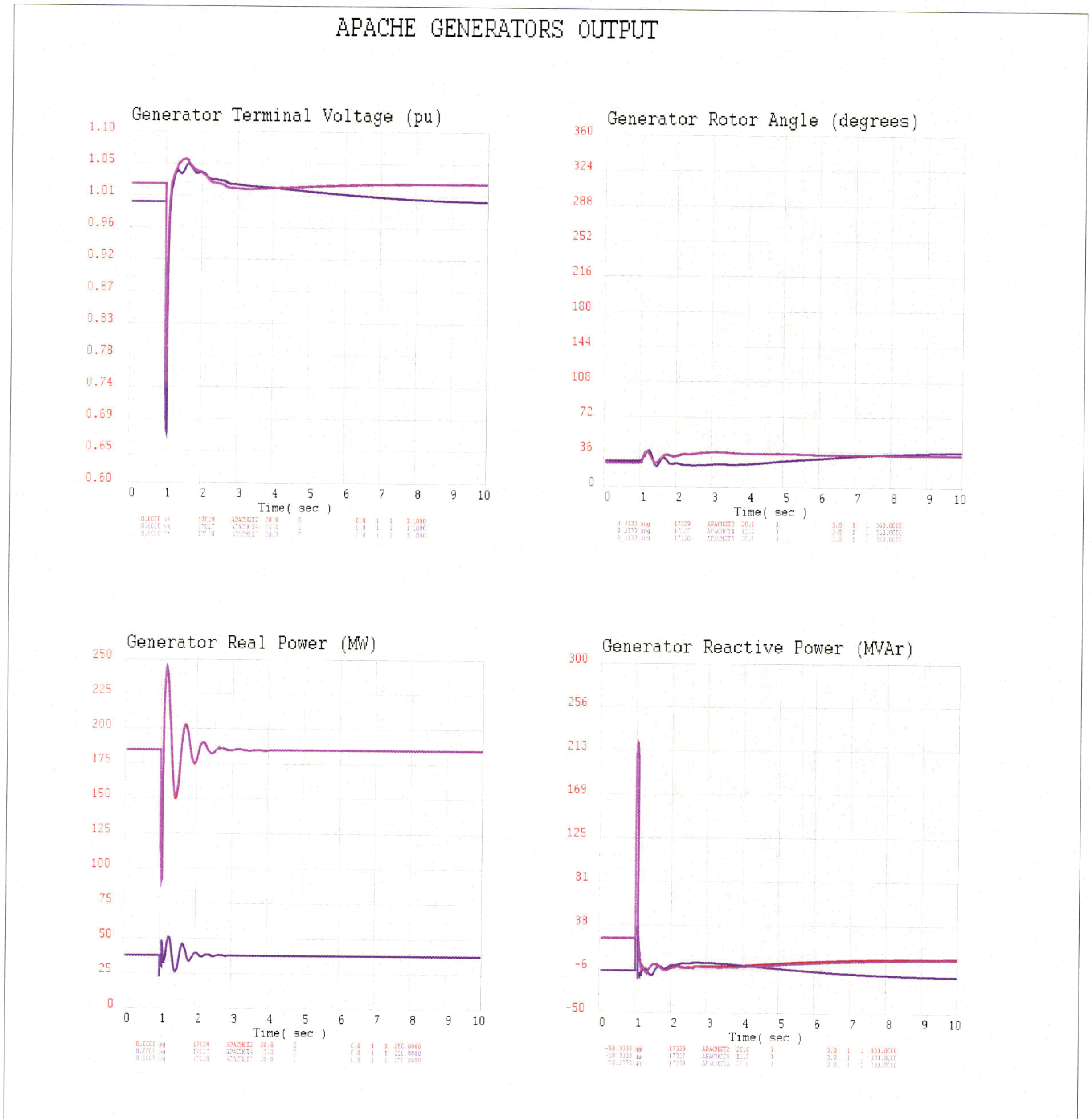
Page 3

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MITibility\APAC230BUTE230SAG.115MARA115\Channel-5.chf

Mon Nov 16 13:17:43 2015

Bicknell – Vail 345 kV & Saguaro East – Marana Tap 115 kV Outage

2016HS – Bicknell to Vail 345 kV & Saguaro East to Marana Tap 115 kV Line Outages – Apache Generators Output



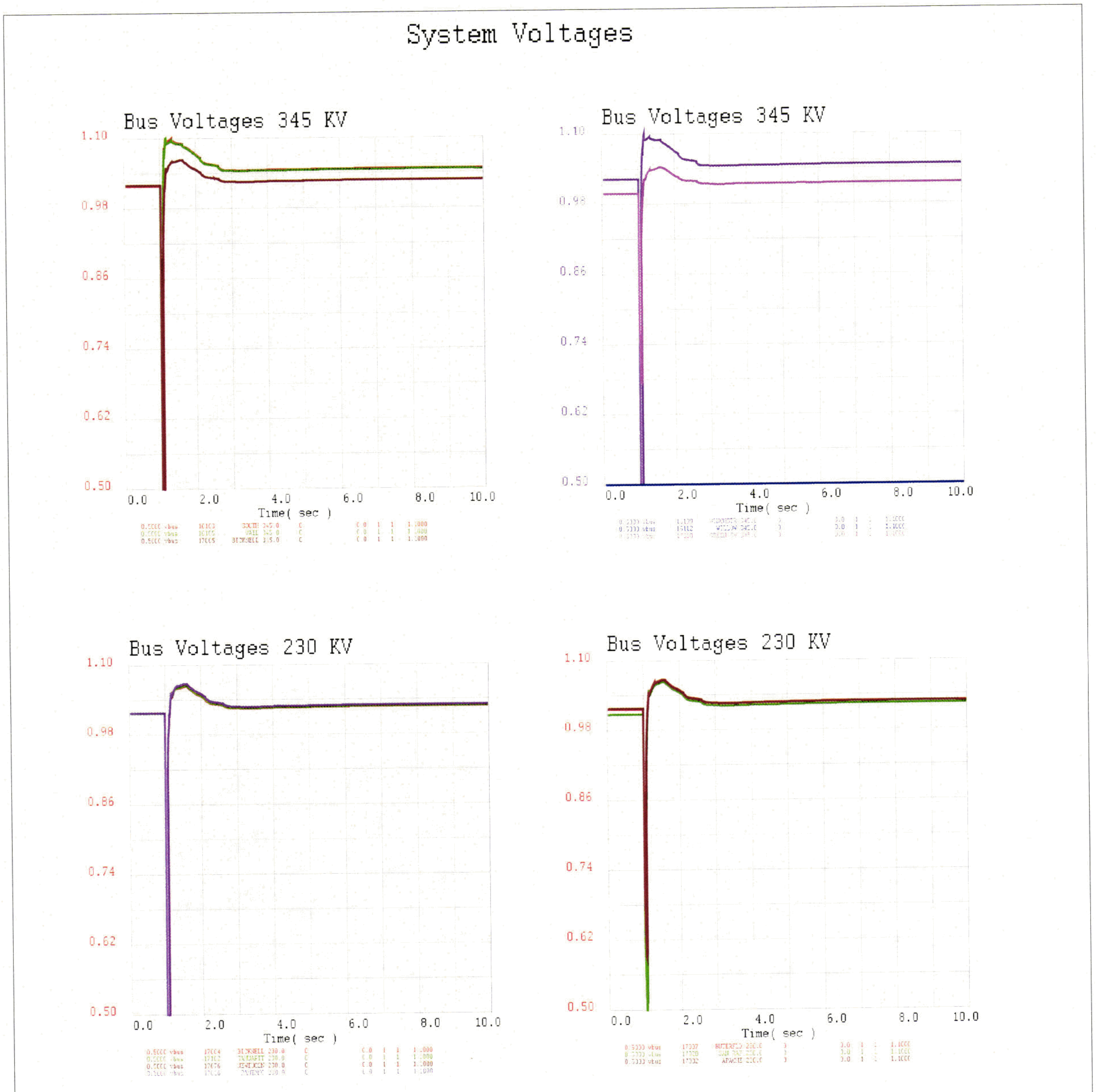
2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: BICKNELL 345 - VAIL 345 dropped.
Single Element Contingency

Page 1

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MITibility\BICK345VAIL345\Channel-3.chf.

