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January 30, 2012

Mr. Steven M. Olea
Director, Utilities Division
Arizona Corporation Commission
1200 West Washington
Phoenix, AZ 85007

RE: Docket No. E-00000D-11-0017

Dear Mr. Olea:

Enclosed is the Southwest Transmission Cooperative, Inc. (SWTC) Ten Year Plan for the period 2012 – 2021. It includes the Ten Year Plan Report and the Technical Study Report. I have enclosed an original plus thirteen copies pursuant to A.R.S. Section 40-360-02 for each Report.

Sincerely,

Jacquelyn Cook
Director of Planning and Business Development

Enc.

c/Corporate Records

Arizona Corporation Commission
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A Touchstone Energy® Cooperative 

TEN-YEAR PLAN

2012 – 2021

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AZ CORP COMMISSION
DOCKET CONTROL

Docket No. E0000D-11-0017

JANUARY 30, 2012

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR PLAN

2012 – 2021

Prepared for the

ARIZONA CORPORATION COMMISSION

Docket No. E-00000D-11-0017

TRANSMISSION PLANNING

JANUARY 30, 2012

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SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR 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 meet anticipated system load growth of its Distribution Cooperative Members (“Members”) and other network and point to point customers.

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 be due to changes in load forecasts, environmental constraints, economic considerations and/or regulatory and legal developments. All 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. This process concludes with the preparation of a 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. Projects that have been studied for this ten-year plan horizon that have not been approved and placed into a CWP for approval by the SWTC Board are considered as “conceptual,” and are still under review by the CAOC. Changes of any significance that occur prior to the next Ten-Year Plan filing will be discussed with the Commission Staff.

This specific report is divided into two sections, as outlined in the Table of Contents on page 1. Section I describes planned and conceptual transmission lines SWTC may construct over the ten-

year plan period, whose nominal rating 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.

The technical study report of the planned transmission projects contained in Section I, 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 to the ACC.

The planned and conceptual transmission lines that are listed in Section I are needed to maintain system reliability, meet reliability standards, and to serve load of SWTC Members and other customers. Due to the proximity of the new lines to the Member load being served, studies conducted show little impact to the overall interconnected system.

REGIONAL PLANNING

SWTC participates in Regional Planning efforts through its involvement in the Southwest Area Transmission (“SWAT”) Planning Group. SWTC is involved in the following subcommittees of SWAT, either through active participation or copy interest:

- Arizona-New Mexico Regional Transmission Subcommittee (“AZNM”)
- Central Arizona Transmission Subcommittee (“CATS”)
- Colorado River Transmission Subcommittee (“CRT”)
- Renewable Transmission Task Force (“RTTF”)
- Southeast Arizona Transmission Study (“SATS”)
 - Cochise County Study Group (CCSG)
- Short-circuit Working Group (“SCWG”)

In addition, SWTC continues to monitor the efforts of the Transmission Expansion Planning Policy Committee (“TEPPC”) of the Western Electricity Coordination Council (“WECC”) and is

active within the following subcommittees of WECC: the Operating Committee (“OC”), the Planning Coordination Committee (“PCC”) and the Technical Studies Subcommittee (“TSS”).

SWTC is also an active participant in WestConnect and was one of the original twelve signatories to the WestConnect Project Agreement for Subregional Transmission Planning (“STP Agreement”). A Planning Management Committee (“PMC”), made up of one representative from each of the signatories to the STP Agreement, is tasked with implementation of the subregional planning process. SWTC participates regularly in the PMC meetings or conference calls.

At the WestConnect Annual Planning Workshop, held November 16, 2011, SWTC presented its 2012-2021 Ten-Year Transmission Plan for inclusion into the 2011 WestConnect Transmission Plan. The WestConnect plan is scheduled for approval at the February 16, 2012 WestConnect Annual Planning Meeting. The projects that are included in this ten year plan filing to the Commission are similar to those presented at the WestConnect Annual Planning Workshop. All of the conceptual projects are subject to change, pending further discussions with the SWTC Members, through ongoing meetings of the CAOC. Notations to this effect are included in the write-up of each of the transmission line project summaries in Section 1.

2010 6th BTA REQUIREMENTS

In December 2010, the ACC approved the Sixth Biennial Transmission Assessment (“BTA”) report with Decision #72031 that adopted staff’s recommendations and proposed orders, along with two new requirements. The specific orders that apply directly to SWTC are noted here, along with those that apply to all jurisdictional utilities:

Requirement #1:

SWTC, APS, Tucson Electric Power Company (“TEP”) and Sulphur Springs Valley Electric Cooperative (“SSVEC”) shall jointly complete additional actions and file specified information related to the Cochise County Study Group plan of service with the Commission as follows:

- a. By June 30, 2011, identify the components of the plan in a facilities report that provide the most benefit to customer reliability and can be implemented in the shortest timeframe, and file a progress report with the Commission that includes planning in-service dates for all relevant elements of the plan reflecting these priorities.
- b. By September 30, 2011, submit a progress report including in-service dates for the components of the plan of service identified in the June 30, 2011, facility study. This schedule shall reflect the most recent load forecast.
- c. By December 31, 2011, substantially complete contractual negotiations with affected parties over cost responsibility, wheeling arrangements, Engineering, Procurement and Construction (“EPC”), operations and maintenance, etc. (described as pending items in the CCSG 2009 report), and file a draft memorandum of understanding among affected parties addressing these items with the Commission.

SWTC’s Response:

SWTC has filed, on behalf of APS, TEP, and SSVEC, progress reports and other required documents to the Commission related to the Cochise County Study Group plan of service, on June 30, 2011, September 30, 2011, and December 31, 2011.

Requirement #2:

The jurisdictional utilities shall report relevant findings in future BTAs regarding compliance with transmission planning standards (e.g., TPL-001 through TPL-004) from NERC/WECC reliability audits that have been finalized and filed with FERC.

SWTC’s Response:

SWTC is scheduled for a NERC/WECC audit on January 30, 2012 – February 9, 2012 and will report relevant findings from the audit in the next ten year plan filing.

Requirement #3:

SWTC shall determine if an engineering “re-rating” of the Apache-Butterfield 230 kV line as proposed in the Sixth BTA filings would be an acceptable measure until the line is upgraded in 2016, and to file the results of this assessment by January 31, 2011.

SWTC’s Response:

The engineering “re-rate” study of the Apache to Butterfield 230 kV line was filed with the Commission on January 28, 2011. As a result of this effort, SWTC no longer requires an upgrade to the Apache to Butterfield 230 kV line.

Requirement #4:

APS, SWTC, and TEP shall conduct additional analysis of potential 230 kV and 138 kV voltage deviations in Southeastern Arizona as noted in the 2009 SATS report and file an update based on the 2010 SATS [Report] by February 20, 2011, and shall finalize mitigation plans if needed for this voltage concern in ten-year plan filing(s) for the 7th BTA by January 31, 2012.

SWTC’s Response:

The 2011-2020 Technical Study Report filed with the Commission on January 28, 2011 addressed this requirement and the 2012-2021 Technical Study Report filed with this Report, also addresses this requirement, as the latest update to the mitigation plans needed on the SWTC system to resolve voltage concerns outlined in the 2010 SATS Report. Studies have shown that the addition of capacitor banks on the system as noted in this report, along with the 115 kV line upgrades, and the proposed loop-in of the Saguaro to Tucson line into Marana, are measures that mitigate the voltage deviations seen in the 2010 SATS Report. As load forecasts may change from year to year, SWTC will ensure that any future mitigation measures needed on its system to alleviate delta-voltage violations, will be provided for in the next ten year plan filing. Please see the 2012-2021 Technical Study Report for additional information regarding this year’s assessment.

In regards to APS and TEP obligations, reference the 2012-2021 Ten-Year Plans as filed by each entity.

Requirement #5:

Jurisdictional utilities shall include planned transmission conductor projects, transformer capacity upgrade projects and reactive power compensation facility additions at 115 kV and above in future BTA ten-year plan filings.

SWTC Response:

SWTC has provided, in previous ten-year plan filings, and in this ten-year plan filing, planned transmission re-conductor projects and transformer capacity upgrade projects as noted in this requirement.

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

<u>Year</u>	<u>Substation</u>	<u>MVAR Quantity</u>
2012	Avra Valley	9.45
2013	Butterfield	28.8
2016	Redtail	16.0
2018	San Rafael	19.2
2019	Avra Valley	9.45

Additional studies conducted during 2012, due to a potential change in the 2012 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, will be reported in the next ten-year plan filing.

Requirement #6:

Jurisdictional utilities shall jointly conduct or procure a study, as well as conduct a stakeholder workshop process in conjunction with the study, which identifies the barriers to solutions for enhancing Arizona's ability to export renewable energy, including identifying specific transmission corridors that should be built out in order to accomplish this objective. The study and results of the workshop shall be filed at the Commission no later than November 1, 2011 and shall be included as part of the 2012 BTA.

SWTC Response:

SWTC has participated in the study and workshops to identify solutions for enhancing Arizona's ability to export renewable energy and is supportive of the study that was submitted to the Commission by PDS Consulting on November 1, 2011.

Requirement #7:

Jurisdictional utilities shall include the effects of distributed renewable generation and energy efficiency programs on future transmission needs in future ten-year plan filings, beginning in January 2011, and a discussion of these effects will take place in future BTAs.

SWTC Response:

As noted in last year's Ten Year Plan Filing, SWTC is a wholesale transmission only cooperative and therefore, does not develop energy efficiency or distributed renewable generation programs. These programs are put in place by SWTC's Class A Members. In addition, each Class A Member files with the ACC an individual Renewable Energy Standard and Tariff which include plans for such programs. Each Class A Member provides the effect of each respective plan for inclusion in SWTC's annual Member approved load forecast. Transmission projects developed in response to load forecasts are net of any energy efficiency or distributed renewable generation programs.

2010 SATS STUDY REPORT

Each year, SATS strives to update its current Study Report, which is a culmination of study efforts throughout the year, to actively evaluate strategies to increase local load serving capability. In addition, the Study Report evaluates impacts of potential EHV transmission to bring in remote resources into the area to serve the growing loads of Southeast Arizona. Study participants continue to acknowledge the importance of renewable resources in the resource study mix.

The Commission should refer to the 2010 Study Report that was filed by TEP on behalf of the SATS participants in January of 2011.

As noted in the 2010 SATS Study Report, the Conclusion section of the Report contains a listing of the proposed projects for the 2011 to 2020 time frame that document projects under consideration by SWTC and TEP for the near and long-term planning horizons. The projects in this Ten Year Plan filing for SWTC have not significantly changed for SWTC.

The following is a brief description of the EHV projects that SWTC either is a participant in, or is evaluating interest in, through the Regional Planning Process, that are contemplated for completion during this Ten-Year Plan Filing ("2012-2021") timeframe:

Pinal Central to Tortolita 500 kV Line

This project contemplates construction of a 500 kV line from the proposed Pinal Central Substation to the TEP Tortolita Substation. SWTC participated in Phase I of this project to evaluate siting and environmental considerations. TEP is the project manager for this project, which has an anticipated in-service date of 2014. Due to significant changes to its Construction Work Plans, SWTC does not plan to continue participation in Phase II.

CHANGES FROM 2011 TEN-YEAR PLAN FILING

There are minimal changes to the projects considered by SWTC for inclusion in this Ten-Year Plan filing over last year's ("2011-2020") Ten-Year Plan filing. These are noted below. The economic downturn continues to have an effect upon projects that SWTC and its Members are considering and as a result, all conceptual projects in this filing are under review and may change with next year's 10 year plan filing. The changes are noted below:

Pantano to Sahuarita 230 kV Line Loop-in to New Tucson. This project is a new delivery point for one of SWTC's Class A Members and was placed into service in May 2011.

Marana Tap to Marana 115 kV Line Upgrade. This project has been changed to the "Saguaro to Tucson 115 kV Line Loop-in to Marana Project." The SWTC 115 kV system taps the Saguaro to Tucson 115 kV line at the Marana Tap and extends 0.2 miles to the Marana Substation. Through discussions with the Western Area Power Administration, the parties are studying the effects of looping the Saguaro to Tucson 115 kV line into Marana rather than simply rebuilding the Marana to Marana Tap 115 kV line. Depending on the outcome of the study the potential in-service date of this project is set for 2013.

Apache/Hayden 115 kV Line Loop-in to San Manuel. The in-service date for this conceptual project has changed from 2014 to 2017, due to economic considerations.

San Rafael 2nd 230/69 kV Transformer. The in-service date for this conceptual project has been changed from 2021 instead of "to be determined" ("TBD"). On-going study efforts of the Cochise County Study Group in 2012 may result in a new in-service date for this project.

Three Points to Bicknell 115 kV Line Upgrade. The in-service date for this new conceptual Project is 2020.

**SECTION I - PLANNED AND CONCEPTUAL
TRANSMISSION LINES**

MARANA TO AVRA VALLEY 115 kV LINE UPGRADE

Line Designation:	Marana to Avra Valley 115 kV Line Upgrade
Size:	
a) Voltage	115 kV
b) Capacity	219 MVA
c) Point of Origin	Marana Substation Sec. 26 T11S R10E
d) Point of Termination	Avra Valley Substation Sec. 11 T13S R10E
e) Length	Approximately 8.75 miles
Routing:	Marana Substation, south to Avra Valley Substation, following the existing Marana to Avra Valley ROW.
Purpose:	To provide system reliability, increased transfer capability and voltage support for the SWTC system and to provide for anticipated Member load growth.
Dates:	
a) Construction Start	2012
b) In-Service Date	2012
Notes:	This project was approved by the ACC Line Siting Committee on May3, 2011 and by the Commission (Case #161, Decision #72447) on June 28, 2011.

AVRA VALLEY TO SANDARIO TAP 115 kV LINE UPGRADE

Line Designation:	Avra Valley to Sandario Tap 115 kV Line Upgrade
Size:	
a) Voltage	115 kV
b) Capacity	219 MVA
c) Point of Origin	Avra Valley Substation Sec. 11 T13S R10E
d) Point of Termination	Sandario Tap Sec. 23 T13S R10E
e) Length	Approximately 2.8 miles
Routing:	Avra Valley Substation, south to the Sandario Tap turning structure, following the existing Avra Valley to Sandario Tap ROW.
Purpose:	To provide system reliability, increased transfer capability and voltage support for the SWTC system and to provide for anticipated Member load growth.
Dates:	
a) Construction Start	2012
b) In-Service Date	2012
Notes:	This project was approved by the ACC Line Siting Committee on May 3, 2011 and by the Commission (Case #161, Decision #72447) on June 28, 2011.

SAGUARO TO TUCSON 115 kV LINE LOOP-IN TO MARANA

Line Designation: Saguario to Tucson 115 kV Line Loop-in to Marana
(Formerly the Marana Tap to Marana 115 kV Line Upgrade)

Size:

- a) Voltage 115 kV
- b) Capacity 219 MVA
- c) Point of Origin Marana Tap
Sec. 26 T11S R10E
- d) Point of Termination Marana Substation
Sec. 26 T11S R10E
- e) Length Approximately 0.2 miles

Routing: Western's Marana Tap, west to the SWTC Marana Substation.

Purpose: To provide system reliability, increased transfer capability and voltage support for the SWTC system and to provide for anticipated Member load growth.

Dates:

- a) Construction Start 2013
- b) In-Service Date 2013

Notes: The Marana Tap to Marana project was approved by the ACC Line Siting Committee on May 3, 2011 and by the Commission (Case #161, Decision #72447) on June 28, 2011. The Saguario to Tucson 115 kV line loop-in to Marana Project is considered to be a minor modification to this original project approval as it utilizes the same line path. The project is currently under study with Western Area Power Administration.

PINAL CENTRAL TO TORTOLITA 500 kV LINE

Line Designation: Pinal Central to Tortolita 500 kV Line

Size:

- | | | |
|----|----------------------|--|
| a) | Voltage | 500 kV |
| b) | Capacity | 1732 MVA |
| c) | Point of Origin | Pinal Central Substation
Sec. 25 T6S R7E |
| e) | Point of Termination | New Tortolita 500 kV Yard
Sec. 23 T10S R10E |
| f) | Length | Approximately 38.0 miles |

Routing: From Pinal Central Substation to Tortolita Substation following the CAP facilities.

Purpose: Identified by TEP as necessary to increase TEP System Load Serving Capability from remote resources. The project would provide for increased transfer capability to SWTC loads in Southeast AZ.

Dates:

- | | | |
|----|--------------------|------|
| a) | Construction Start | 2013 |
| b) | In-Service Date | 2014 |

Notes: SWTC is a participant in Phase I of the project to evaluate line siting and environmental considerations. Due to significant changes to its Construction Work Plan, SWTC does not plan to participate in Phase II of this project.

SANDARIO TAP TO THREE POINTS 115 kV LINE UPGRADE

Line Designation: Sandario Tap to Three Points 115 kV Line Upgrade

Size:

- a) Voltage 115 kV
- b) Capacity 219 MVA
- c) Point of Origin Sandario Tap
Sec. 23 T13S R10E
- d) Point of Termination Three Points Substation
Sec. 25 T15S R10E
- e) Length Approximately 13.71 miles

Routing: Sandario Tap turning structure, south to the existing Three Points Substation, following the existing Sandario Tap to Three Points ROW.

Purpose: To provide system reliability, increased transfer capability and voltage support for the SWTC system and to provide for anticipated Member load growth.

Dates:

- a) Construction Start 2014
- b) In-Service Date 2015

Notes: The in-service date for this conceptual project is subject to change with load growth in the area.

BICKNELL 345/230 kV TRANSFORMER REPLACEMENT

Line Designation: Bicknell 345/230 kV Transformer Replacement

Size:

- a) Voltage 345 kV
- b) Capacity 420 MVA
- c) Point of Origin Bicknell Substation
Sec. 30 T17S R13E
- d) Point of Termination Bicknell Substation
Sec. 30 T17S R13E
- e) Length 0 miles

Routing: None

Purpose: Provide increased regional reliability and import capability into the SWTC transmission system.

Dates:

- a) Construction Start 2015
- b) In-Service Date 2015

Notes: The in-service date for this conceptual project is subject to change. SWTC sees no current justification for building this project on its own and will be eliciting the support of neighboring entities in 2012 to jointly study the need for this project and participate in a cost share of the costs of constructing the project. No certificate is necessary for this project.

GREENLEE 2ND 345/230 kV TRANSFORMER

Line Designation: Greenlee 2nd 345/230 kV Transformer

Size:

- | | | |
|----|----------------------|--|
| a) | Voltage | 345 kV |
| b) | Capacity | 193 MVA |
| c) | Point of Origin | SWTC Greenlee Substation
Sec. 29 T5S R31E |
| d) | Point of Termination | SWTC Greenlee Substation
Sec. 29 T5S R31E |
| e) | Length | 0 miles |

Routing: None

Purpose: Provide increased import capability into the SWTC transmission system.

Dates:

- | | | |
|----|--------------------|------|
| a) | Construction Start | 2015 |
| b) | In-Service Date | 2015 |

Notes: The in-service date for this conceptual project is subject to change. SWTC sees no current justification for building this project on its own and will be eliciting the support of neighboring entities in 2012 to jointly study the need for this project and participate in a cost share of the costs of constructing the project. No certificate is necessary for this project.

APACHE/HAYDEN TO SAN MANUEL 115 kV LINE

Line Designation: Apache/Hayden to San Manuel 115 kV line

Size:

- a) Voltage 115 kV
- b) Capacity 123 MVA
- c) Point of Origin Apache/Hayden 115 kV line near San Manuel
Sec. 19 T9S R18E
- d) Point of Termination APS San Manuel Substation
Sec. 29 T9S R17E
- e) Length Approximately 4.5 miles

Routing: Apache/Hayden 115 kV line, heading generally west then southwest to San Manuel Substation.

Purpose: To provide system reliability, increased transfer capability and voltage support for the SWTC system and to provide for anticipated Member load growth.

Dates:

- a) Construction Start 2016
- b) In-Service Date 2017

Notes: This project was approved by the ACC Line Siting Committee on May 12, 2009 and by the Commission (Case #142, Decision #71218) on July 9, 2009. This in-service date for this conceptual project is subject to change.

THREE POINTS TO BICKNELL 115 kV LINE UPGRADE

Line Designation:	Three Points To Bicknell 115 kV Line Upgrade
Size:	
a) Voltage	115 kV
b) Capacity	219 MVA
c) Point of Origin	Three Points Substation Sec. 25 T15S R10E
d) Point of Termination	Bicknell Substation Sec. 30 T17S R13E
e) Length	Approximately 21 miles
Routing:	Three Points Substation, south to the existing Bicknell Substation, following the existing Three Points to Bicknell ROW.
Purpose:	To provide system reliability, increased transfer capability and voltage support for the SWTC system and to provide for anticipated Member load growth.
Dates:	
a) Construction Start	2019
b) In-Service Date	2020
Notes:	The in-service date for this conceptual project is subject to change with load growth in the area.

SAN RAFAEL 2ND 230/69 kV TRANSFORMER

Line Designation: San Rafael 2nd 230/69 kV Transformer

Size:

- | | | |
|----|----------------------|--|
| a) | Voltage | 230 kV |
| b) | Capacity | TBD |
| c) | Point of Origin | San Rafael Substation
Sec. 17 T22S R21E |
| d) | Point of Termination | San Rafael Substation
Sec. 17 T22S R21E |
| e) | Length | 0 miles |

Routing: None

Purpose: Provide continuous reliable service to SSVEC under certain N-1 outage conditions in the Sierra Vista area. Note: This project is part of the ongoing Cochise County Study efforts.

Dates:

- | | | |
|----|--------------------|------|
| a) | Construction Start | 2021 |
| b) | In-Service Date | 2021 |

Notes: The in-service date for this project was changed from TBD to 2021. On-going efforts of the Cochise County Study Group in 2012 may change this conceptual project to occur sooner within the current ten year plan timeframe. No certificate is necessary for the project.

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 October 12, 2011, 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 NERC and Western Electricity Coordinating Council ("WECC") standards, this document sets forth the methodology used by SWTC to rate its facilities. It is the method by which the Rating of SWTC major Bulk Electric System ("BES") equipment is determined.

- 1.1 The facilities addressed in this document include transmission conductors, transformers, relay protective devices, terminal equipment, and series and shunt compensation devices.
- 1.2 This methodology addresses Normal and Emergency ratings for the facilities that comprise SWTC's BES.
- 1.3 This Facility Ratings Methodology considers the ratings provided by equipment manufacturers, IEEE and ANSI standards, ambient conditions for solar input, temperature and wind speed, design criteria, operating limitations, and other assumptions, as applicable.
- 1.4 The ratings for all of SWTC BES facilities, including but not limited to lines, transformers, and shunt compensation devices, shall be equal to the most limiting applicable equipment rating of the individual equipment that comprises the facility.
- 1.5 This methodology will be made available for inspection and technical review within 15 business days of receipt of a request from SWTC's Loveland Reliability Coordination Center ("LLRC"), Transmission Planners, Planning Authorities/Coordinators, and any other FERC jurisdictional entity that has responsibility for the area in which the facilities are located. Requests and responses for the methodology will be tracked by the Manager of System Operations at SWTC.
- 1.6 A written response to any comments regarding this Facility Ratings Methodology will be sent to the commenting entity within 45 calendar days of the comment receipt. The response shall indicate whether a change will be made to the Facility Ratings Methodology and, if no change will be made to that Facility Ratings Methodology, the reason why. Comments and responses regarding the methodology will be tracked by the Manager of System Operations at SWTC.
- 1.7 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.

In cases where a facility is owned in segments (such as a transmission line being 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 other owners to determine the most limiting segment. The rating for the most limiting segment would be used for the entire facility.

2.0 Facility Rating Methodologies for Transmission Facilities

The following sections describe the rating method for SWTC facilities.

2.1 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.

2.2 Transmission Lines

SWTC owns transmission facilities. The rating of transmission lines involves comparison of the ratings of all elements which make up the line between the two identified busses, including the terminal equipment. The overall line rating is limited by the rating of the component with the lowest rating element or the stability limit of the line, whichever is lower. The bulk of SWTC's transmission lines are thermally limited and are currently based on the Western Area Power Administration ("Western") Power System Bulletin 510, dated July 13, 1989 and updated on January 14, 1992.

In 2009 SWTC undertook studies to re-rate its transmission facilities to more fully comply with the NERC Standards. On October 14, 2009, SWTC contracted with LIDAR to fly its southeast transmission system for the gathering of parameters to use in developing new transmission line ratings. The assembly of this data is not complete, but when it is, it will be provided in a revision to this standard.

2.2.1 Transmission Line Conductors

The transmission line conductor ratings from the Western PDS Bulletin 50 dated January 14, 1992 are found below in the following tables:

TABLE 1: Conductor Thermal Ratings			
At 75 Deg. Celsius Operating Temperature			
Based on 2 ft. per second Wind Velocity			
and 40 deg. Celsius Air Temperature			
ACSR Conductor		Copper Conductor	
SIZE	AMPS	SIZE	AMPS
1/0 – 105.5 MCM	240	6 – 26.3 MCM	120
2/0 – 133.1 MCM	270	4 – 41.7 MCM	170
3/0 – 167.8 MCM	310	2 – 66.4 MCM	240
4/0 – 221.6 MCM	360	1/0 – 105.5 MCM	310
266.8 MCM	380	2/0 – 133.1 MCM	360
336.4 MCM	500	3/0 – 167.8 MCM	415
397.5 MCM	550	4/0 – 221.6 MCM	485
477.0 MCM	620	250.0 MCM	540
556.0 MCM	676	300.0 MCM	605
636.0 MCM	760	350.0 MCM	680
795.0 MCM	840	500.0 MCM	840
954.0 MCM	920	605.0 MCM	950
984.9 MCM	940	750.0 MCM	1090
1033.5 MCM	980		
1192.5 MCM	1074		
1272.0 MCM	1100		
1351.5 MCM	1150		
1590.0 MCM	1250		
2167.0 MCM	1500		

TABLE 2: Conductor Rating Parameters		
Parameters Common to All Locations/Conductors		
Parameter	Continuous Rating	Emergency Rating
Wind Direction	Perpendicular to Line	Perpendicular to Line
Emissivity	0.5	0.5
Absorptivity	0.5	0.5
Date	July 1	July 1
Time	12 PM	12 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	110% of Continuous
Wind Speed	2 ft/s	2 ft/s
Ambient Temperature	40°C	40°C

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

- a. The thermal ratings from Table 1, used by SWTC to rate its transmission lines, are considered to be very conservative. 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 shown in Table 1 for development of the existing conductor thermal ratings are based on the Western PSD bulletin. The conductor ratings are based on a 75 degree Celsius operating temperature that is based on a 2 ft. per second wind speed and a 40 degree Celsius air temperature. Emergency ratings are based on a conservative increase of 10% above the values in Table 1. SWTC allows operation at the emergency ratings for no more than a 30 minute time period. 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. The transmission line rating program is based on the classical House and Tuttle method of line rating which uses a heat balance equation to determine the allowable line current for a specified conductor temperature. This is also the basis for IEEE Standard 738.
- d. Rigid Bus and Strain Bus design are determined by the RUS Design Guide for Rural Substations Bulletin 1724E-300 (Bulletin) and National Electric Safety Code 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", which is rated at approximately 1900 A. For new 230 kV substations, SWTC uses an aluminum pipe conductor size of 4", which is rated at approximately 2,500A. 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.

2.3 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
SWTC Transformers	100% Manufacturer's Nameplate Rating @45°C or 55°C rise	100% Manufacturer's Nameplate Rating @55°C or 65°C rise

Transformers in the SWTC system have a continuous rating which is based on the manufacturer's nameplate data. SWTC operates and monitors its transformers according to PRC-023 which mandates the ability to sustain short-term overloads. In an emergency event, the transformer emergency rating may be exceeded, thus allowing for operator intervention within 30 minutes. 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 C57.13-2209, IEEE Std. 57.91-1995 or IEEE Std. C57.119-2001.

2.4 Relay Protective Devices

None of SWTC BES facilities have ratings that are limited by protection or monitoring devices. SWTC's 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.

2.5 Terminal Equipment (switches, breakers, etc)

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

SWTC shall consult the most current and applicable IEEE standards as deemed necessary regarding the rating of its terminal equipment: IEEE Std. C37.010-1999 (R2005), IEEE Std C37.37-1996, IEEE Std. C57.13-2008, IEEE Std. C93.3-1995, or RUS Bulletin 1724E-300.

2.6 Shunt Compensation Devices

The normal and emergency ratings for shunt compensation devices are determined as follows:

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

3.0 **Internal Planning Criteria for Facility Ratings**

The factors used to determine equipment ratings were outlined above. They represent criteria that SWTC has used for a number of years, to meet requirements of the NERC, WECC, and the Federal Energy Regulatory Commission (FERC).

The following is SWTC's internal transmission reliability planning criteria as published in the 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, a power factor of 0.95 lagging 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 110% of the thermal rating of the conductors.
- Transmission system voltages should not fall below 0.90 per unit (p.u.) of nominal rating nor rise above 1.10 p.u. of nominal rating.
- For long range planning system studies, a power factor of 0.95 lagging will be used.

- For operating system studies, an appropriate power factor for the operating planning period will be used.

4.0 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.

SWTC shall communicate its ratings for its solely and jointly owned Facilities that are existing Facilities, new Facilities, modifications to existing Facilities and re-ratings of existing Facilities to WECC, its LLRC, its Planning Authority/Coordinator, and to other Transmission Owners, Operators, or Planners as scheduled by such requesting entities.

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 years, in accordance with NERC Standard FAC-008-1.

The following table of SWTC Transmission Line Rating Limits is found in Appendix A of SWTC's Facility Rating 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	PINAL WEST HASSAYAMPA	500 500	3000 3000	3000 3000	2598 2598	2598 2598	Breaker Out for Maintenance
GREEN-SW GREENLEE	GREENLEE GREEN-SW	345 345	1370 1370	1507 1507	819 819	901 901	Conductor Conductor
BICKNELL VAIL	VAIL BICKNELL	345 345	1370 1370	1507 1507	819 819	901 901	Conductor Conductor
PINAL WEST VAIL	VAIL PINAL WEST	345 345	1548 1548	1858 1858	925 925	1110 1110	Station Terminal Equipment
PINAL WEST WESTWING	WESTWING PINAL WEST	345 345	1548 1548	1858 1858	925 925	1110 1110	Station Terminal Equipment
DOSCONDO HACKBERRY	HACKBERRY DOSCONDO	230 230	1100 1100	1210 1210	438 438	482 482	Conductor Conductor
HACKBERRY MORENCI	MORENCI HACKBERRY	230 230	1100 1100	1210 1210	438 438	482 482	Conductor Conductor
GREEN-SW MORENCI	MORENCI GREEN-SW	230 230	1100 1100	1210 1210	438 438	482 482	Conductor Conductor
MORENCI PD-MORNC	PD-MORNC MORENCI	230 230	920 920	1012 1012	367 367	403 403	Conductor Conductor
APACHE BUTERFLD	BUTERFLD APACHE	230 230	840 840	924 924	335 335	368 368	Conductor Conductor
APACHE RED TAIL	RED TAIL APACHE	230 230	1100 1100	1210 1210	438 438	482 482	Conductor Conductor
APACHE WINCHESTER	WINCHESTER APACHE	230 230	1100 1100	1210 1210	438 438	482 482	Conductor Conductor
BUTERFLD PANTANO	PANTANO BUTERFLD	230 230	840 840	924 924	335 335	368 368	Conductor Conductor
BUTERFLD PANTANO	SAN RAF PANTANO	230 230	920 840	1012 924	367 335	403 368	Conductor Conductor
NEW TUCSN SAHUARITA	SAHUARITA NEW TUCSN	230 230	840 840	924 924	335 335	368 368	Conductor Conductor
SAHUARITA BICKNELL	BICKNELL SAHUARITA	230 230	840 840	924 924	335 335	368 368	Conductor Conductor
RED TAIL DOSCONDO	DOSCONDO RED TAIL	230 230	1100 1100	1210 1210	438 438	482 482	Conductor Conductor
DAVIS	RIVIERA	230	600	660	239	263	WAPA Relays wound CT
APACHE HAYDENAZ	HAYDENAZ APACHE	115 115	600 600	660 660	120 120	132 132	SRP disconnect switch
MARANA MARANATP	MARANATP MARANA	115 115	500 500	550 550	100 100	109 109	Jumpers Jumpers
MARANA AVRA	AVRA MARANA	115 115	360 360	396 396	72 72	79 79	Conductor Conductor
AVRA SANDARIO	SANDARIO AVRA	115 115	360 360	396 396	72 72	79 79	Conductor Conductor
SANDARIO THREEPNT	THREEPNT SANDARIO	115 115	360 360	396 396	72 72	79 79	Conductor Conductor
BICKNELL THREEPNT	THREEPNT BICKNELL	115 115	620 620	682 682	124 124	136 136	Conductor Conductor
THREEPNT PANTANO	VALENCIA KARTCHNR	115 115	620 620	682 682	124 124	136 136	Conductor 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 3.85% 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.



A Touchstone Energy® Cooperative 

TECHNICAL STUDY REPORT

2012 – 2021

Docket No. E-00000D-11-0017

JANUARY 30, 2012

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR PLAN

2012 – 2021

TECHNICAL STUDY REPORT

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

**TRANSMISSION PLANNING
JANUARY 30, 2012**

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SOUTHWEST TRANSMISSION COOPERATIVE, INC.
TEN-YEAR PLAN
2012 – 2021
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.

Power flow analyses used for this report were performed in accordance with the NERC criteria for Planning Standards TPL-001-0 through TPL-004-0, such that the reliability of the SWTC transmission system was analyzed within the near-term planning horizon (2012-2016) and the long-term planning horizon (2016-2021). Each year, SWTC performs an annual assessment of its interconnected transmission system in accordance with the TPL Standards. Some of the stability results of that assessment are included in this report.

The analyses performed for this study provided an excellent snapshot of how the system would perform with the most recent forecasted loads used in this Ten-Year Plan Filing. The analyses showed that under a variety of outage conditions, the system performed well with minimal violations of the NERC criteria. Mitigation Plans, however, are in place to resolve these minor violations, as noted below for each of the study years.

Post-transient Stability Analyses were recently performed on the heavy summer of 2012 and 2016 conditions, as part of the annual TPL Assessment performed, and some of these results can be found in Appendix D of this report, which starts on page 204.

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

SWTC’s current and planned transmission system maps are included in Appendix A, which starts on page 14. A sampling of the 2012-2021 Contingency Lists are included in Appendix B, which starts on page 18. Selective power flow one-line diagrams are included in Appendix C, which starts on page 27. The power flow diagrams show the entire SWTC system under N-0 conditions for the years 2012, 2013, 2016, and 2021 of the Ten-Year Plan. As part of SWTC’s TPL Assessment, all possible N-2 outages of the SWTC transmission system were evaluated. However, only selective High Voltage (HV) and Extra-High Voltage (EHV) N-1 and N-2 outage simulations for the years 2012, 2013, 2016, and 2021 are shown in this report. A few N-n outage simulations for each year are also included; however, these are extreme transmission contingency events and it would be necessary for SWTC to drop load to its member cooperatives in the event any of these extreme contingencies occurred. There were also a few non-solved

cases in each of the years studied, and these too would require the need for SWTC to drop load. N-1 simulations for radial transmission lines have been excluded from this listing.

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 2012-2021 study period, using the latest Arizona seed cases that have been developed from Western Electricity Coordinating Council ("WECC") approved base cases. Specifically, the 2012, 2016 and 2021 cases were used from these Arizona seed cases which are also used by the Southeast Arizona Transmission Study ("SATS") and the Southwest Area Transmission ("SWAT") Planning Groups. The cases used for this report are listed below:

- 2012HS Case (Created from coordinated Arizona 2014HS seed case that was originally developed from WECC 2014HS3-SA approved base case) – Load Flow and stability
- 2013HS Case (Created from coordinated Arizona 2014HS seed case that was originally developed from WECC 2014HS3-SA approved base case) – Load Flow
- 2016HS Case (Created from coordinated Arizona 2014HS seed case that was originally developed from WECC 2014HS3-SA approved base case) – Load Flow and stability
- 2021HS Case (Created from coordinated Arizona 2021HS SWAT seed case that was originally developed from WECC 2021HS1A approved base case) – Load Flow

These base cases were updated with the latest (2011) load projections of SWTC, using the medium economic forecast. Base case and single contingency conditions were evaluated using PSLF to determine system impacts and timing of transmission facilities needed to mitigate those system impacts.

Numerous outage simulations were performed for the years 2012, 2013, 2016 and 2021. The analyses looked at the impact of the most recent projected member system load growth to the interconnected transmission system. The analyses determined where facilities would be placed to most economically serve this projected member system load.

FULFILLMENT OF BTA REQUIREMENT

The Commission's Sixth Biennial Transmission Assessment for 2010-2019 ("BTA") in Decision No. 72031, dated December 10, 2010, ordered that:

"APS, SWTC, and TEP shall conduct additional analyses of potential 230 kV and 138 kV voltage deviations in Southeastern Arizona as noted in the 2009 SATS report and file an update based on the 2010 SATS [Report] by February 28, 2011, and shall finalize mitigation plans if needed for this voltage concern in ten-year plan filing(s) for the 7th BTA by January 31, 2012."

The analyses that were performed for this report address this order. The 2010 SATS Report reported on analyses done for 2011, 2012, 2015 and 2020 heavy summer conditions. It noted

that for 2011 and 2012 heavy summer conditions that delta-voltage violations were seen at a few SWTC buses for loss of the Apache to Butterfield 230 kV but stated these “are also resolved through the proposed addition of voltage switched capacitor banks on the system in 2013.” As seen below and as noted in the Ten Year Plan Report, capacitor banks are planned for installation at the Butterfield Substation in 2013 to mitigate these deviations.

The SATS Report also states that “voltage violations are seen on the 115 kV system from Marana Tap to Sandario, due to the loss of the Western Saguaro East to Marana Tap 115 kV line or the SWTC Marana Tap to Marana 115 kV line. SWTC has been in discussion with Western on its study efforts and may initiate additional discussions towards a cost effective solution.” SWTC has initiated additional discussions with Western and a joint study effort is being conducted to determine the feasibility, as noted in this Ten Year Plan Report, of looping the Saguaro to Tucson 115 kV line into Marana. If SWTC and Western proceed with this project, it will significantly reduce the voltage violations noted in the SATS Report on the SWTC 115 kV system.

For the 2015 heavy summer conditions, the Report notes that the “SWTC analysis did not identify voltage or delta-voltage violations within the SWTC system.”

For the 2020 heavy summer conditions, the Report notes that the “SWTC analysis did not identify any voltage violations. With the placement of the voltage switched capacitor banks at Redtail and San Rafael, in 2020, a delta-voltage violation that occurs at the San Rafael bus for loss of the Apache to Butterfield 230 kV line and a delta-voltage violation that occurs at the Redtail bus for the loss of the Apache to Redtail 230 kV line are resolved.” Analyses performed for this year’s Ten Year Plan have determined that capacitor banks are needed at Redtail in 2016 and at San Rafael in 2018 to resolve voltage issues.

This study shows that the addition of capacitor banks to the SWTC system, the 115 kV line upgrades, and the proposed loop-in of the Saguaro to Tucson line into Marana, are measures that mitigate the voltage deviations that were noted in the 2010 SATS Report and therefore meet the requirements of a mitigation plan to fulfill the 6th BTA Order. As load forecasts may change from year to year, SWTC will ensure that any future mitigation measures needed on its system to alleviate delta-voltage violations, will be provided for in the next ten year plan filing.

As noted in this year’s ten year plan filing, SWTC will be adding the following capacitor bank additions to its system:

<u>Year</u>	<u>Substation</u>	<u>MVAR Quantity</u>
2012	Avra Valley	9.45 (Moved from Bicknell Substation)
2013	Butterfield	28.8
2016	Redtail	16.0
2018	San Rafael	19.2
2019	Avra Valley	9.45

Additional studies conducted during 2012, due to a potential change in the 2012 load forecast or other circumstances that may tend to refine these values and/or suggest the need for to adjust locations for reactive support to the SWTC system, will be reported in the next ten year plan filing.

NEAR TERM ASSESSMENT (2012-2016)

2012 Category A (N-0) Analysis:

Under all lines in service (ALIS) conditions there are no voltage violations or thermal overloads.

2012 Category B (N-1) Analysis:

The N-1 analysis for 2012 yields some low voltages on the SWTC 115 kV system in its Western Area for loss of the Western Saguaro to Tucson 115 kV lines or for loss of the Marana Tap to Marana 115 kV line. These are seen at the Marana, Marana Tap, Sandario, and Valencia 115 kV buses.

The N-1 analysis also yields some voltage deviations on the SWTC 115 kV and 230 kV systems. For the 115 kV system, upon loss of the Western Saguaro to Tucson 115 kV lines or for loss of the Marana Tap to Marana 115 kV line these are seen at the Avra Valley, Marana, Marana Tap, Sandario, Three Points, and Valencia 115 kV buses. For the 230 kV system, upon the loss of the Apache to Butterfield 230 kV line, these are seen at the Butterfield, Kartchner, Pantano and San Rafael 230 kV buses. Upon a loss of the Apache to Redtail 230 kV line, a deviation is seen at the Redtail 230 kV bus.

Voltage Mitigation Plans: The upgrade of the Marana to Avra Valley and Avra Valley to Sandario Tap 115 kV lines in 2012, as well as the placement of a 9.45 MVAR capacitor bank at Avra Valley, projects included in the Ten Year Plan Report of this filing, resolve the low voltage issues noted above under N-1 outage conditions on the SWTC 115 kV system, but there are still voltage deviations at the Avra, Marana, and Marana Tap buses. With the exception of Marana Tap, the Avra and Marana buses have load-tap changing transformers that bring the voltages to acceptable levels for customers served off of those buses. The project described in the Ten Year Plan Report of this filing to loop the Western Area Power Administration (Western) Saguaro to Tucson 115 kV line into Marana in 2013, also resolves these voltage deviations.

The delta-voltage violations seen on the 230 kV system will be resolved by placement of capacitor banks at Butterfield in 2013. Load buses at Kartchner and San Rafael have load-tap changing transformers that bring the voltages to acceptable levels for customers served off of those buses. The delta-voltage violation seen at Redtail due to a loss of the Apache to Redtail 230 kV line is resolved by utilizing the existing capacitor banks on the system.

The SWTC Greenlee 345/230 kV transformer slightly overloads (1.01%) for loss of either the Greenlee to Copper Verde 345 kV line or the Copper Verde to Frisco 230 kV line. Prior to the mitigation plans described below, and as noted in previous Technical Study Reports, through

operator instructions that have been in place for many years on the SWTC transmission system, a large mine will be alerted to reduce load to protect this transformer, if it begins to overload.

Device Overload Mitigation Plans: As noted in the Ten Year Plan Report of this filing, a second 345/230 kV transformer is scheduled to be installed at Greenlee Substation in 2015, which resolves the overload of the existing Greenlee 345/230 kV transformer for the foreseeable future. Until 2015, operator intervention is in place to ensure that this transformer does not overload under the outage conditions described.

2012 Category C (N-2) Analysis:

The N-2 analysis for 2012 yields some low voltages on the SWTC system for loss of the Apache-Butterfield 230 kV & Marana-Avra 230 kV lines and for loss of the Marana-Avra 115 kV & Bicknell-Vail 345 kV lines. These are seen at the Avra Valley, San Rafael, Sandario, Three Points and Valencia 115 kV buses.

The N-2 analysis also yields some voltage deviations on the SWTC system for loss of the Apache-Butterfield 230 kV & Marana-Avra 230 kV lines and for loss of the Marana-Avra 115 kV & Bicknell-Vail 345 kV lines. These are seen at the Avra Valley, Butterfield, Kartchner, San Rafael, Sandario, Three Points and Valencia buses.

Voltage Mitigation Plans: To resolve the voltage and delta-voltage violations at the buses noted above for the various N-2 outage conditions, the placement of a 9.45 MVAR capacitor bank at Avra, as well as use of existing capacitor banks on the system resolves these issues.

The Bicknell 345/230 kV transformer overloads to 1.037% for loss of the Apache-Butterfield 230 kV & Marana-Avra 115 kV lines. Prior to the mitigation plans described below, it will be necessary for SWTC to drop load on its system to protect this transformer under these outage conditions.

Device Overload Mitigation Plans: As noted in the Ten Year Plan Report of this filing, a new and larger 345/230 kV transformer is proposed to be installed at Bicknell Substation in 2015, which resolves the overload of the existing Bicknell transformer for the N-2 outage noted above for the foreseeable future. Until 2015, operator intervention is in place to drop load to ensure that this transformer does not overload under the outage conditions described above.