Mon Nov 16 13:27:22 2015

2016HS – Bicknell to Vail 345 kV & Saguaro East to Marana Tap 115 kV Line Outages – 345 kV & 230 kV Bus Voltages



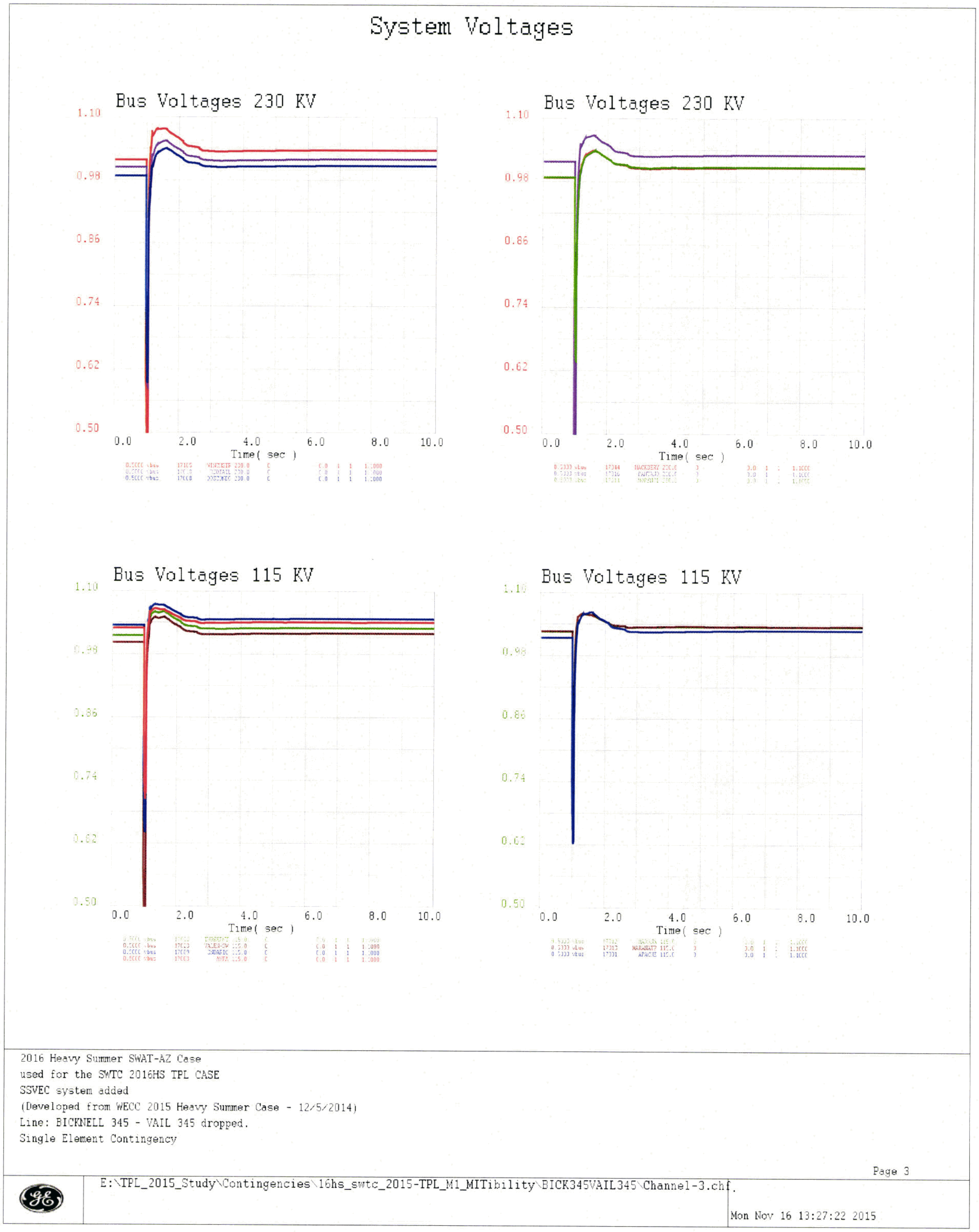
2016 Heavy Summer SWAT-AZ Case
used for the SWTC 2016HS TPL CASE
SSVEC system added
(Developed from WECC 2015 Heavy Summer Case - 12/5/2014)
Line: BICKNELL 345 - VAIL 345 dropped.
Single Element Contingency

Page 2

E:\TPL_2015_Study\Contingencies\16hs_swtc_2015-TPL_M1_MITibility\BICK345VAIL345\Channel-3.chf.

Mon Nov 16 13:27:22 2015

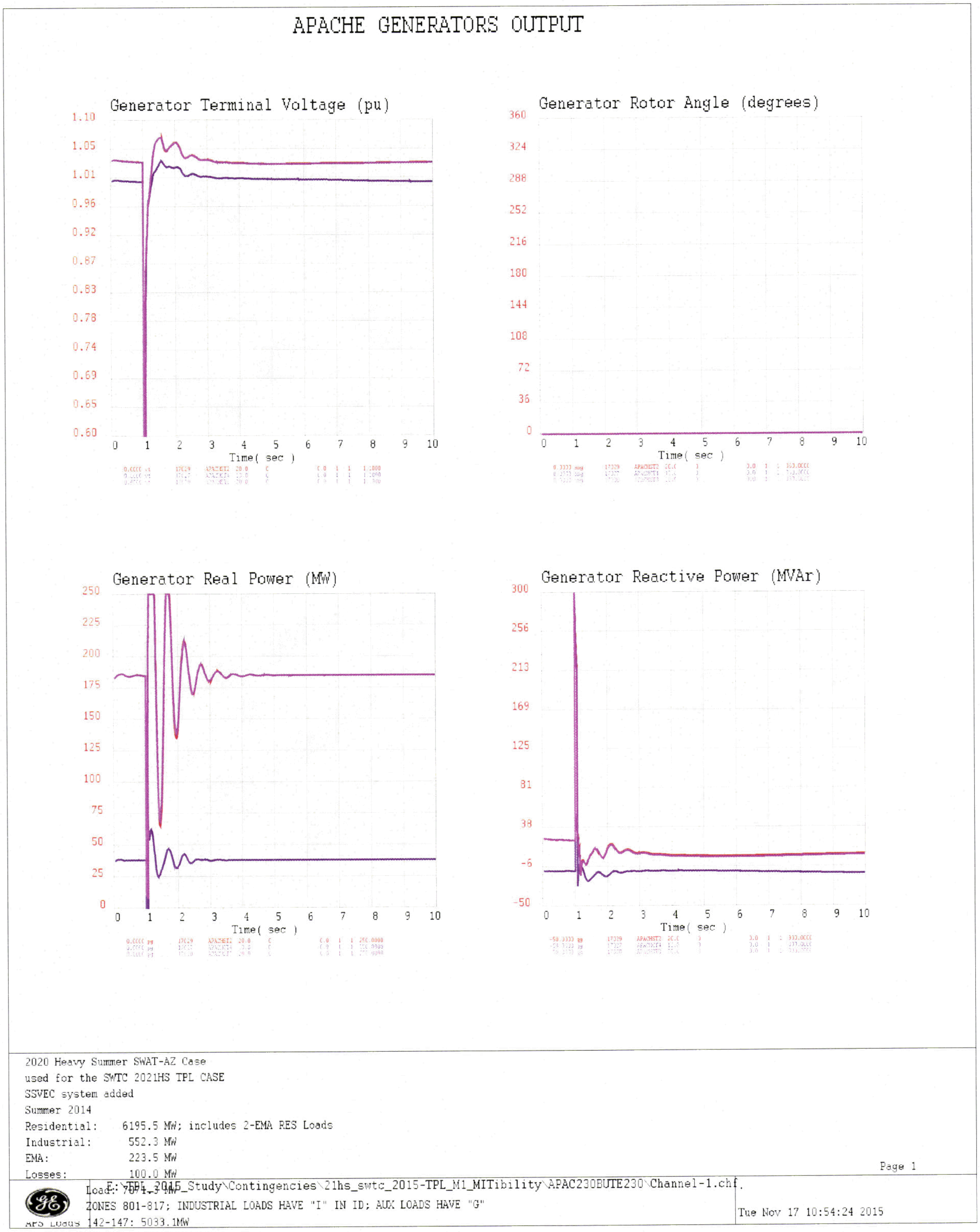
2016HS – Bicknell to Vail 345 kV & Saguaro East to Marana Tap 115 kV Line Outages – 230 kV & 115 kV Bus Voltages



2020HS Plots:

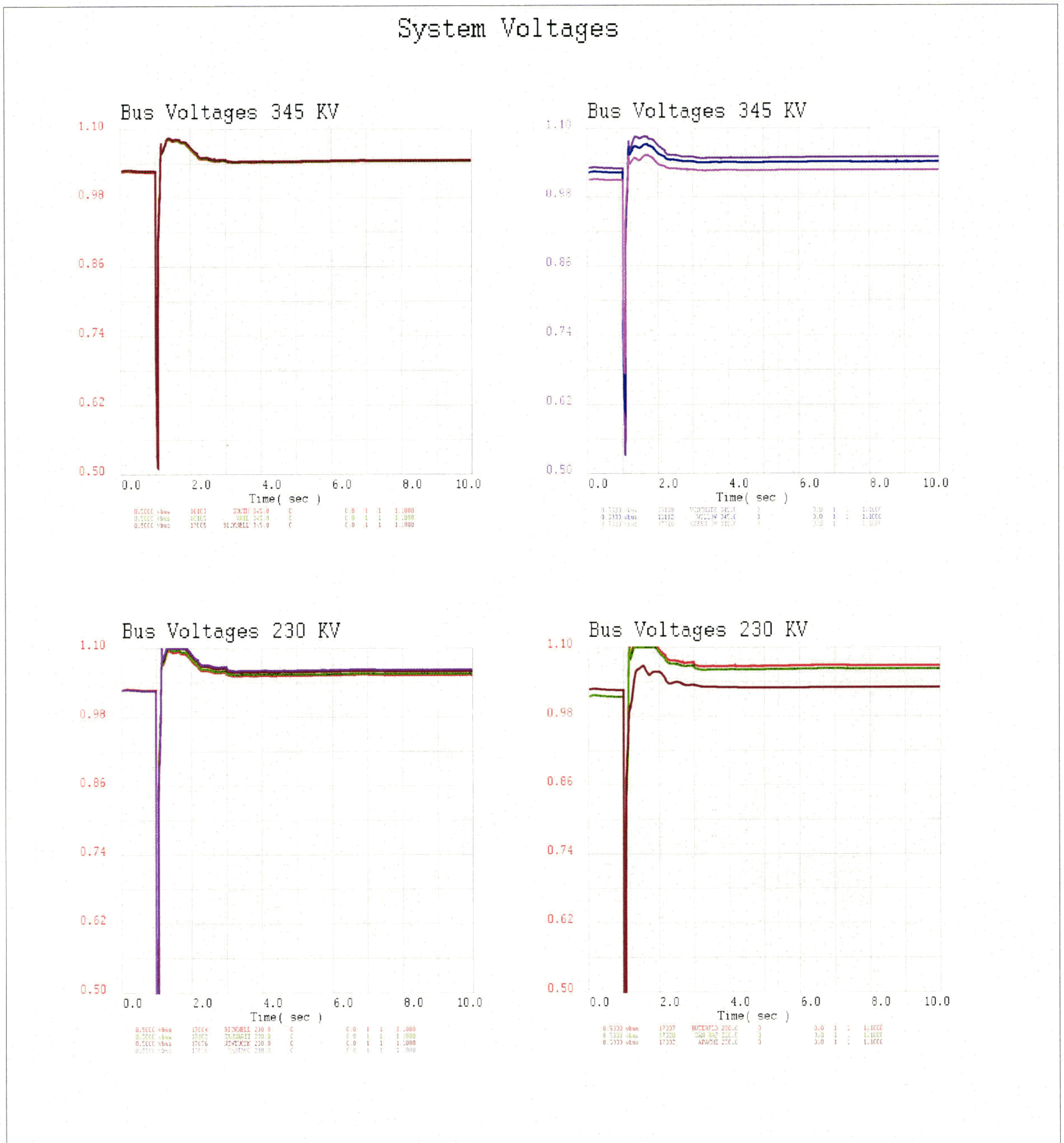
Apache – Butterfield 230 kV Outage

2020HS – Apache to Butterfield 230 kV Line Outage – Apache Generators Output



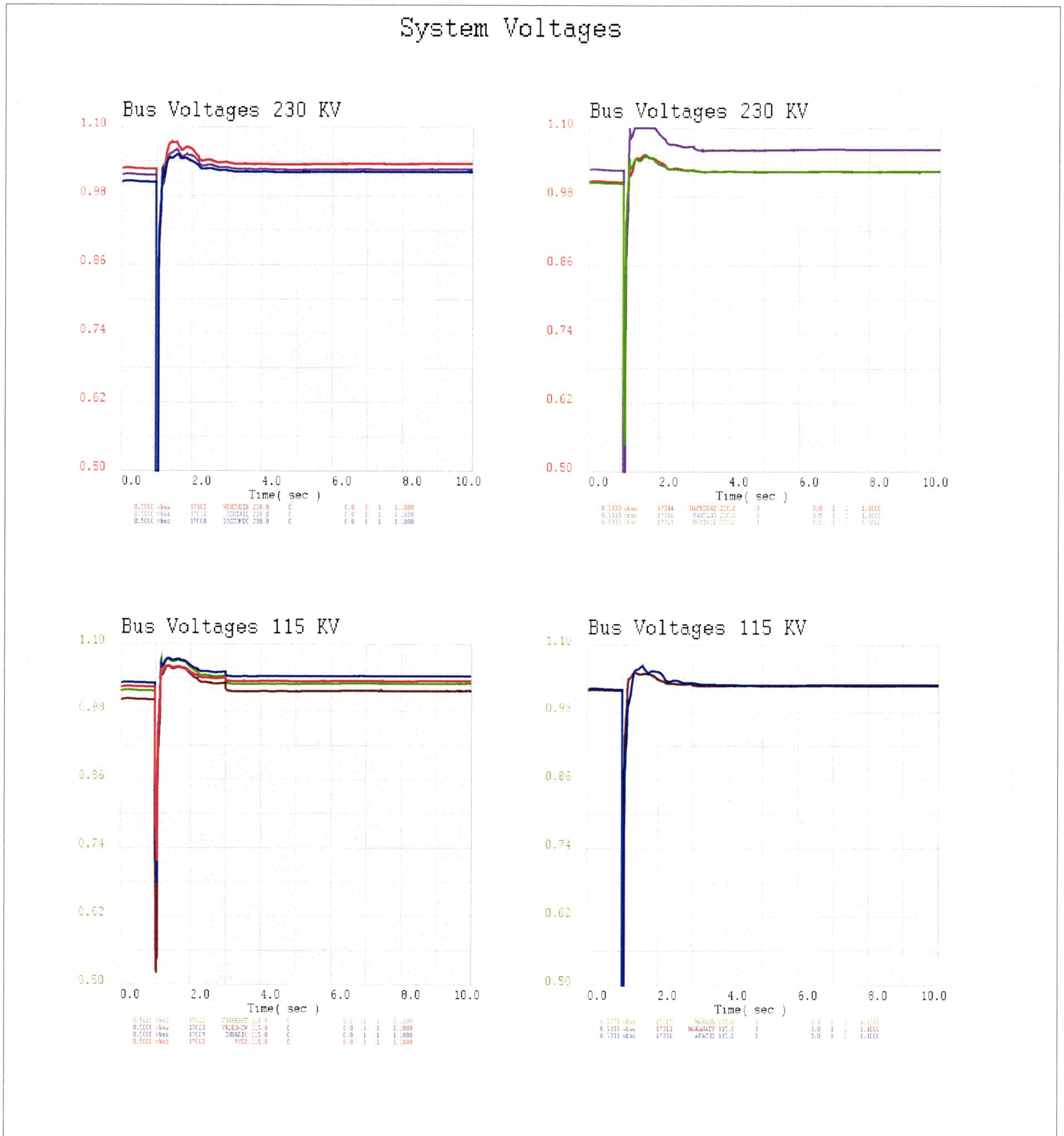
Line: APACHE 230 - BUTERFLD 230 dropped.