2012 Category D (N-n) Analysis:

The N-n analysis showed voltage violations for loss of the Apache-Butterfield/Redtail 230 kV & Marana-Avra 115 kV lines. These are seen at the San Rafael, Sandario and Valencia buses. The same outage yields voltage deviations at the Avra Valley, Butterfield, Kartchner, Pantano, San Rafael, Sandario, Three Points and Valencia buses.

Voltage Mitigation Plans: The placement of a 9.45 MVAR capacitor bank at Avra, as well as use of existing capacitor banks on the system resolves the voltage issues and delta-voltage issues

seen for loss of the Apache-Butterfield, Apache-Redtail 230 kV & Marana-Avra 115 kV lines. This outage also causes an overload of the Bicknell 345/230 kV Transformer to 1.042% of its emergency rating. Prior to the mitigation plans described below, it will be necessary for SWTC to drop load on its system to protect this transformer under these outage conditions.

Device Overload Mitigation Plans: Again, as noted in this Ten Year Plan filing, a new and larger 345/230 kV transformer is scheduled to be proposed at Bicknell Substation in 2015, which resolves the overload of the existing Bicknell transformer for loss of the Apache-Butterfield/Redtail 230 kV & Marana-Avra 115 kV lines for the foreseeable future. Until 2015, operator intervention is in place to drop load to ensure that this transformer does not overload as noted above.

2013 Category A (N-0) Analysis:

2013 heavy summer conditions were studied with the Western Saguaro to Tucson 115 kV line looped into Marana. A more detailed study is being undertaken by Western and SWTC to develop this proposed project and ensure that it provides benefits to both parties. With the Saguaro to Tucson 115 kV line looped into Marana, under all lines in service (ALIS) conditions there are no voltage violations or thermal overloads.

2013 Category B (N-1) Analysis:

The N-1 analysis for 2013 yields no voltage violations or voltage deviations.

The SWTC Greenlee 345/230 kV transformer overloads (1.207%) for loss of either the Greenlee to Copper Verde 345 kV line or the Copper Verde 230 kV line. Prior to the mitigation plans described below, and as noted in previous Technical Study Reports, through operator instructions that have been in place for many years on the SWTC transmission system, a large mine will be alerted to reduce load to protect this transformer, if it begins to overload.

Device Overload Mitigation Plans: As noted in the 2012 analysis above, a second 345/230 kV transformer is scheduled to be installed at Greenlee Substation in 2015, which resolves the overload of the existing Greenlee 345/230 kV transformer for the foreseeable future. Until 2015, operator intervention is in place to ensure that this transformer does not overload under the outage conditions described.

2013 Category C (N-2) Analysis:

The N-2 analysis for 2013 yields no voltage violations or voltage deviations.

The Bicknell 345/230 kV transformer overloads to 1.079% for loss of the Apache-Butterfield 230 kV & Marana-Avra 115 kV lines. Prior to the mitigation plans described below, it will be necessary for SWTC to drop load on its system to protect this transformer under these outage conditions.

Device Overload Mitigation Plans: As noted in the 2012 analysis above, a new and larger 345/230 kV transformer is scheduled to be installed at Bicknell Substation in 2015, which resolves the overload of the existing Bicknell transformer for the N-2 outage noted above for the foreseeable future. Until 2015, operator intervention is in place to drop load to ensure that this transformer does not overload under the outage conditions described above.

2013 Category D (N-n) Analysis:

The N-n analysis for 2013 yields no voltage violations or voltage deviations.

The Bicknell 345/230 kV transformer overloads to 1.079% for loss of the Apache-Butterfield, Apache-Redtail 230 kV & Marana-Avra 115 kV lines. Prior to the mitigation plans described below, it will be necessary for SWTC to drop load on its system to protect this transformer under these outage conditions.

Device Overload Mitigation Plans: Again, as noted in the 2012 analysis, a new and larger 345/230 kV transformer is scheduled to be installed at Bicknell Substation in 2015, which resolves the overload of the existing Bicknell transformer for loss of the Apache-Butterfield, Apache-Redtail 230 kV & Marana-Avra 115 kV lines for the foreseeable future. Until 2015, operator intervention is in place to drop load to ensure that this transformer does not overload as noted above.

LONG TERM ASSESSMENT (2016-2021)

2016 Category A (N-0) Analysis:

Under all lines in service (ALIS) conditions there are no voltage violations, delta-voltage violations, or thermal overloads.

2016 Category B (N-1) Analysis:

With the addition of the Redtail capacitor bank in 2016, the N-1 analysis for 2016 yields no voltage violations, delta-voltage violations, or thermal overloads.

2016 Category C (N-2) Analysis:

The N-2 analysis for 2016 yields no voltage violations, delta-voltage violations, or thermal overloads.

2016 Category D (N-n) Analysis:

The N-n analysis for 2016 yields no voltage violations, delta-voltage violations, or thermal overloads.

2021 Category A (N-0) Analysis:

Under all lines in service (ALIS) conditions there are no voltage violations, delta-voltage violations, or thermal overloads.

2021 Category B (N-1) Analysis:

With the addition of the New Tucson capacitor banks in 2017, the San Rafael capacitor bank in 2018, and a second Avra capacitor bank in 2019, the N-1 analysis for 2021 yields no voltage-violations, delta-voltage violations or thermal overloads.

2021 Category C (N-2) Analysis:

The N-2 analysis for 2021 yields no voltage violations, delta-voltage violations, or thermal overloads.

2021 Category D (N-n) Analysis:

The N-n analysis for 2021 yields no voltage violations, delta-voltage violations, or thermal overloads.

STABILITY ANALYSIS

SWTC transient stability analyses for its interconnected transmission system were performed for 2012 heavy summer conditions, and 2016 heavy summer and light winter conditions. The stability base cases created for use in this report are as follows:

- 2012HS Case (Created from coordinated Arizona 2014HS seed case that was originally developed from WECC 2014HS3-SA approved base case) – Load Flow and Stability
- 2016HS Case (Created from coordinated Arizona 2014HS seed case that was originally developed from WECC 2014HS3-SA approved base case) – Load Flow and Stability

The outages selected for analysis in both 2012 and 2016 include only select N-1 and N-2 outage conditions.

For years beyond 2012, SWTC did not study the system with the proposed loop-in of the Saguaro to Tucson 115 kV line into Marana. SWTC is working with Western on studies to determine the viability of this loop-in and will report the results of that study in the next Ten Year Plan filing.

SWTC included the most severe N-2 outage conditions in this report. The outages considered are as follows:

N-1 Outage conditions:

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

N-2 Outage Conditions:

- Apache to Butterfield 230 kV & Marana Tap to Marana 115 kV (2012)
- Apache to Butterfield 230 kV & Bicknell to Vail 345 kV (2012 and 2016)

Previous stability studies for SWTC have noted a problem with the damping of the Apache CT1 unit. These studies noted that General Electric, the maker of the turbine, and SWTC considered this result to be a modeling issue.

In 2010, AEPSCO replaced the existing Woodward control system on the Apache CT1 (and CT3), because replacement parts are not readily available. The Woodward control system was replaced by an Allen Bradley control system. In late 2011, generator performance tests were completed on the Apache units as required by WECC. The generator test data was recently analyzed and the results do not show any stability problems.

As no new generation is planned for the foreseeable future on the SWTC system, these results are considered adequate for the ten-year planning horizon of this Report. Future ten year plan filings will include stability analyses for generation that may be planned for location on the SWTC transmission system, as they become known.

Additional generation that is planned for the area, such as the proposed Bowie Project or variable generation that may become associated with the SunZia Southwest and Southline Transmission Projects, will be studied in detail by the entities that have expressed interest in those projects and will be reported on in future ten year plan filings.

Selective stability plots can be found in Appendix D.

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR PLAN

2011 – 2020

TECHNICAL STUDY REPORT

APPENDICES

APPENDIX A
CURRENT AND PLANNED TRANSMISSION SYSTEM MAPS

SWTC CURRENT & PLANNED SYSTEM SOUTHERN AREA 2011-2020

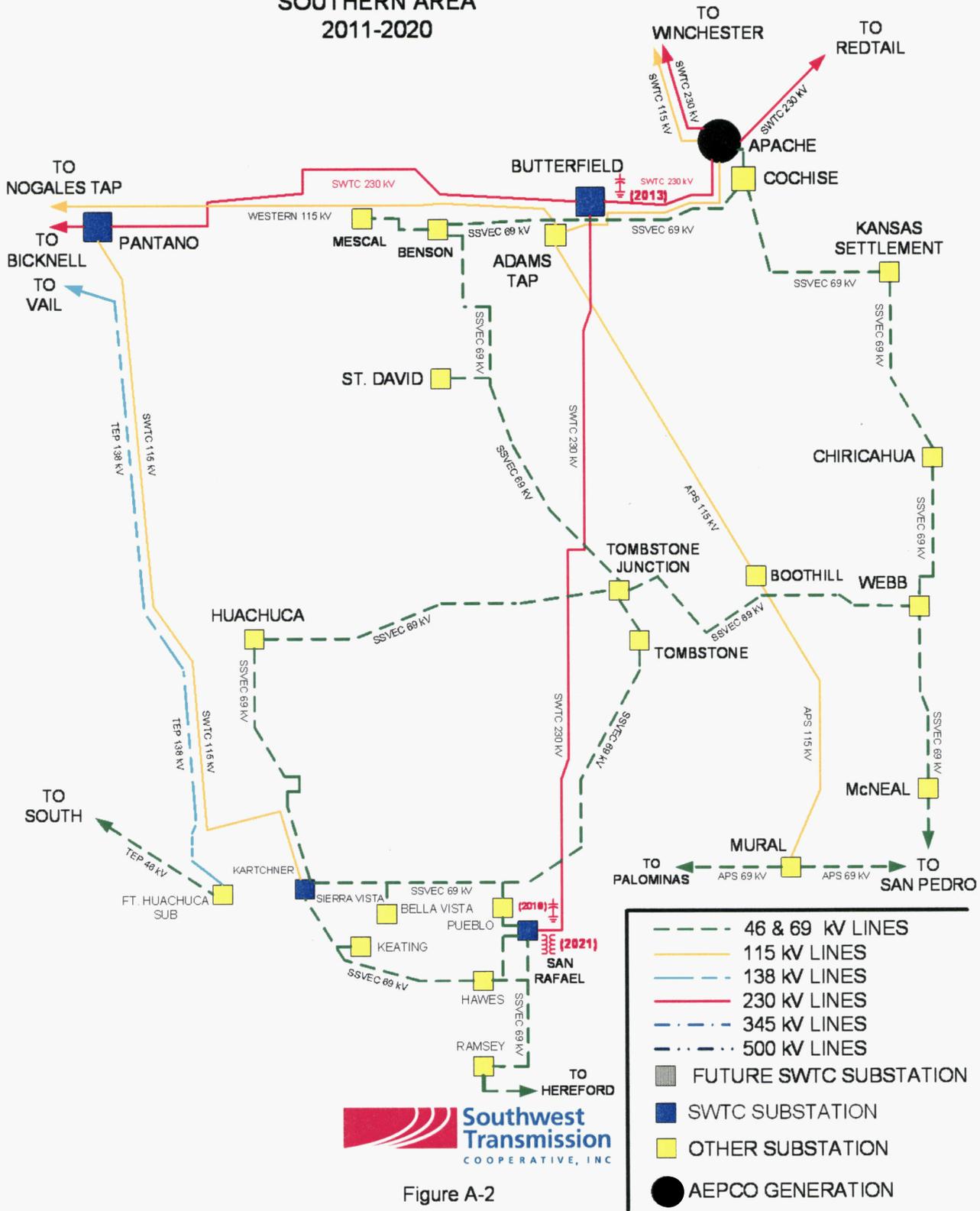


Figure A-2

APPENDIX B
2012-2021 POWER FLOW CONTINGENCY LISTS

2012 CONTINGENCY LIST

line_1 "Line BICKNELL 345.0 to VAIL 345.0 Circuit 1"
line_2 "Line GREEN-SW 345.0 to GREENLEE 345.0 Circuit 1"
line_3 "Line APACHE 230.0 to BUTERFLD 230.0 Circuit 1"
line_4 "Line APACHE 230.0 to RED TAIL 230.0 Circuit 1"
line_5 "Line APACHE 230.0 to WINCHSTR 230.0 Circuit 1"
line_6 "Line BUTERFLD 230.0 to PANTANO 230.0 Circuit 1"
line_7 "Line BUTERFLD 230.0 to SAN RAF 230.0 Circuit 1"
line_8 "Line DAVIS 230.0 TO RIVIERA 230.0 Circuit 1"
line_9 "Line DOSCONDO 230.0 to HACKBERY 230.0 Circuit 1"
line_10 "Line HACKBERY 230.0 to MORENCI 230.0 Circuit 1"
line_11 "Line MORENCI 230.0 to GREEN-SW 230.0 Circuit 1"
line_12 "Line MORENCI 230.0 to PD-MORNC 230.0 Circuit 1"
line_13 "Line NEWTUCSN 230.0 to SAHUARIT 230.0 Circuit 1"
line_14 "Line PANTANO 230.0 to NEWTUCSN 230.0 Circuit 1"
line_15 "Line RED TAIL 230.0 to DOSCONDO 230.0 Circuit 1"
line_16 "Line SAHUARIT 230.0 to BICKNELL 230.0 Circuit 1"
line_17 "Line APACHE 115.0 to HAYDENAZ 115.0 Circuit 1"
line_18 "Line AVRA 115.0 to SNDARIO 115.0 Circuit 1"
line_19 "Line BICKNELL 115.0 to THREEPNT 115.0 Circuit 1"
line_20 "Line MARANA 115.0 to AVRA 115.0 Circuit 1"
line_21 "Line MARANATP 115.0 to MARANA 115.0 Circuit 1"
line_22 "Line PANTANO 115.0 to KARTCHNR 115.0 Circuit 1"
line_23 "Line THREEPNT 115.0 to SNDARIO 115.0 Circuit 1"
line_24 "Line THREEPNT 115.0 to VALEN-SW 115.0 Circuit 1"
tran_25 "Tran BICKNELL 345.00 to BICKNELL 230.00 Circuit 1"
tran_26 "Tran GREEN-SW 345.00 to GREEN-SW 230.00 Circuit 1"
tran_27 "Tran WINCHSTR 345.00 to WINCHSTR 230.00 Circuit 1"
tran_28 "Tran APACHE 230.00 to APACHE 115.00 Circuit 1"
tran_29 "Tran APACHE 230.00 to APACHE 115.00 Circuit 2"
tran_30 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 1"
tran_31 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 2"
tran_32 "Tran PANTANO 230.00 to PANTANO 115.00 Circuit 1"
line_33 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 1"
line_34 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 2"
line_35 "Line GREENLEE 345.0 to COPPERVR 345.0 Circuit 1"
line_36 "Line GREENLEE 345.0 to WINCHSTR 345.0 Circuit 1"
line_37 "Line HIDALGO 345.0 to GREENLEE 345.0 Circuit 1"
line_38 "Line PINALWES 345.0 to SOUTH 345.0 Circuit 1"
line_39 "Line SPRINGR 345.0 to GREENLEE 345.0 Circuit 1"
line_40 "Line SPRINGR 345.0 to VAIL2 345.0 Circuit 1"
line_41 "Line VAIL 345.0 to SOUTH 345.0 Circuit 1"
line_42 "Line WESTWING 345 to PINALWES 345.0 Circuit 1"
line_43 "Line WINCHSTR 345.0 to VAIL 345.0 Circuit 1"

line_44 "Line COPPERVR 230.0 to FRISCO 230.0 Circuit 1"
line_45 "Line PD-MORNC 230.0 to FRISCO 230.0 Circuit 1"
tran_46 "Tran PINAL_W 500.00 to PINALWES 345.00 Circuit 1"
tran_47 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 1"
tran_48 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 2"
line_49 "Line ADAMSTAP 115.0 to APACHE 115.0 Circuit 1"
line_50 "Line DEL BAC 115.0 to NOGALES 115.0 Circuit 1"
line_51 "Line MARANATP 115.0 to RATTLSNK 115.0 Circuit 1"
line_52 "Line RATTLSNK 115.0 to TUCSON 115.0 Circuit 1"
line_53 "Line RATTLSNK 115.0 to TWINPEAK 115.0 Circuit 1"
line_54 "Line SAG.EAST 115.0 to MARANATP 115.0 Circuit 1"
line_55 "Line SAG.EAST 115.0 to ORACLE 115.0 Circuit 1"
line_56 "Line TUCSON 115.0 to DEL BAC 115.0 Circuit 1"
line_57 "Line TUCSON 115.0 to ORACLE 115.0 Circuit 1"
line_58 "Line BOOTHILL 115.0 to ADAMS 115.0 Circuit 1"
line_59 "Line ORACLE 115.0 to S.BRKRCH 115.0 Circuit 1"
line_60 "Line S.BRKRCH 115.0 to SNMANUEL 115.0 Circuit 1"
line_61 "Line SAG.EAST 115.0 to SAG.WEST 115.0 Circuit 1"
line_62 "Line SAG.WEST 115.0 to SNMANUEL 115.0 Circuit 1"
tran_63 "Tran SAGUARO 500.00 to SAG.EAST 115.00 Circuit 1"
tran_64 "Tran SAGUARO 230.00 to SAG.EAST 115.00 Circuit 1"
line_65 "Line HASSYAMP 500.0 to PINAL_W 500.0 Circuit 1"
line_66 "N-2:Line APA-BUTT 230.0 & APA-RED TAIL 230.0"
line_67 "N-2:Line APA-BUTT 230.0 & APA-WIN 230.0"
line_68 "N-2:Line APA-BUTT 230.0 & BICK-VAIL 345.0"
line_69 "N-2:Line APA-BUTT 230.0 & GREEN-SW 345/230 XFMR"
line_70 "N-2:Line APA-BUTT 230.0 & MARANA-AVRA 115.0"
line_71 "N-2:Line APA-BUTT 230.0 & MARANATP-MARANA 115.0"
line_72 "N-2:Line APACHE-WIN 230.0 & APA-REDTAIL 230.0"
line_73 "N-2:Line APACHE-WIN 230.0 & MARANA-AVRA 115.0"
line_74 "N-2:Line MARANA-AVRA 115.0 & BICK-VAIL 345.0"
line_75 "N-n:COMMON CORRIDOR LINES OUT OF APACHE"
line_76 "N-n:COMMON CORRIDOR: APA-BUTT & ADAMSTP-APACHE 115.0"
line_77 "N-n:APA-BUTTERFLD/REDTAIL & APA-WINCHESTER 230.0"
line_78 "N-n:APA-BUTTERFLD/REDTAIL & MARANA-AVRA 115.0"
line_79 "N-n:APA-BUTTERFLD/REDTAIL & BICK-VAIL 345.0"
line_80 "N-n:APA-BUTT 230.0 & MARANA-AVRA 115.0 & BICKL-VAIL 345.0"
line_81 "N-n:COMMON CORRIDOR: BICK-3PTS & PINALWES-SOUTH 345.0"
line_82 "N-n:COMMON CORRIDOR: BUTT-PANTANO & ADAMSTP-APACHE"
line_83 "N-n:COMMON CORRIDOR: GRNL-COPPERVR & MOR-GREEN-SW"
line_84 "N-n:COMMON CORRIDOR: GRNL-COPPERVR & MOR-PD-MORNC"
line_85 "N-n:COMMON CORRIDOR: NEWTUCSN-SAHUAR & VAIL-SOUTH"
line_86 "N-n:COMMON CORRIDOR: 3PTS-SNDARIO & PINALWES-SOUTH"

2013 CONTINGENCY LIST

line_1 "Line BICKNELL 345.0 to VAIL 345.0 Circuit 1"
line_2 "Line GREEN-SW 345.0 to GREENLEE 345.0 Circuit 1"
line_3 "Line APACHE 230.0 to BUTERFLD 230.0 Circuit 1"
line_4 "Line APACHE 230.0 to RED TAIL 230.0 Circuit 1"
line_5 "Line APACHE 230.0 to WINCHSTR 230.0 Circuit 1"
line_6 "Line BUTERFLD 230.0 to PANTANO 230.0 Circuit 1"
line_7 "Line BUTERFLD 230.0 to SAN RAF 230.0 Circuit 1"
line_8 "Line DAVIS 230.0 TO RIVIERA 230.0 Circuit 1"
line_9 "Line DOSCONDO 230.0 to HACKBERY 230.0 Circuit 1"
line_10 "Line HACKBERY 230.0 to MORENCI 230.0 Circuit 1"
line_11 "Line MORENCI 230.0 to GREEN-SW 230.0 Circuit 1"
line_12 "Line MORENCI 230.0 to PD-MORNC 230.0 Circuit 1"
line_13 "Line NEWTUCSN 230.0 to SAHUARIT 230.0 Circuit 1"
line_14 "Line PANTANO 230.0 to NEWTUCSN 230.0 Circuit 1"
line_15 "Line RED TAIL 230.0 to DOSCONDO 230.0 Circuit 1"
line_16 "Line SAHUARIT 230.0 to BICKNELL 230.0 Circuit 1"
line_17 "Line APACHE 115.0 to HAYDENAZ 115.0 Circuit 1"
line_18 "Line AVRA 115.0 to SNDARIO 115.0 Circuit 1"
line_19 "Line BICKNELL 115.0 to THREEPNT 115.0 Circuit 1"
line_20 "Line MARANA 115.0 to AVRA 115.0 Circuit 1"
line_22 "Line PANTANO 115.0 to KARTCHNR 115.0 Circuit 1"
line_23 "Line THREEPNT 115.0 to SNDARIO 115.0 Circuit 1"
line_24 "Line THREEPNT 115.0 to VALEN-SW 115.0 Circuit 1"
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tran_26 "Tran GREEN-SW 345.00 to GREEN-SW 230.00 Circuit 1"
tran_27 "Tran WINCHSTR 345.00 to WINCHSTR 230.00 Circuit 1"
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tran_29 "Tran APACHE 230.00 to APACHE 115.00 Circuit 2"
tran_30 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 1"
tran_31 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 2"
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line_39 "Line SPRINGR 345.0 to GREENLEE 345.0 Circuit 1"
line_40 "Line SPRINGR 345.0 to VAIL2 345.0 Circuit 1"
line_41 "Line VAIL 345.0 to SOUTH 345.0 Circuit 1"
line_42 "Line WESTWING 345 to PINALWES 345.0 Circuit 1"
line_43 "Line WINCHSTR 345.0 to VAIL 345.0 Circuit 1"
line_44 "Line COPPERVR 230.0 to FRISCO 230.0 Circuit 1"

line_45 "Line PD-MORNC 230.0 to FRISCO 230.0 Circuit 1"
 tran_46 "Tran PINAL_W 500.00 to PINALWES 345.00 Circuit 1"
 tran_47 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 1"
 tran_48 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 2"
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 line_61 "Line SAG.EAST 115.0 to SAG.WEST 115.0 Circuit 1"
 line_62 "Line SAG.WEST 115.0 to SNMANUEL 115.0 Circuit 1"
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 tran_64 "Tran SAGUARO 230.00 to SAG.EAST 115.00 Circuit 1"
 line_65 "Line HASSYAMP 500.0 to PINAL_W 500.0 Circuit 1"
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 line_67 "N-2:Line APA-BUTT 230.0 & APA-WIN 230.0"
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 line_74 "N-2:Line MARANA-AVRA 115.0 & BICK-VAIL 345.0"
 line_75 "N-n:COMMON CORRIDOR LINES OUT OF APACHE"
 line_76 "N-n:COMMON CORRIDOR: APA-BUTT & ADAMSTP-APACHE 115.0"
 line_77 "N-n:APA-BUTTERFLD/REDTAIL & APA-WINCHESTER 230.0"
 line_78 "N-n:APA-BUTTERFLD/REDTAIL & MARANA-AVRA 115.0"
 line_79 "N-n:APA-BUTTERFLD/REDTAIL & BICK-VAIL 345.0"
 line_80 "N-n:APA-BUTT 230.0 & MARANA-AVRA 115.0 & BICKL-VAIL 345.0"
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 line_82 "N-n:COMMON CORRIDOR: BUTT-PANTANO & ADAMSTP-APACHE"
 line_83 "N-n:COMMON CORRIDOR: GRNL-COPPERVR & MOR-GREEN-SW"
 line_84 "N-n:COMMON CORRIDOR: GRNL-COPPERVR & MOR-PD-MORNC"
 line_85 "N-n:COMMON CORRIDOR: NEWTUCSN-SAHUAR & VAIL-SOUTH"
 line_86 "N-n:COMMON CORRIDOR: 3PTS-SNDARIO & PINALWES-SOUTH"

2016 CONTINGENCY LIST

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line_4 "Line APACHE 230.0 to RED TAIL 230.0 Circuit 1"
line_5 "Line APACHE 230.0 to WINCHSTR 230.0 Circuit 1"
line_6 "Line BUTERFLD 230.0 to PANTANO 230.0 Circuit 1"
line_7 "Line BUTERFLD 230.0 to SAN RAF 230.0 Circuit 1"
line_8 "Line DAVIS 230.0 TO RIVIERA 230.0 Circuit 1"
line_9 "Line DOSCONDO 230.0 to HACKBERY 230.0 Circuit 1"
line_10 "Line HACKBERY 230.0 to MORENCI 230.0 Circuit 1"
line_11 "Line MORENCI 230.0 to GREEN-SW 230.0 Circuit 1"
line_12 "Line MORENCI 230.0 to PD-MORNC 230.0 Circuit 1"
line_13 "Line NEWTUCSN 230.0 to SAHUARIT 230.0 Circuit 1"
line_14 "Line PANTANO 230.0 to NEWTUCSN 230.0 Circuit 1"
line_15 "Line RED TAIL 230.0 to DOSCONDO 230.0 Circuit 1"
line_16 "Line SAHUARIT 230.0 to BICKNELL 230.0 Circuit 1"
line_17 "Line APACHE 115.0 to HAYDENAZ 115.0 Circuit 1"
line_18 "Line AVRA 115.0 to SNDARIO 115.0 Circuit 1"
line_19 "Line BICKNELL 115.0 to THREEPNT 115.0 Circuit 1"
line_20 "Line MARANA 115.0 to AVRA 115.0 Circuit 1"
line_22 "Line PANTANO 115.0 to KARTCHNR 115.0 Circuit 1"
line_23 "Line THREEPNT 115.0 to SNDARIO 115.0 Circuit 1"
line_24 "Line THREEPNT 115.0 to VALEN-SW 115.0 Circuit 1"
tran_25 "Tran BICKNELL 345.00 to BICKNELL 230.00 Circuit 1"
tran_26 "Tran GREEN-SW 345.00 to GREEN-SW 230.00 Circuit 1"
tran_27 "Tran WINCHSTR 345.00 to WINCHSTR 230.00 Circuit 1"
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tran_31 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 2"
tran_32 "Tran PANTANO 230.00 to PANTANO 115.00 Circuit 1"
line_33 "Line PINAL_C 500.0 to TORTOLIT 500.0 Circuit 1"
line_34 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 1"
line_35 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 2"
line_36 "Line GREENLEE 345.0 to COPPERVR 345.0 Circuit 1"
line_37 "Line GREENLEE 345.0 to WINCHSTR 345.0 Circuit 1"
line_38 "Line HIDALGO 345.0 to GREENLEE 345.0 Circuit 1"
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line_42 "Line VAIL 345.0 to SOUTH 345.0 Circuit 1"
line_43 "Line WESTWING 345 to PINALWES 345.0 Circuit 1"
line_44 "Line WINCHSTR 345.0 to VAIL 345.0 Circuit 1"

line_45 "Line COPPERVR 230.0 to FRISCO 230.0 Circuit 1"
line_46 "Line PD-MORNC 230.0 to FRISCO 230.0 Circuit 1"
tran_47 "Tran PINAL_W 500.00 to PINALWES 345.00 Circuit 1"
tran_48 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 1"
tran_49 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 2"
line_50 "Line ADAMSTAP 115.0 to APACHE 115.0 Circuit 1"
line_51 "Line DEL BAC 115.0 to NOGALES 115.0 Circuit 1"
line_52 "Line MARANA 115.0 to RATTLSNK 115.0 Circuit 1"
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line_55 "Line SAG.EAST 115.0 to MARANA 115.0 Circuit 1"
line_56 "Line SAG.EAST 115.0 to ORACLE 115.0 Circuit 1"
line_57 "Line TUCSON 115.0 to DEL BAC 115.0 Circuit 1"
line_58 "Line TUCSON 115.0 to ORACLE 115.0 Circuit 1"
line_59 "Line BOOTHILL 115.0 to ADAMS 115.0 Circuit 1"
line_60 "Line ORACLE 115.0 to S.BRKRCH 115.0 Circuit 1"
line_61 "Line S.BRKRCH 115.0 to SNMANUEL 115.0 Circuit 1"
line_62 "Line SAG.EAST 115.0 to SAG.WEST 115.0 Circuit 1"
line_63 "Line SAG.WEST 115.0 to SNMANUEL 115.0 Circuit 1"
tran_64 "Tran SAGUARO 500.00 to SAG.EAST 115.00 Circuit 1"
tran_65 "Tran SAGUARO 230.00 to SAG.EAST 115.00 Circuit 1"
line_66 "Line HASSYAMP 500.0 to PINAL_W 500.0 Circuit 1"
line_67 "Line PINAL_W 500.0 to DUKE 500.0 Circuit 1"
line_68 "Line DUKE 500.0 to PINAL_C 500.0 Circuit 1"
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line_72 "N-2:Line APA-BUTT 230.0 & GREEN-SW 345/230 XFMR"
line_73 "N-2:Line APA-BUTT 230.0 & MARANA-AVRA 115.0"
line_75 "N-2:Line APACHE-WIN 230.0 & APA-REDTAIL 230.0"
line_76 "N-2:Line APACHE-WIN 230.0 & MARANA-AVRA 115.0"
line_77 "N-2:Line MARANA-AVRA 115.0 & BICK-VAIL 345.0"
line_78 "N-n:COMMON CORRIDOR LINES OUT OF APACHE"
line_79 "N-n:COMMON CORRIDOR: APA-BUTT & ADAMSTP-APACHE 115.0"
line_80 "N-n:APA-BUTTERFLD/REDTAIL & APA-WINCHESTER 230.0"
line_81 "N-n:APA-BUTTERFLD/REDTAIL & MARANA-AVRA 115.0"
line_82 "N-n:APA-BUTTERFLD/REDTAIL & BICK-VAIL 345.0"
line_83 "N-n:APA-BUTT 230.0 & MARANA-AVRA 115.0 & BICKL-VAIL 345.0"
line_84 "N-n:COMMON CORRIDOR: BICK-3PTS & PINALWES-SOUTH 345.0"
line_85 "N-n:COMMON CORRIDOR: BUTT-PANTANO & ADAMSTP-APACHE"
line_86 "N-n:COMMON CORRIDOR: GRNL-COPPERVR & MOR-GREEN-SW"
line_87 "N-n:COMMON CORRIDOR: GRNL-COPPERVR & MOR-PD-MORNC"
line_88 "N-n:COMMON CORRIDOR: NEWTUCSN-SAHUAR & VAIL-SOUTH"
line_89 "N-n:COMMON CORRIDOR: 3PTS-SNDARIO & PINALWES-SOUTH"

2021 CONTINGENCY LIST

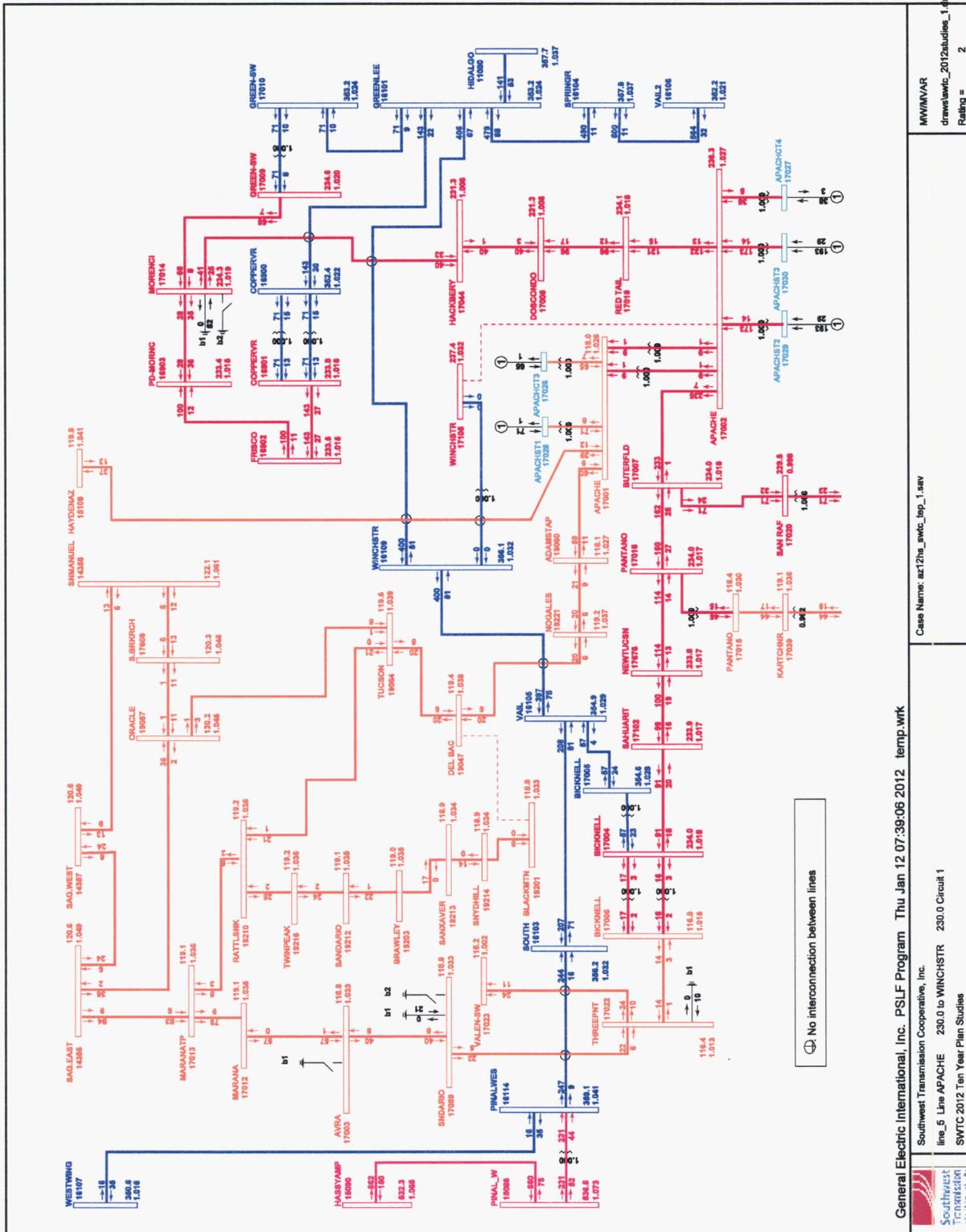
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line_2 "Line GREEN-SW 345.0 to GREENLEE 345.0 Circuit 1"
line_3 "Line APACHE 230.0 to BUTERFLD 230.0 Circuit 1"
line_4 "Line APACHE 230.0 to RED TAIL 230.0 Circuit 1"
line_5 "Line APACHE 230.0 to WINCHSTR 230.0 Circuit 1"
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line_13 "Line NEWTUCSN 230.0 to SAHUARIT 230.0 Circuit 1"
line_14 "Line PANTANO 230.0 to NEWTUCSN 230.0 Circuit 1"
line_15 "Line RED TAIL 230.0 to DOSCONDO 230.0 Circuit 1"
line_16 "Line SAHUARIT 230.0 to BICKNELL 230.0 Circuit 1"
line_17 "Line APACHE 115.0 to SNM1 115.0 Circuit 1"
line_18 "Line AVRA 115.0 to SNDARIO 115.0 Circuit 1"
line_19 "Line BICKNELL 115.0 to THREEPNT 115.0 Circuit 1"
line_20 "Line MARANA 115.0 to AVRA 115.0 Circuit 1"
line_22 "Line PANTANO 115.0 to KARTCHNR 115.0 Circuit 1"
line_23 "Line SNM1 115.0 to SNMANUEL 115.0 Circuit 1"
line_24 "Line SNM1 115.0 to HAYDENAZ 115.0 Circuit 1"
line_25 "Line THREEPNT 115.0 to SNDARIO 115.0 Circuit 1"
line_26 "Line THREEPNT 115.0 to VALEN-SW 115.0 Circuit 1"
tran_27 "Tran BICKNELL 345.00 to BICKNELL 230.00 Circuit 1"
tran_28 "Tran GREEN-SW 345.00 to GREEN-SW 230.00 Circuit 1"
tran_29 "Tran WINCHSTR 345.00 to WINCHSTR 230.00 Circuit 1"
tran_30 "Tran APACHE 230.00 to APACHE 115.00 Circuit 1"
tran_31 "Tran APACHE 230.00 to APACHE 115.00 Circuit 2"
tran_32 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 1"
tran_33 "Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 2"
tran_34 "Tran PANTANO 230.00 to PANTANO 115.00 Circuit 1"
line_35 "Line PINAL_C 500.0 to TORTOLIT 500.0 Circuit 1"
line_36 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 1"
line_37 "Line SAGUARO 500.0 to TORTOLIT 500.0 Circuit 2"
line_38 "Line GREENLEE 345.0 to COPPERVR 345.0 Circuit 1"
line_39 "Line GREENLEE 345.0 to WILLOW 345.0 Circuit 1"
line_40 "Line HIDALGO 345.0 to GREENLEE 345.0 Circuit 1"
line_41 "Line PINALWES 345.0 to SOUTH 345.0 Circuit 1"
line_42 "Line SPRINGR 345.0 to GREENLEE 345.0 Circuit 1"
line_43 "Line SPRINGR 345.0 to VAIL2 345.0 Circuit 1"
line_44 "Line VAIL 345.0 to SOUTH 345.0 Circuit 1"

line_45 "Line WESTWING 345 to PINALWES 345.0 Circuit 1"
line_46 "Line WILLOW 345.0 to Bowie 345.0 Circuit 1"
line_47 "Line WINCHSTR 345.0 to VAIL 345.0 Circuit 1"
line_48 "Line WINCHSTR 345.0 to WILLOW 345.0 Circuit 1"
line_49 "Line COPPERVR 230.0 to FRISCO 230.0 Circuit 1"
line_50 "Line PD-MORNC 230.0 to FRISCO 230.0 Circuit 1"
tran_51 "Tran PINAL_W 500.00 to PINALWES 345.00 Circuit 1"
tran_52 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 1"
tran_53 "Tran COPPERVR 345.00 to COPPERVR 230.00 Circuit 2"
line_54 "Line ADAMSTAP 115.0 to APACHE 115.0 Circuit 1"
line_55 "Line DEL BAC 115.0 to NOGALES 115.0 Circuit 1"
line_56 "Line MARANA 115.0 to RATTLSNK 115.0 Circuit 1"
line_57 "Line RATTLSNK 115.0 to TUCSON 115.0 Circuit 1"
line_58 "Line RATTLSNK 115.0 to TWINPEAK 115.0 Circuit 1"
line_59 "Line SAG.EAST 115.0 to MARANA 115.0 Circuit 1"
line_60 "Line SAG.EAST 115.0 to ORACLE 115.0 Circuit 1"
line_61 "Line TUCSON 115.0 to DEL BAC 115.0 Circuit 1"
line_62 "Line TUCSON 115.0 to ORACLE 115.0 Circuit 1"
line_63 "Line BOOTHILL 115.0 to ADAMS 115.0 Circuit 1"
line_64 "Line ORACLE 115.0 to S.BRKRCH 115.0 Circuit 1"
line_65 "Line S.BRKRCH 115.0 to SNMANUEL 115.0 Circuit 1"
line_66 "Line SAG.EAST 115.0 to SAG.WEST 115.0 Circuit 1"
line_67 "Line SAG.WEST 115.0 to SNMANUEL 115.0 Circuit 1"
tran_68 "Tran SAGUARO 500.00 to SAG.EAST 115.00 Circuit 1"
tran_69 "Tran SAGUARO 230.00 to SAG.EAST 115.00 Circuit 1"
line_70 "Line HASSYAMP 500.0 to PINAL_W 500.0 Circuit 1"
line_71 "Line PINAL_W 500.0 to DUKE 500.0 Circuit 1"
line_72 "Line DUKE 500.0 to PINAL_C 500.0 Circuit 1"
line_73 "N-2:Line APA-BUTT 230.0 & APA-RED TAIL 230.0"
line_74 "N-2:Line APA-BUTT 230.0 & APA-WIN 230.0"
line_75 "N-2:Line APA-BUTT 230.0 & BICK-VAIL 345.0"
line_76 "N-2:Line APA-BUTT 230.0 & GREEN-SW 345/230 XFMR"
line_77 "N-2:Line APA-BUTT 230.0 & MARANA-AVRA 115.0"
line_79 "N-2:Line APACHE-WIN 230.0 & APA-REDTAIL 230.0"
line_80 "N-2:Line APACHE-WIN 230.0 & MARANA-AVRA 115.0"
line_81 "N-2:Line MARANA-AVRA 115.0 & BICK-VAIL 345.0"
line_82 "N-n:COMMON CORRIDOR LINES OUT OF APACHE"
line_83 "N-n:COMMON CORRIDOR: APA-BUTT & ADAMSTP-APACHE 115.0"
line_84 "N-n:APA-BUTTERFLD/REDTAIL & APA-WINCHESTER 230.0"
line_85 "N-n:APA-BUTTERFLD/REDTAIL & MARANA-AVRA 115.0"
line_86 "N-n:APA-BUTTERFLD/REDTAIL & BICK-VAIL 345.0"
line_87 "N-n:APA-BUTT 230.0 & MARANA-AVRA 115.0 & BICKL-VAIL 345.0"
line_88 "N-n:COMMON CORRIDOR: BICK-3PTS & PINALWES-SOUTH 345.0"
line_89 "N-n:COMMON CORRIDOR: BUTT-PANTANO & ADAMSTP-APACHE"
line_90 "N-n:COMMON CORRIDOR: GRNL-COPPERVR & MOR-GREEN-SW"

line_91 "N-n:COMMON CORRIDOR: GRNL-COPPERVR & MOR-PD-MORNC"
line_92 "N-n:COMMON CORRIDOR: NEWTUCSN-SAHUAR & VAIL-SOUTH"
line_93 "N-n:COMMON CORRIDOR: 3PTS-SNDARIO & PINALWES-SOUTH"
line_94 "N-n:COMMON CORRIDOR: LOSS OF WILLOW TO BOWIE 345 kV LNS"

APPENDIX C
POWER FLOW ONE LINE DIAGRAMS

2012HS Southwest Transmission Cooperative Base System with Apache to Winchester 230 kV Line out of service



General Electric International, Inc. PSLF Program Thu Jan 12 07:39:06 2012 temp.wrk

Southwest Transmission Cooperative, Inc.