2020HS – Apache to Butterfield 230 kV Line Outage – 345 kV & 230 kV Bus Voltages




```
2020 Heavy Summer SWAT-AZ Case
used for the SWTC 2021HS TPL CASE
SSVEC system added
Summer 2014
Residential:    6195.5 MW; includes 2-EMA RES Loads
Industrial:      552.3 MW
EMA:             223.5 MW
Losses:          100.0 MW                                          Page 2
Load:                E:\TPL_2015_Study\Contingencies\21hs_swtc_2015-TPL_M1_MITibility\APAC230BUTE230\Channel-1.chf.
ZONES 801-817; INDUSTRIAL LOADS HAVE "I" IN ID; AUX LOADS HAVE "G"
APS Loads 142-147: 5033.1MW                                        Tue Nov 17 10:54:24 2015
Line: APACHE 230 - BUTERFLD 230 dropped.
```

2020HS – Apache to Butterfield 230 kV Line Outage – 230 kV & 115 kV Bus Voltages



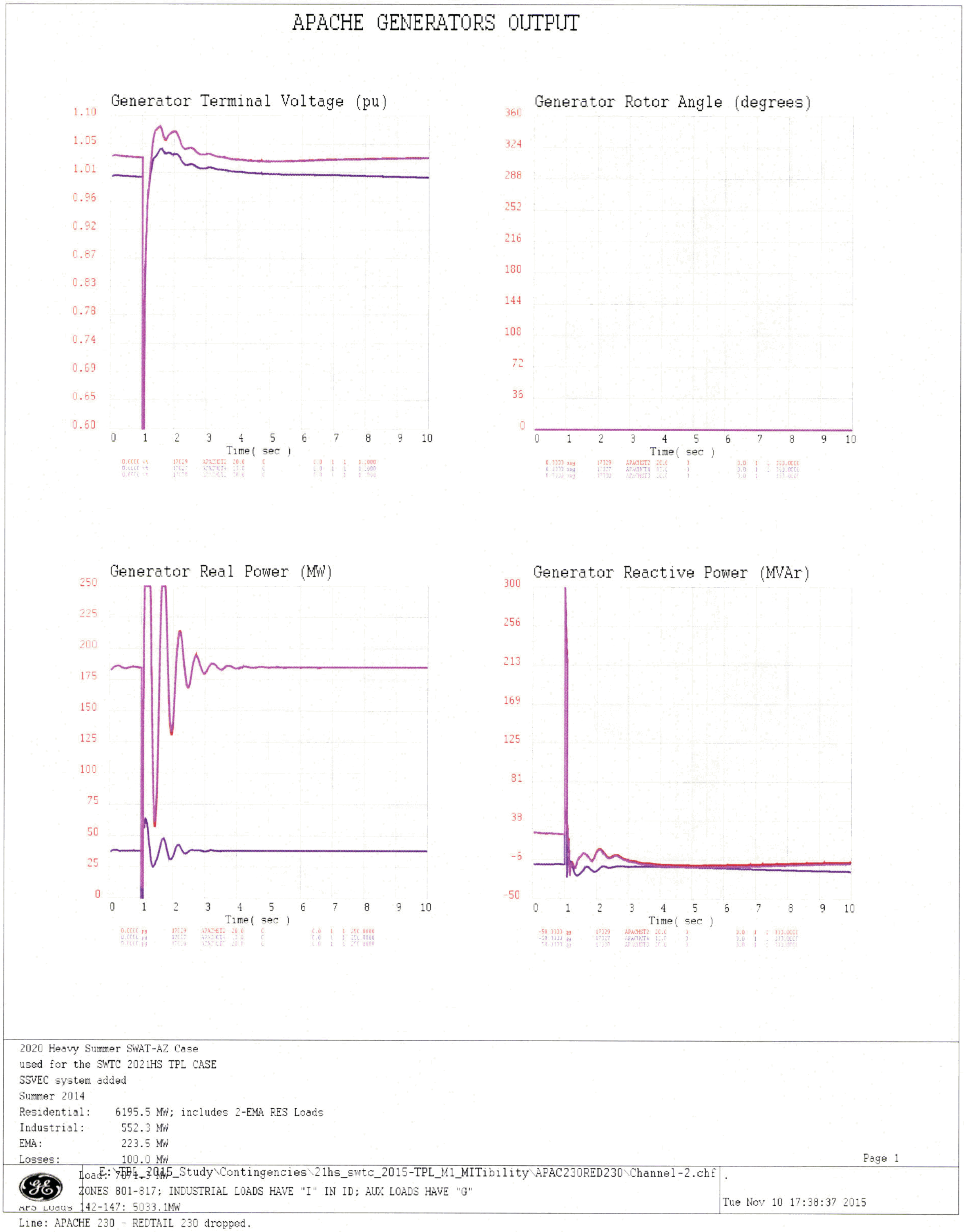

```
2020 Heavy Summer SWAT-AZ Case
used for the SWTC 2021HS TPL CASE
SSVEC system added
Summer 2014
Residential:    6195.5 MW; includes 2-EMA RES Loads
Industrial:      552.3 MW
EMA:             223.5 MW
Losses:          100.0 MW
Load:
E:\TPL_2015_Study\Contingencies\21hs_swtc_2015-TPL_M1_MITibility\APAC230BUTE230\Channel-1.chf.
ZONES 801-817; INDUSTRIAL LOADS HAVE "I" IN ID; AUX LOADS HAVE "G"
APS Loads 142-147: 5033.1MW
Line: APACHE 230 - BUTERFLD 230 dropped.
```

Page 3

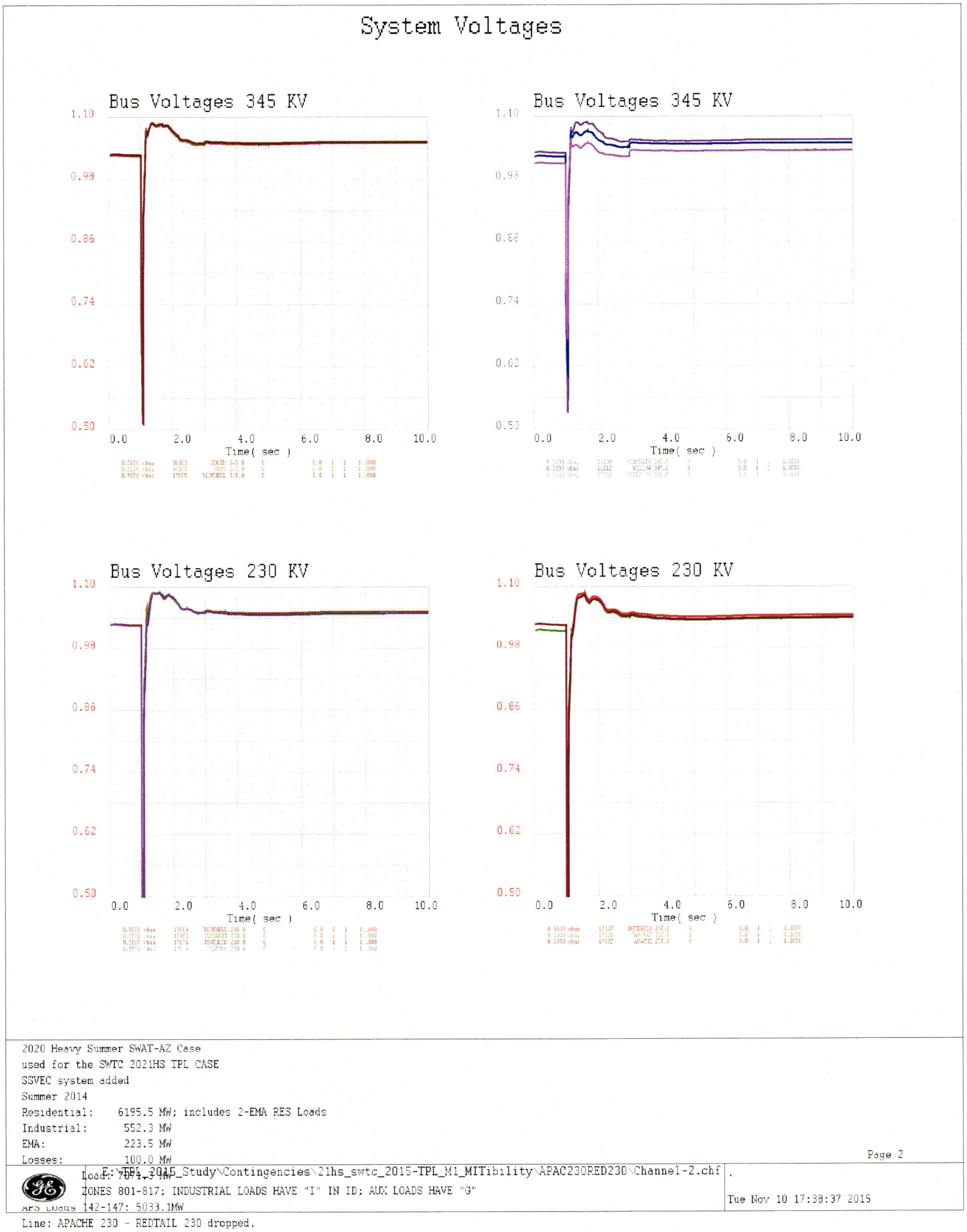
Tue Nov 17 10:54:24 2015

Apache – Redtail 230 kV Outage

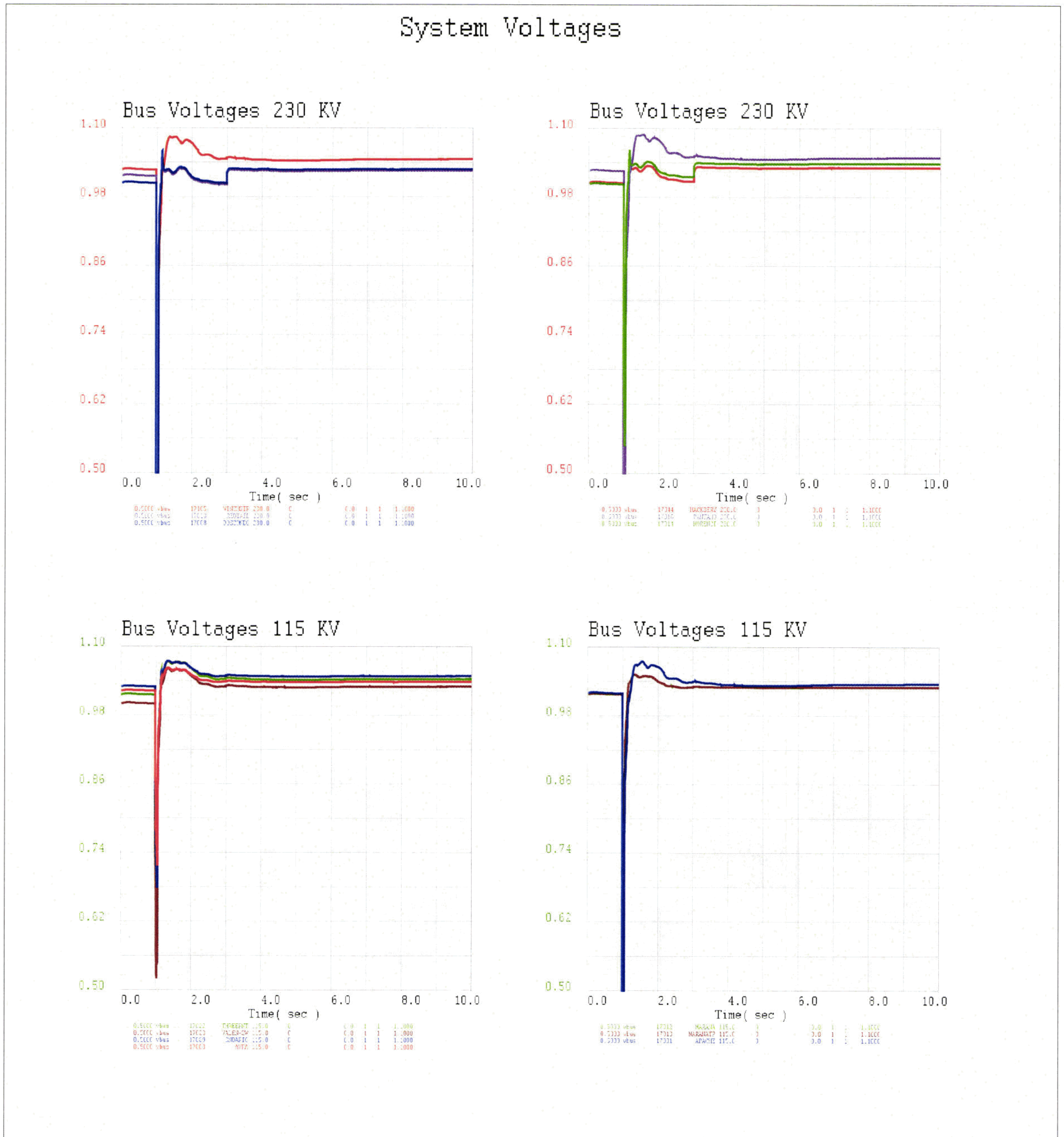
2020HS – Apache to Redtail 230 kV Line Outage – Apache Generators Output



2020HS – Apache to Redtail 230 kV Line Outage – 345 kV & 230 kV Bus Voltages



2020HS – Apache to Redtail 230 kV Line Outage – 230 kV & 115 kV Bus Voltages



2020 Heavy Summer SWAT-AZ Case
used for the SWTC 2021HS TPL CASE
SSVEC system added
Summer 2014
Residential: 6195.5 MW; includes 2-EMA RES Loads
Industrial: 552.3 MW
EMA: 223.5 MW
Losses: 100.0 MW
Load: [illegible]

E:\TPL_2015_Study\Contingencies\21hs_swtc_2015-TPL_M1_MITibility\APAC230RED230\Channel-2.chf