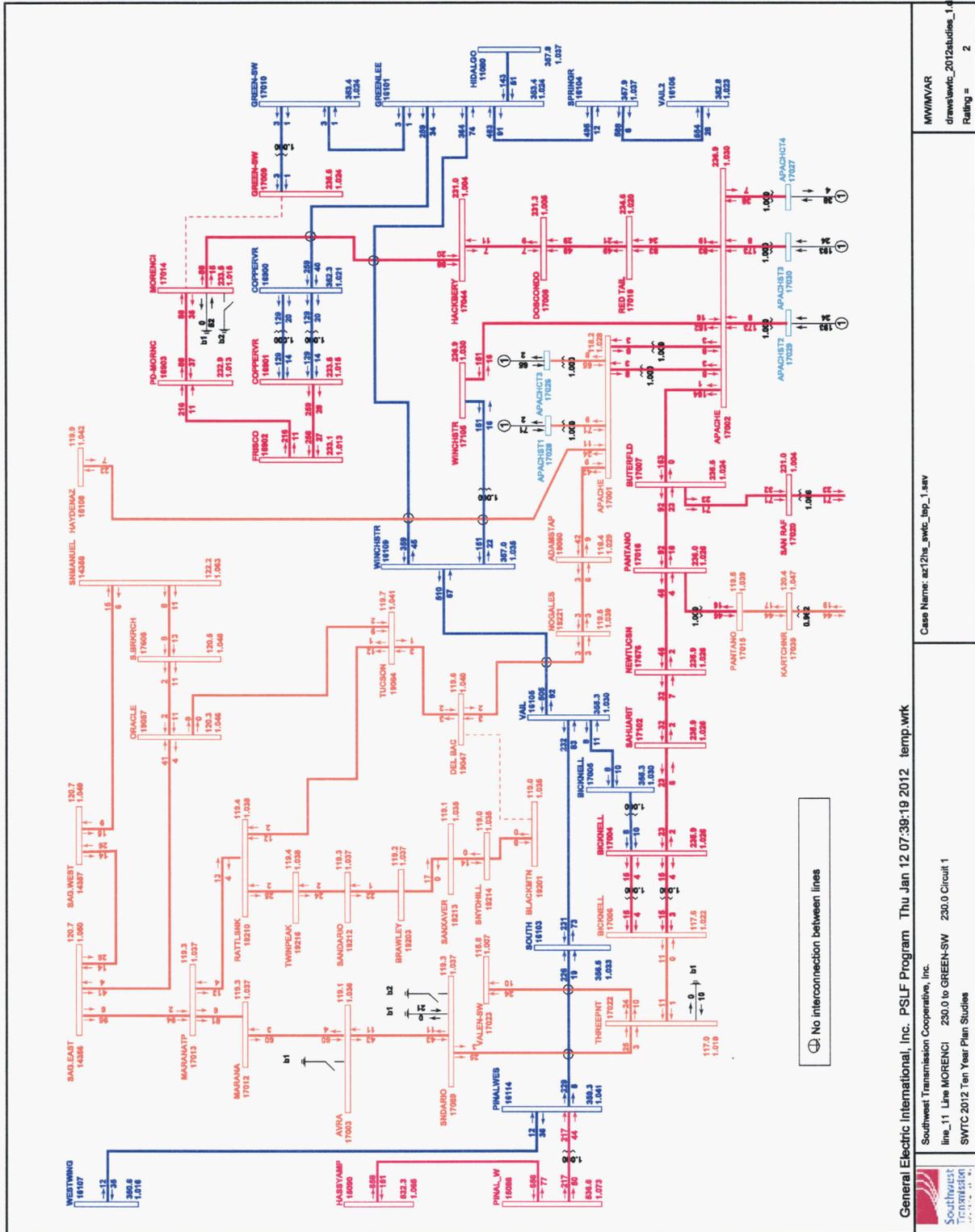
line_5 Line APACHE 230.0 to WINCHISTR 230.0 Circuit 1

SWTC 2012 Ten Year Plan Studies

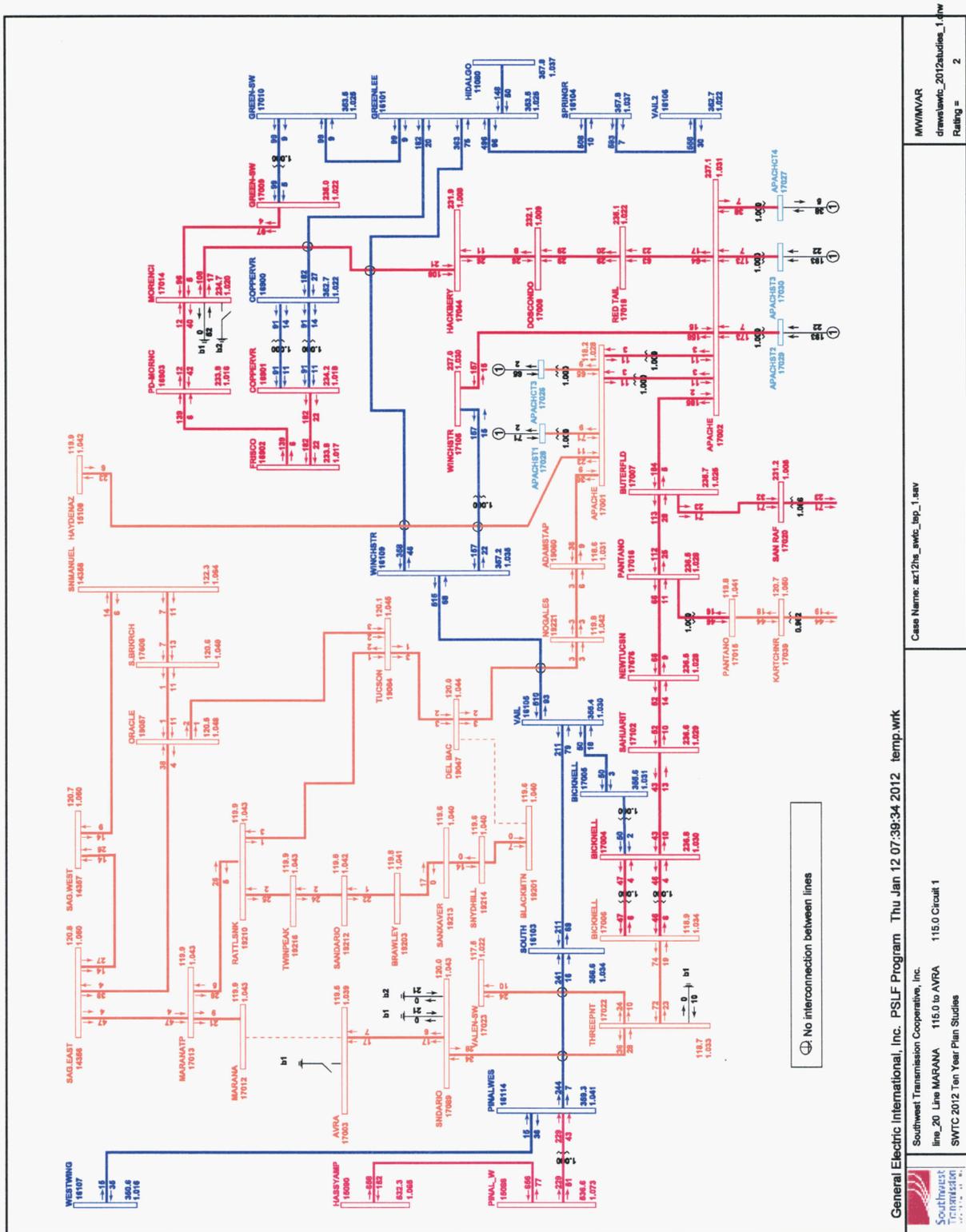
Case Name: az12hs_swc_lpp_1.sav

MWAVAR
drawswtc_2012studies_1.dwg
Rating = 2

2012HS Southwest Transmission Cooperative Base System with Morenci to Greenlee 230 kV Line out of service



2012HS Southwest Transmission Cooperative Base System with Marana to Avra 115 kV Line out of service



General Electric International, Inc. PSLF Program Thu Jan 12 07:39:34 2012 temp.wrk

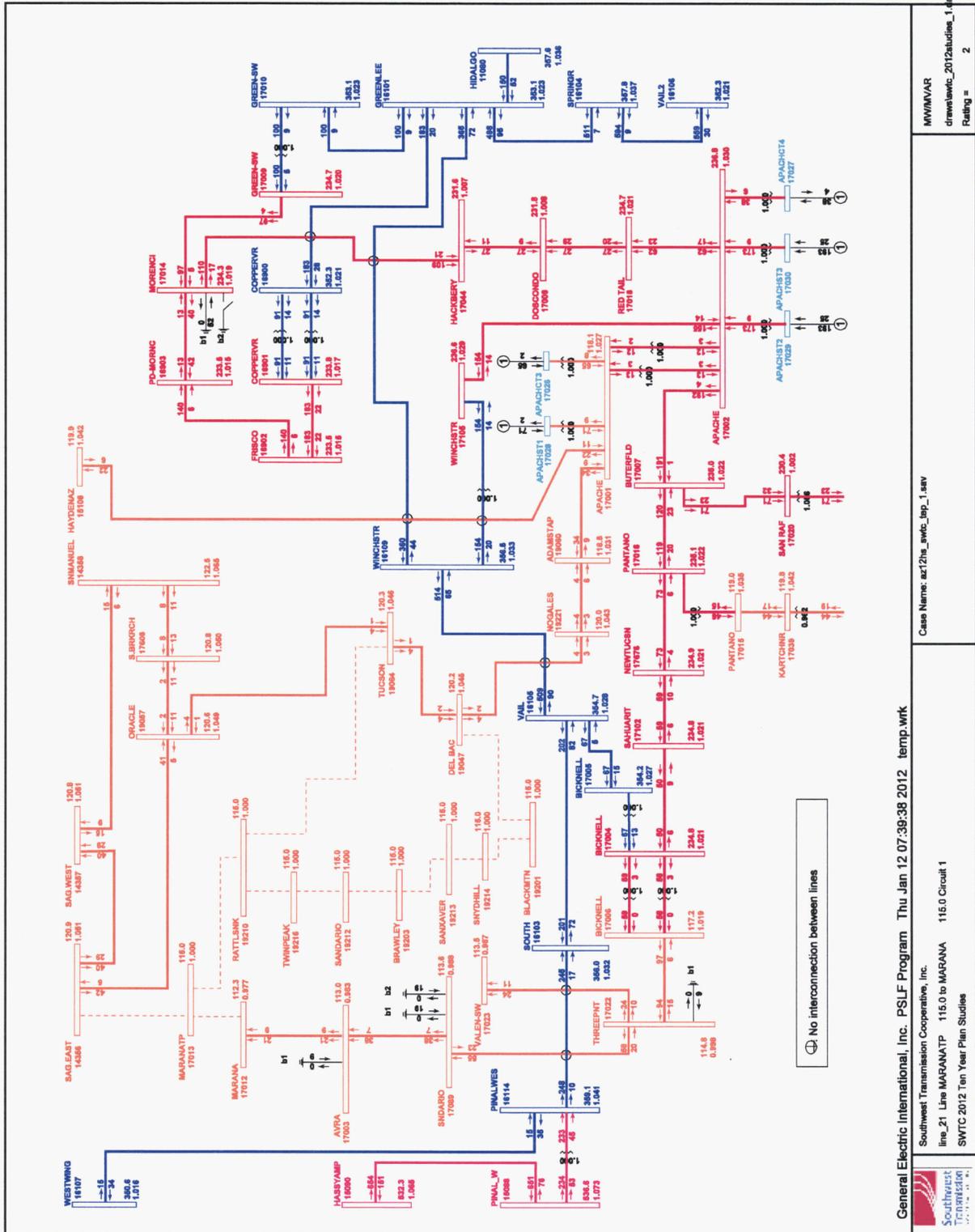


Southwest Transmission Cooperative, Inc.
line_20 Line MARANA 115.0 to AVRA
SWTC 2012 Ten Year Plan Studies

Case Name: ac21hs_awc_top_1.asv

MW/MVAR
drawswtc_2012studies_1.dwg
Rating = 2

2012HS Southwest Transmission Cooperative Base System with Marana Tap to Marana 115 kV Line out of service



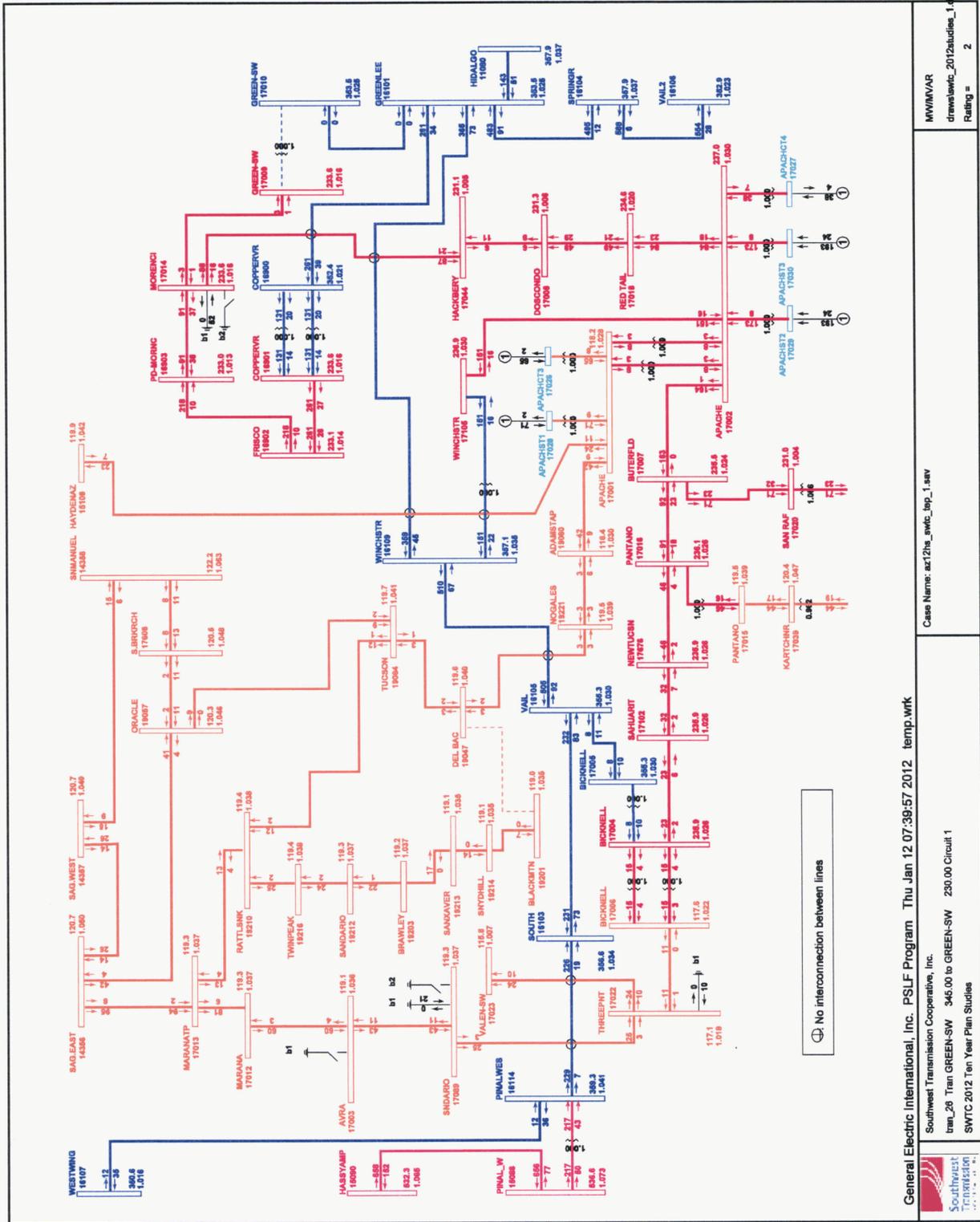
General Electric International, Inc. PSLE Program Thu Jan 12 07:39:38 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
 line_21 Line MARANATP 115.0 to MARANA 115.0 Circuit 1
 SWTC 2012 Ten Year Plan Studies

Case Name: act2hs_awc_top_1.svw

MW/MVAR
 drawswtc_2012studies_1.dwg
 Rating = 2

2012HS Southwest Transmission Cooperative Base System with Greenlee 345/230 kV Transformer out of service

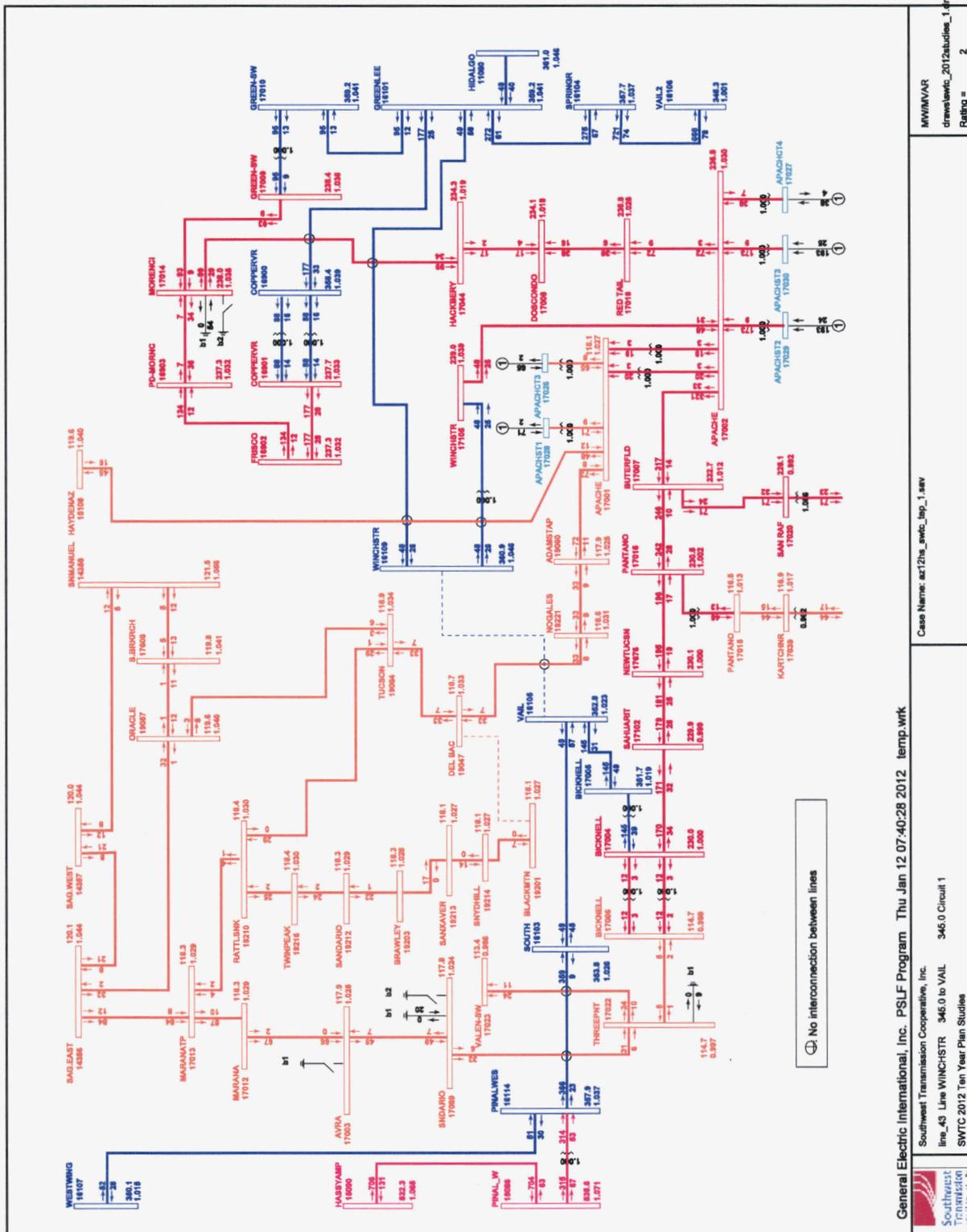


General Electric International, Inc. PSLF Program Thu Jan 12 07:39:57 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 tran_26 Tran GREEN-SW 345.00 to GREEN-SW 230.00 Circuit 1
 SWTC 2012 Ten Year Plan Studies

Case Name: act12hs_etc_top_1.ssv

MW/MVAR
 drawslwtc_2012studies_1.dwg
 Rating = 2

2012HS Southwest Transmission Cooperative Base System with Winchester to Vail 345 kV Line out of service



General Electric International, Inc. PSLF Program Thu Jan 12 07:40:28 2012 temp.wrk

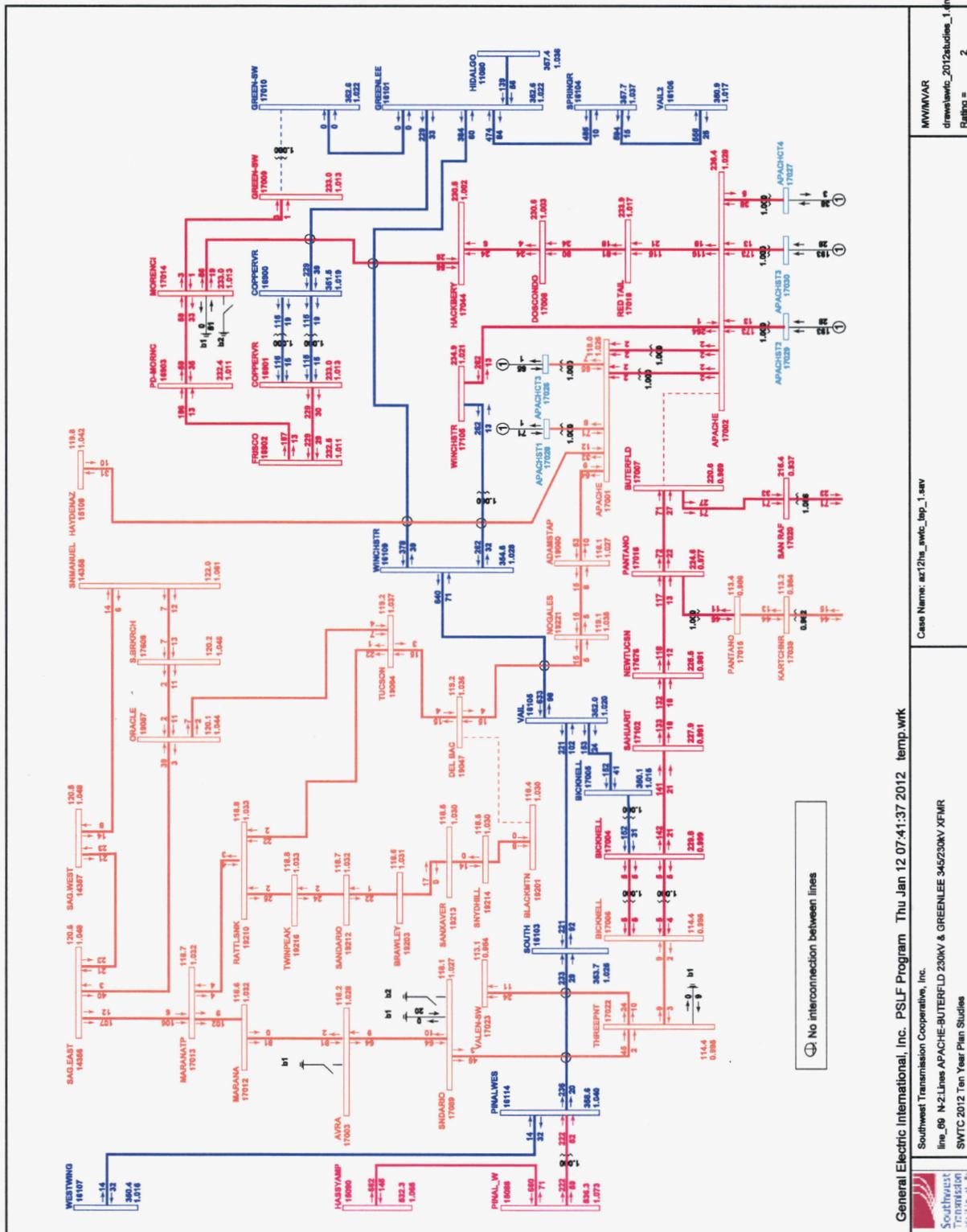


Southwest Transmission Cooperative, Inc.
line_43 Line WINCHSTR 345.0 to VAIL
SWTC 2012 Ten Year Plan Studies

Case Name: sw12hs_swtc_inp_1.sev

MMWVAR
drawn:swtc_2012bases_1.dwg
Rating = 2

2012HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line & Greenlee 345/230 kV Transformer out of service

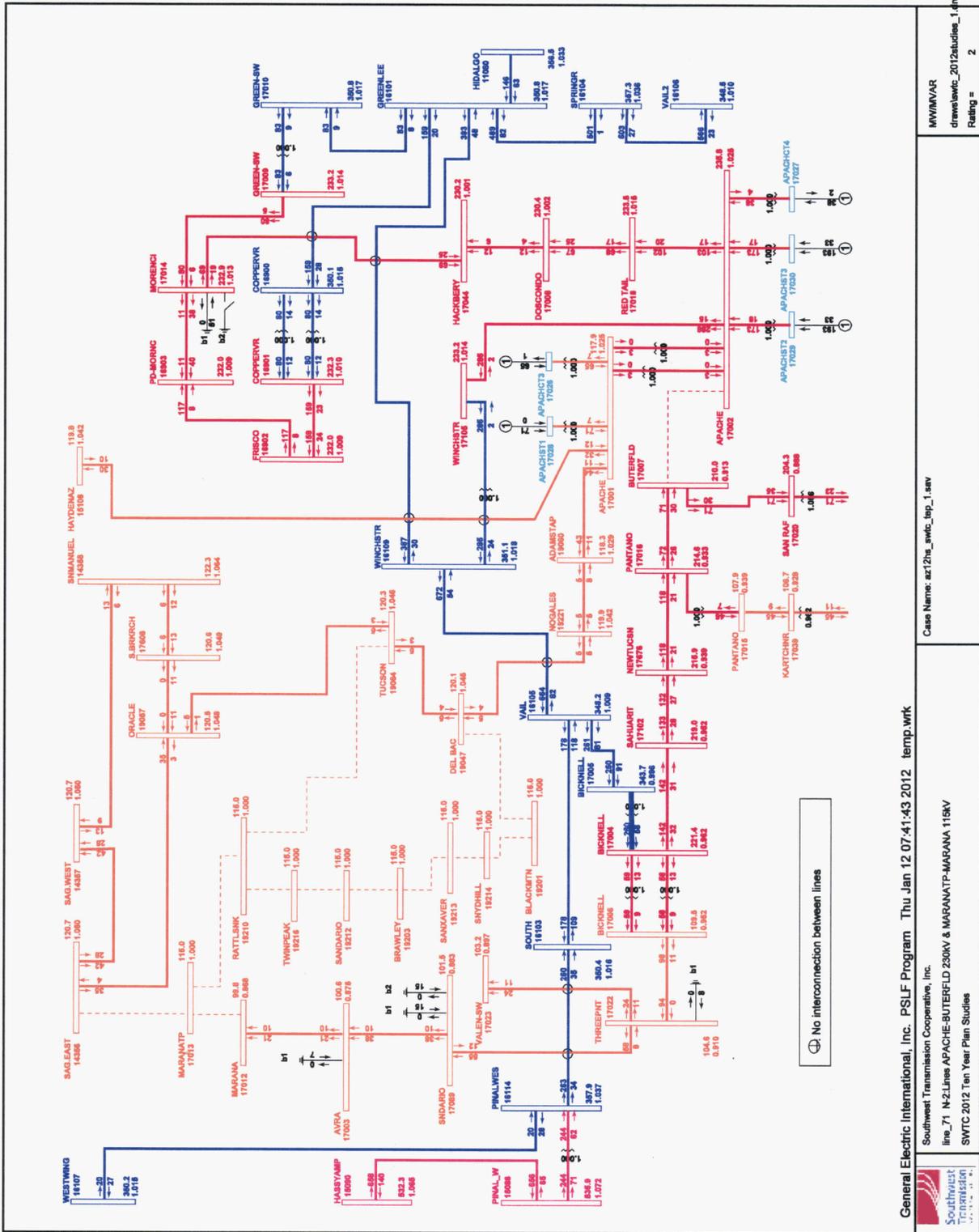


Case Name: act12a_awc_lap_1.sav
Rating = 2

General Electric International, Inc. PSUF Program Thu Jan 12 07:41:37 2012 temp.wk
Southwest Transmission Cooperative, Inc.
line_06 N2Lines APACHE-BUTTERFIELD 230KV & GREENLEE 345/230KV XFMR
SWTC 2012 Ten Year Plan Studies

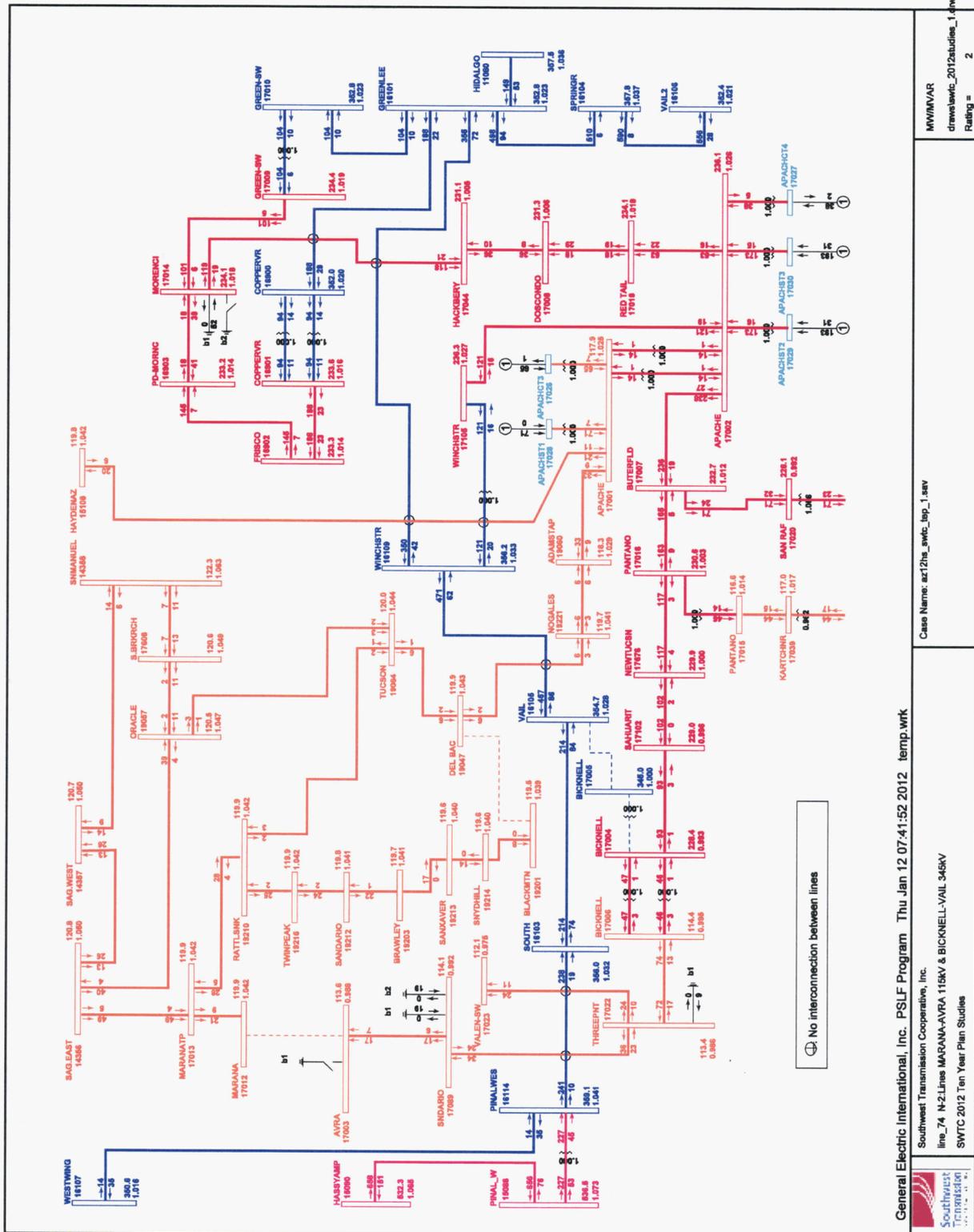
MW/MVAR
drawn:awc_2012studies_1.dwg
Rating = 2

2012HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV & Marana Tap to Marana 115 kV Lines out of service



Case Name: act2hw_swtc_fep_1.svw
 Rating = 2
 MW/MVAR
 crwswtc_2012studie_1.dwg
 General Electric International, Inc. PSLF Program Thu Jan 12 07:41:43 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_71 N-2 Lines APACHE-BUTTERFIELD 230KV & MARANATAP-MARANA 115KV
 SWTC 2012 Ten Year Plan Studies

2012HS Southwest Transmission Cooperative Base System with Marana to Avra 115 kV & Bicknell to Vail 345 kV Lines out of service



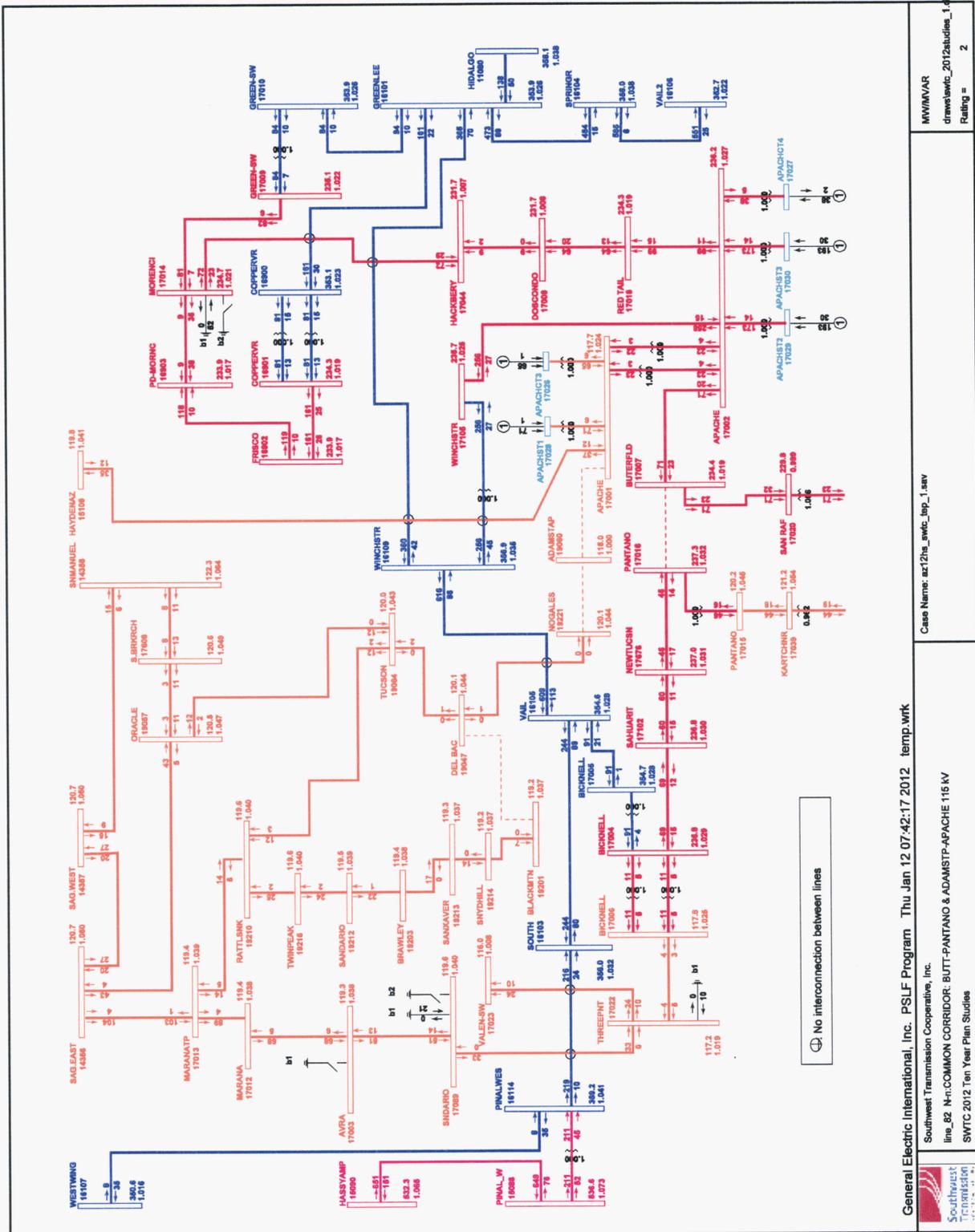
Case Name: sac12hs_wdc_lmp_1.sev

MMWVAR
drawnwtc_2012studies_1.dwg
Rating = 2

General Electric International, Inc. PSLF Program Thu Jan 12 07:41:52 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
line_74 N-2 Lines MARANA-AVRA 115kV & BICKNELL-VAIL 345kV
SWTC 2012 Ten Year Plan Studies

2012HS Southwest Transmission Cooperative Base System with Common Corridor Butterfield to Pantano 230 kV and Adams Tap to Apache 115 kV Lines out of service



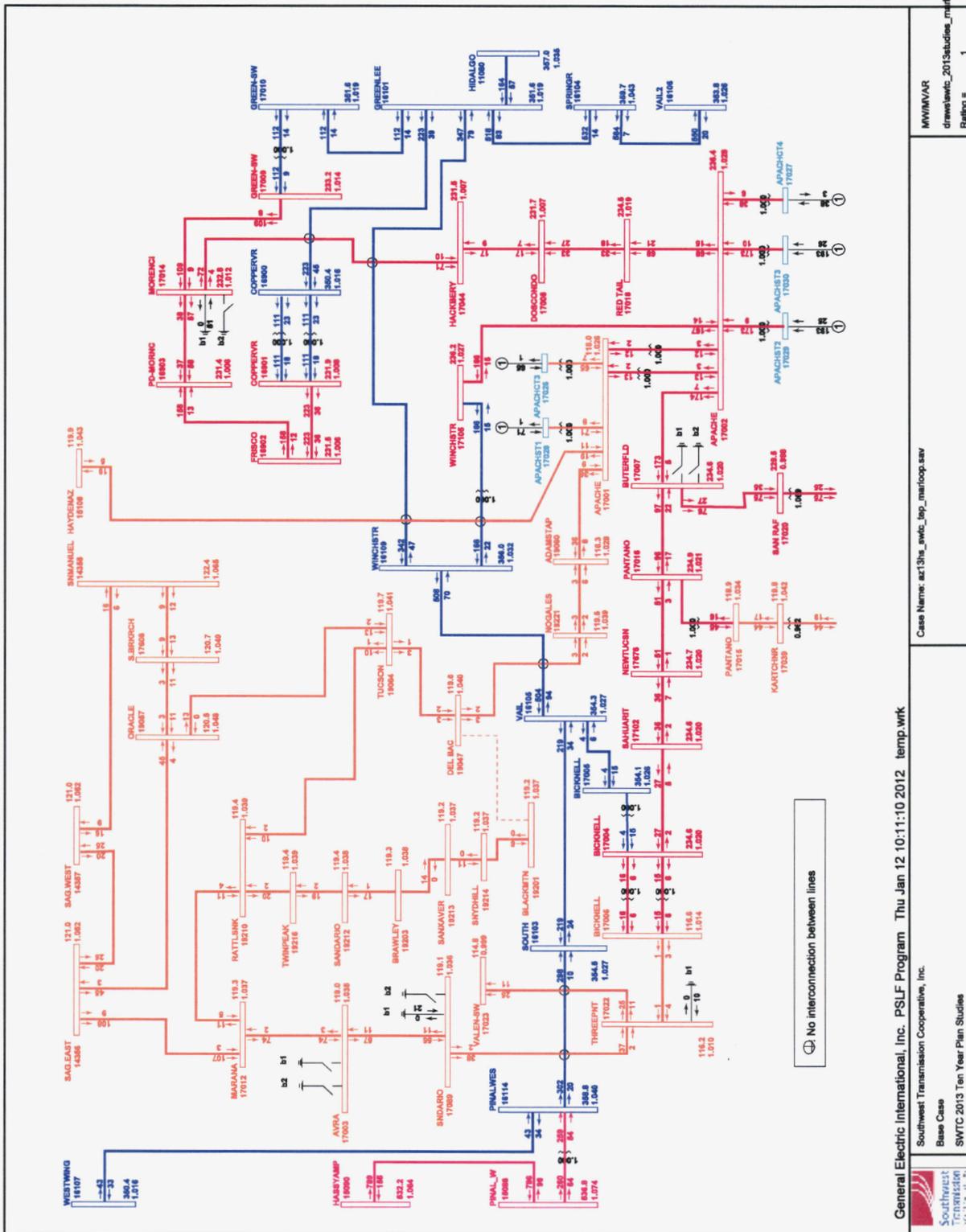
General Electric International, Inc. PSFL Program Thu Jan 12 07:42:17 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
 line_82 N-Common Corridor: BUTT-PANTANO & ADAMSTP-APACHE 115 kV
 SWTC 2012 Ten Year Plan Studies

Case Name: ar12hs_ewtc_lns_1.sev

MW/MVAR
 draws/awc_2012studies_1.dwg
 Rating = 2

2013HS Southwest Transmission Cooperative Base System

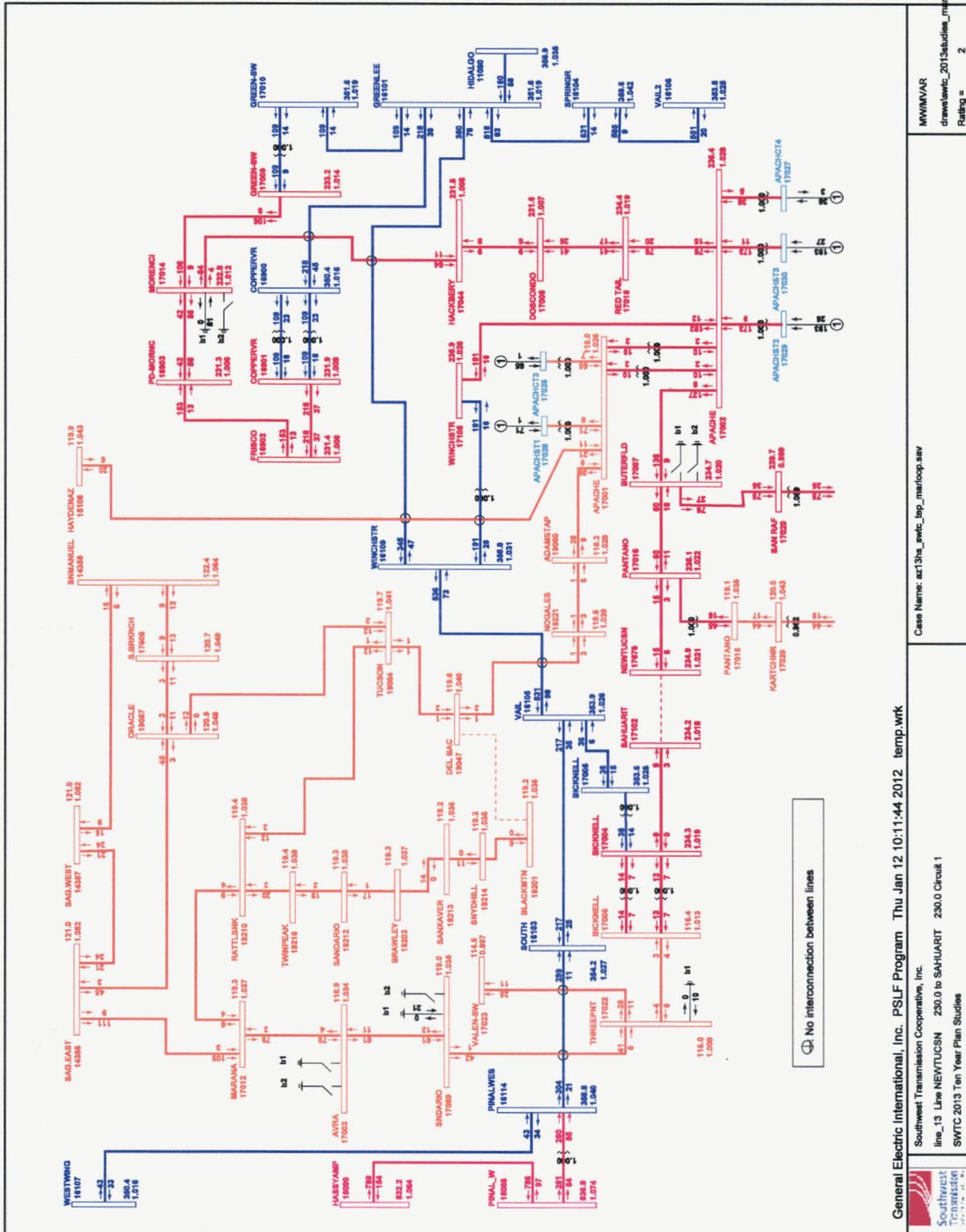


General Electric International, Inc. PSLF Program Thu Jan 12 10:11:10 2012 temp.wrk

Case Name: act13hs_wtc_inp_nearloop.sav

MWIMVAR
drawnwtc_2013studios.mxd
Rating = 1

2013HS Southwest Transmission Cooperative Base System with New Tucson to Sahuarita 230 kV Line out of service



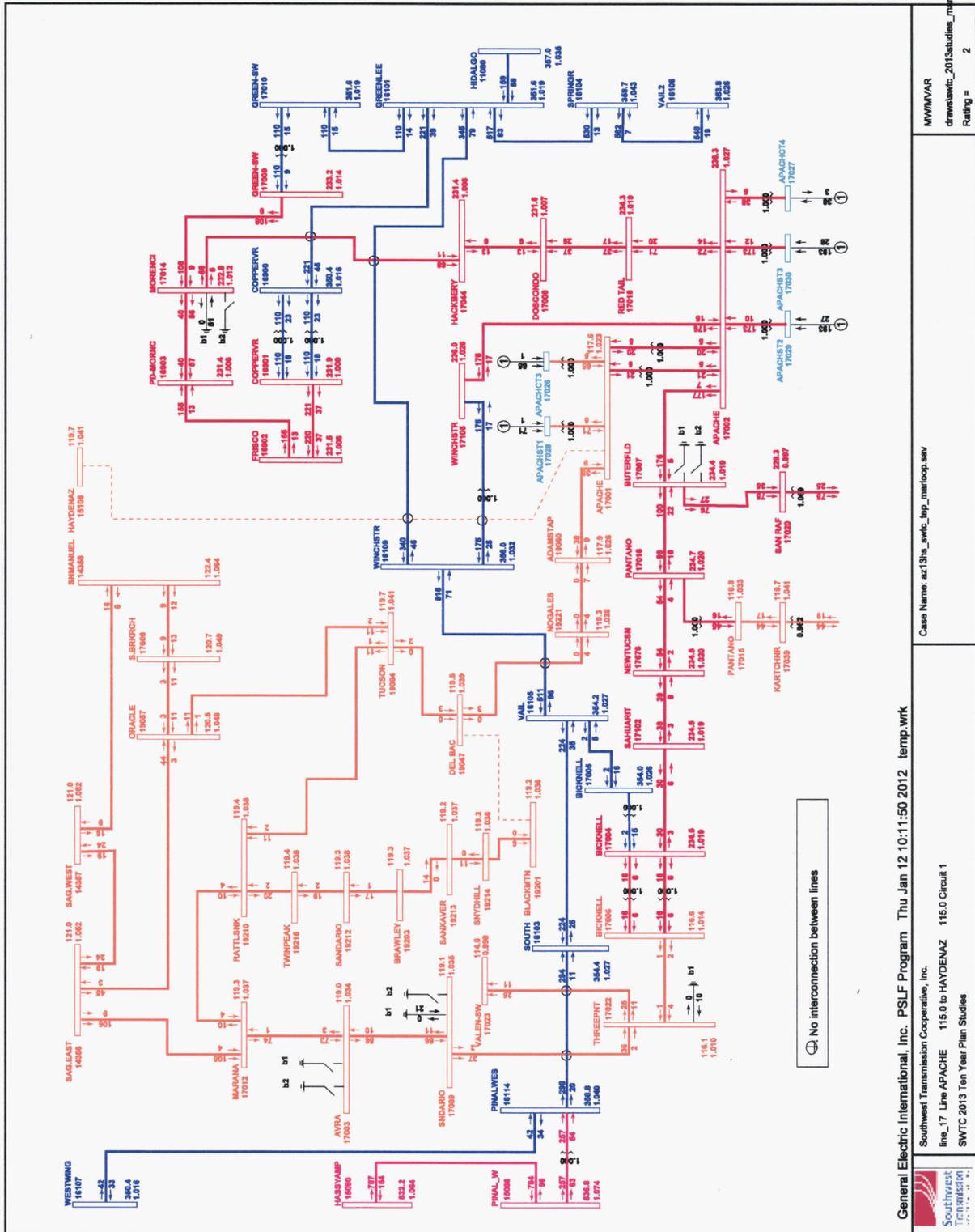
MWM/VAR
drawn:awc_2013abidies_mfjmk
Rating = 2

Case Name: ac:13hs_awc_lay_mfjmkloop.sav

General Electric International, Inc. PSLE Program Thu Jan 12 10:11:44 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
line_15 Line NEWTUCSN 230.0 to SAHUART 230.0 Circuit 1
SWTC 2013 Ten Year Plan Studies

2013HS Southwest Transmission Cooperative Base System with Apache to Hayden 115 kV Line out of service



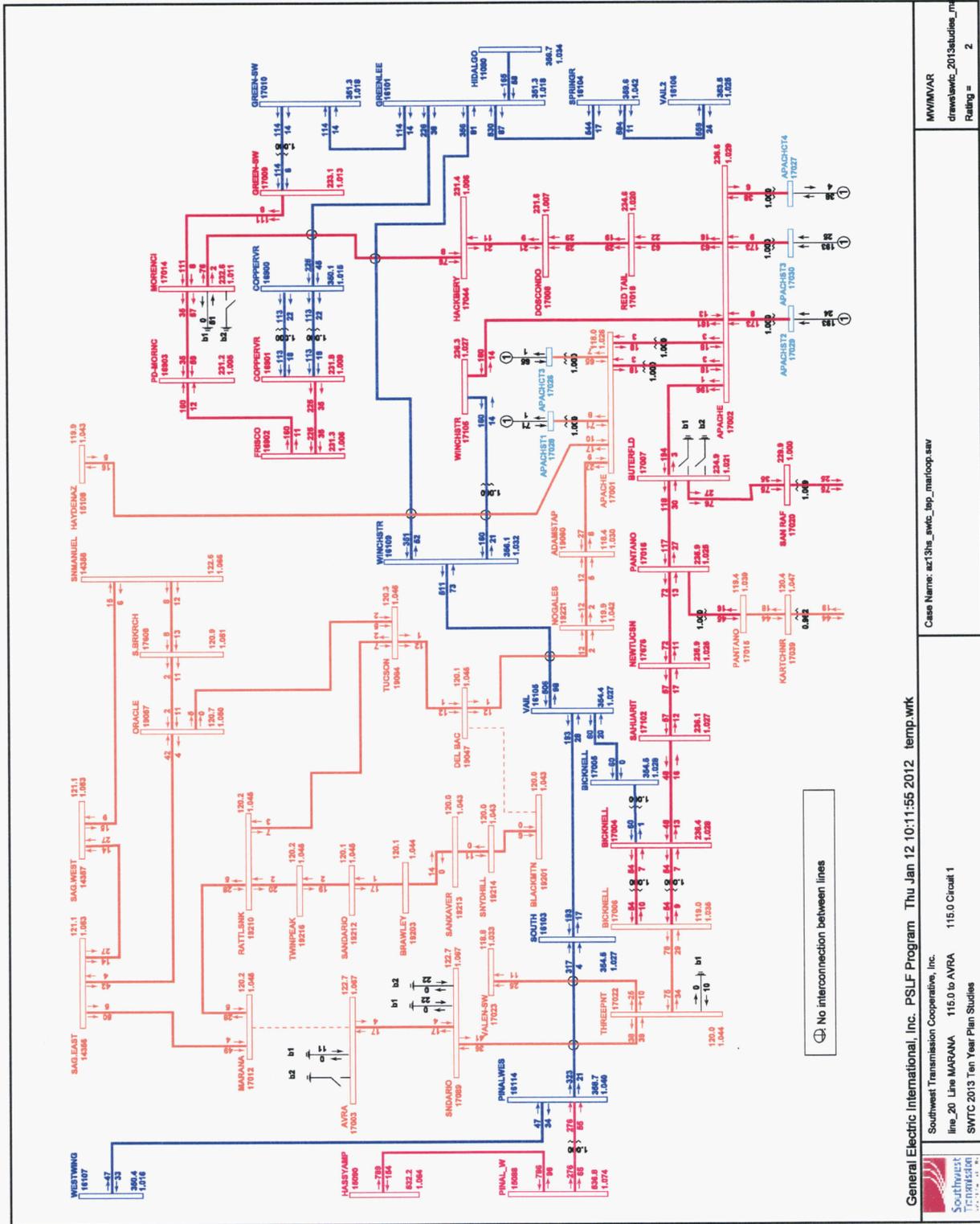
General Electric International, Inc. PSLE Program Thu Jan 12 10:11:50 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
 line_17 Line APACHE 115.0 to HAYDENAZ 115.0 Circuit 1
 SWTC 2013 Ten Year Plan Studies

Case Name: swt3hs_awtc_top_maribop.saw

MP/MN/AVR
 drawswtc_2013studie_maribop
 Rating = 2

2013HS Southwest Transmission Cooperative Base System with Marana to Avra 115 kV Line out of service

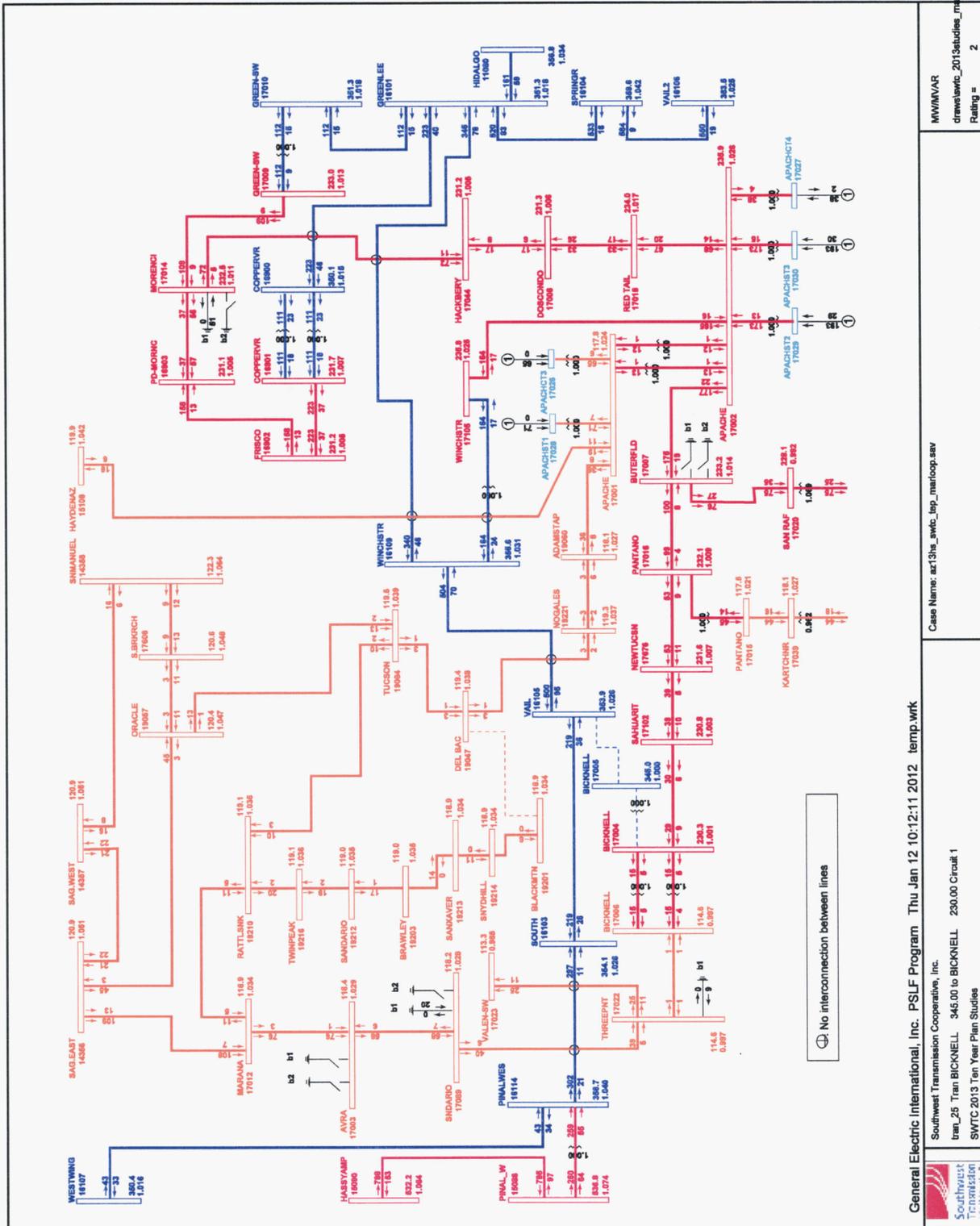


General Electric International, Inc. PSLF Program Thu Jan 12 10:11:55 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_20 Line MARANA 115.0 to AVRA 115.0 Circuit 1
 SWTC 2013 Ten Year Plan Studies

Case Name: ac13hs_swtc_tep_mainloop.saw
 Rating = 2

MMW/AVR
 drawslawtc_2013sludies_mifex

2013HS Southwest Transmission Cooperative Base System with Bicknell 345/230kV Transformer out of service

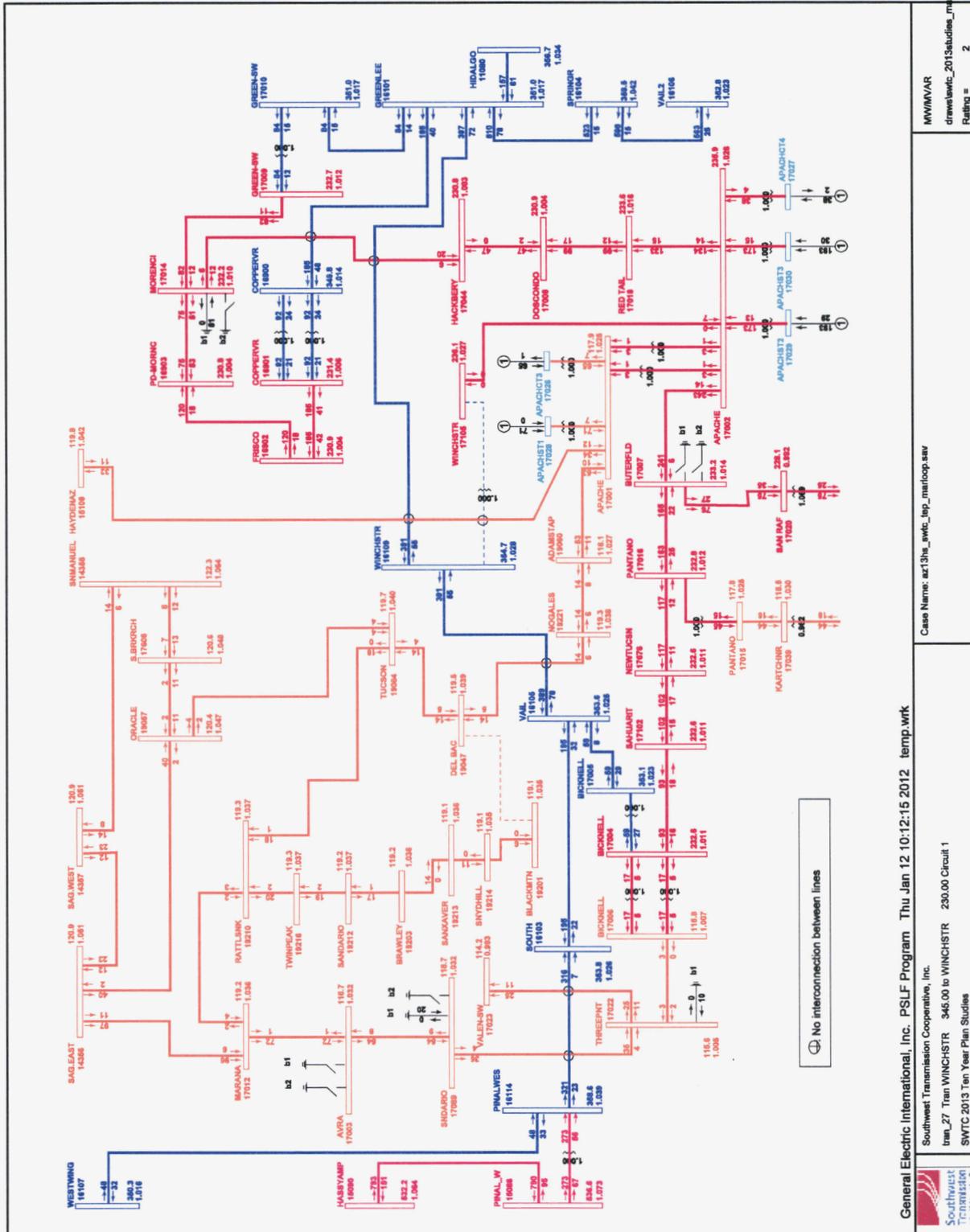


General Electric International, Inc. PSLF Program Thu Jan 12 10:12:11 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 tran_25 Tran BICKNELL 345.00 to BICKNELL 230.00 Circuit 1
 SWTC 2013 Ten Year Plan Studies

Case Name: act3ha_ewic_inp_maitloop.sav

MW/MVAR
 drawbwtrc_2013Studies_mfifox
 Rating = 2

2013HS Southwest Transmission Cooperative Base System with Winchester 345/230 kV Transformer out of service

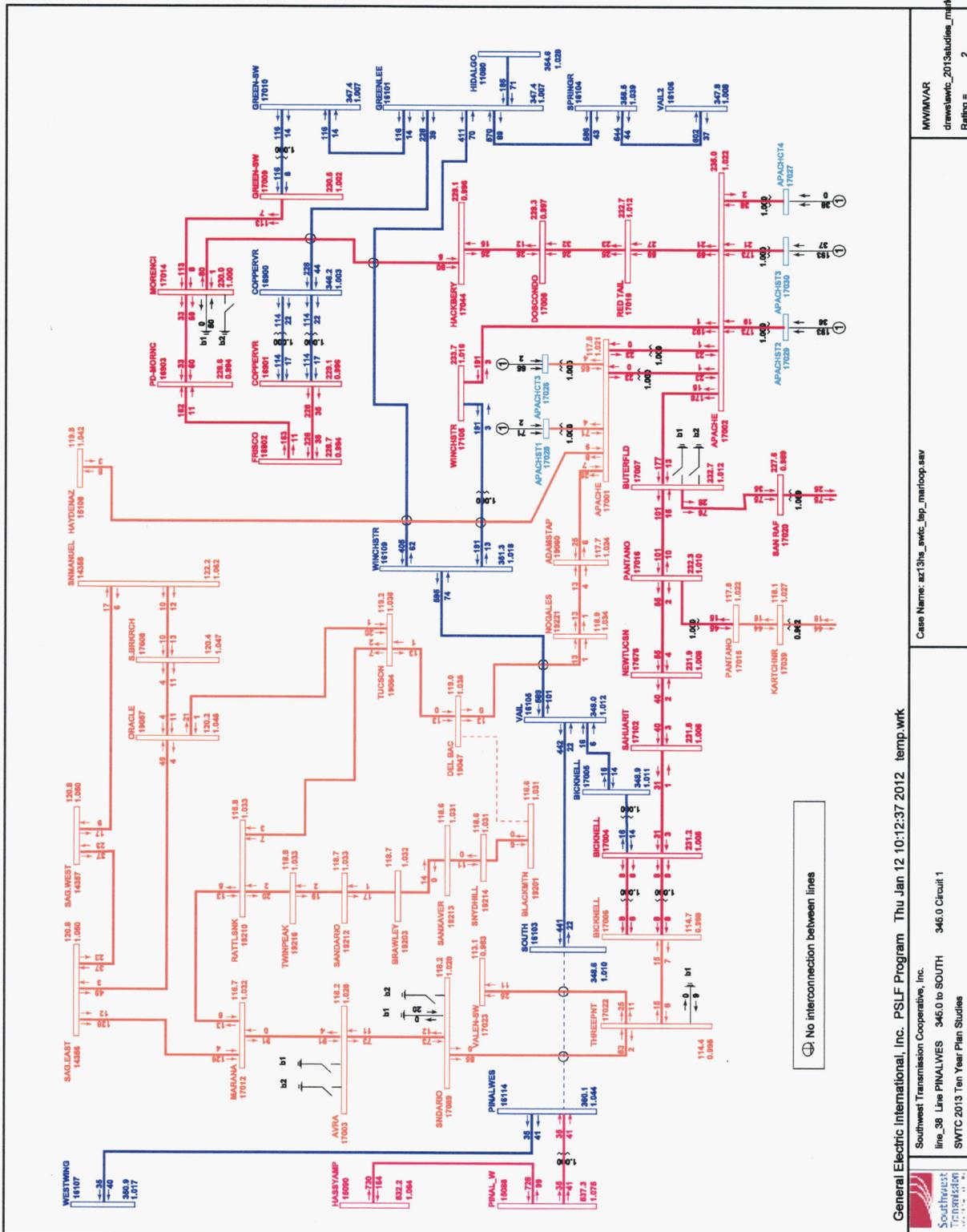


Case Name: ac13hs_swtc_ipo_mainloop_sav
 Rating = 2

General Electric International, Inc. PSLF Program Thu Jan 12 10:12:15 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 tran_27 Tran WINCHSTR 345.00 to WINCHSTR 230.00 Circuit 1
 SWTC 2013 Ten Year Plan Studies

MW/MVAR
 drawslawc_2013studies_mainloop

2013HS Southwest Transmission Cooperative Base System with Pinal West to South 345 kV Line out of service



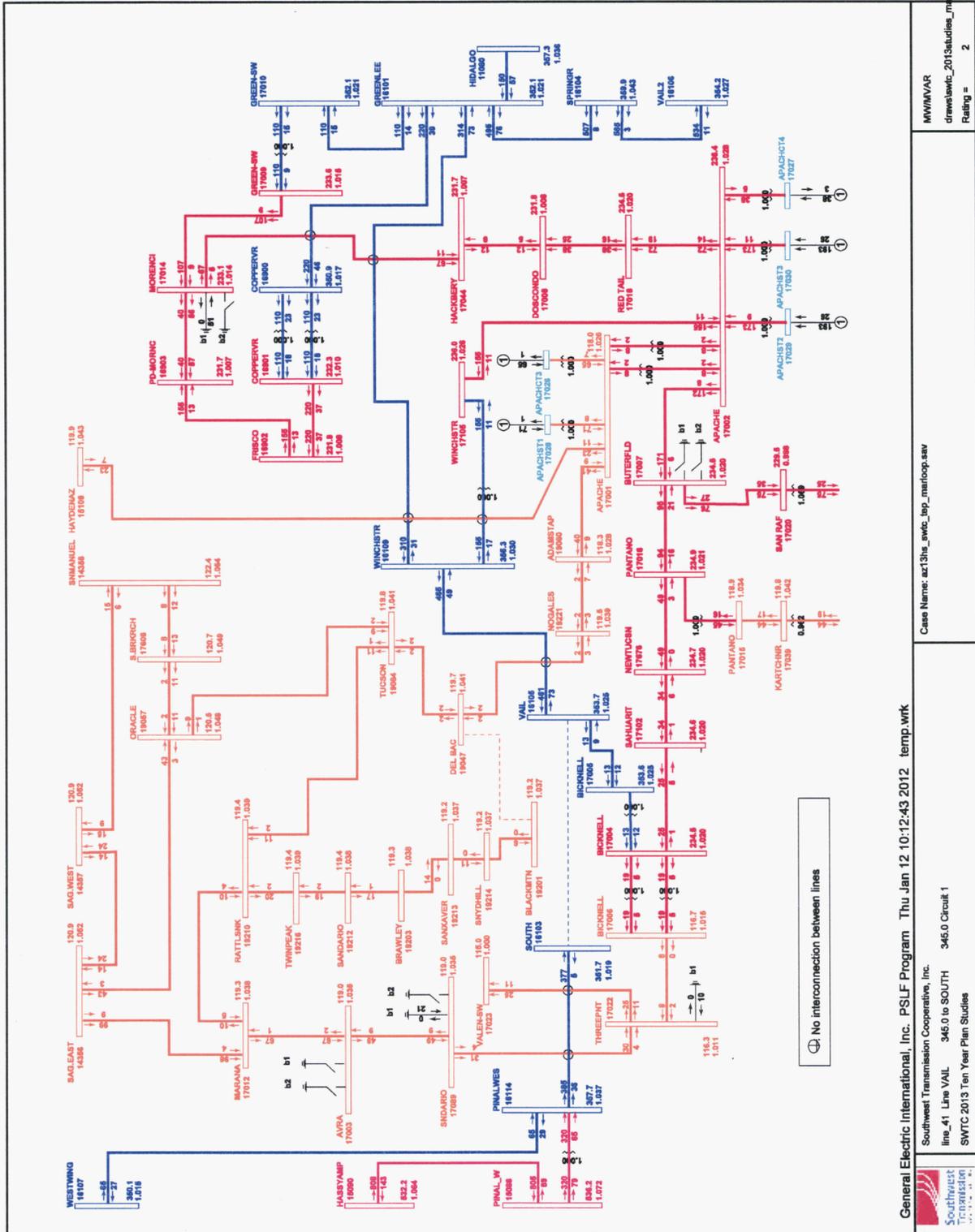
General Electric International, Inc. PSLF Program Thu Jan 12 10:12:37 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
 Line_36 Line PINALWES 345.0 to SOUTH 345.0 Circuit 1
 SWTC 2013 Ten Year Plan Studies

Case Name: az13hs_swic_lep_mainloop.swp

MMWVAR
 drawdate: 2013solstudios_mpldrc
 Rating = 2

2013HS Southwest Transmission Cooperative Base System with Vail to South 345 kV Line out of service

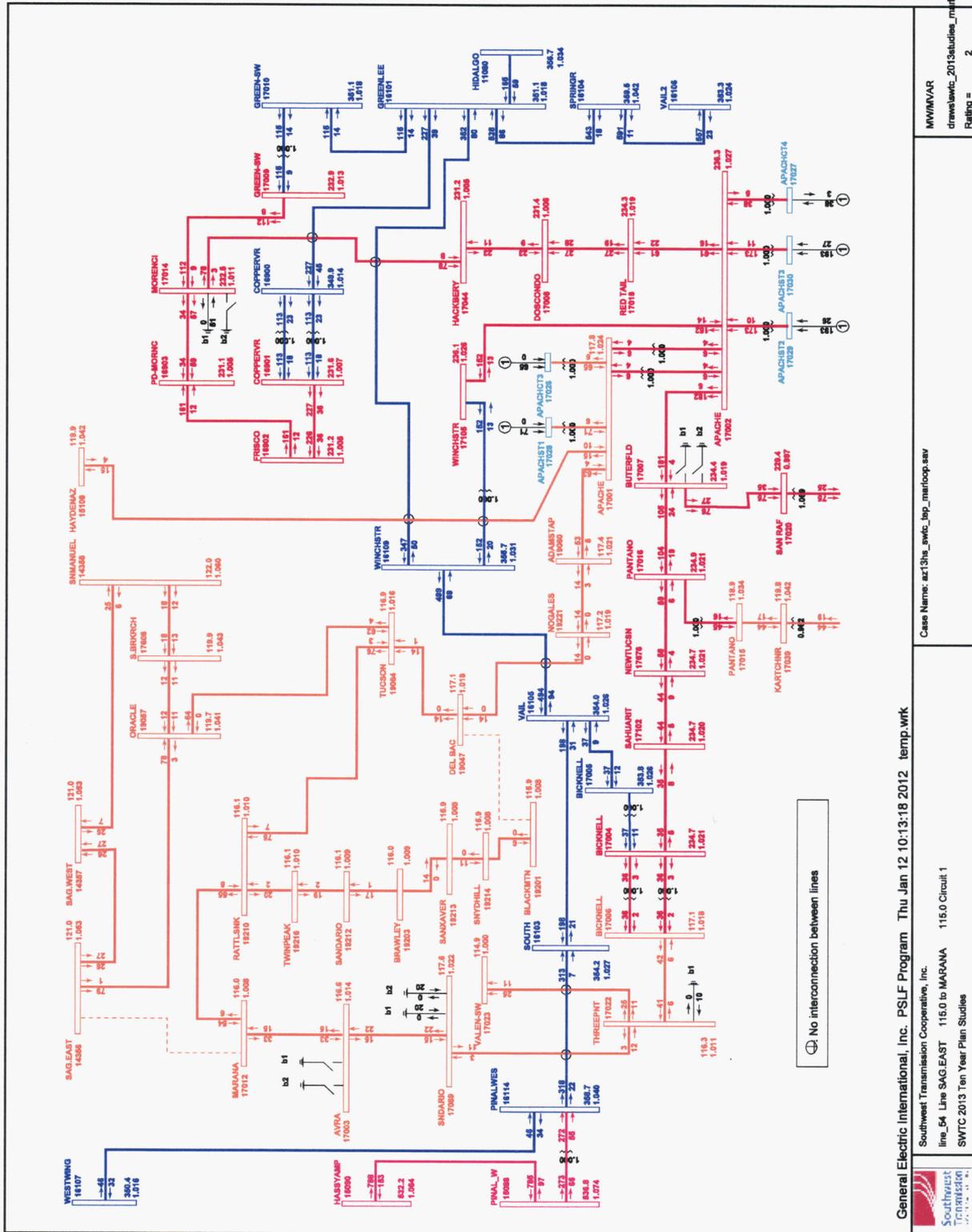


Case Name: ac13hw_ewd_1ap_marhoop.saw
 Rating = 2

General Electric International, Inc. PSLF Program Thu Jan 12 10:12:43 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_41 Line VAIL 345.0 to SOUTH 345.0 Circuit 1
 SWTC 2013 Ten Year Plan Studies

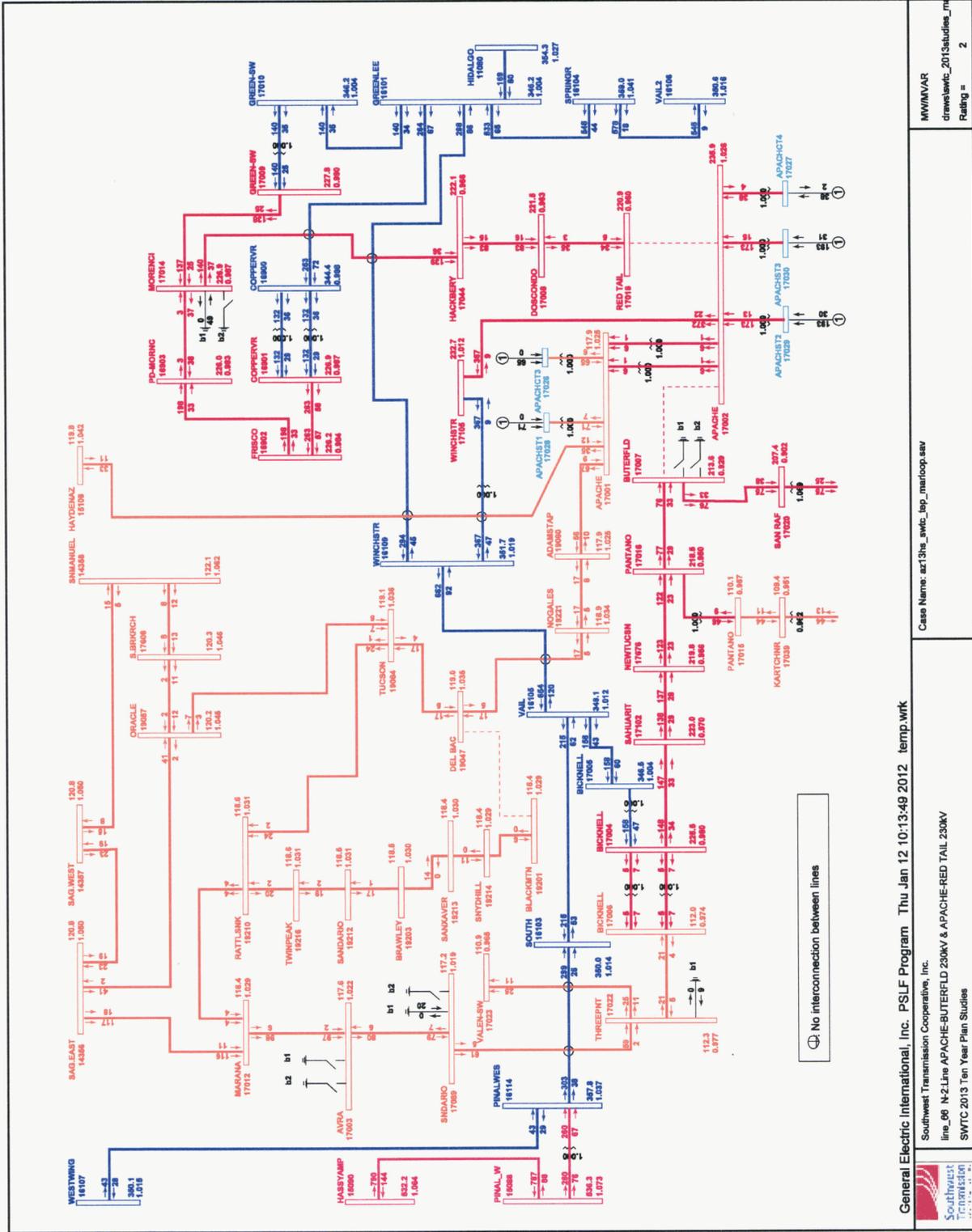
MMWVAR
 drawlwtc_2013studies_mf10x

2013HS Southwest Transmission Cooperative Base System with Saguaro East to Marana 115 kV Line out of service



Case Name: acr13hs_awc_lep_marloop.saw	MW/MVAR drawsawc_2013studies_mfbc Rating = 2
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2013HS Southwest Transmission Cooperative Base System with Apache to Butterfield and Apache to Redtail 230 kV Lines out of service

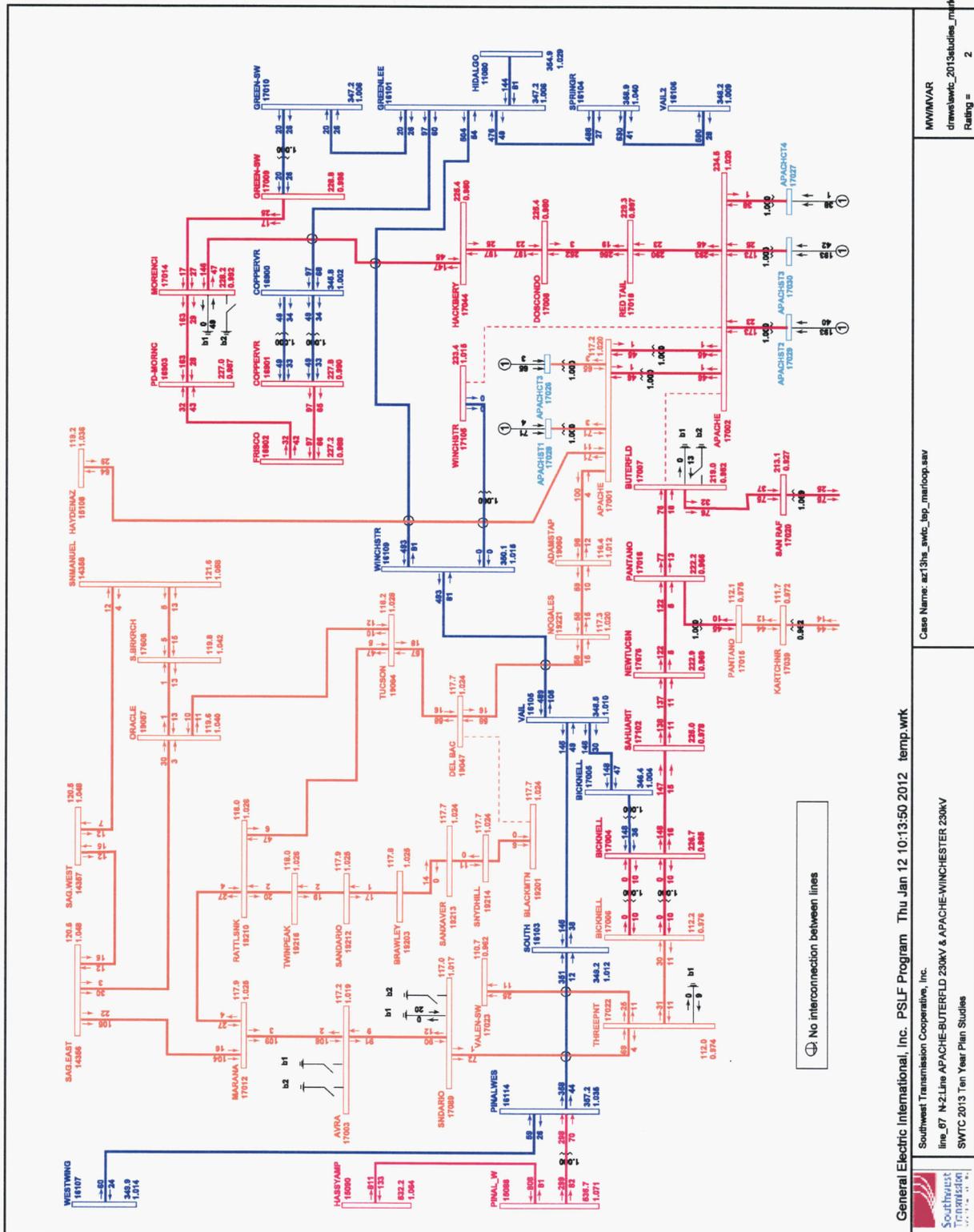


Case Name: ac3\3ha_wmc_bep_marioop.saw
 MW/MVAR
 drawdate: 2013 studies_mf10c
 Rating = 2

General Electric International, Inc. PSLE Program Thu Jan 12 10:13:49 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_06 N2 Line APACHE-BUTTERFIELD 230KV & APACHE-RED TAIL 230KV
 SWTC 2013 Ten Year Plan Studies

SWTC
 Southwest
 Transmission
 Cooperative, Inc.

2013HS Southwest Transmission Cooperative Base System with Apache to Butterfield and Apache to Winchester 230 kV Lines out of service

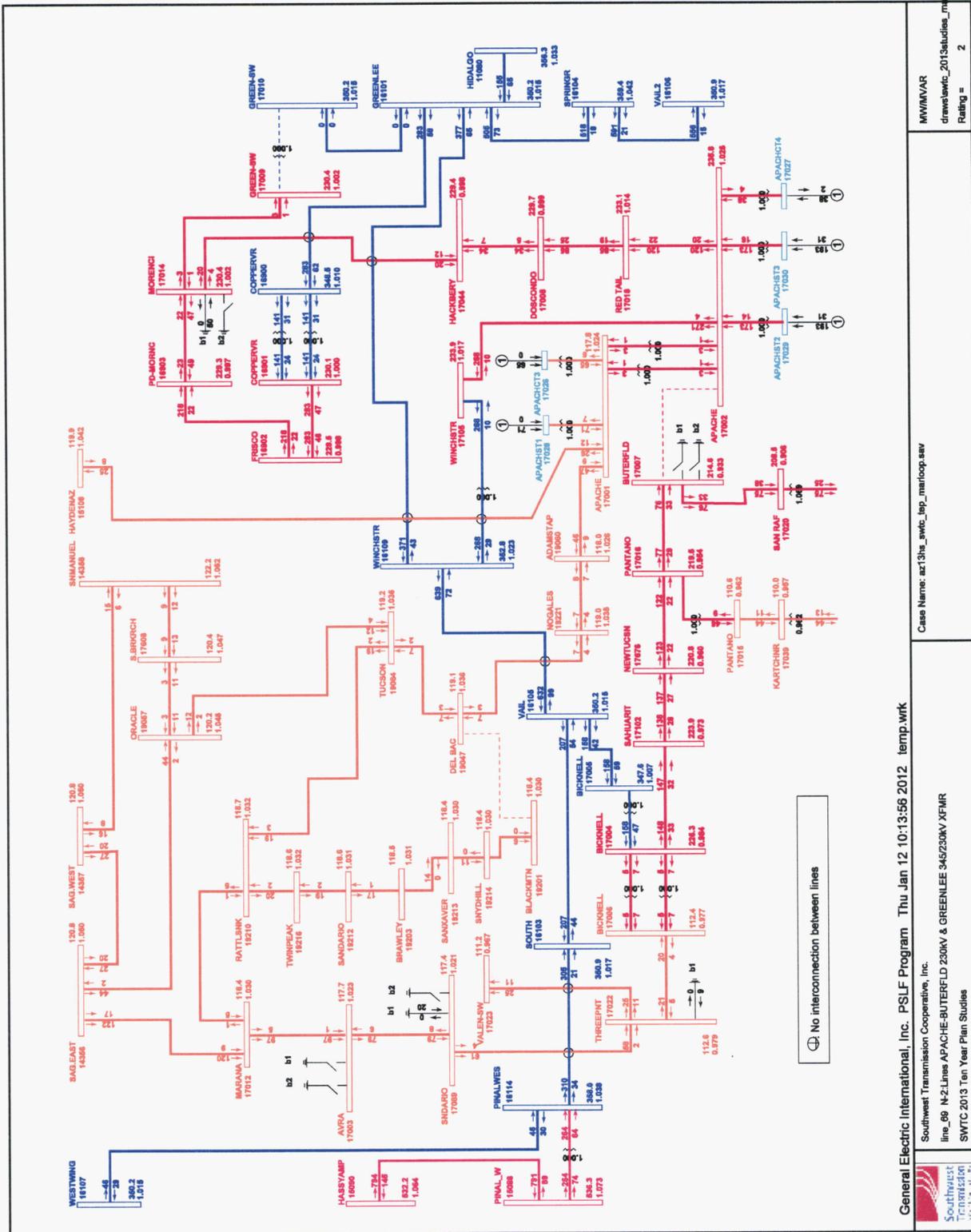


General Electric International, Inc. PSLE Program Thu Jan 12 10:13:50 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_07 N-2-Line APACHE-BUTTERFIELD 230KV & APACHE-WINCHESTER 230KV
 SWTC 2013 Ten Year Plan Studies

Case Name: at13hs_awc_lap_mariocp.svw

MW/MVAR
 drawslwts_2013studies_mjrfk
 Rating = 2

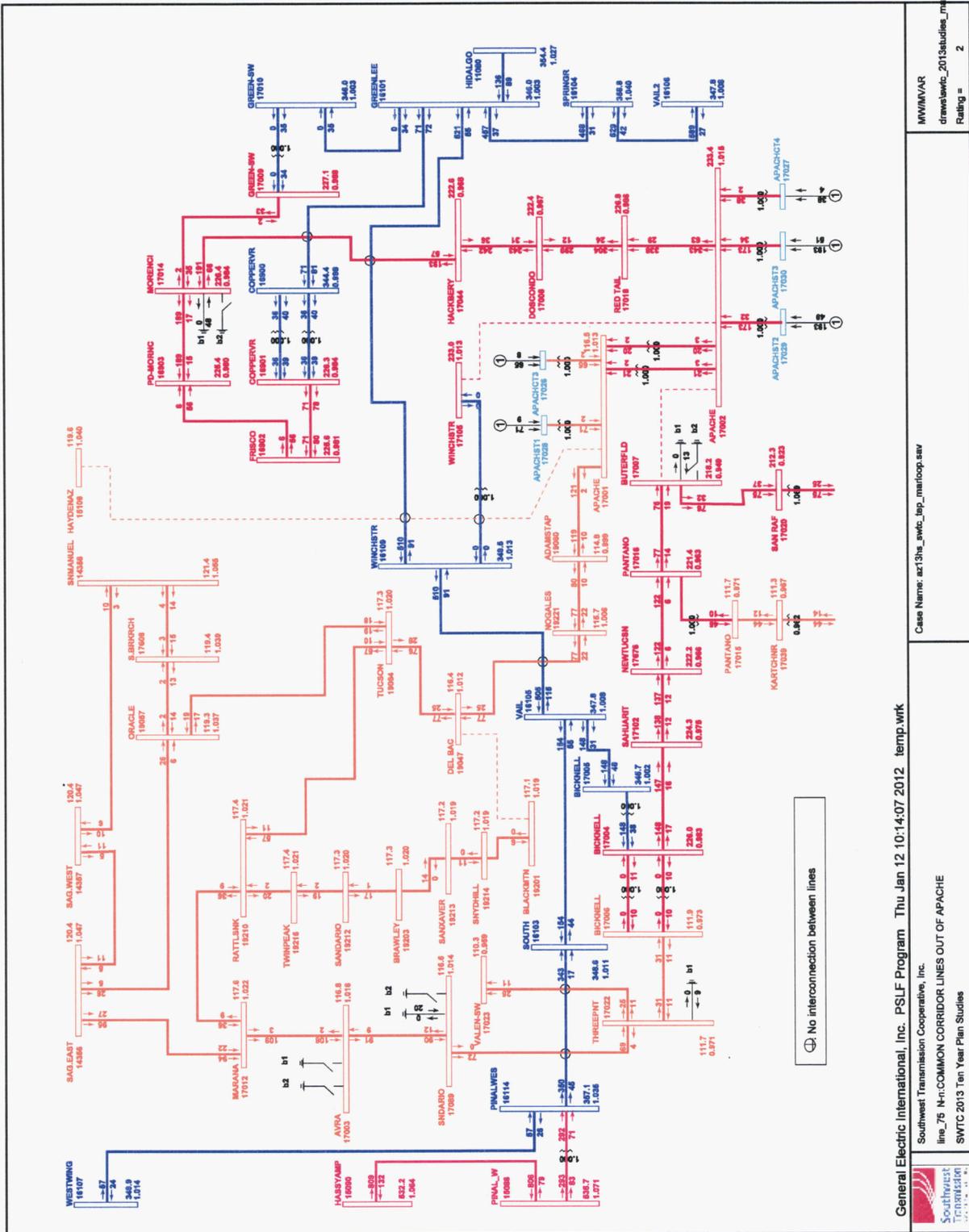
2013HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV line and Green-SW 345/230 kV Transformer out of service



General Electric International, Inc. PSLF Program Thu Jan 12 10:13:56 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_09 N-2 Lines APACHE-BUTTERFIELD 230KV & GREENLEE 345/230KV XFMR
 SWTC 2013 Ten Year Plan Studies

Case Name: at3hs_ewd_lap_martloop.srv
 MWM/VAR
 draw:awc_2013studies_mfbox
 Rating = 2

2013HS Southwest Transmission Cooperative Base System with Common Corridor Lines out of Apache out of service