ZONES 801-817; INDUSTRIAL LOADS HAVE "I" IN ID; AUX LOADS HAVE "G"
APS Loads 142-147: 5033.1MW

Page 3

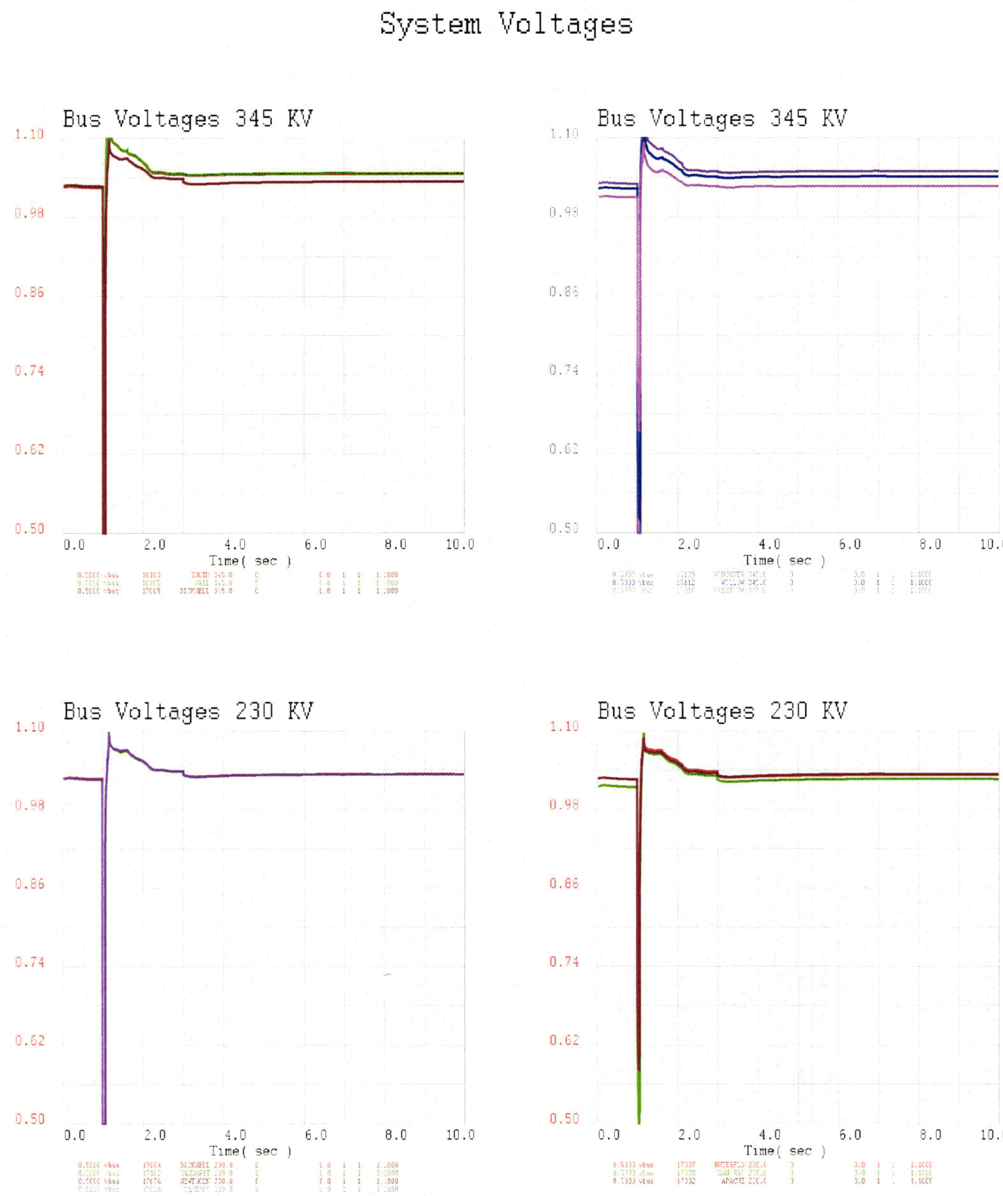
Tue Nov 10 17:38:37 2015

Line: APACHE 230 - REDTAIL 230 dropped.

Bicknell – Vail 345 kV Outage

2020HS – Bicknell to Vail 345 kV Line Outage – Apache Generators Output

2020HS – Bicknell to Vail 345 kV Line Outage – 345 kV & 230 kV Bus Voltages



2020 Heavy Summer SWAT-AZ Case
used for the SWTC 2021HS TPL CASE
SSVEC system added
Summer 2014
Residential: 6195.5 MW; includes 2-EMA RES Loads
Industrial: 552.3 MW
EMA: 223.5 MW
Losses: 100.0 MW

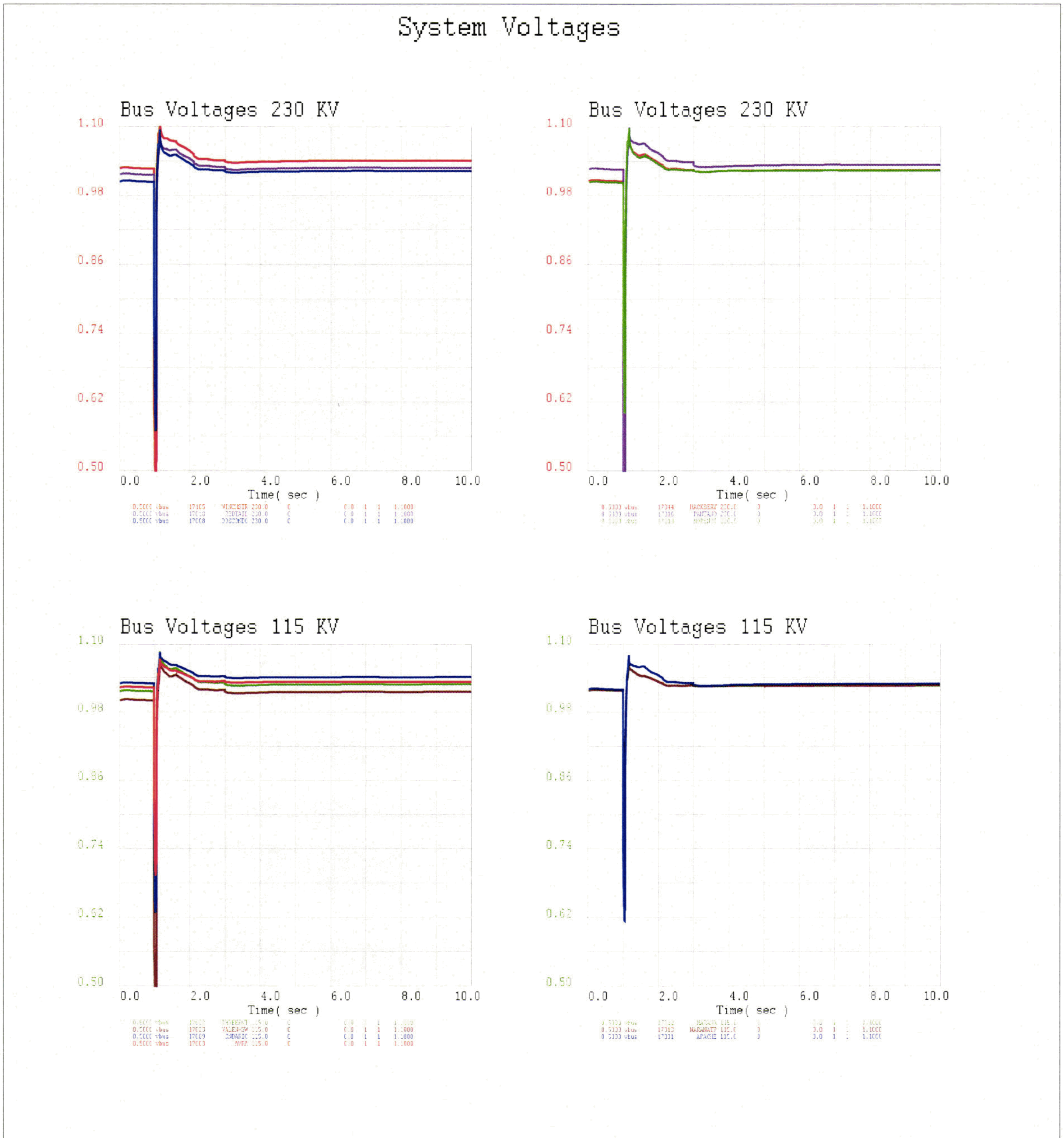
Page 2

F:\TPL_2015_Study\Contingencies\21hs_swtc_2015-TPL_M1_MITibility\BICK345VAIL345\Channel-3.chf.
Load: [illegible] MW
ZONES 801-817; INDUSTRIAL LOADS HAVE "I" IN ID; AUX LOADS HAVE "G"
APS Loads 142-147: 5033.1MW

Tue Nov 17 12:16:50 2015

Line: BICKNELL 345 - VAIL 345 dropped.

2020HS – Bicknell to Vail 345 kV Line Outage – 230 kV & 115 kV Bus Voltages



2020 Heavy Summer SWAT-AZ Case
used for the SWTC 2021HS TPL CASE
SSVEC system added
Summer 2014
Residential: 6195.5 MW; includes 2-EMA RES Loads
Industrial: 552.3 MW
EMA: 223.5 MW
Losses: 100.0 MW

Page 3

E:\TPL_2015_Study\Contingencies\21hs_swtc_2015-TPL_M1_MITibility\BICK345VAIL345\Channel-3.chf