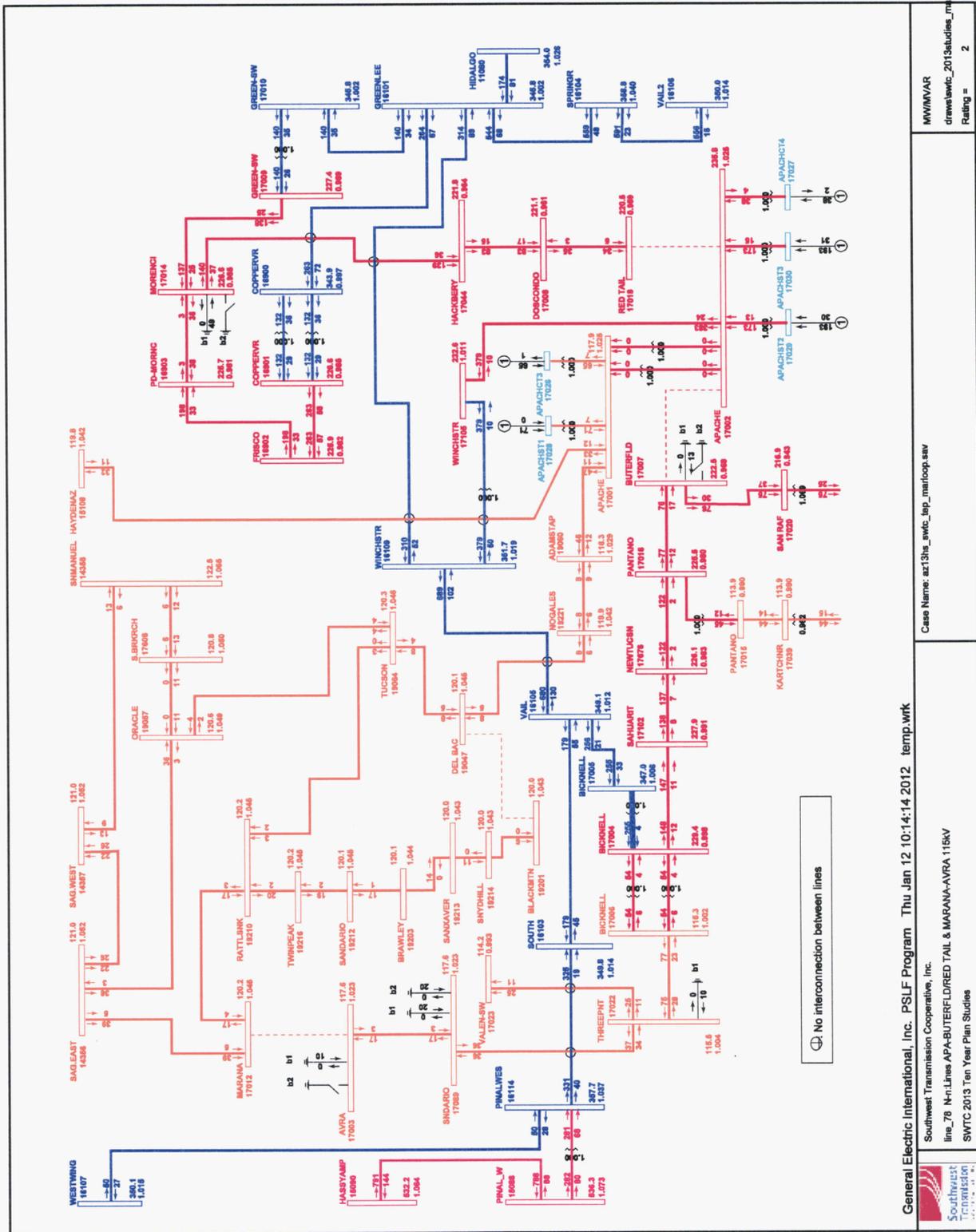
MW/MVAR
 draw:swc_2013studies_mstfbc
 Rating = 2

Case Name: az13hw_etc_inp_mstfbcp.asv

General Electric International, Inc. PSLF Program Thu Jan 12 10:14:07 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_76 Non-COMMON CORRIDOR LINES OUT OF APACHE
 SWTC 2013 Ten Year Plan Studies



2013HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV, Apache to Redtail 230 kV and Marana to Avra 115 kV Lines out of service



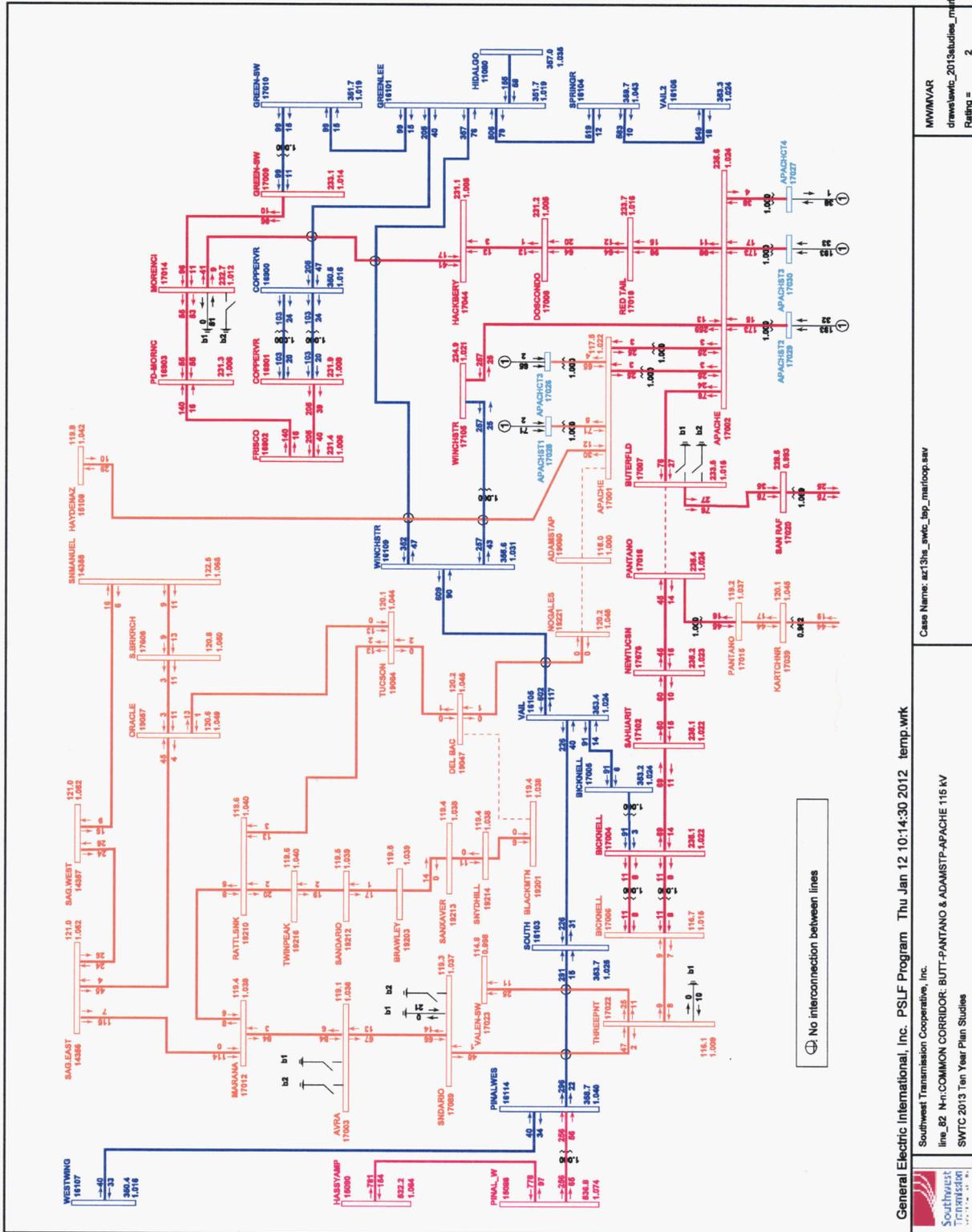
General Electric International, Inc. PSFL Program Thu Jan 10 10:14:14 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
 line_78_N-n.Lines.APA-BUTTERFIELD/RED TAIL & MARANA-AVRA 115KV
 SWTC 2013 Ten Year Plan Studies

Case Name: act3hs_swtc_ln_marloop.sav

MW/MVAR
 draws/swtc_2013studies_mfbox
 Rating = 2

2013HS Southwest Transmission Cooperative Base System with Common Corridor: Butterfield to Pantano 230 kV and Adams Tap to Apache 115 kV Lines out of service

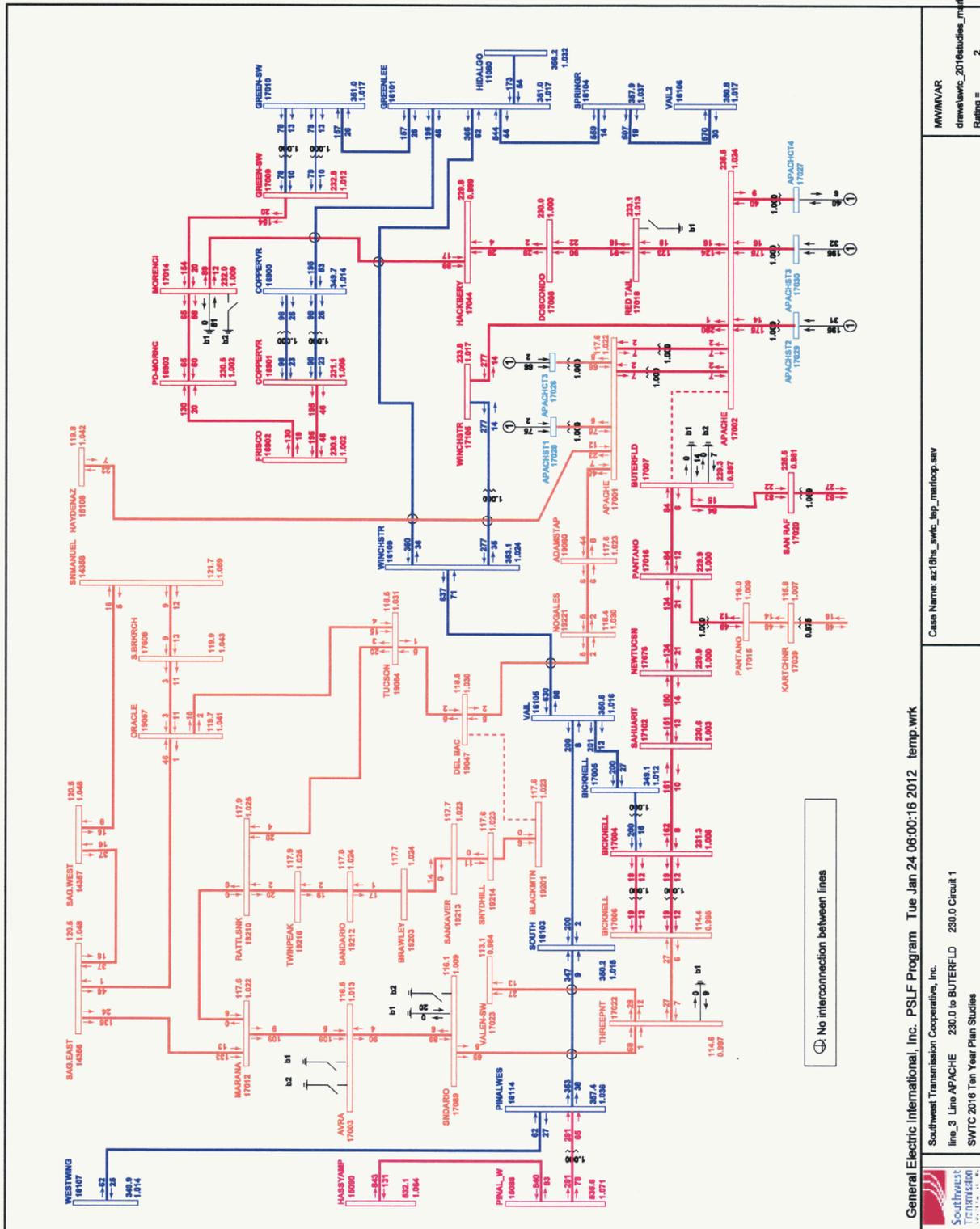


General Electric International, Inc. PSFL Program Thu Jan 12 10:14:30 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_82 N-n:COMMON CORRIDOR: BUTT-PANTANO & ADAMSTP-APACHE 115 kV
 SWTC 2013 Ten Year Plan Studies

Case Name: acr13ha_awc_lap_mstloop.saw

MW/MVAR
 drawslawtc_2013studies_mstloop
 Rating = 2

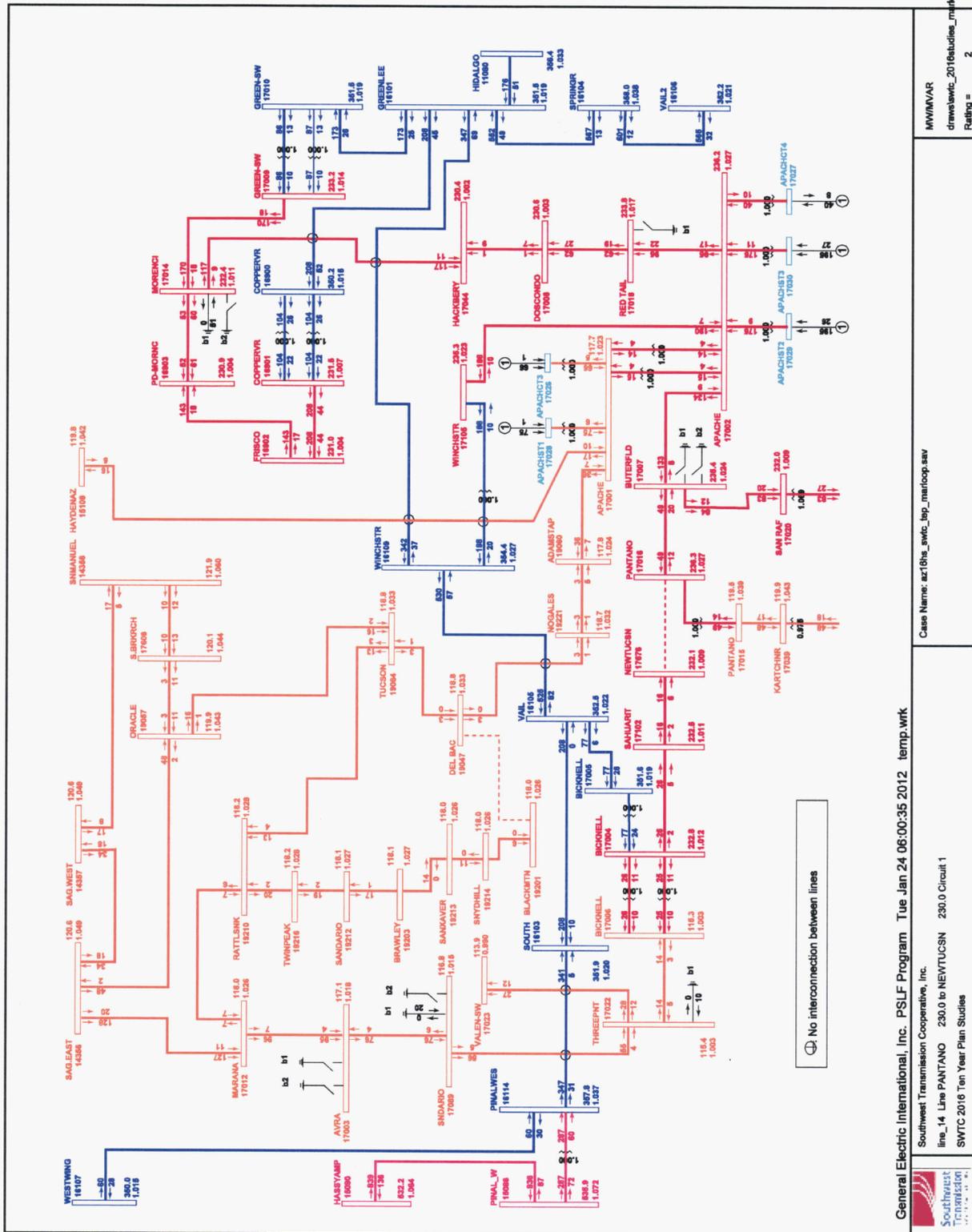
2016HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV Line out of service



General Electric International, Inc. PSLF Program Tue Jan 24 06:00:16 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_3 Line APACHE 230.0 to BUTERFIELD 230.0 Circuit 1
 SWTC 2016 Ten Year Plan Studies

Case Name: az18hs_wmc_bsp_mainloop.saw
 MW/MVAR
 drawbwtc_2016studies_mfbox
 Rating = 2

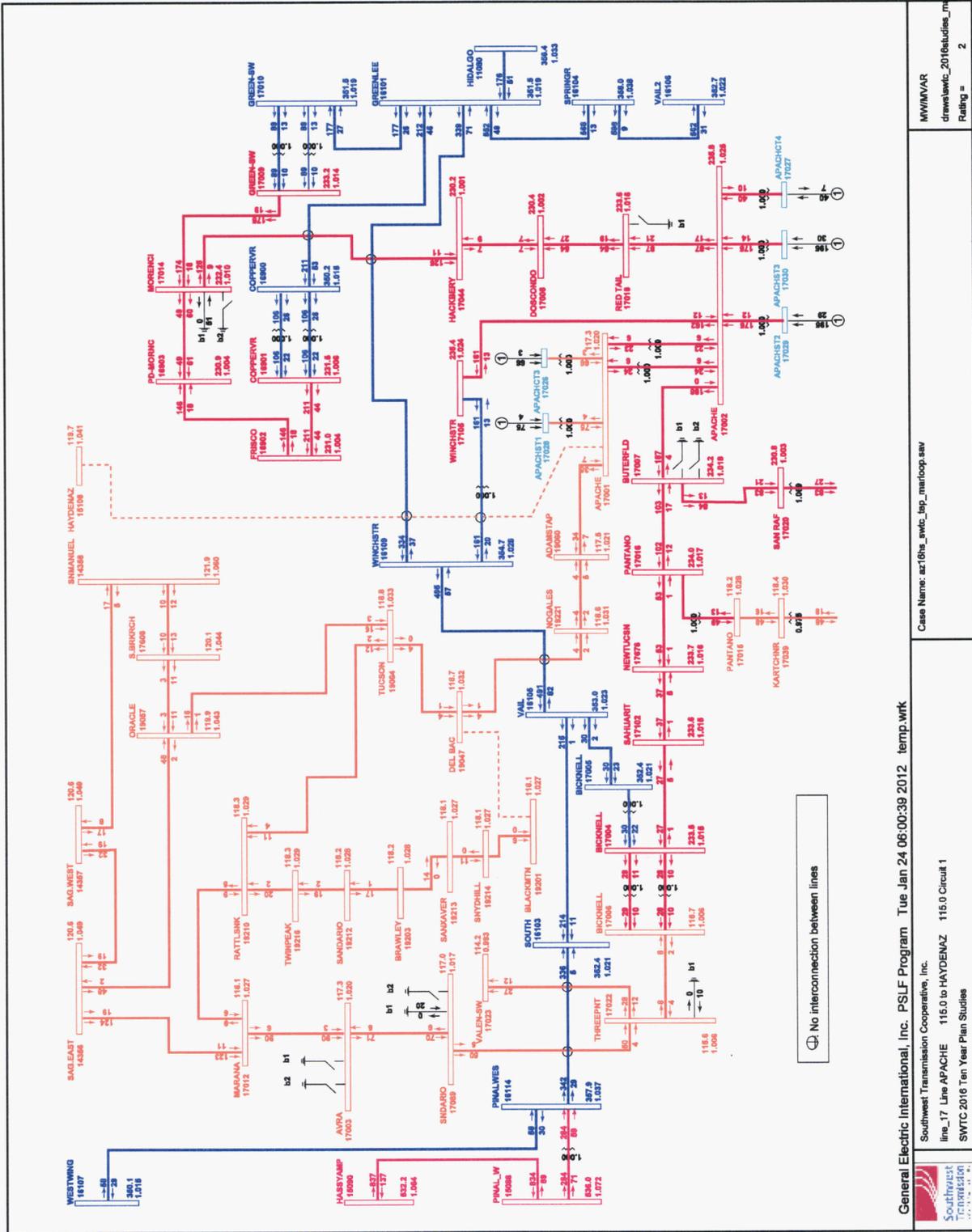
2016HS Southwest Transmission Cooperative Base System with Pantano to New Tucson 230 kV Line out of service



General Electric International, Inc. PSIF Program Tue Jan 24 06:00:35 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_14 Line PANTANO 230.0 to NEWTUCSN 230.0 Circuit 1
 SWTC 2016 Ten Year Plan Studies

Case Name: az\this_ewc_bep_mstloop.sav
 MW/MVAR
 drawtwc_2016studies_mfbox
 Rating = 2

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



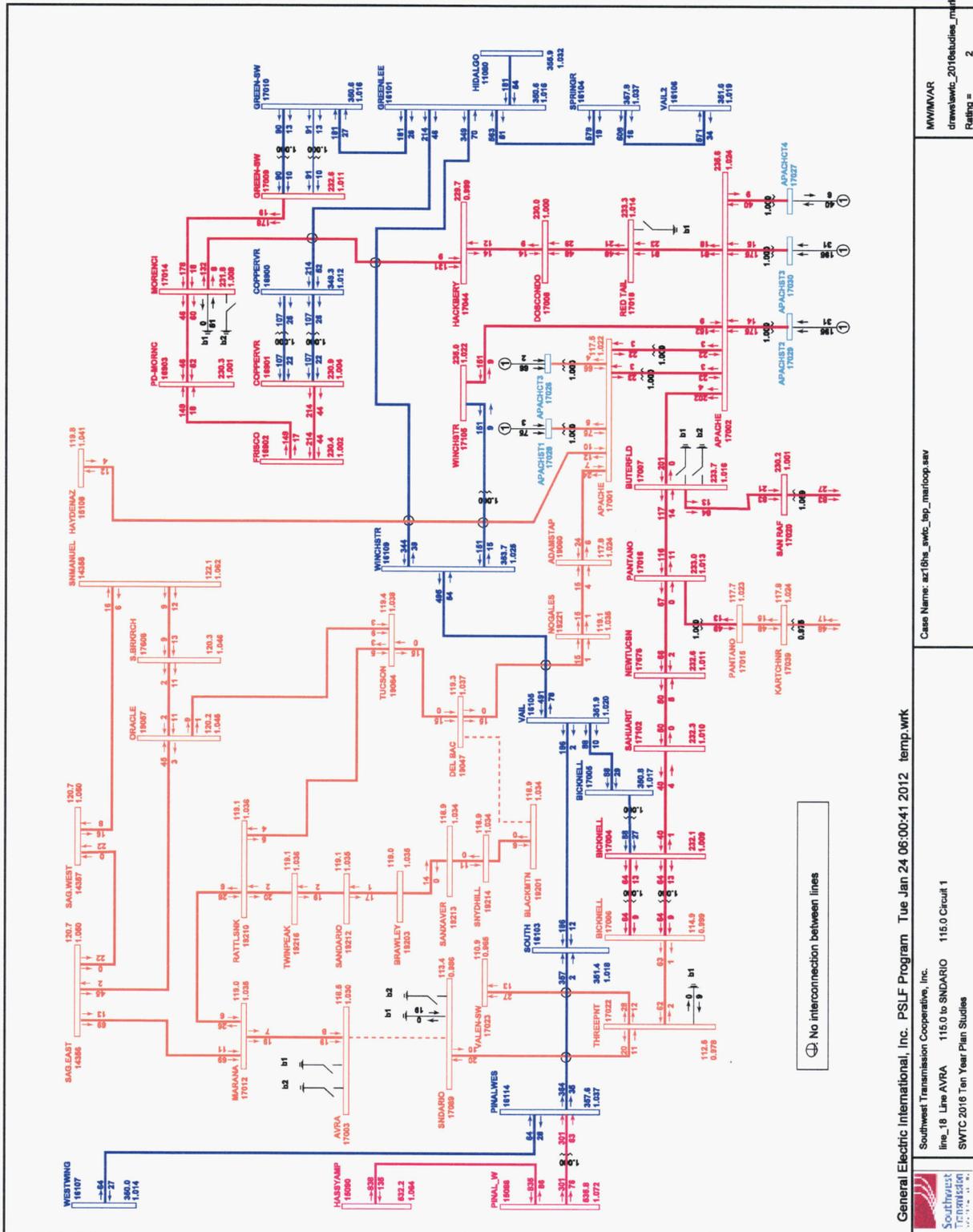
General Electric International, Inc. PSLF Program Tue Jan 24 06:00:39 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
 line_17 Line APACHE 115.0 to HAYDENAZ 115.0 Circuit 1
 SWTC 2016 Ten Year Plan Studies

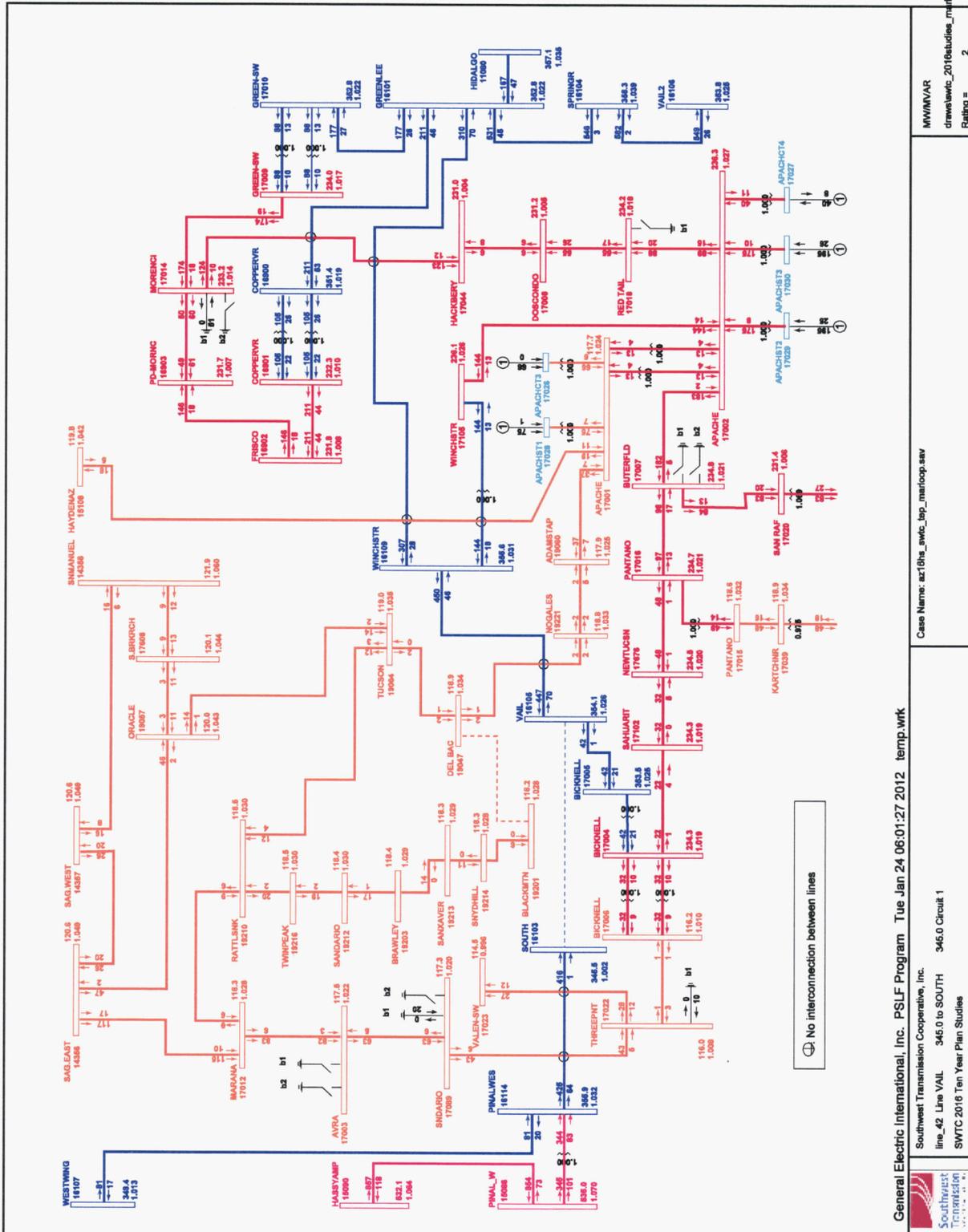
Case Name: acf\the_wmc_lap_marloop.sav

MW/MVAR
 drawbwrc_2016studies_mjfox
 Rating = 2

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



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

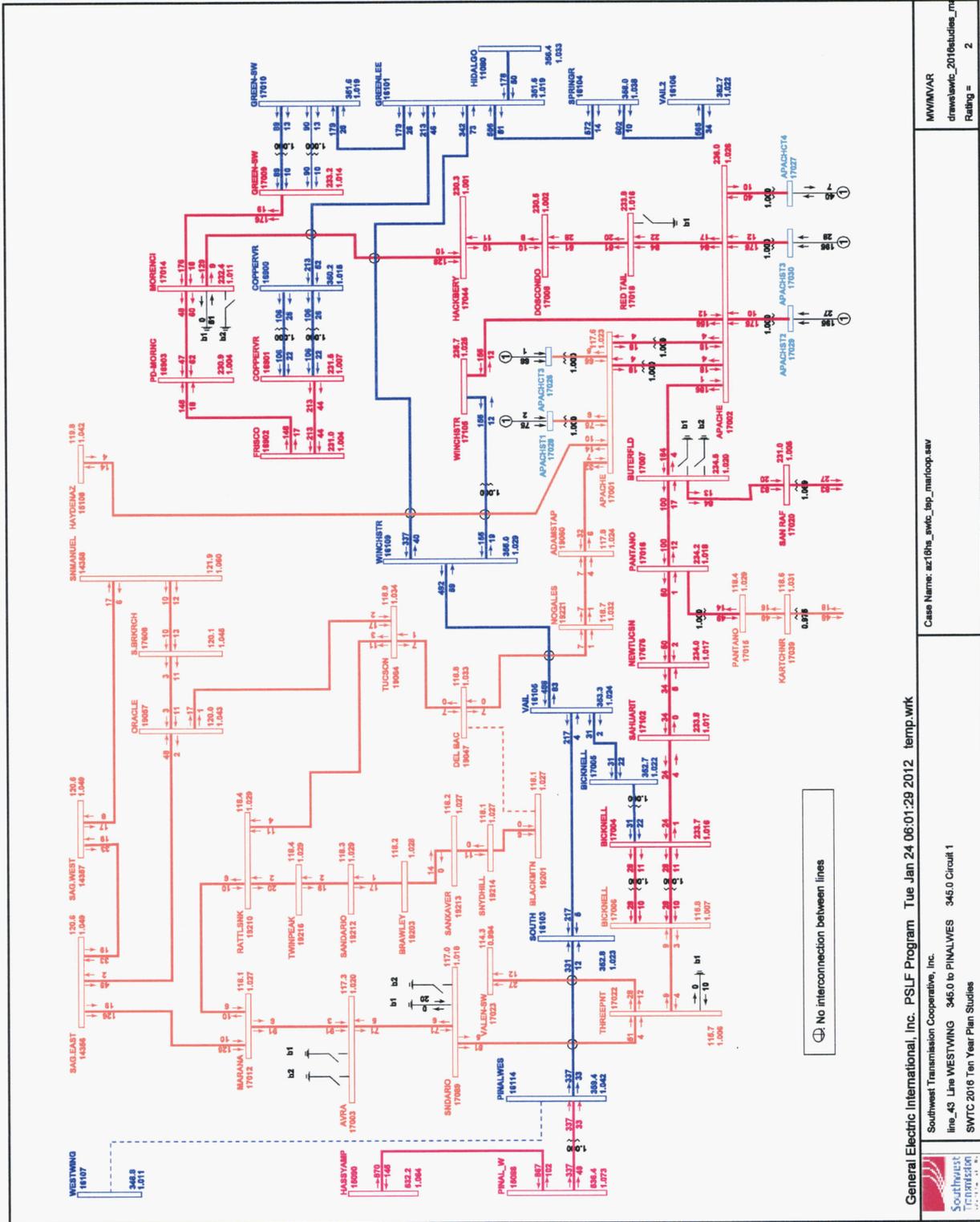


General Electric International, Inc. PSLE Program Tue Jan 24 06:01:27 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_42 Line VAIL 345.0 to SOUTH 345.0 Circuit 1
 SWTC 2016 Ten Year Plan Studies

Case Name: act19hs_abc_1ap_maintoo.saw

MMWVAR
 drawnwvc_2016studias_mf1.doc
 Rating = 2

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



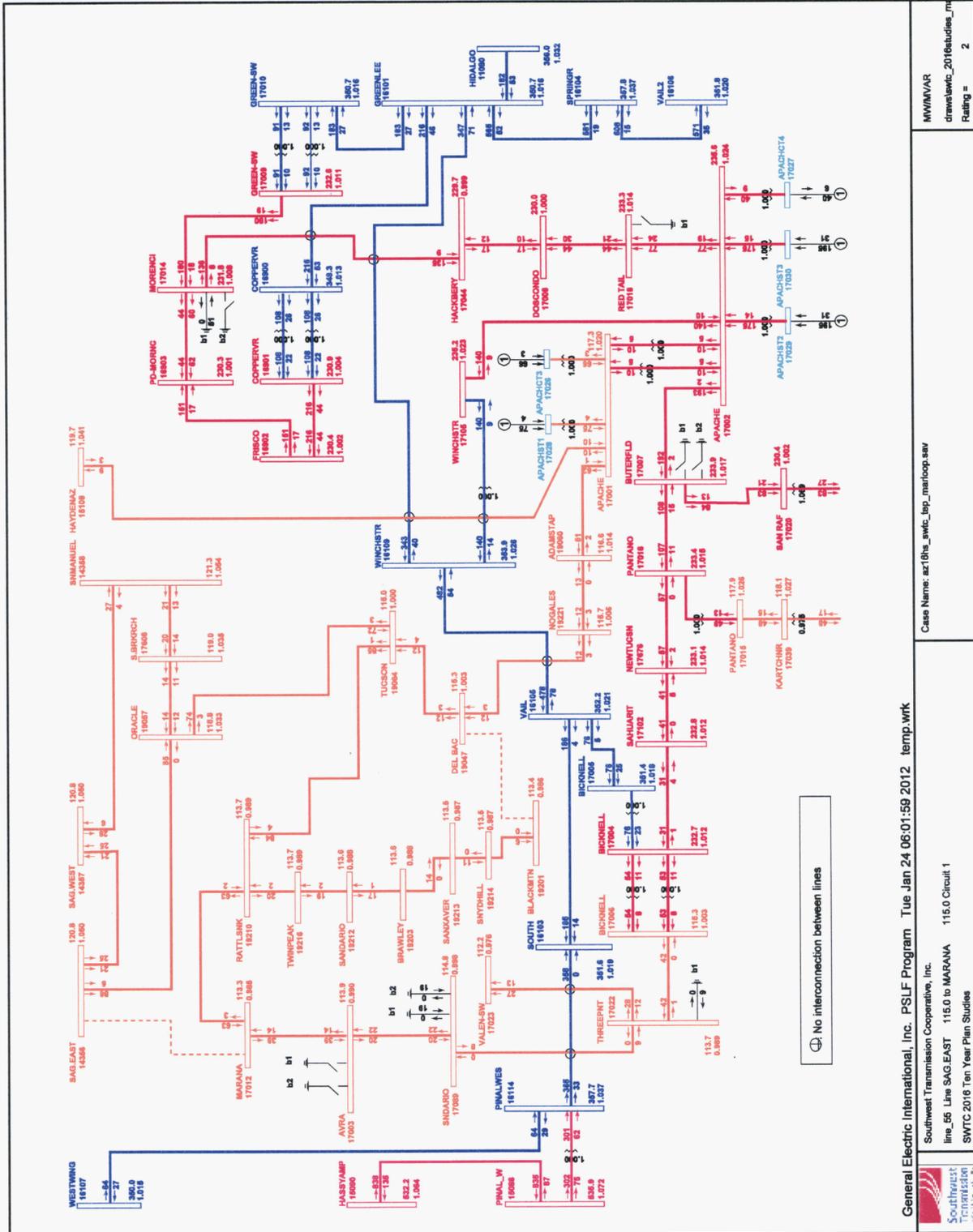
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 Rating = 2

MMWAVAR
 drawlswtc_2016studies_mariopaw

General Electric International, Inc. PSFL Program Tue Jan 24 06:01:29 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_43 Line WESTWING 345.0 to PINALWEST 345.0 Circuit 1
 SWTC 2016 Ten Year Plan Studies

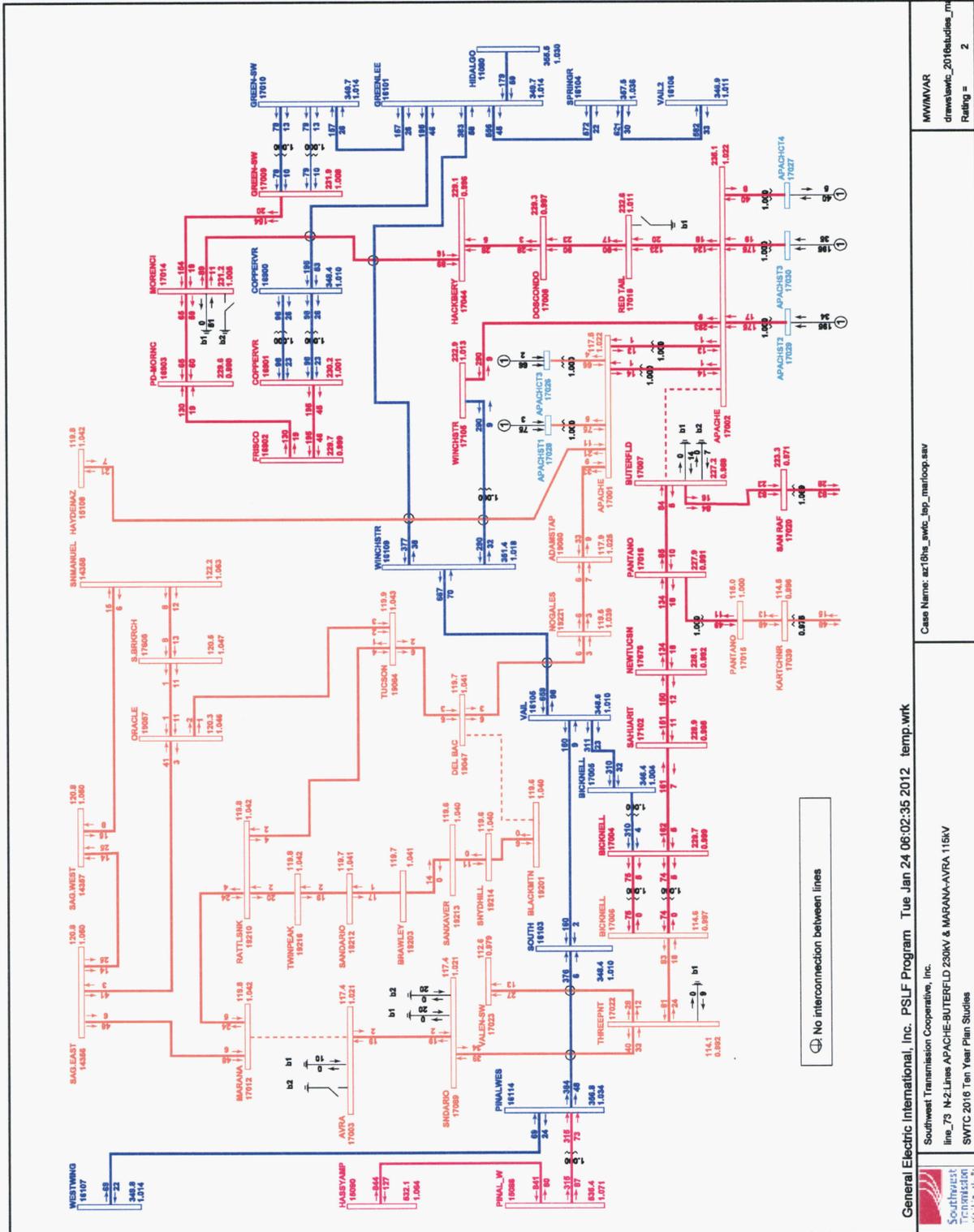


2016HS Southwest Transmission Cooperative Base System with Saguro East to Marana 115 kV Line out of service



General Electric International, Inc. PSLE Program Tue Jan 24 06:01:59 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_05 Line SAG:WEST 115.0 to MARANA
 SWTC 2016 Ten Year Plan Studies
 Case Name: ac218hs_wtc_1eg_mai1oop.sav
 MW/MVAR
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 Rating = 2

2016HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV and Marana to Avra 115 kV Lines of service



⊕ No interconnection between lines

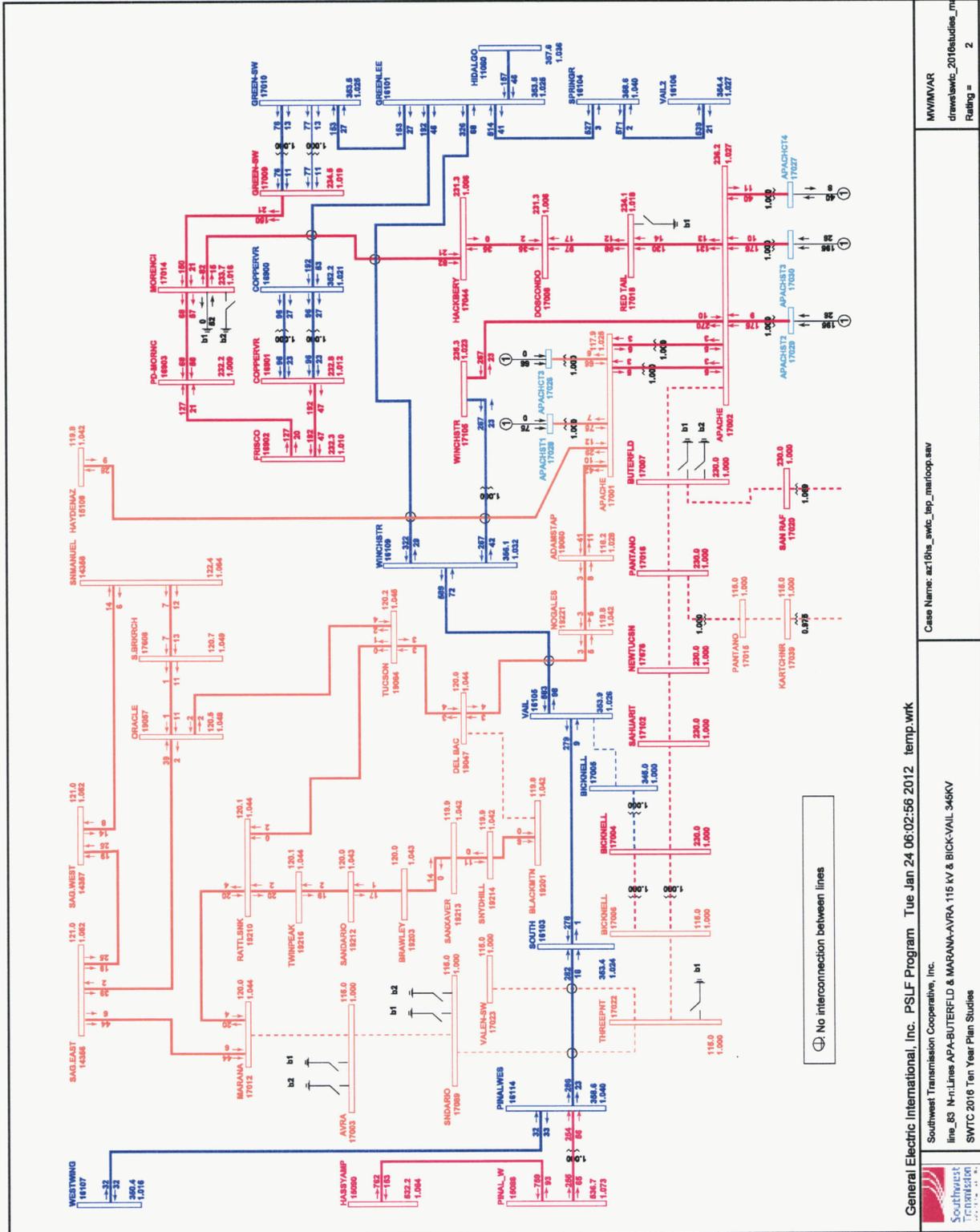
General Electric International, Inc. PSLE Program Tue Jan 24 06:02:35 2012 temp.wk