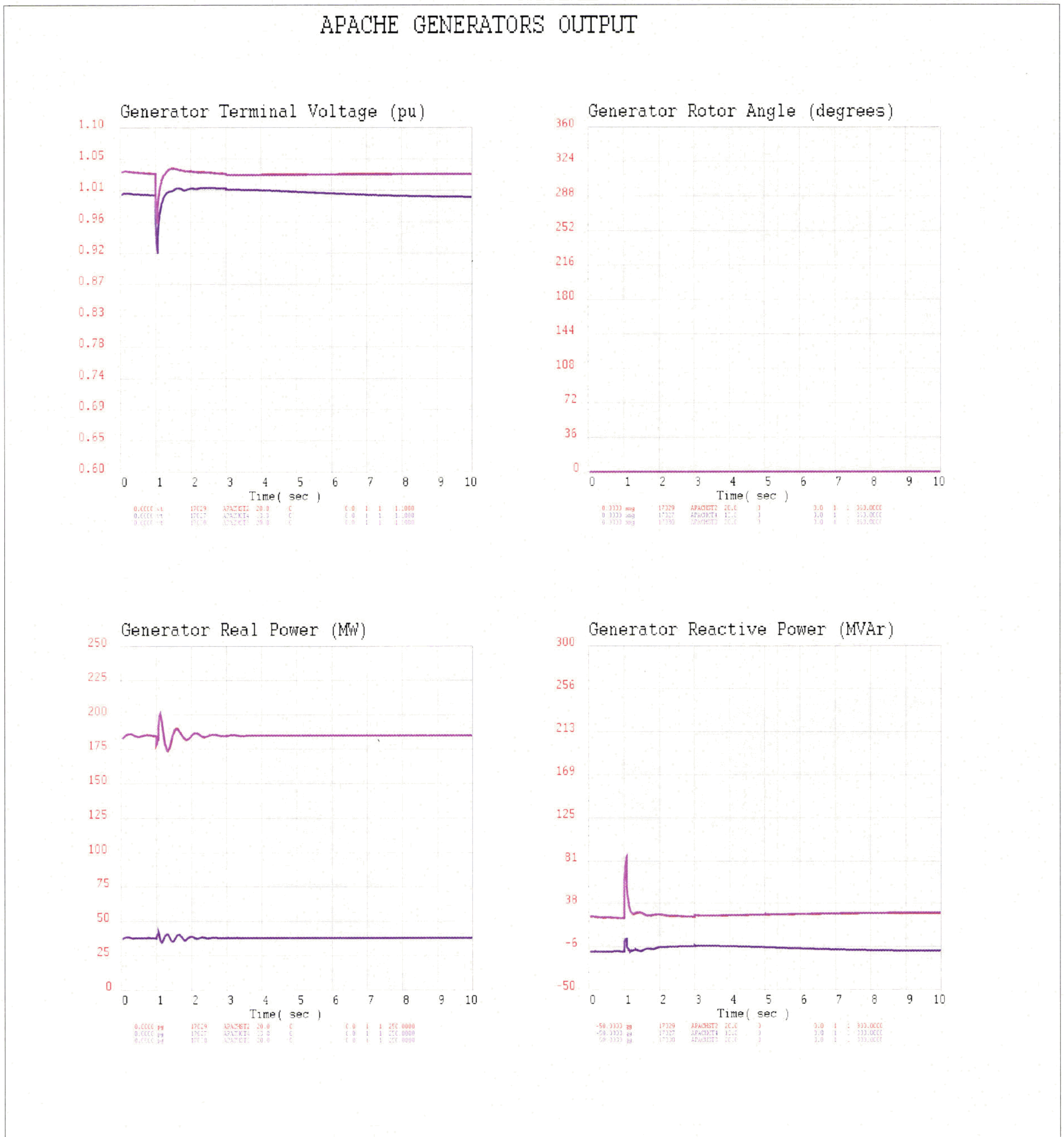
Load: 7071.7 MW
ZONES 801-817; INDUSTRIAL LOADS HAVE "I" IN ID; AUX LOADS HAVE "G"
APS Loads 142-147: 5033.1MW

Tue Nov 17 12:16:50 2015

Line: BICKNELL 345 - VAIL 345 dropped.

Marana Group 115 kV Outage

2020HS – Marana Group 115 kV Line Outage – Apache Generators Output




```
2020 Heavy Summer SWAT-AZ Case
used for the SWTC 2021HS TPL CASE
SSVEC system added
Summer 2014
Residential:    6195.5 MW; includes 2-EMA RES Loads
Industrial:      552.3 MW
EMA:             223.5 MW
Losses:          100.0 MW
Load: 7071.3 MW
APS Loads 142-147: 5033.1MW
Line: MARANATP 115 - MARANA 115 dropped.
```

Page 1

E:\TPL 2015_Study\Contingencies\21hs_swtc_2015-TPL_M1_MITibility\Group_MARA115\Channel-4.chf

ZONES 801-817; INDUSTRIAL LOADS HAVE "I" IN ID; AUX LOADS HAVE "G"

Tue Nov 17 12:38:01 2015

2020HS – Marana Group 115 kV Line Outage – 345 kV & 230 kV Bus Voltages

2020 Heavy Summer SWAT-AZ Case
used for the SWTC 2021HS TPL CASE
SSVEC system added
Summer 2014
Residential: 6195.5 MW; includes 2-EMA RES Loads
Industrial: 552.3 MW
EMA: 223.5 MW
Losses: 100.0 MW
Load: 7074.3 MW

Page 2

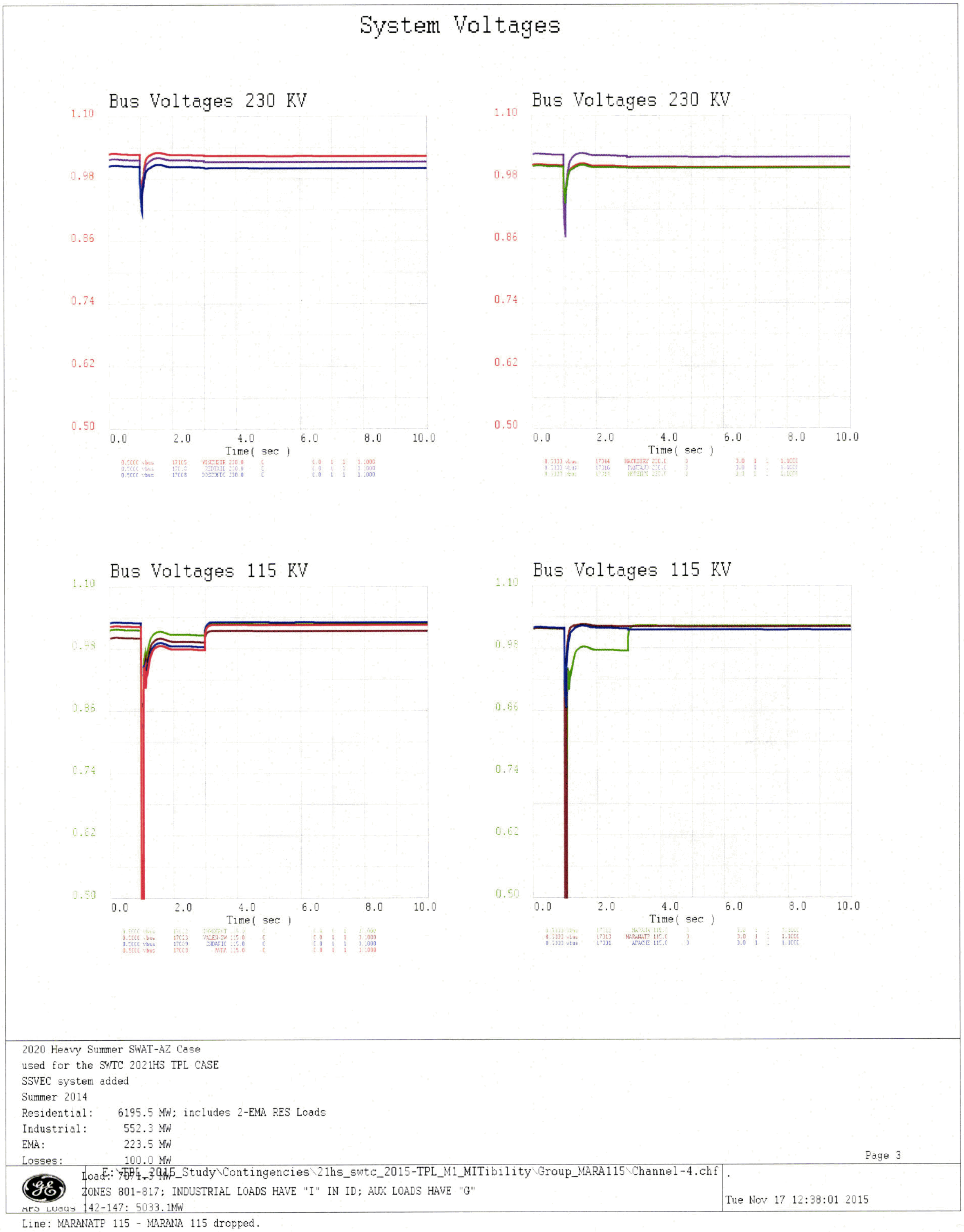
E:\TPL_2015_Study\Contingencies\21hs_swtc_2015-TPL_M1_MITibility\Group_MARA115\Channel-4.chf

ZONES 801-817; INDUSTRIAL LOADS HAVE "I" IN ID; AUX LOADS HAVE "G"
APS Loads 142-147: 5033.1MW

Tue Nov 17 12:38:01 2015

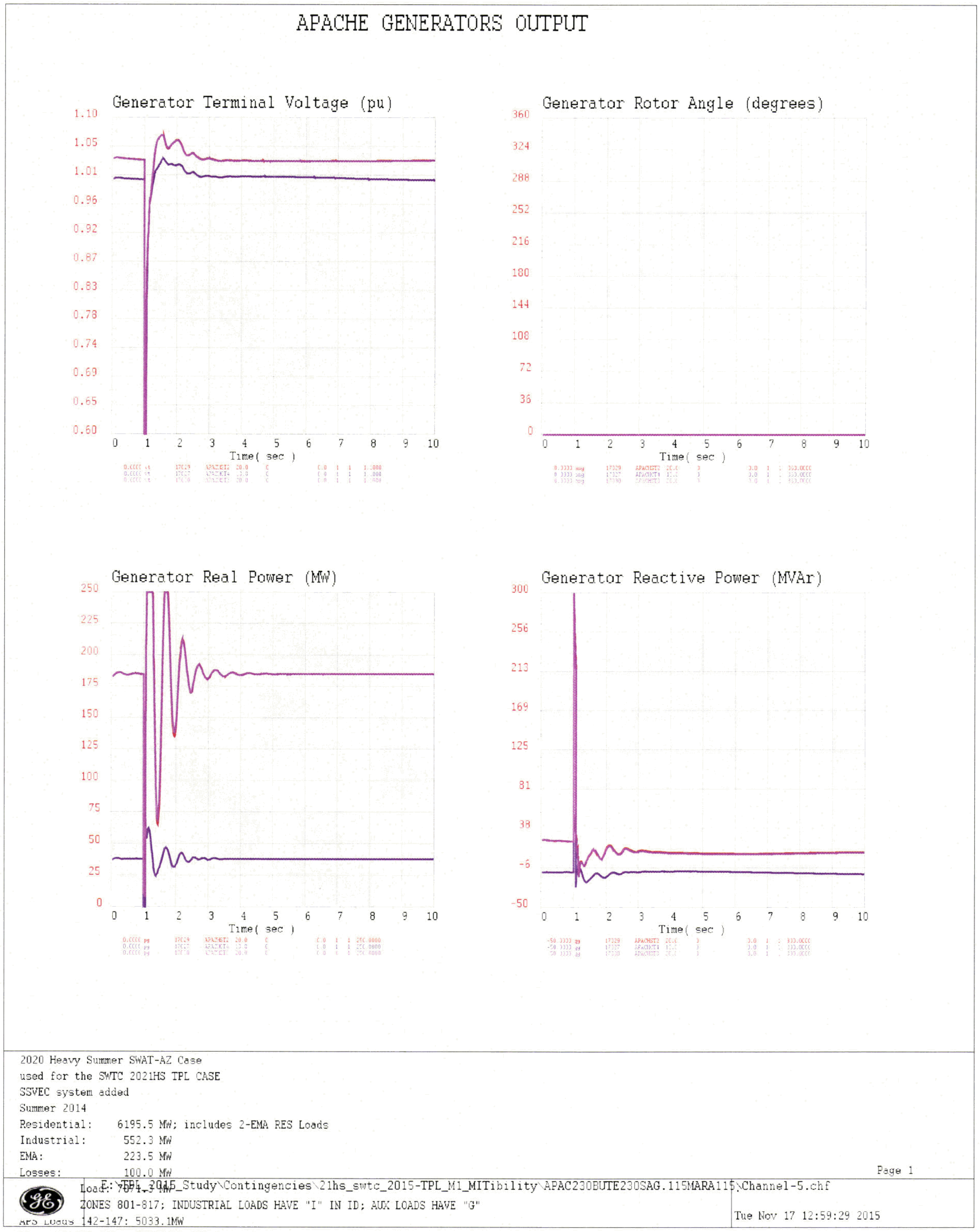
Line: MARANATP 115 - MARANA 115 dropped.

2020HS – Marana Group 115 kV Line – 230 kV & 115 kV Bus Voltages

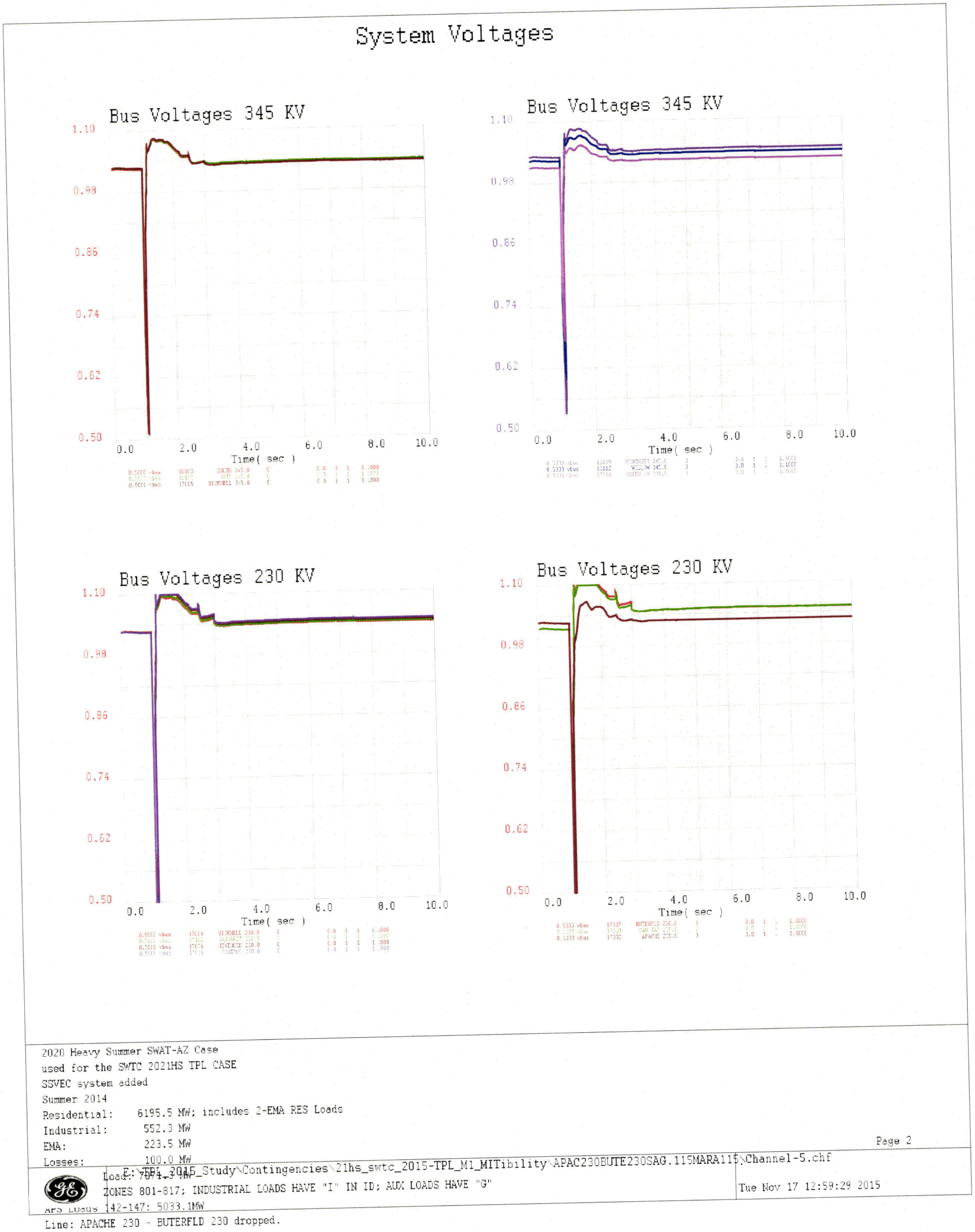


Apache – Butterfield 230 kV & Saguaro East – Marana Tap 115 kV Outage

2020HS – Apache to Butterfield 230 kV & Saguaro East to Marana Tap 115 kV Line Outage – Apache Generators Output



2020HS – Apache to Butterfield 230 kV & Saguaro East to Marana Tap 115 kV Line Outage – 345 kV & 230 kV Bus Voltages



2020HS – Apache to Butterfield 230 kV & Saguaro East to Marana Tap 115 kV Line Outage – 230 kV & 115 kV Bus Voltages