Southwest Transmission Cooperative, Inc.
line_73 N-2 Lines APACHE-BUTTERFIELD 230KV & MARANA-AVRA 115KV
SWTC 2016 Ten Year Plan Studies

Case Name: az19ha_avec_1ap_marloop.sav

MW/MVAR
drawn by: c_2016studies_mjfbx
Rating = 2

2016HS Southwest Transmission Cooperative Base System with Apache to Butterfield 230 kV, Marana to Avra 115 kV, and Bicknell to Vail 345 kV Lines out of service



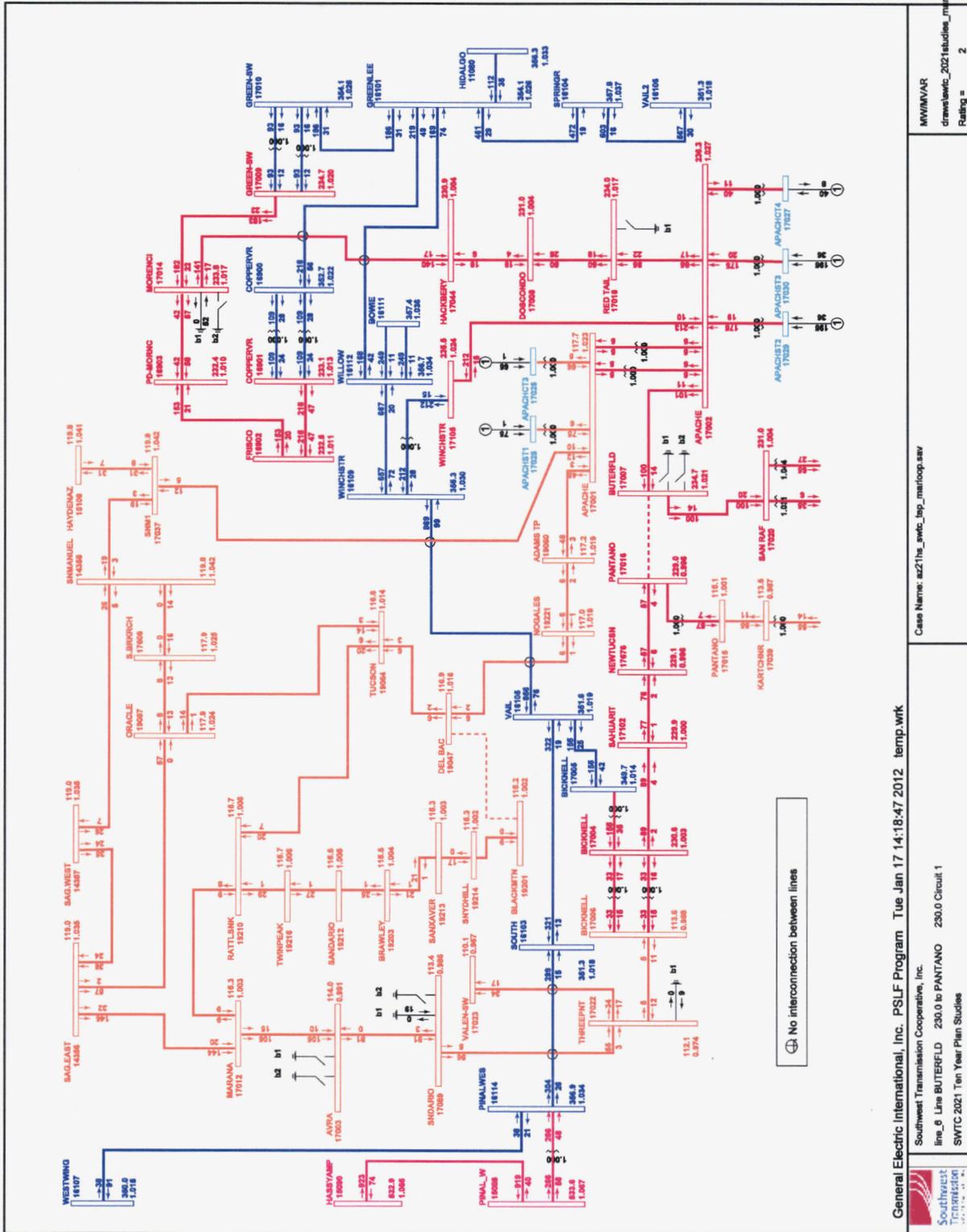
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Southwest Transmission Cooperative, Inc.
 line_B3 N-m-1 Lines APA-BUTTERFIELD & MARANA-AVRA 115 kV & BICK-VAIL 345kV
 SWTC 2016 Ten Year Plan Studies

Case Name: act\lms_swtc_ipc_mainloop.sav

MW/MVAR
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 Rating = 2

2021HS Southwest Transmission Cooperative Base System with Butterfield to Pantano 230 kV Line out of service

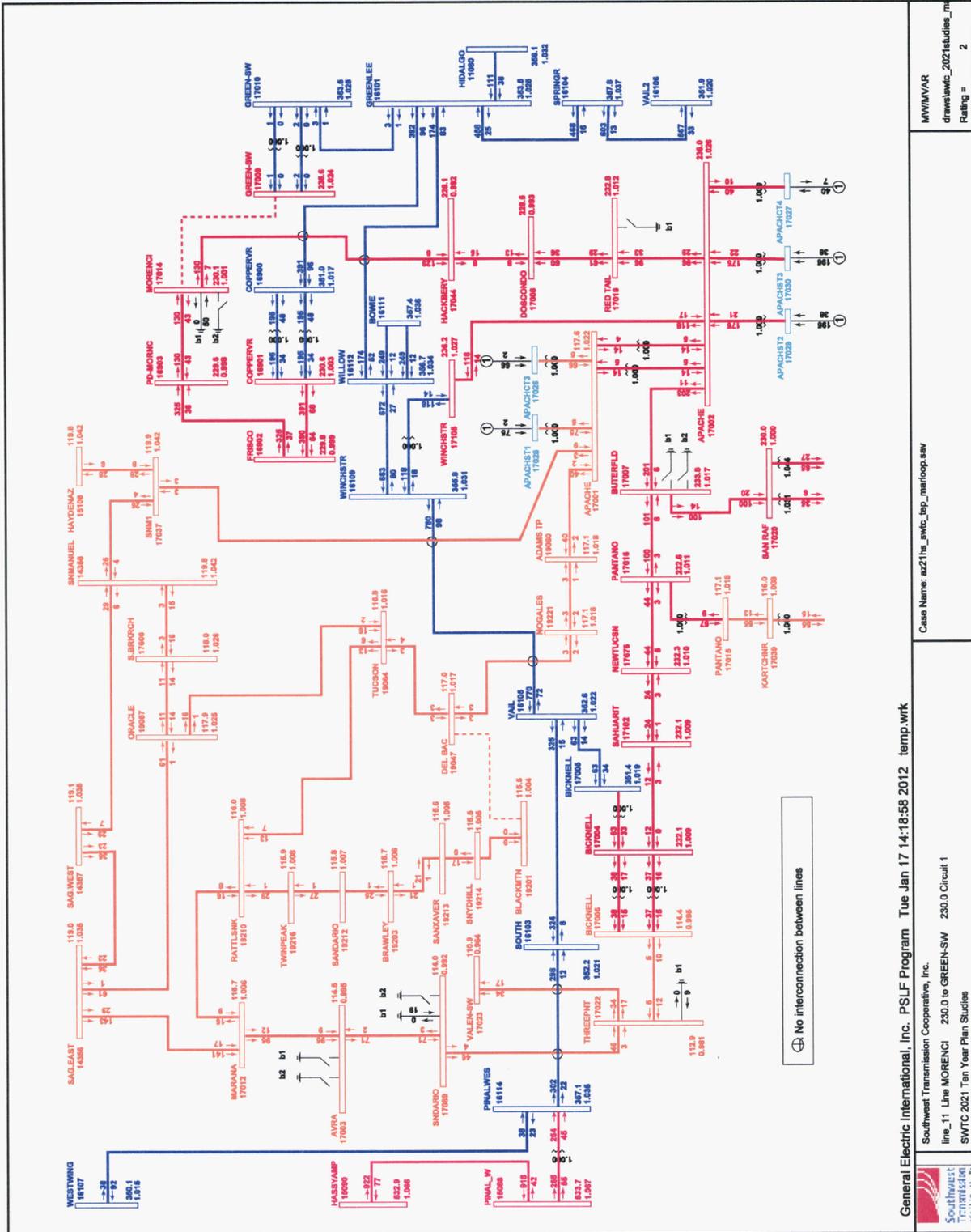


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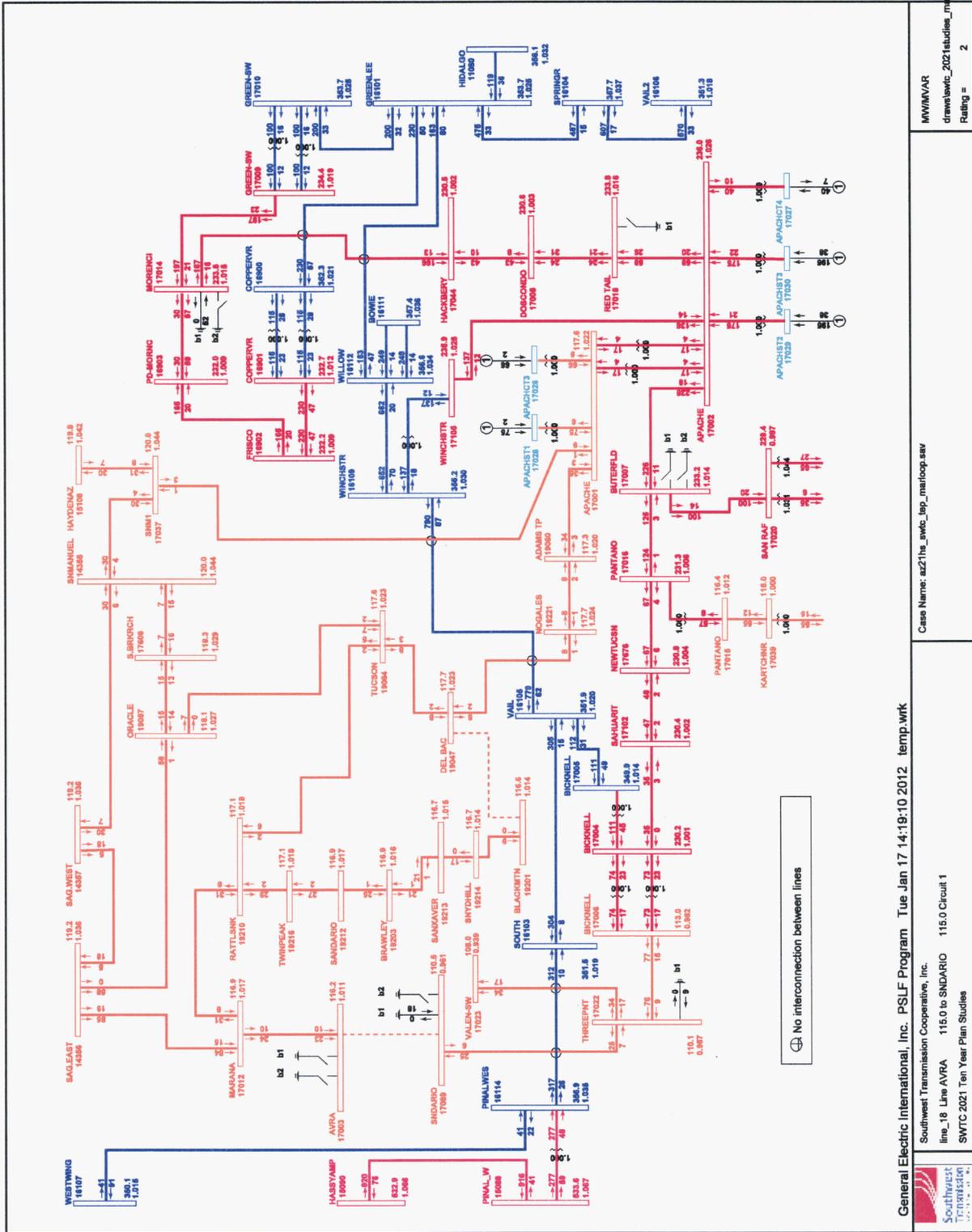
General Electric International, Inc. PSLF Program Tue Jan 17 14:18:47 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 Line_6 Line BUTTERFIELD 230.0 to PANTANO 230.0 Circuit 1
 SWTC 2021 Ten Year Plan Studies

SWTC 2021 Ten Year Plan Studies
 Southwest Transmission Cooperative, Inc.
 Line_6 Line BUTTERFIELD 230.0 to PANTANO 230.0 Circuit 1
 SWTC 2021 Ten Year Plan Studies

2021HS Southwest Transmission Cooperative Base System with Morenci to Greenlee 230 kV Line out of service



2021HS Southwest Transmission Cooperative Base System with Avra to Sandario 115 kV Line out of service

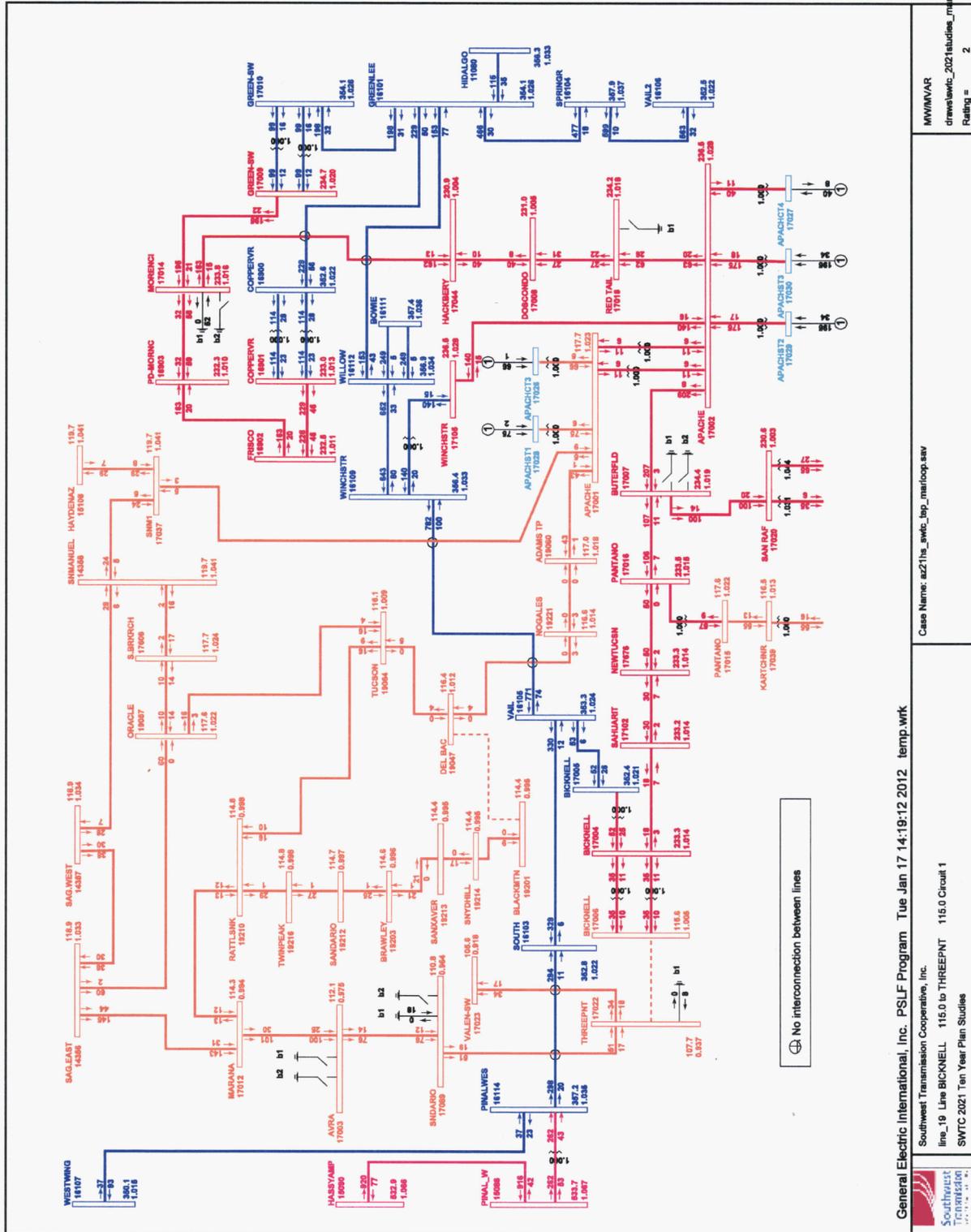


General Electric International, Inc. PSFL Program Tue Jan 17 14:19:10 2012 temp.wk
 Southwest Transmission Cooperative, Inc.
 line_18 Line AVRA 115.0 to SANDARIO 115.0 Circuit 1
 SWTC 2021 Ten Year Plan Studies

Case Name: sz21hs_etc_lep_marloop.sav

MWM/AR
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 Rating = 2

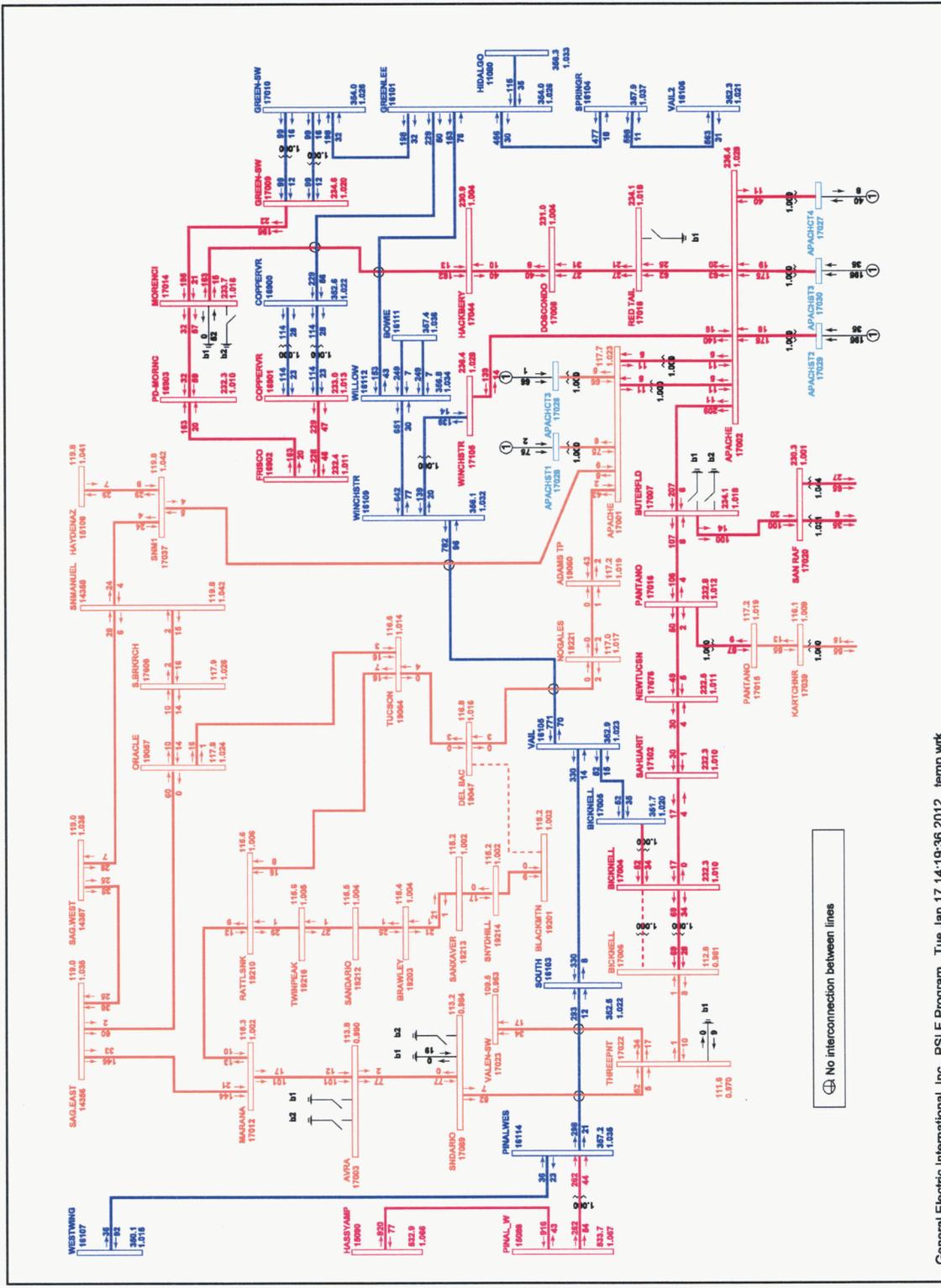
2021HS Southwest Transmission Cooperative Base System with Bicknell to Three Points 115 kV Line out of service



General Electric International, Inc. PSLF Program Tue Jan 17 14:19:12 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_19 Line BICKNELL 115.0 to THREEPNT 115.0 Circuit 1
 SWTC 2021 Ten Year Plan Studies

Case Name: az21ha_etc_log_mainloop.sav
 Rating = 2

2021HS Southwest Transmission Cooperative Base System with one Bicknell 230/115 kV Transformer out of service

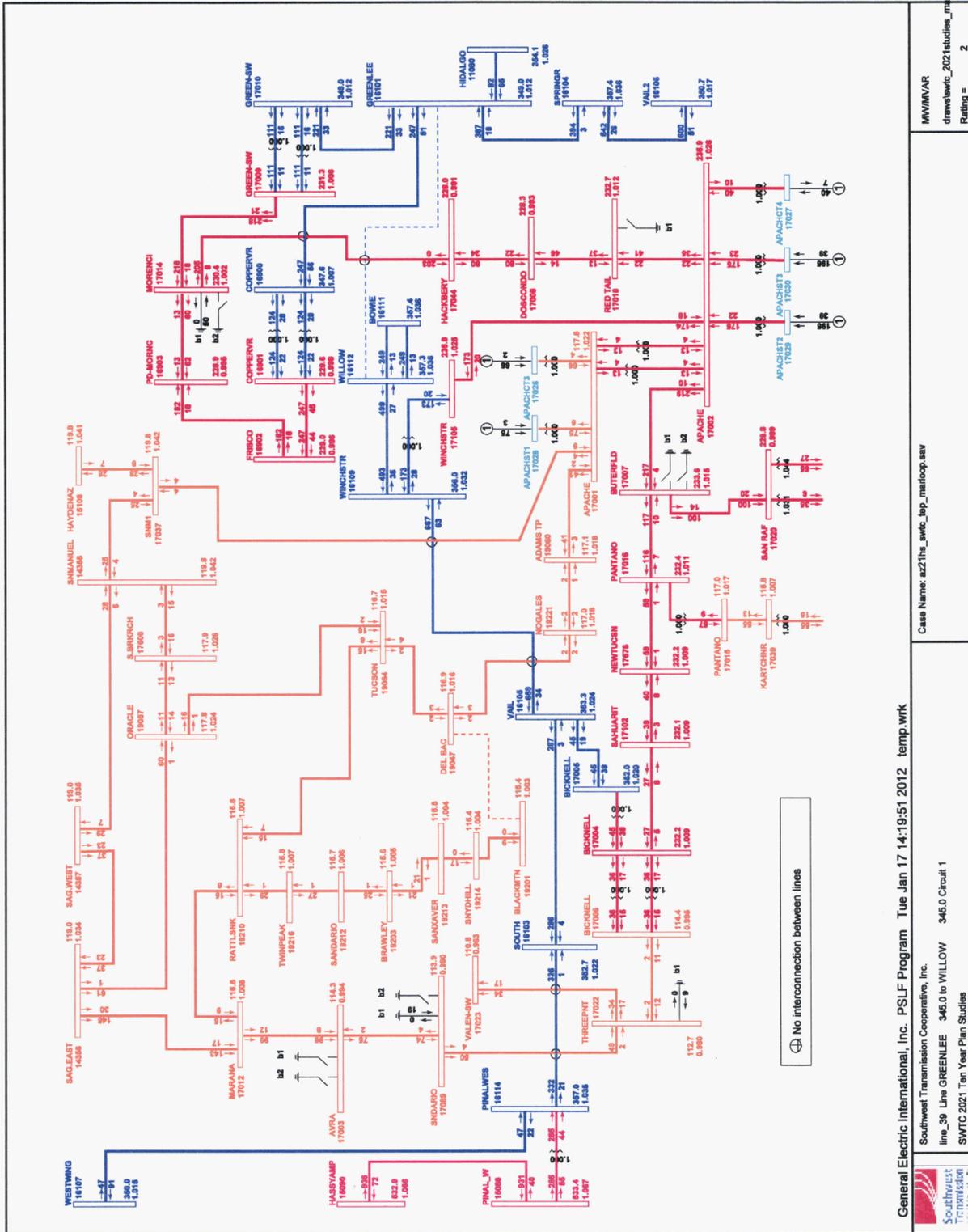


General Electric International, Inc. PSFL Program Tue Jan 17 14:19:36 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 tran_32 Tran BICKNELL 230.00 to BICKNELL 115.00 Circuit 1
 SWTC 2021 Ten Year Plan Studies

Case Name: az21hs_awc_lap_marloop.sav

MW/MVAR
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 Rating = 2

2021HS Southwest Transmission Cooperative Base System with Greenlee to Willow 345 kV Line out of service



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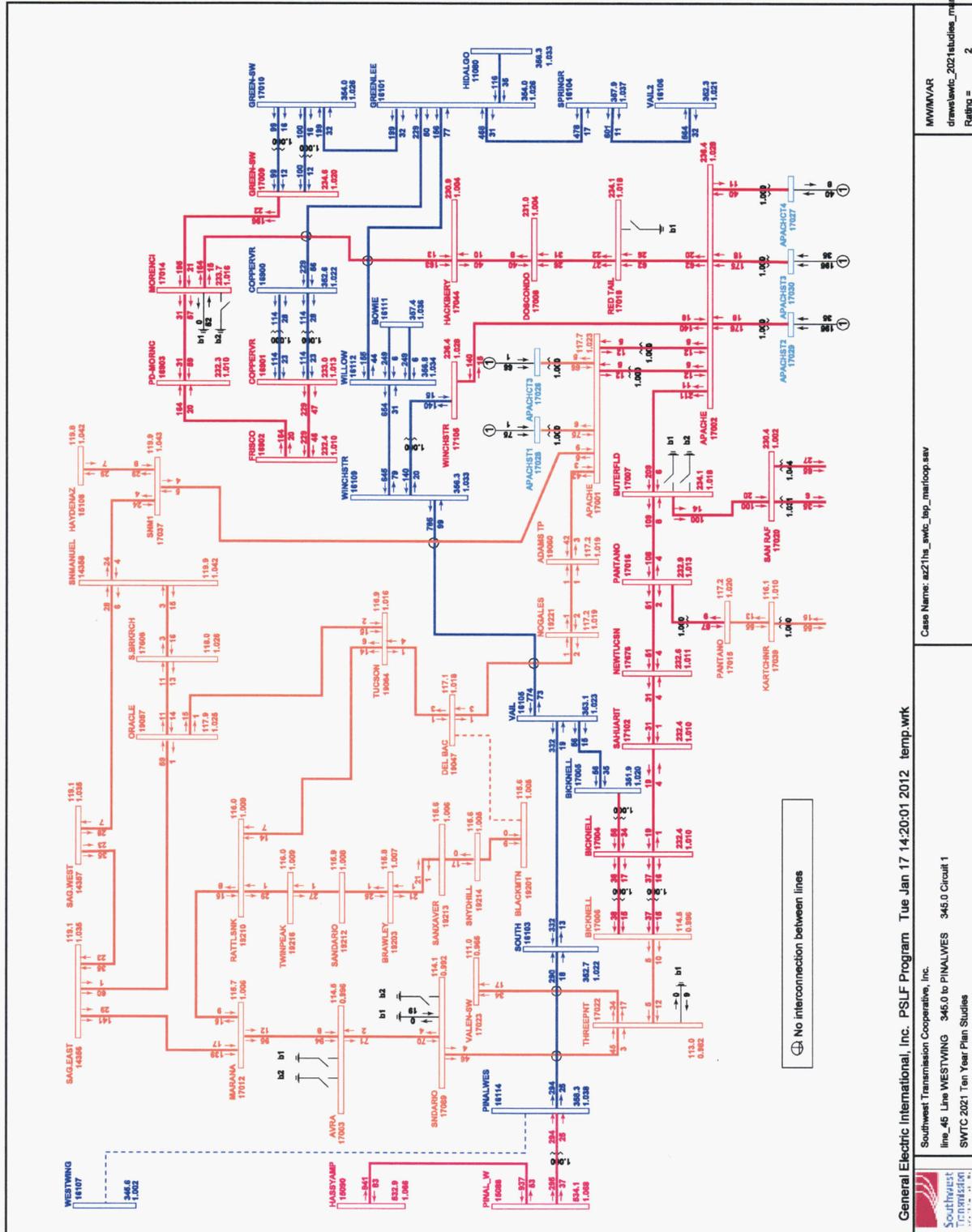
Southwest Transmission Cooperative, Inc.
line_39 Line GREENLEE 345.0 to WILLOW 345.0 Circuit 1
SWTC 2021 Ten Year Plan Studies

Case Name: az21hs_swc_lap_matloop.sav

MW/MVAR
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Rating = 2



2021HS Southwest Transmission Cooperative Base System with Westwing to Pinal West 345 kV Line out of service



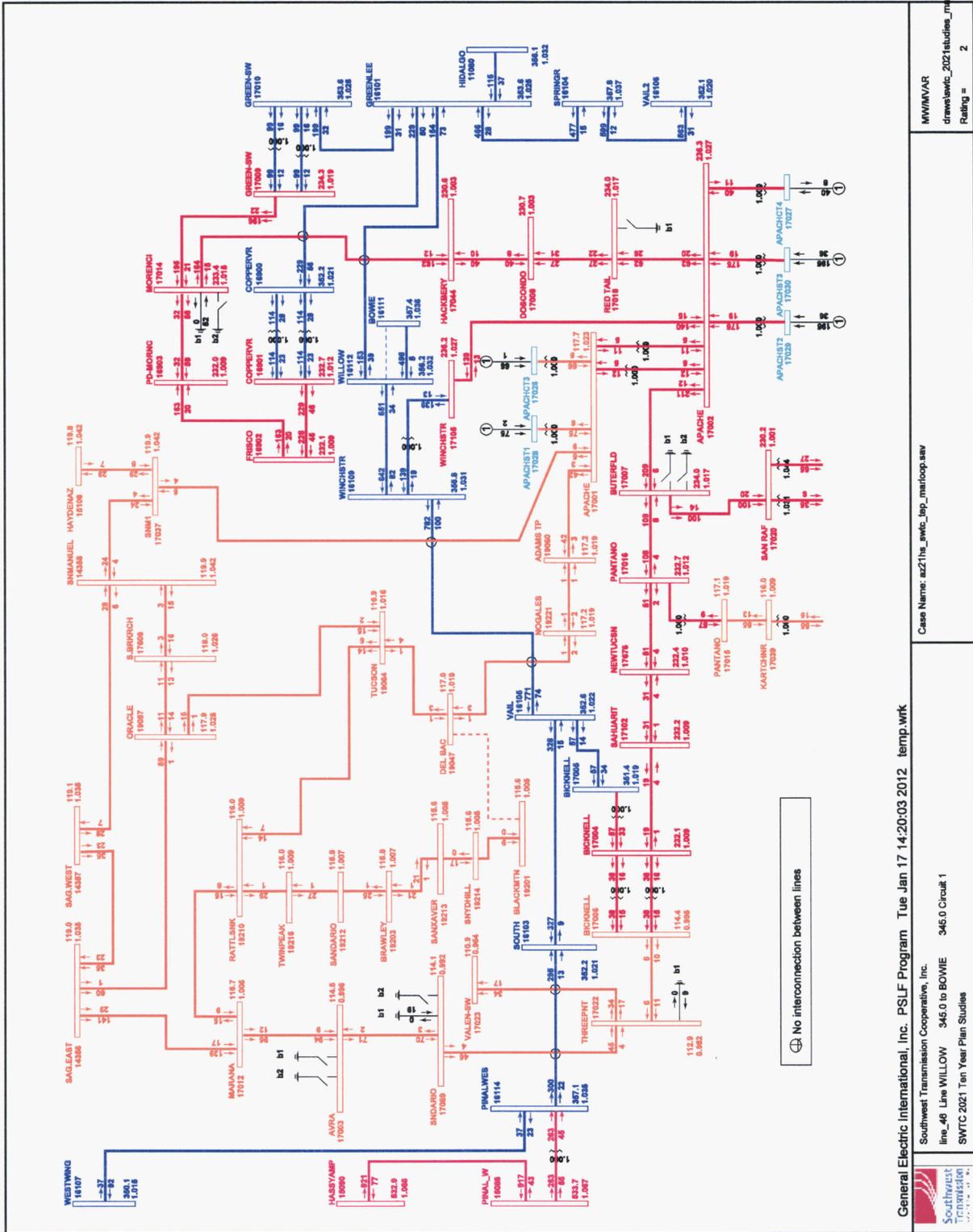
General Electric International, Inc. PSLE Program Tue Jan 17 14:20:01 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
line_46 Line WESTWING 345.0 to PINALWES 345.0 Circuit 1
SWTC 2021 Ten Year Plan Studies

Case Name: az21ha_5wic_top_maintloop.saw

MWIK/AVR
drawslawic_2021studies_maintfox
Rating = 2

2021HS Southwest Transmission Cooperative Base System with one Willow to Bowie 345 kV Line out of service



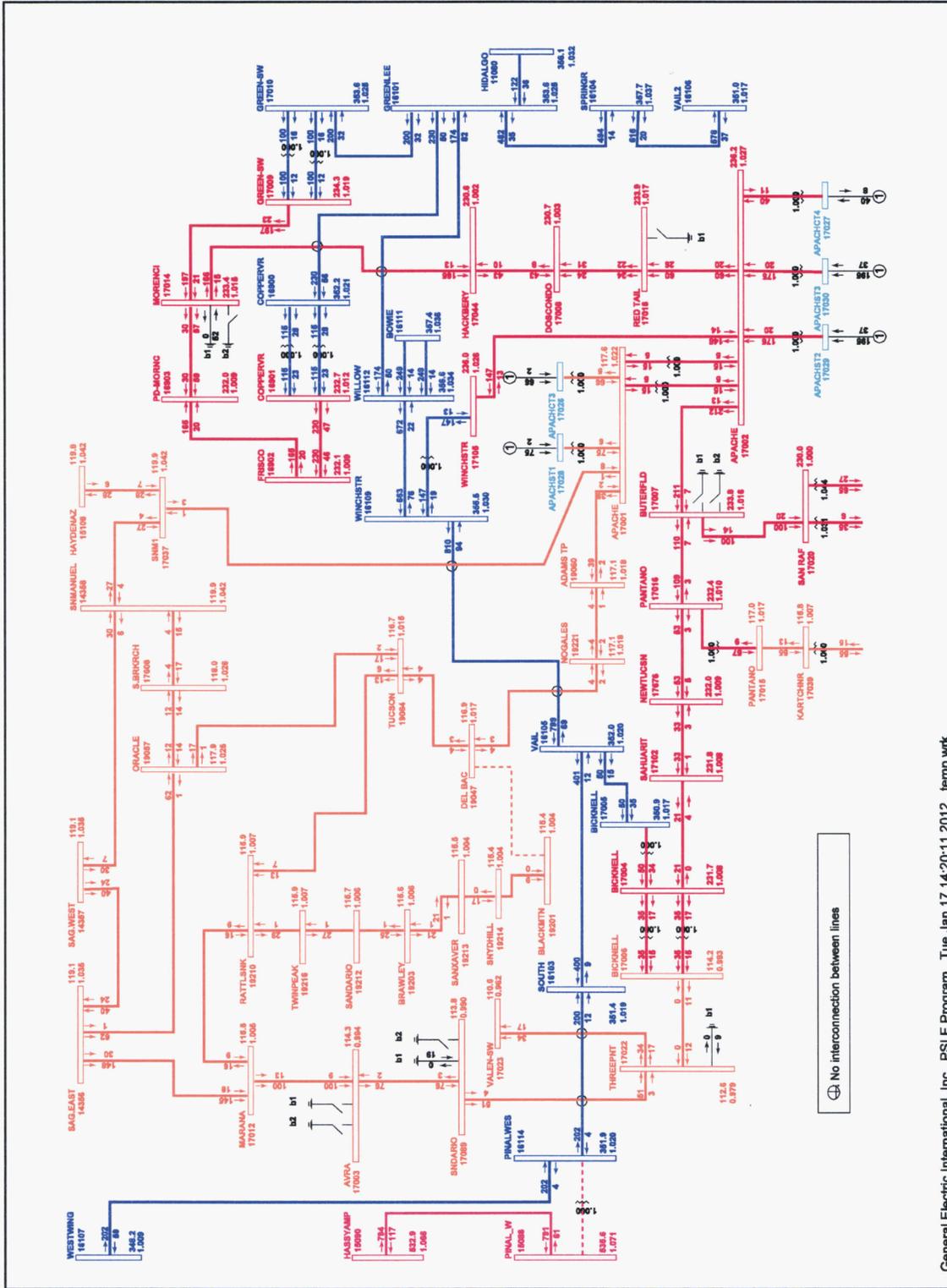
General Electric International, Inc. PSLF Program Tue Jan 17 14:20:03 2012 temp.wrk

Southwest Transmission Cooperative, Inc.
 line_46 Line WILLOW 345.0 to BOWIE 345.0 Circuit 1
 SWTC 2021 Ten Year Plan Studies

Case Name: az21hs_swc_lap_mastloop.sav

MMWAVAR
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 Rating = 2

2021HS Southwest Transmission Cooperative Base System with Pinal West 500/345 kV Transformer out of service

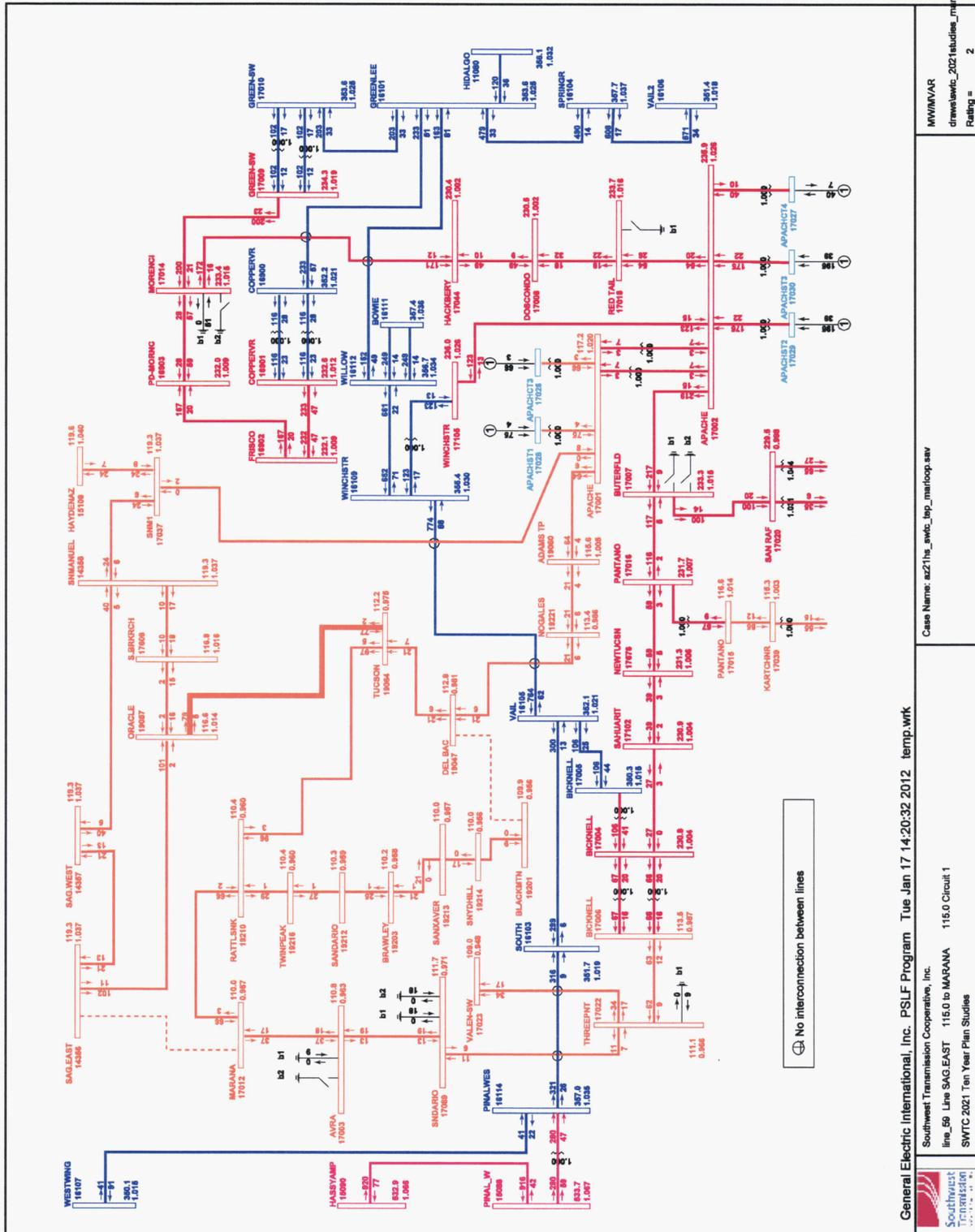


General Electric International, Inc. PSFL Program Tue Jan 17 14:20:11 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 tram_51 Tran PINAL_W 500.00 to PINALWES 345.00 Circuit 1
 SWTC 2021 Ten Year Plan Studies

Case Name: az21ha_swtc_bsp_marioop.sav

MW/MVAR
 drawlewtc_2021studies_marioop
 Rating = 2

2021HS Southwest Transmission Cooperative Base System with Saguaro East to Marana 115 kV Line out of service



Case Name: sz21ha_ewc_top_marioop.saw
 Rating = 2
 MW/MVAR
 drawlenc_2021studie_mufoc
 General Electric International, Inc. PSLE Program Tue Jan 17 14:20:32 2012 temp.wrk
 Southwest Transmission Cooperative, Inc.
 line_56 Line SAG-EAST 115.0 to MARANA 115.0 Circuit 1
 SWTC 2021 Ten Year Plan Studies

APPENDIX D

TRANSIENT STABILITY PLOTS

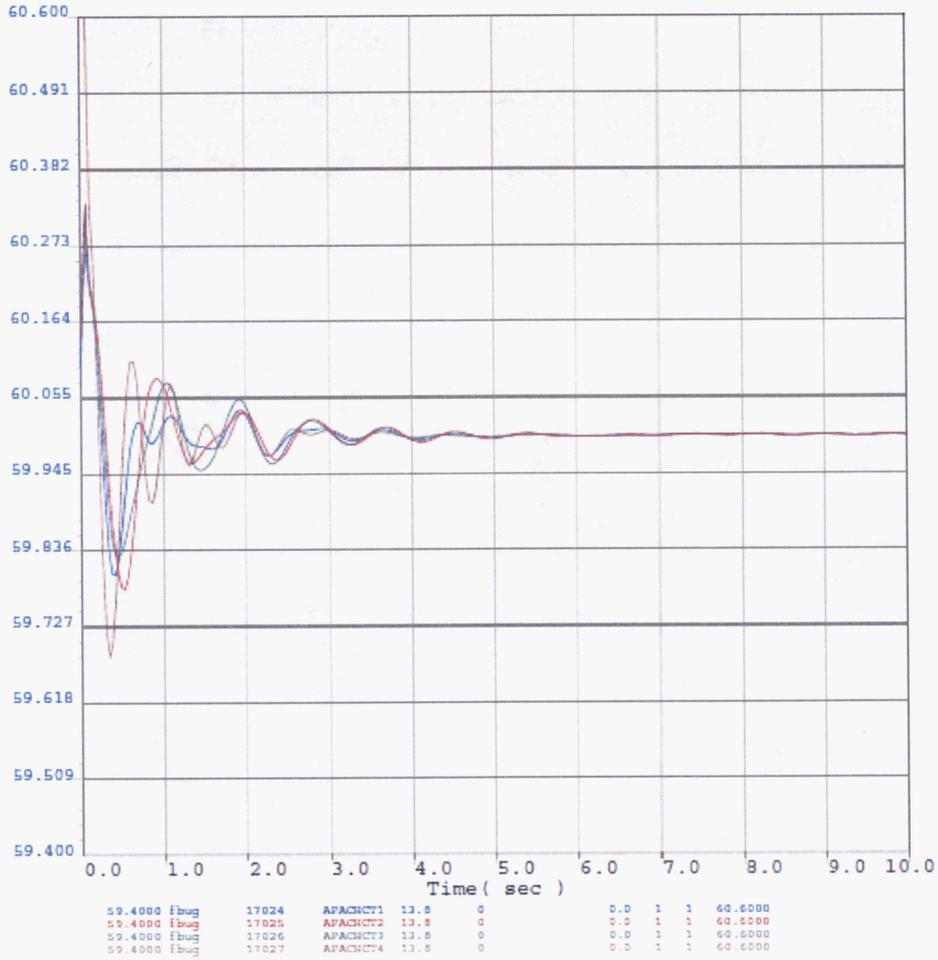
2012 Plots:

Apache – Butterfield 230 kV Outage	206
Apache – Redtail 230 kV Outage	212
Bicknell – Vail 345 kV Outage	218
Marana Tap – Marana 115 kV Outage.	224
Apache – Butterfield 230 kV & Marana Tap – Marana 115 kV Outage	230
Apache – Butterfield 230 kV & Bicknell – Vail 345 kV Outage.	234

2016 Plots:

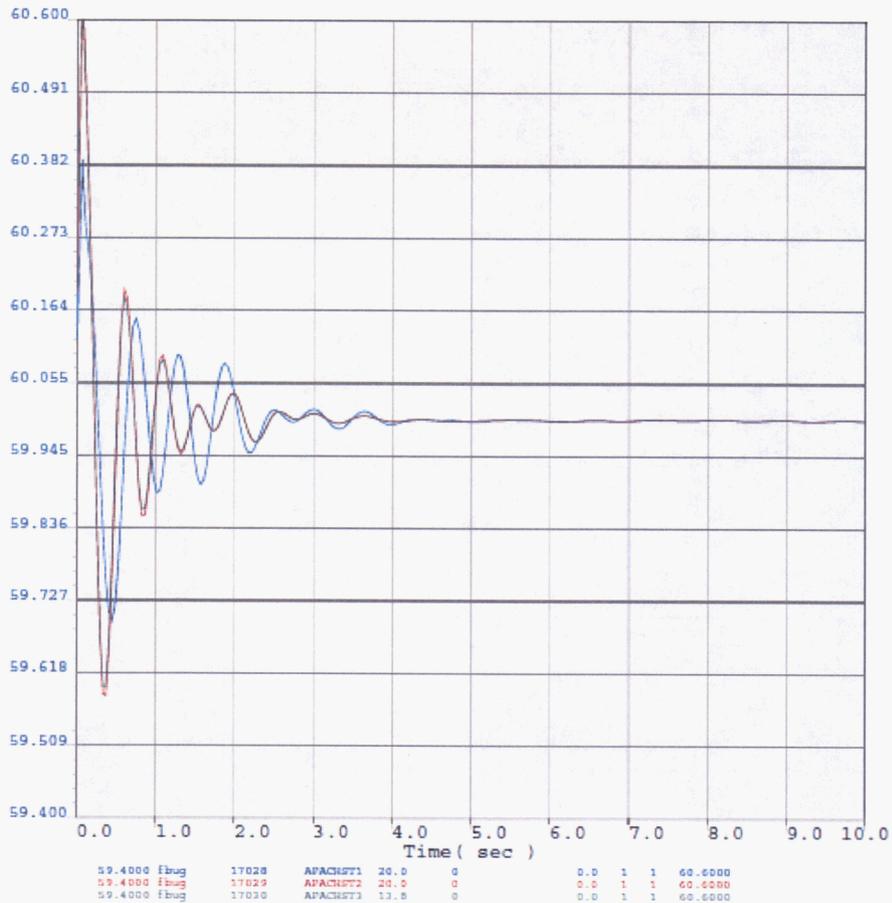
Apache – Butterfield 230 kV Outage	238
Apache – Redtail 230 kV Outage	244
Bicknell – Vail 345 kV Outage	250
Apache – Butterfield 230 kV & Bicknell – Vail 345 kV Outage.	256

APACHE-BUTTERFLD-230 kV
 2012 Heavy Summer
 Generator Frequency Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

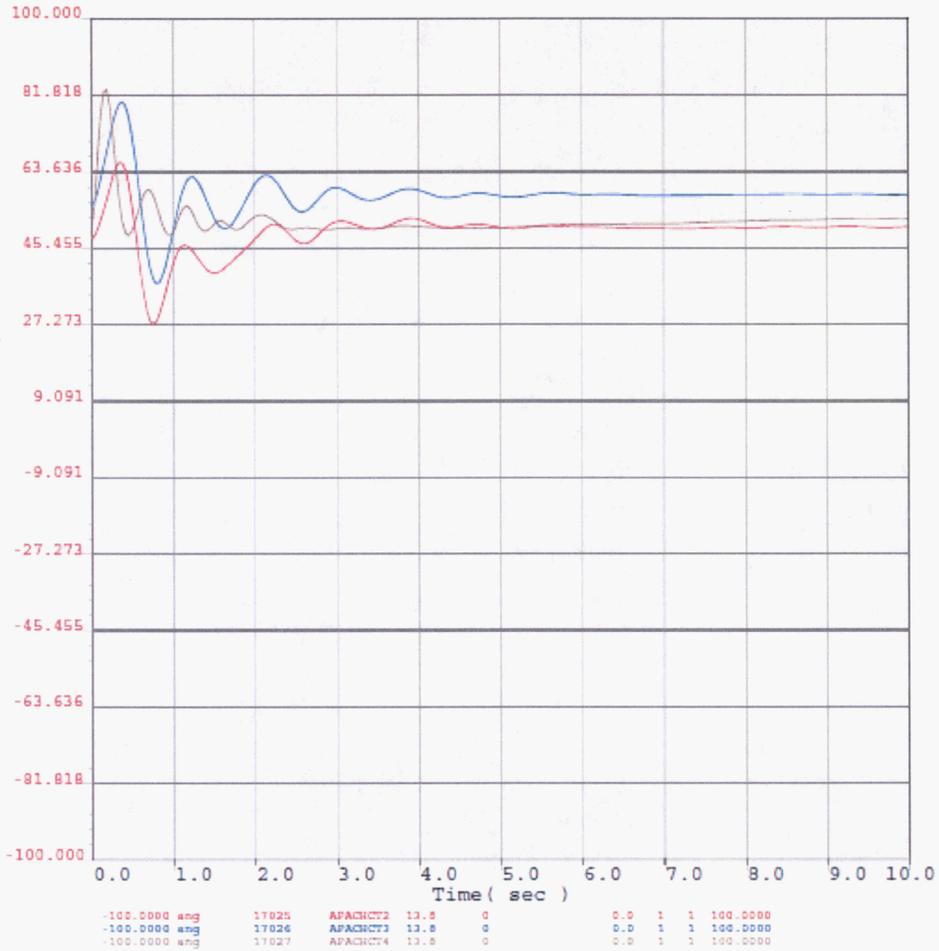
APACHE-BUTTERFLD-230 kV
 2012 Heavy Summer
 Generator Frequency Plots



2012 HS case
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 developed from WECC 2014 HS3-SA APPROVED BASE CASE



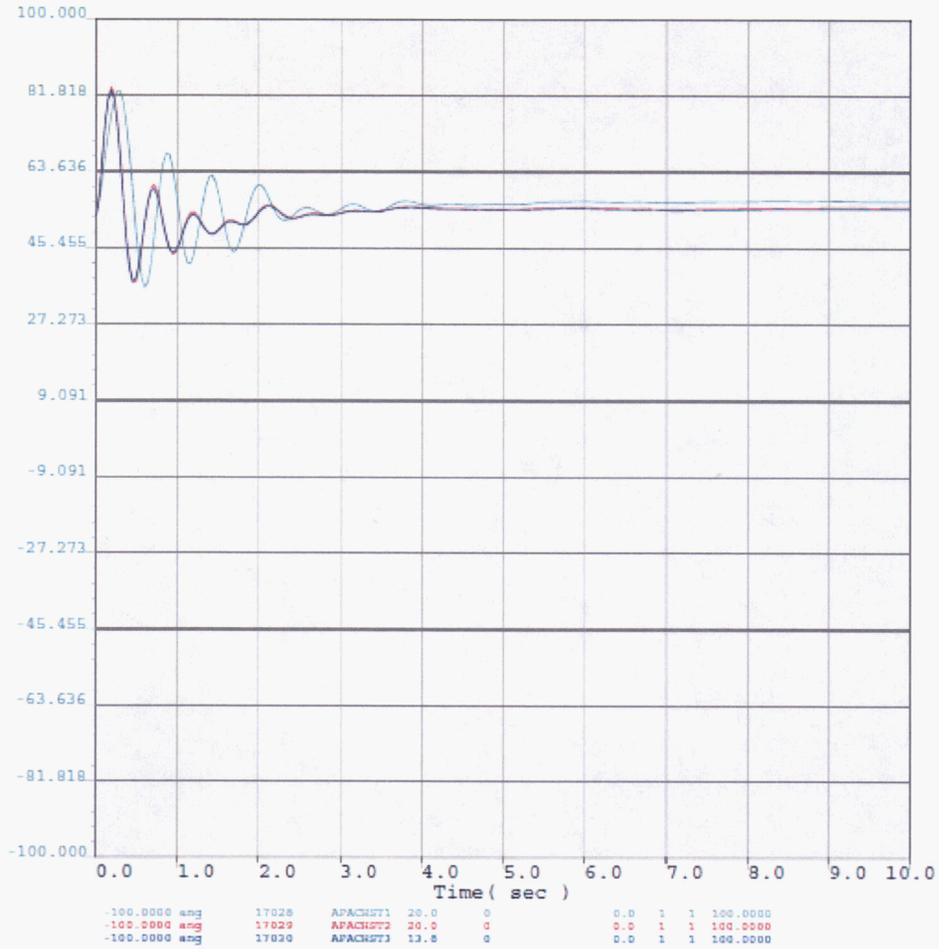
APACHE-BUTTERFLD-230 kV
 2012 Heavy Summer
 Generator Angle Plots



2012 HS case
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 developed from WECC 2014 HS3-SA APPROVED BASE CASE

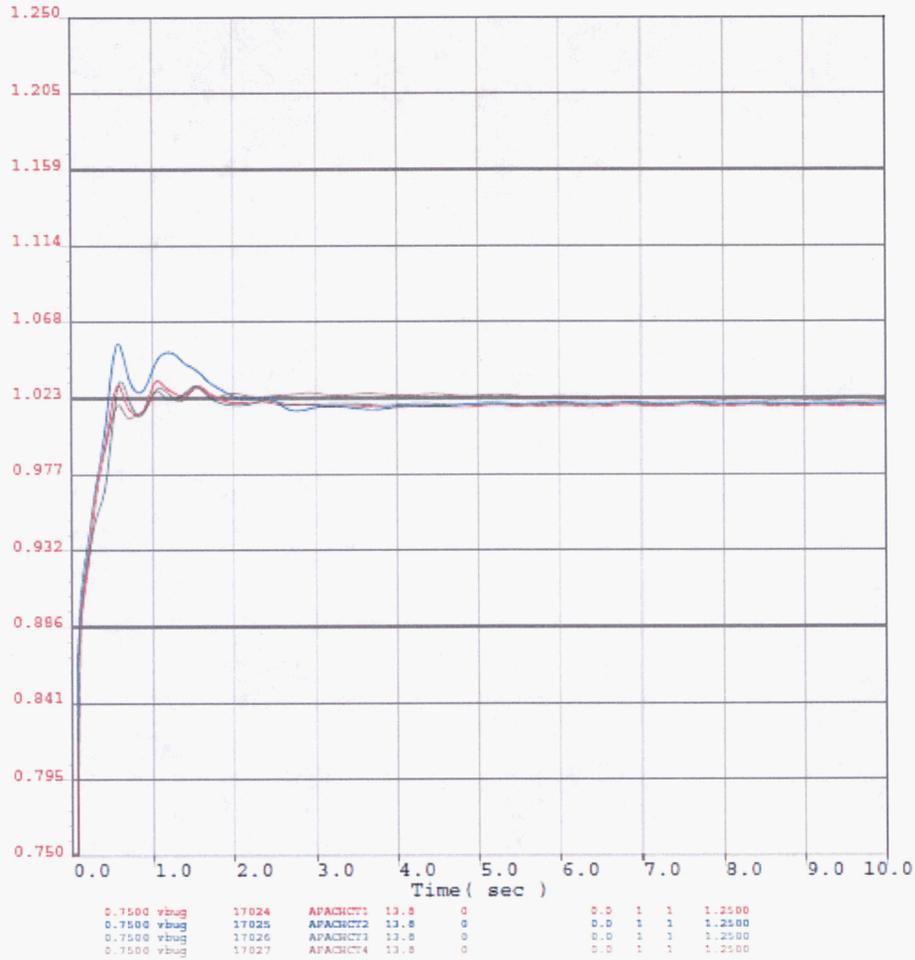


APACHE-BUTTERFLD-230 kV
 2012 Heavy Summer
 Generator Angle Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

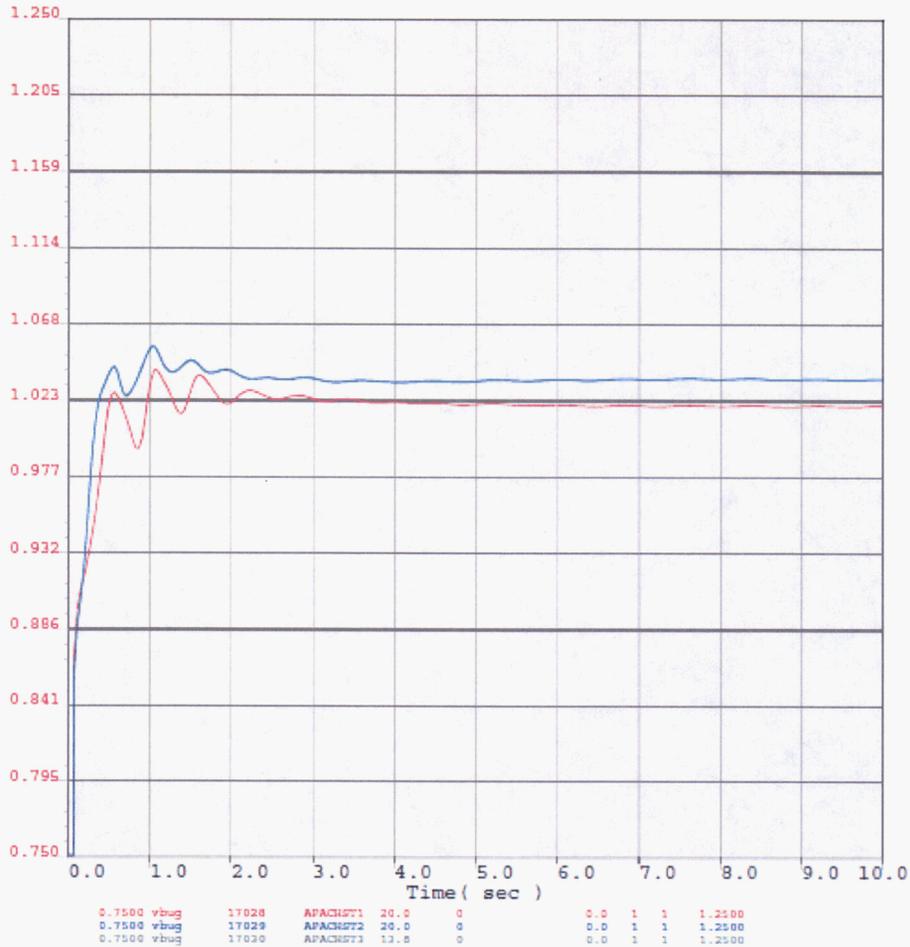
APACHE-BUTTERFLD-230 kV
 2012 Heavy Summer
 Generator Voltage Plots



2012 HS case
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 developed from WECC 2014 HS3-SA APPROVED BASE CASE

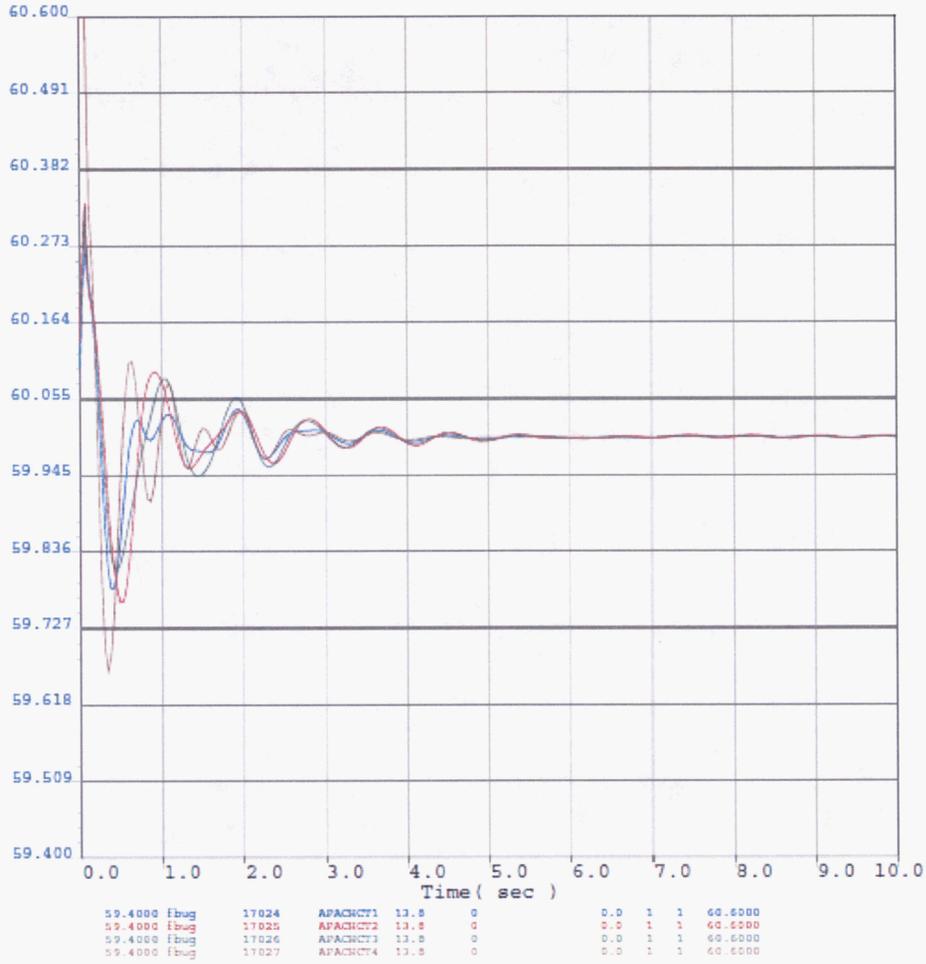


APACHE-BUTTERFLD-230 kV
 2012 Heavy Summer
 Generator Voltage Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

APACHE-REDTAIL 230.0 kV
 2012 Heavy Summer
 Generator Frequency Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

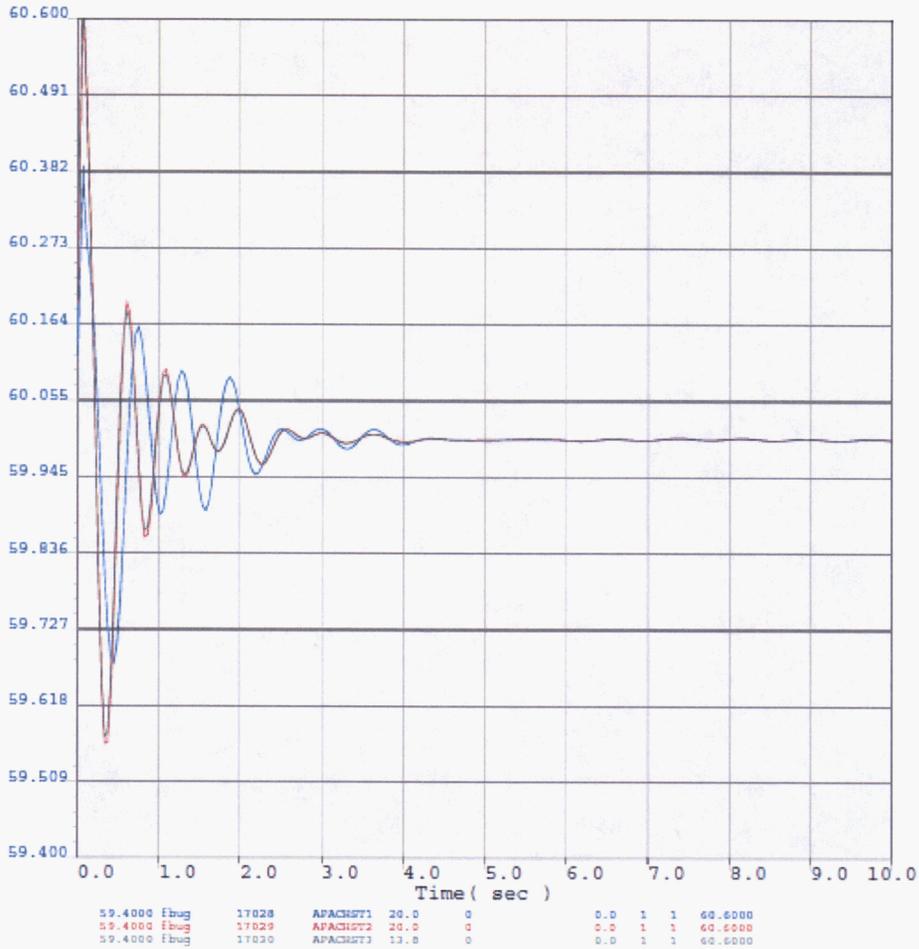


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Wed Jan 04 16:01:43 2012

APACHE-REDTAIL 230.0 kV
 2012 Heavy Summer
 Generator Frequency Plots



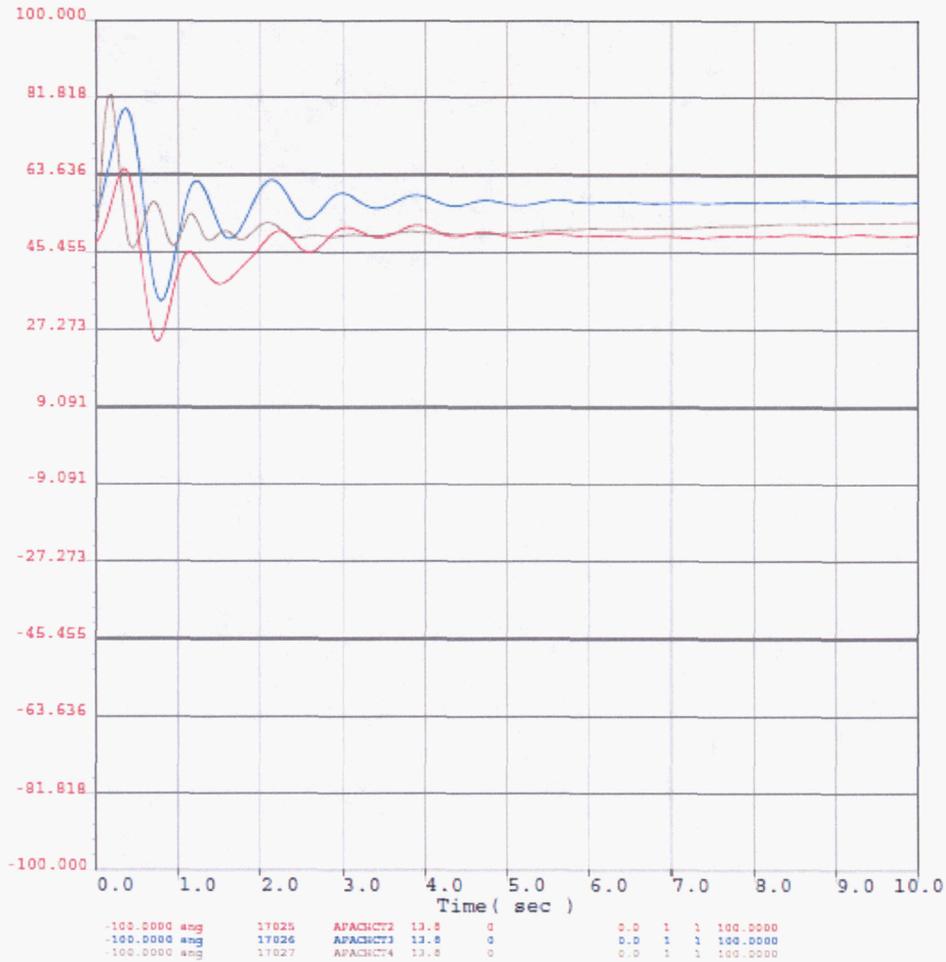
2012 HS case
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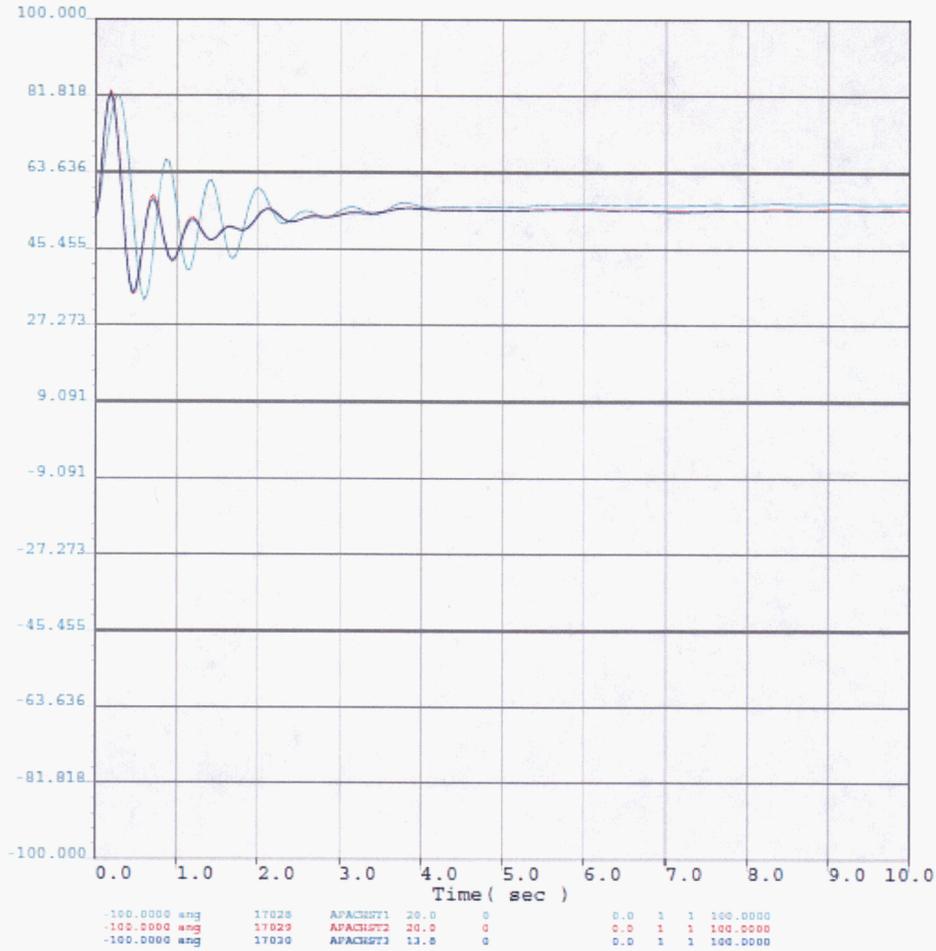
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 Wed Jan 04 16:01:43 2012

APACHE-REDTAIL 230.0 kV
 2012 Heavy Summer
 Generator Angle Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

APACHE-REDTAIL 230.0 kV
 2012 Heavy Summer
 Generator Angle Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

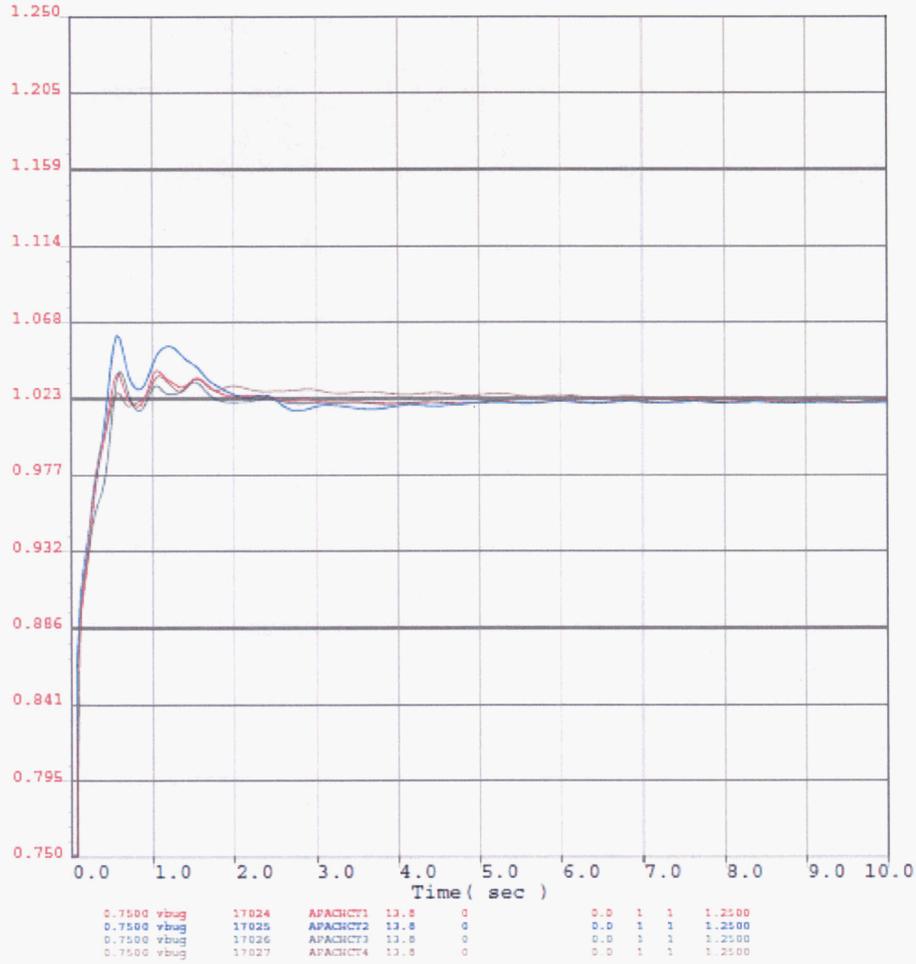


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Wed Jan 04 16:01:43 2012

APACHE-REDTAIL 230.0 kV
 2012 Heavy Summer
 Generator Voltage Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

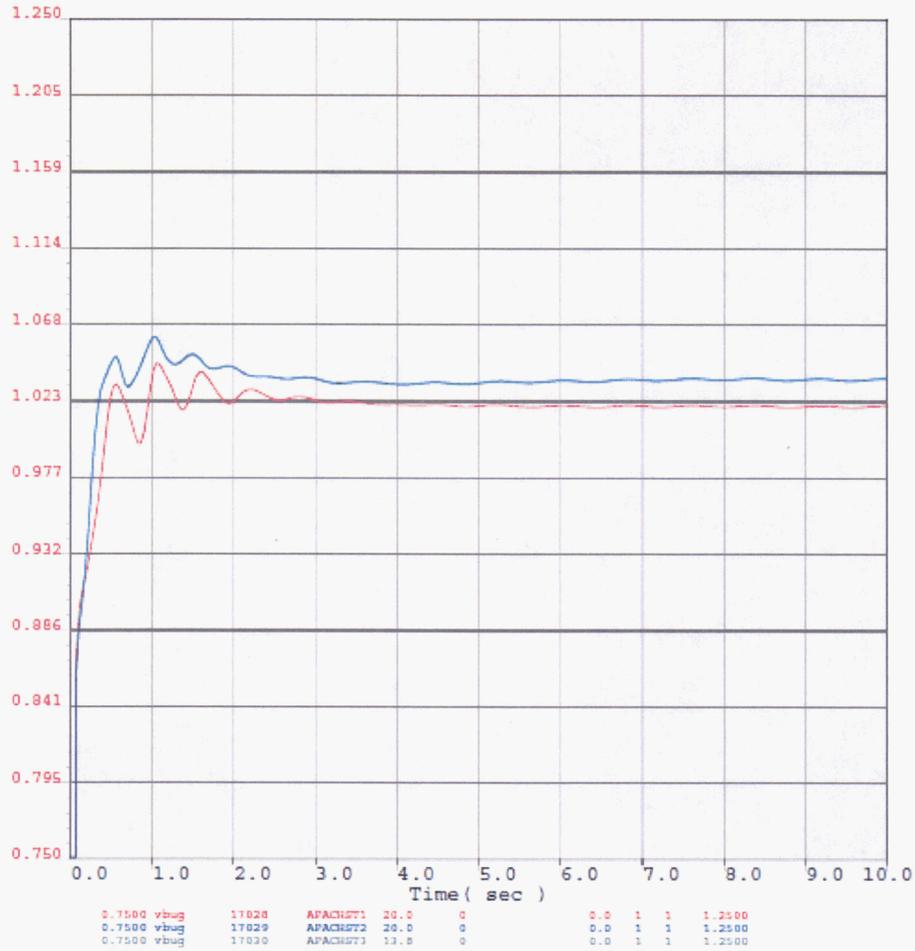


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Wed Jan 04 16:01:43 2012

APACHE-REDTAIL 230.0 kV
 2012 Heavy Summer
 Generator Voltage Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HSE-SA APPROVED BASE CASE

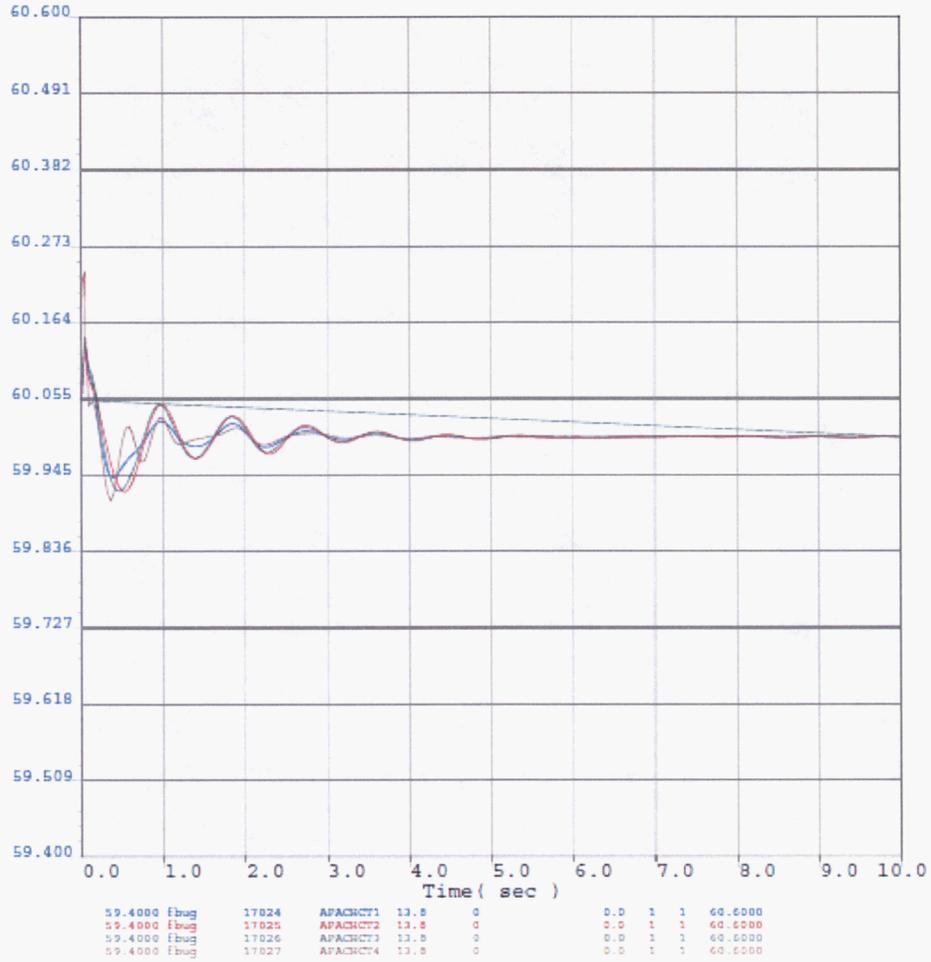


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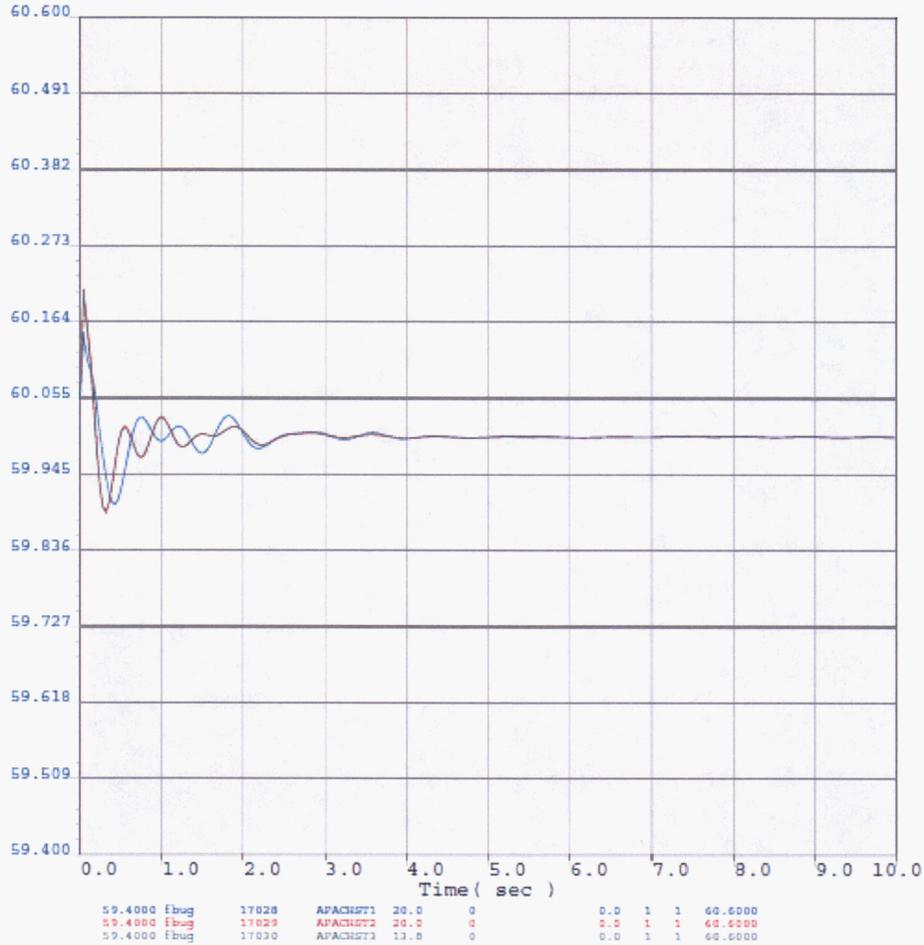
BICKNELL-VAIL 345 kV
 2012 Heavy Summer
 Generator Frequency Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE



BICKNELL-VAIL 345 kV
 2012 Heavy Summer
 Generator Frequency Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

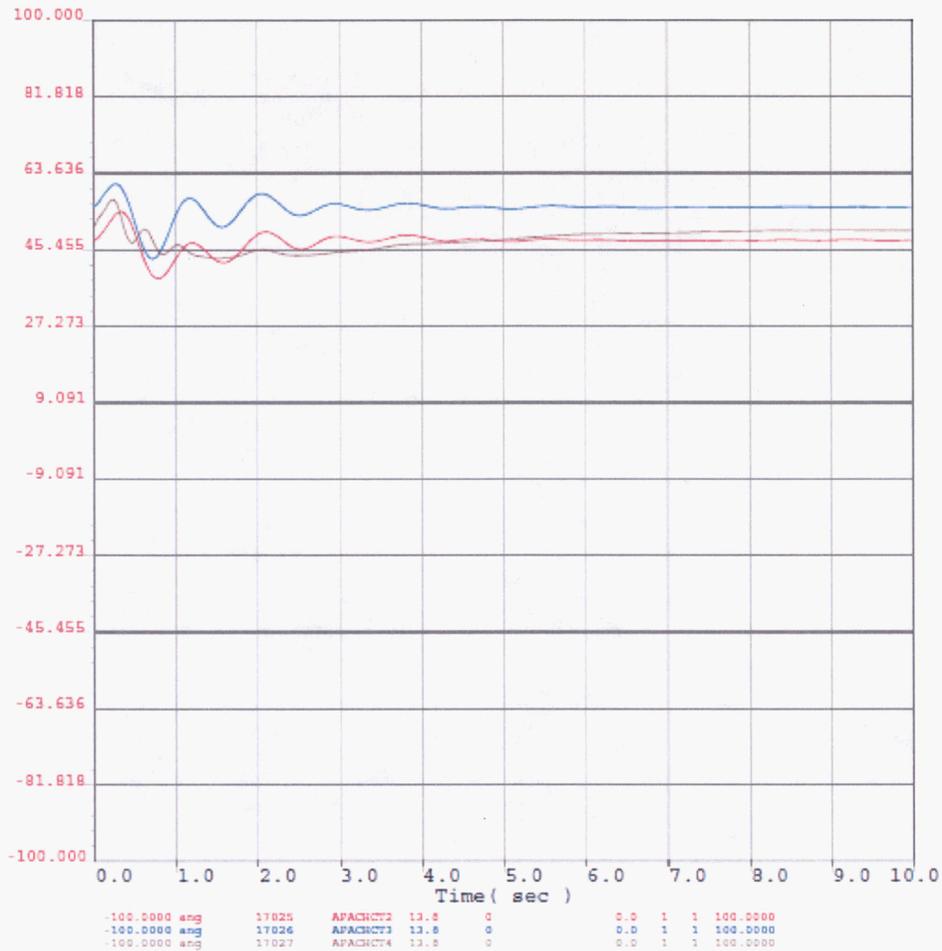


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BICKNELL-VAIL 345 kV
 2012 Heavy Summer
 Generator Angle Plots



2012 HS case
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 developed from WECC 2014 HS3-SA APPROVED BASE CASE

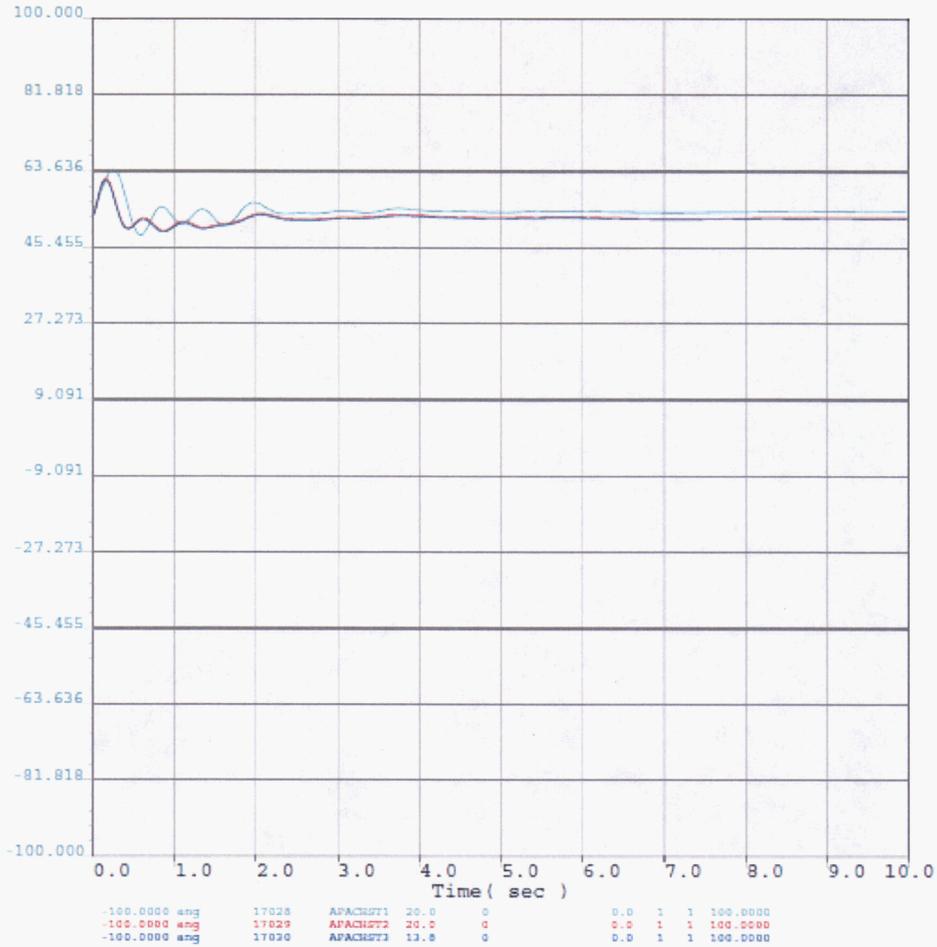


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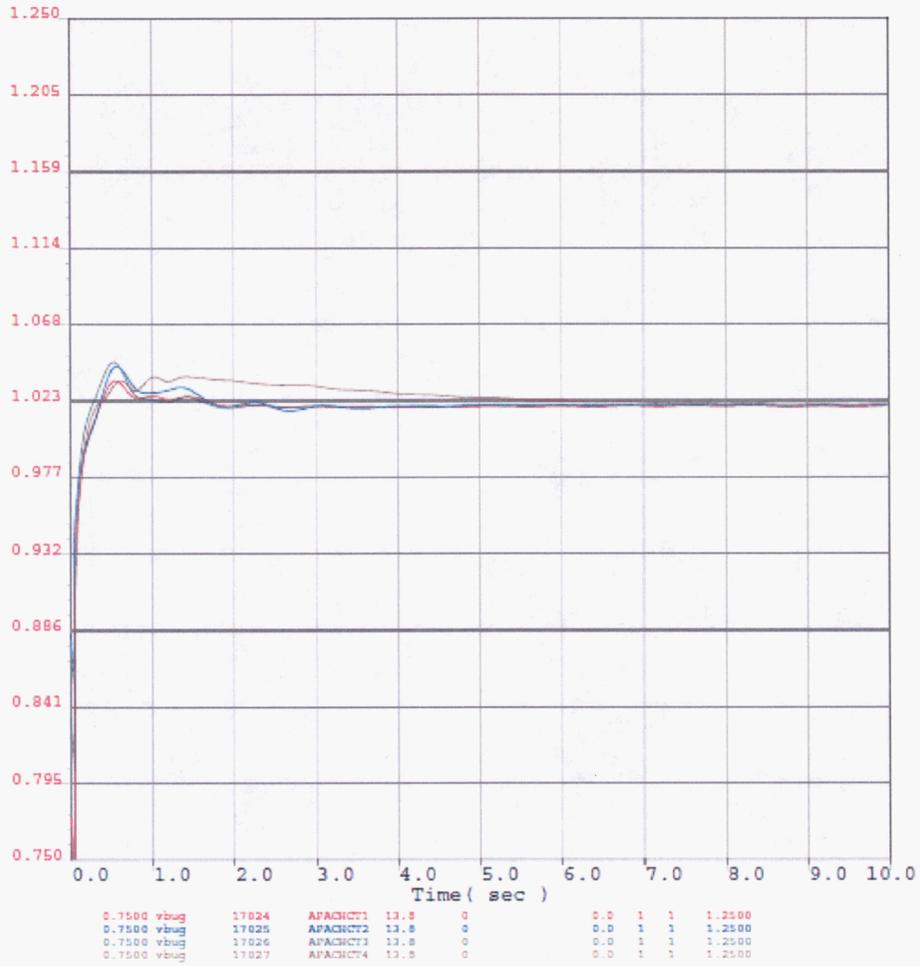
Wed Jan 04 16:03:20 2012

BICKNELL-VAIL 345 kV
 2012 Heavy Summer
 Generator Angle Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

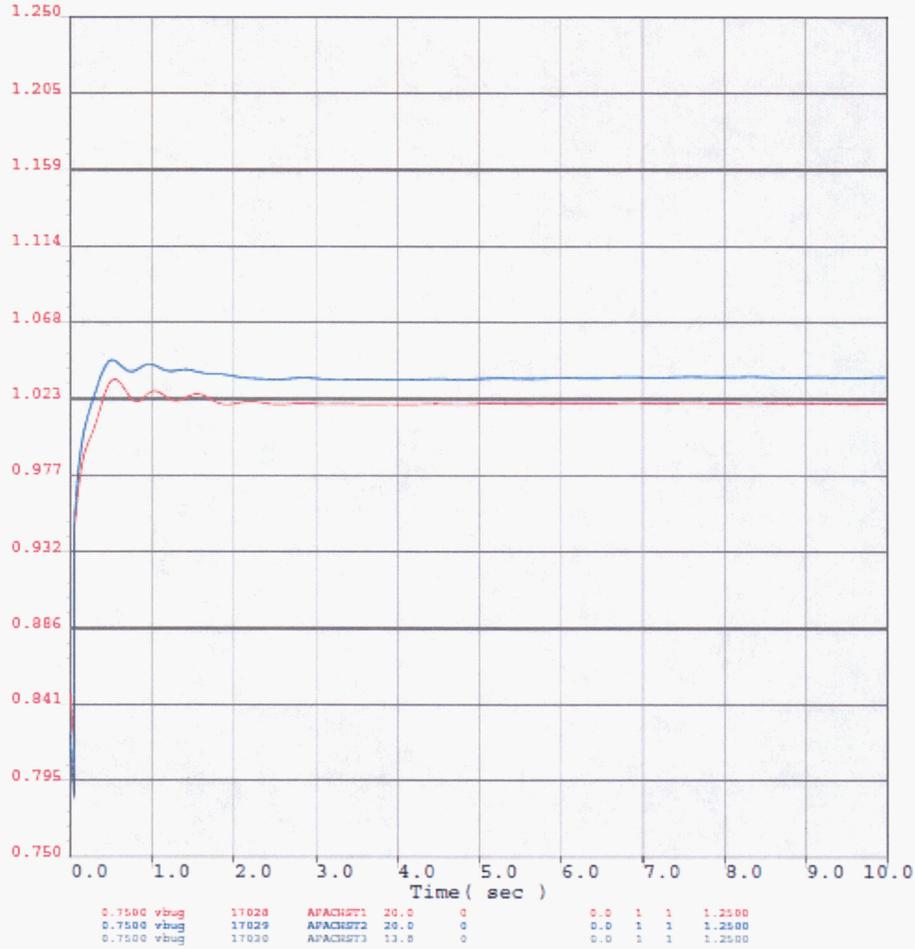
BICKNELL-VAIL 345 kV
 2012 Heavy Summer
 Generator Voltage Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE



BICKNELL-VAIL 345 kV
 2012 Heavy Summer
 Generator Voltage Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

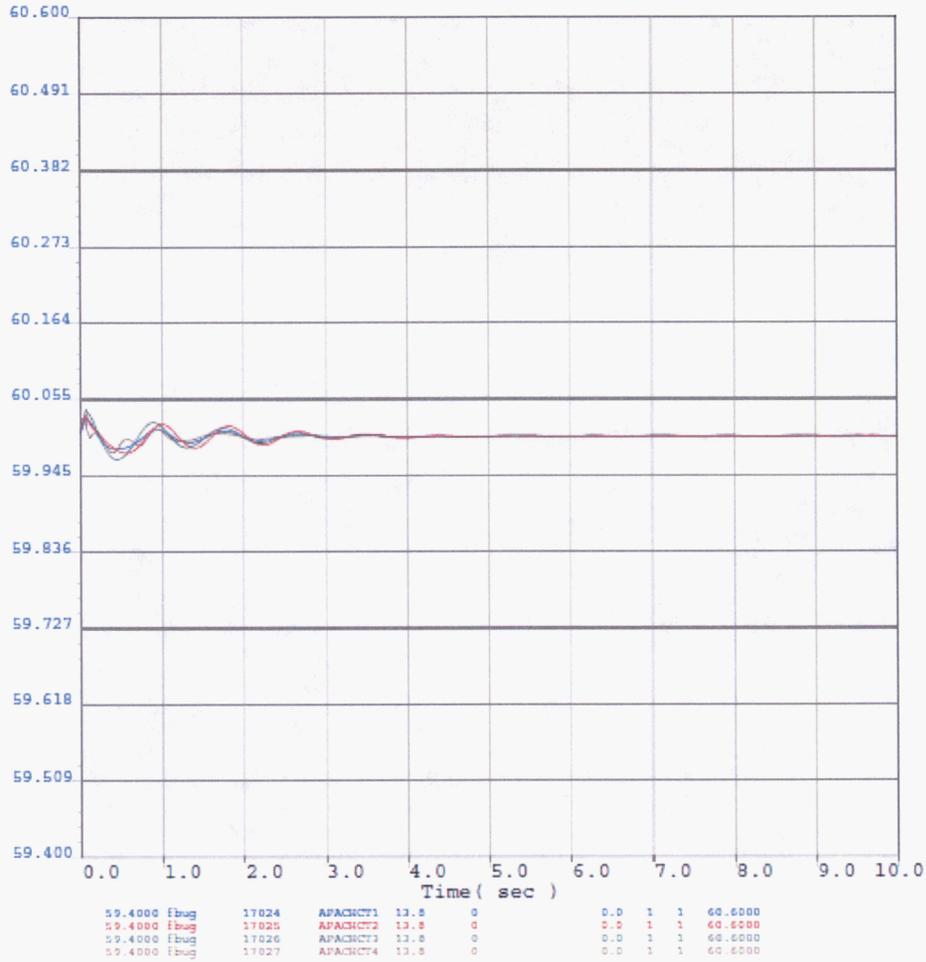


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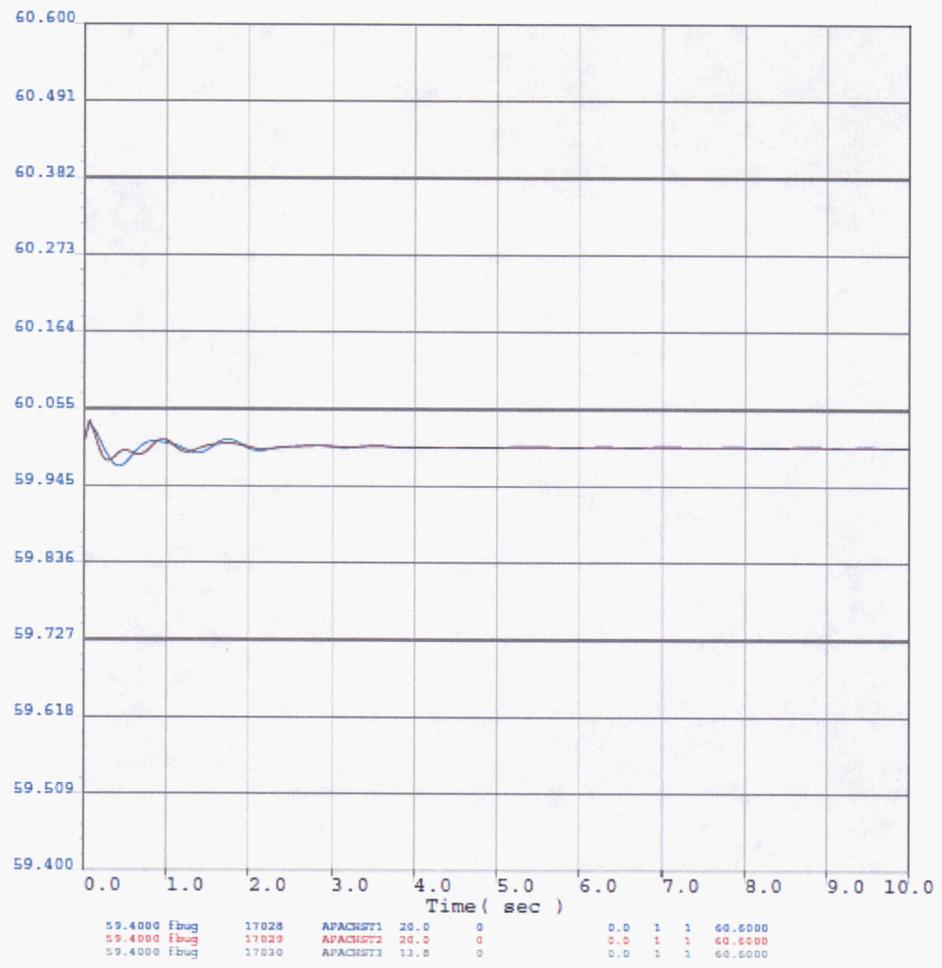
MARANATP-MARANA 115 kV
 2012 Heavy Summer
 Generator Frequency Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

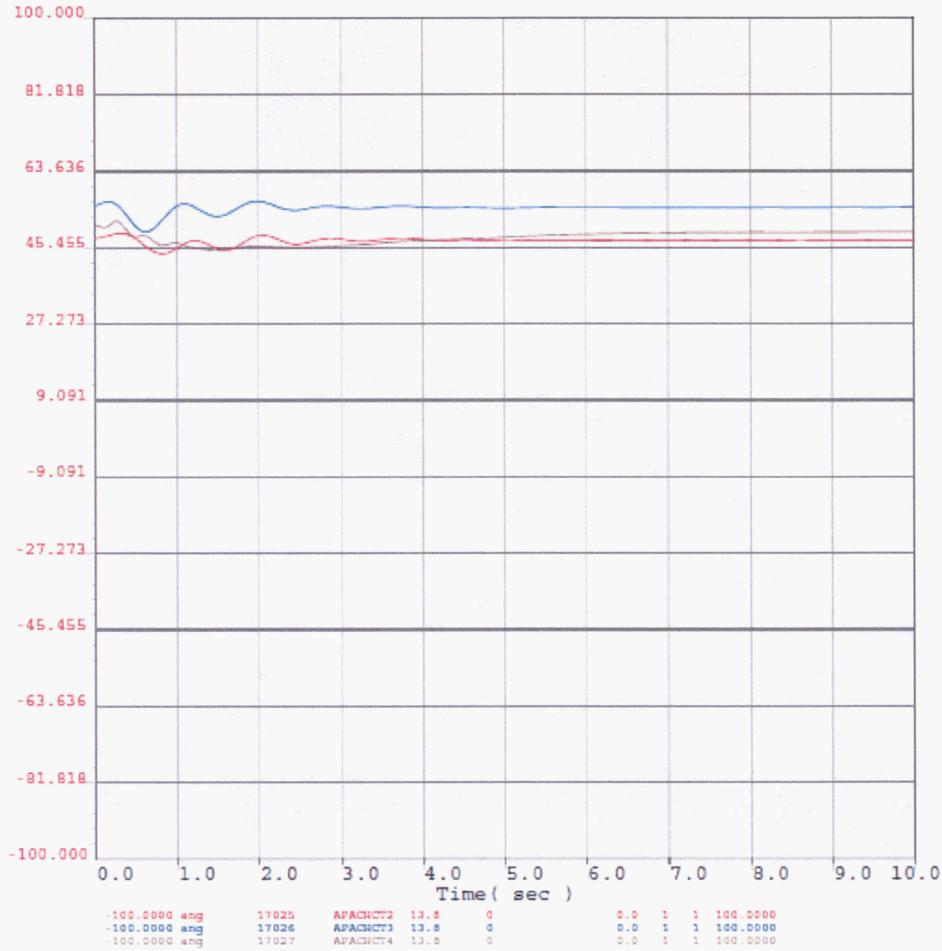


MARANATP-MARANA 115 kV
 2012 Heavy Summer
 Generator Frequency Plots



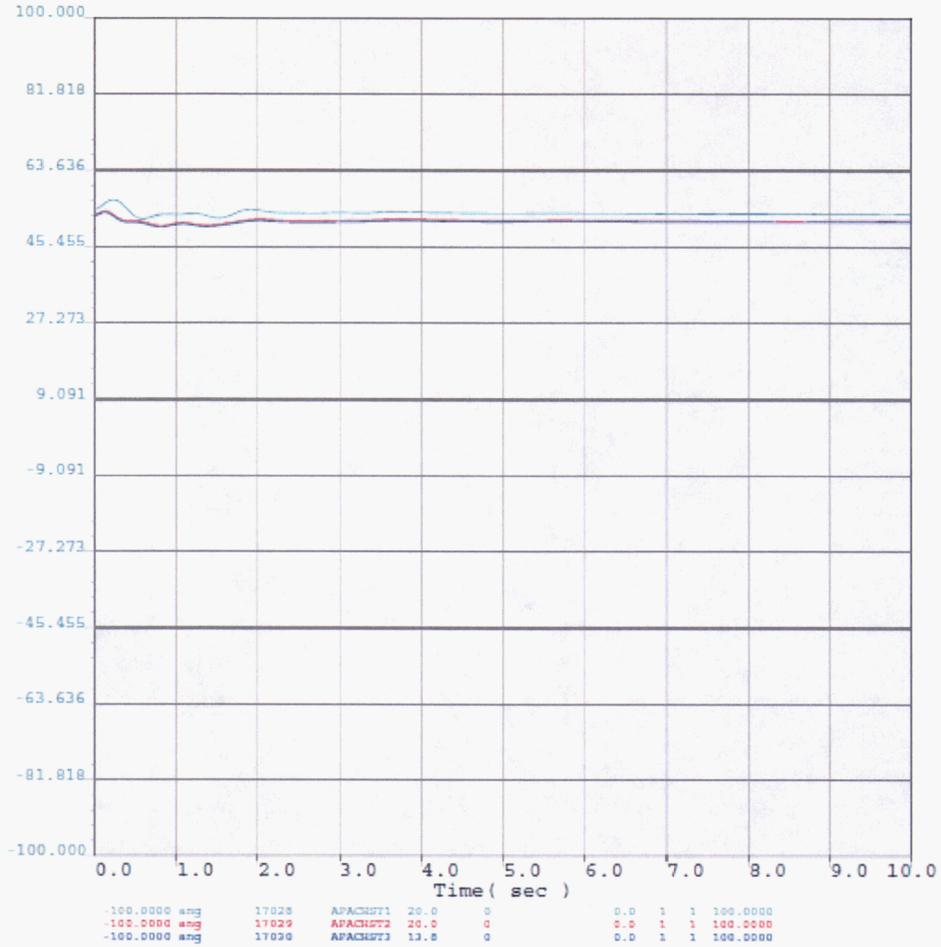
2012 HS case
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 developed from WECC 2014 HS3-SA APPROVED BASE CASE

MARANATP-MARANA 115 kV
 2012 Heavy Summer
 Generator Angle Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

MARANATP-MARANA 115 kV
 2012 Heavy Summer
 Generator Angle Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

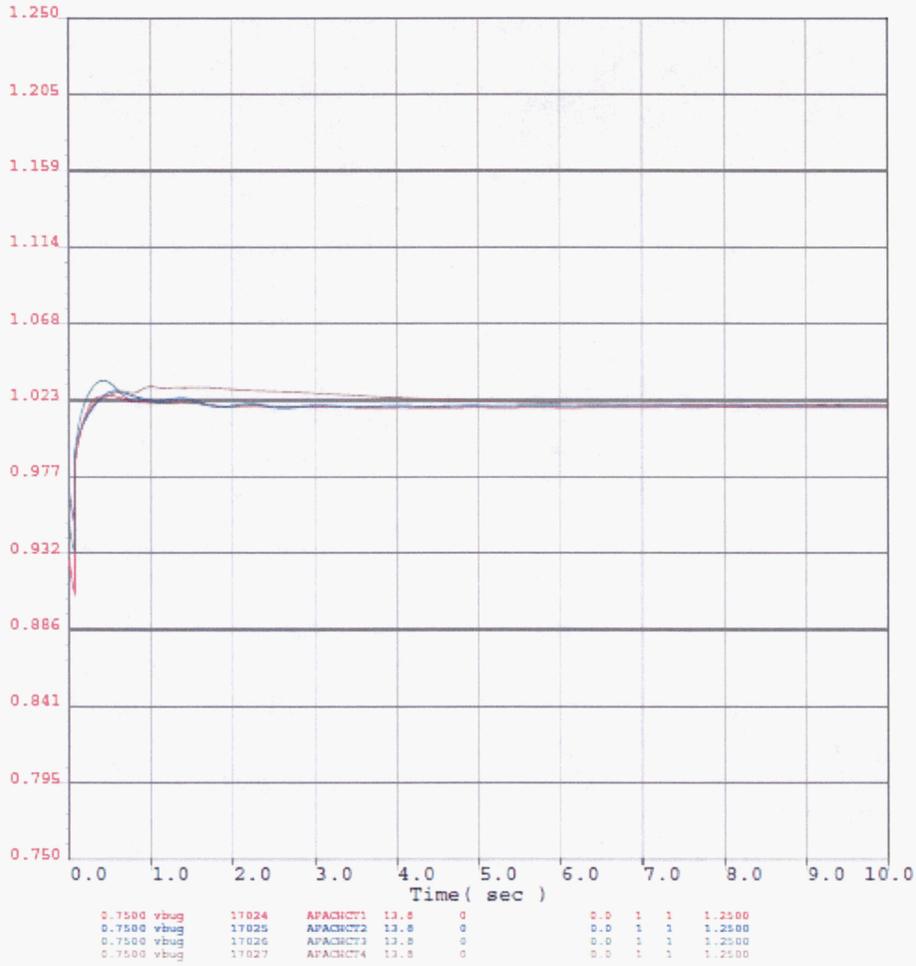


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MARANATP-MARANA 115 kV
 2012 Heavy Summer
 Generator Voltage Plots



2012 HS case
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 developed from WECC 2014 HS3-SA APPROVED BASE CASE

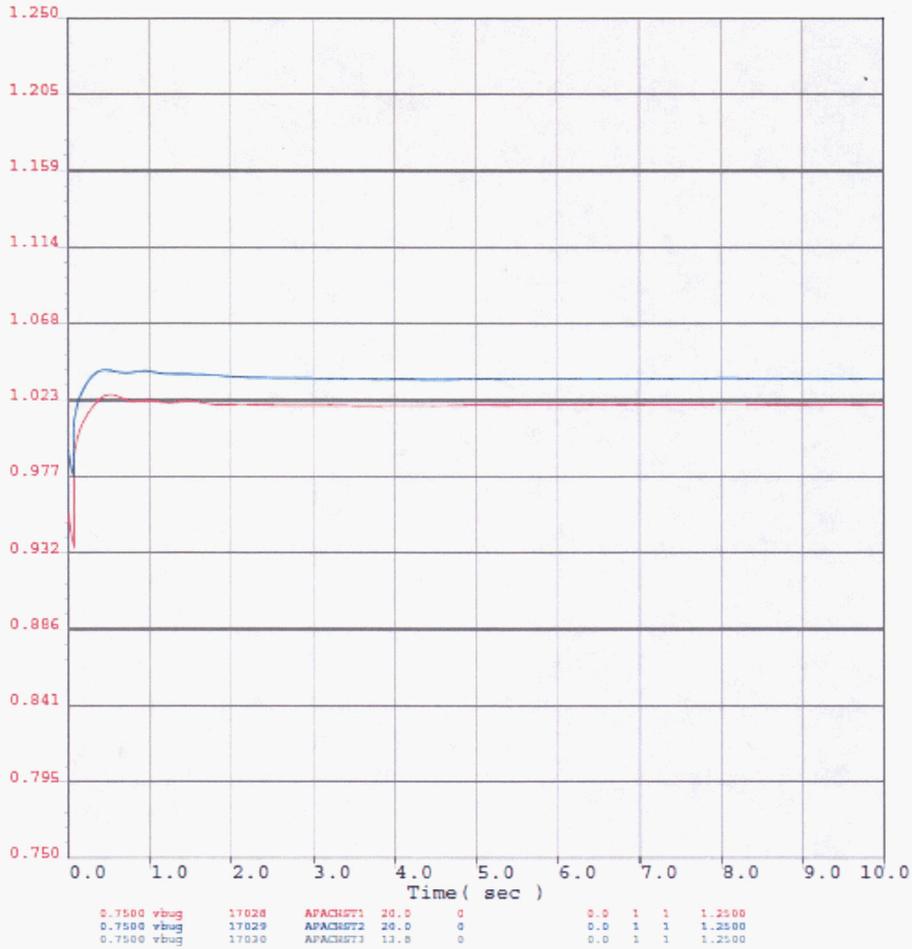


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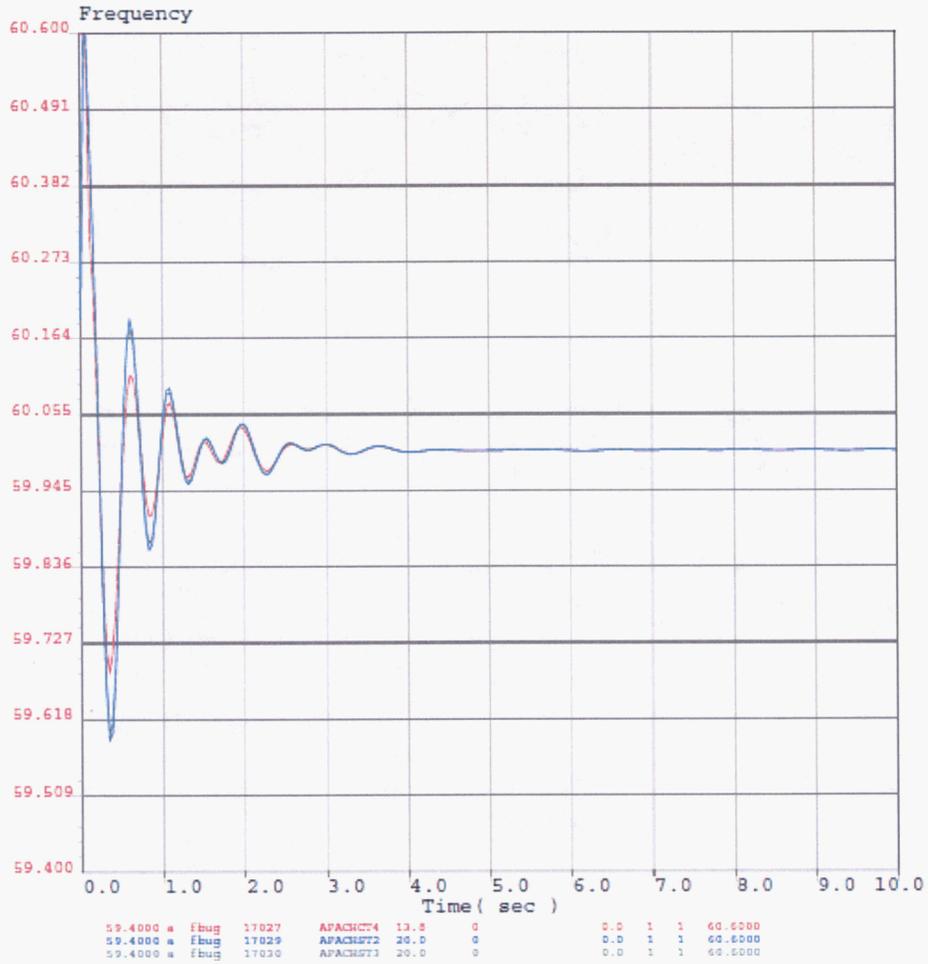
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MARANATP-MARANA 115 kV
 2012 Heavy Summer
 Generator Voltage Plots



2012 HS case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

APACHE-BUTERFLD 230.0 AND MARANATP-MARANA 115 kV
230kV Generator Frequency Stability Plots



2012 HS case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE

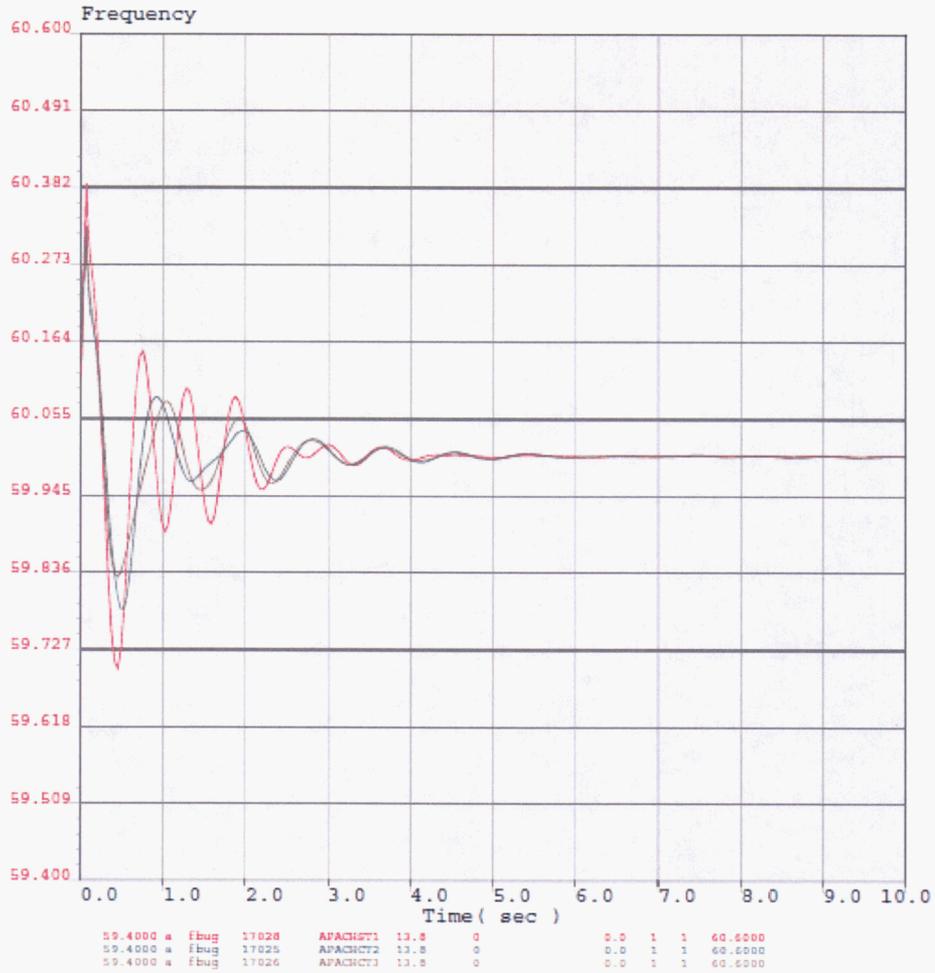


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Wed Dec 21 02:09:53 2011

APACHE-BUTERFLD 230.0 AND MARANATP-MARANA 115 kV
115kV Generator Frequency Stability Plots



2012 HS case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE



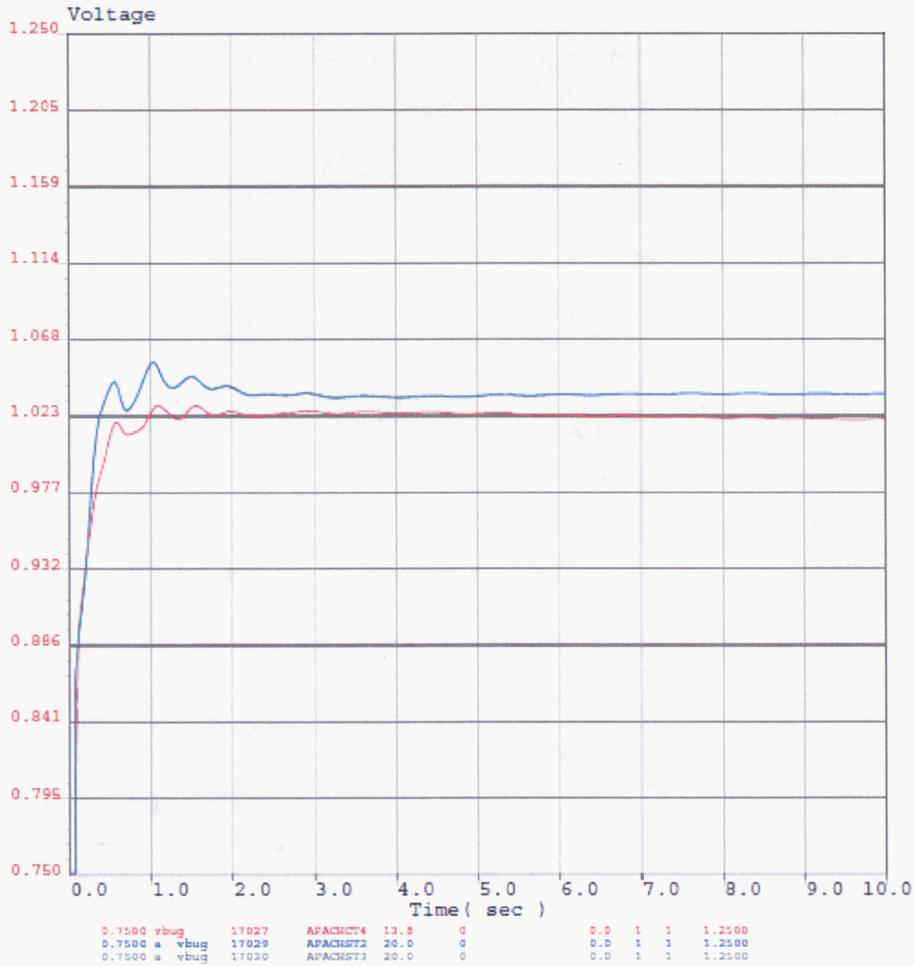
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c:\swtc_tpl

Wed Dec 21 02:09:53 2011

Page 9

APACHE-BUTERFLD 230kV #1 & MARANATP-MARANA 115kV #1
230kV Generator Voltage Plots



2012 HS case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE

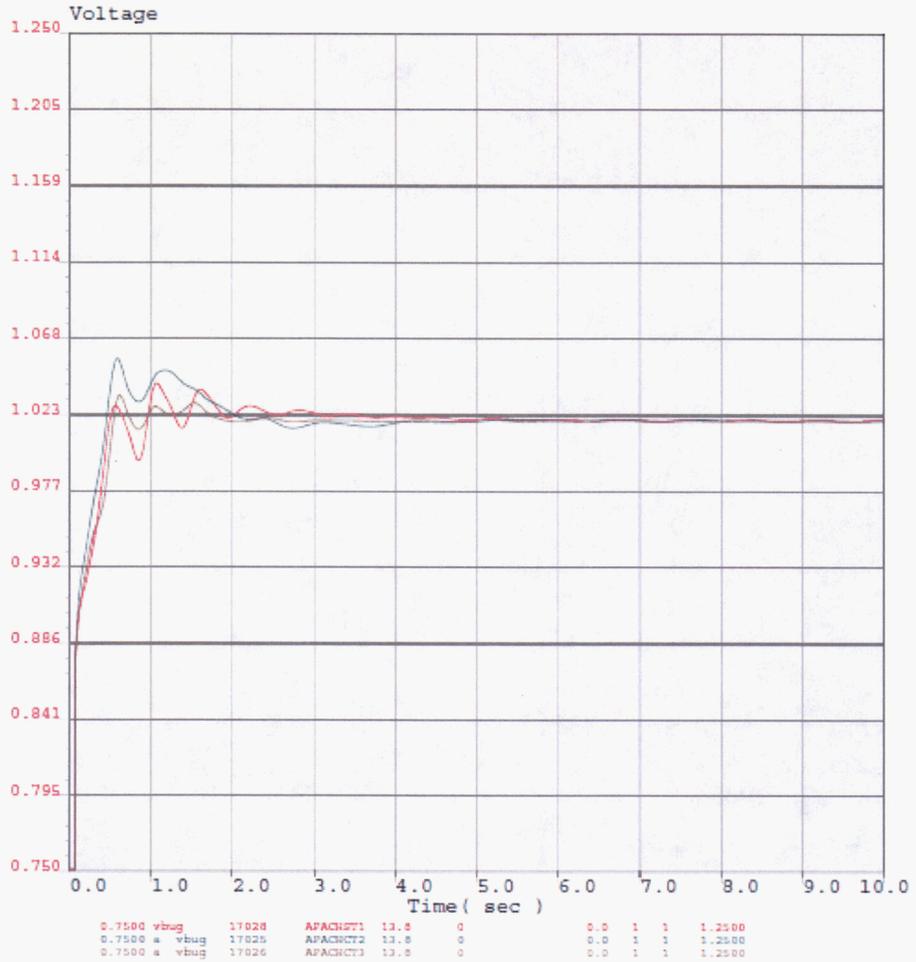


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Wed Dec 21 02:12:51 2011

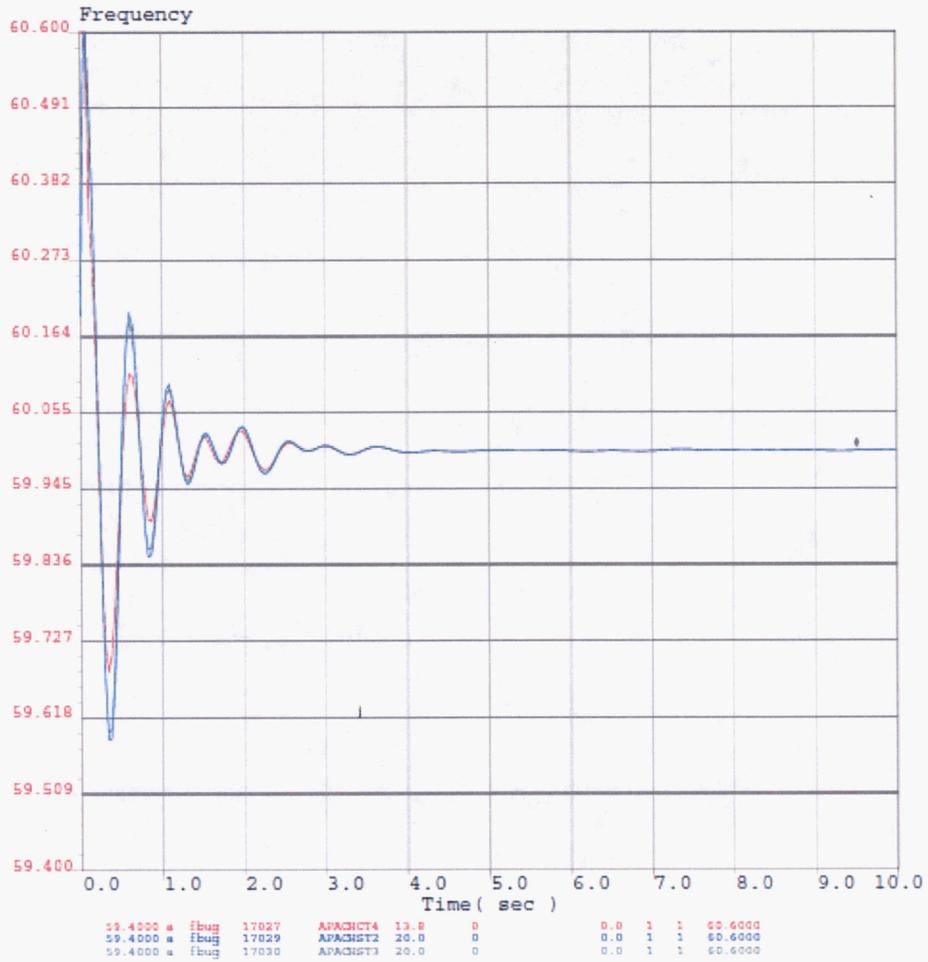
APACHE-BUTERFLD 230kV #1 & MARANATP-MARANA 115kV #1
115 kV Generator Voltage Plots



2012 HS case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE



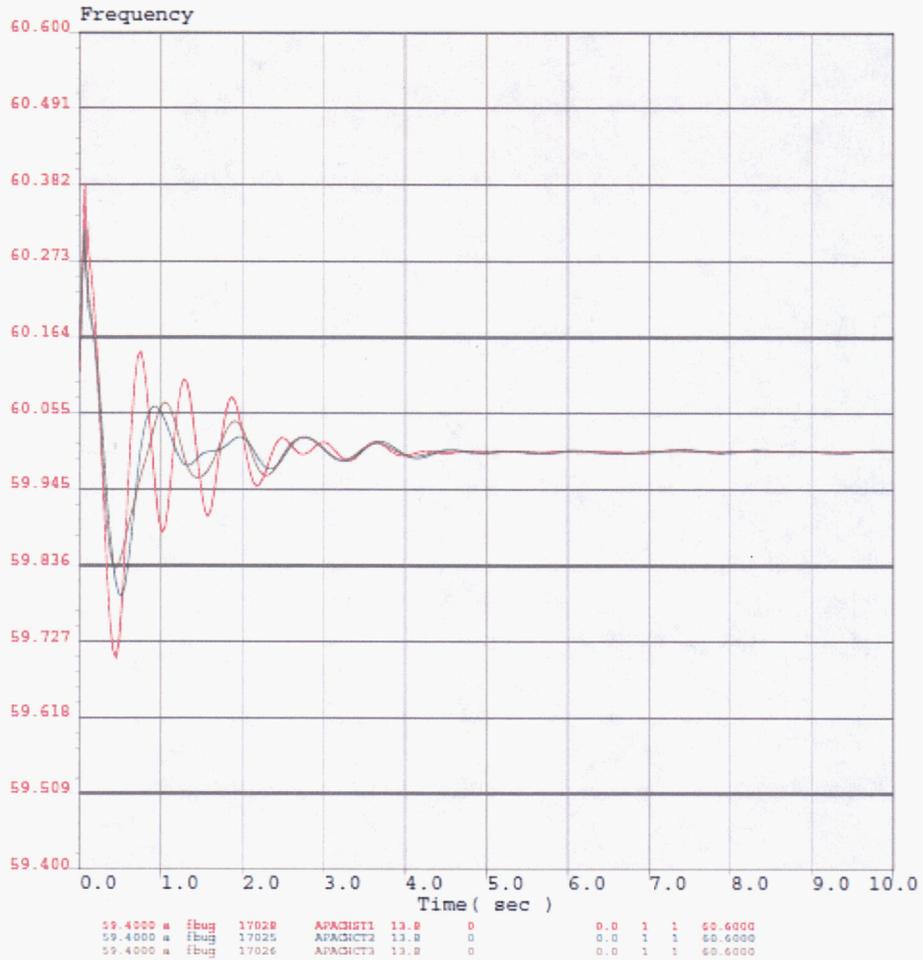
APACHE-BUTERFLD 230kV #1 & BICKNELL-VAIL 345kV #1
230kV Generator Frequency Stability Plots



2012 HS case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE



APACHE-BUTERFLD 230kV #1 & BICKNELL-VAIL 345kV #1
115kV Generator Frequency Stability Plots



2012 HS case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE

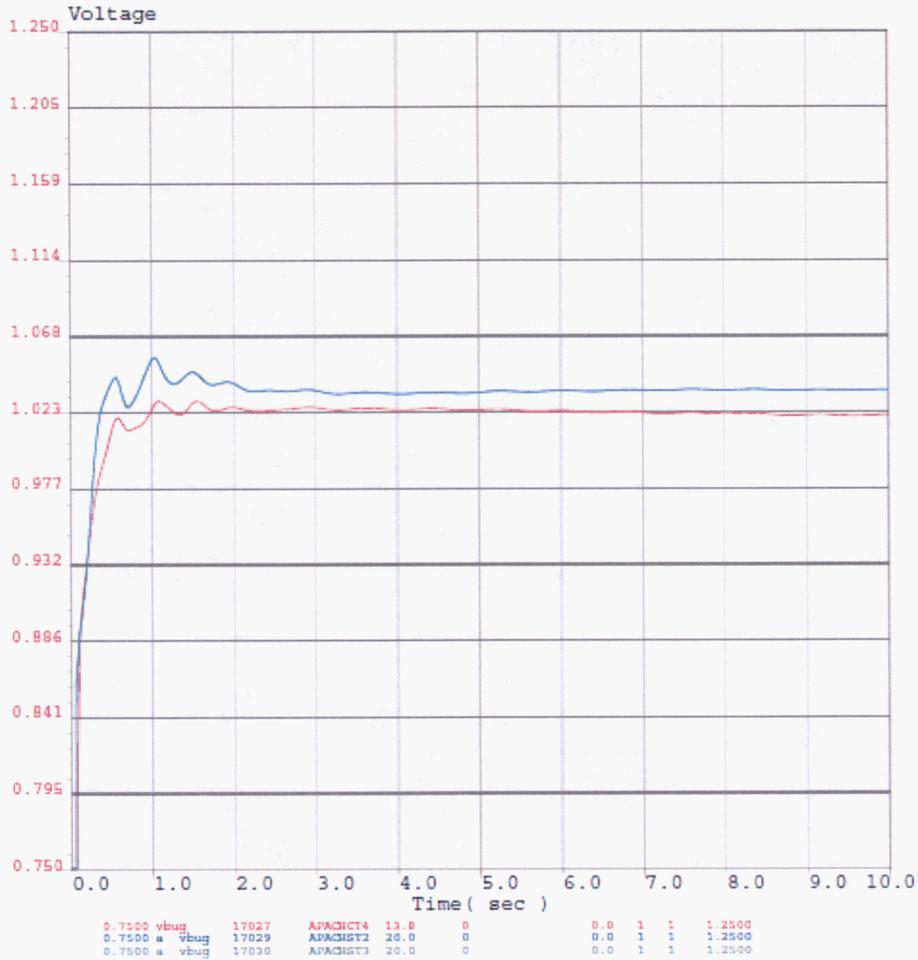


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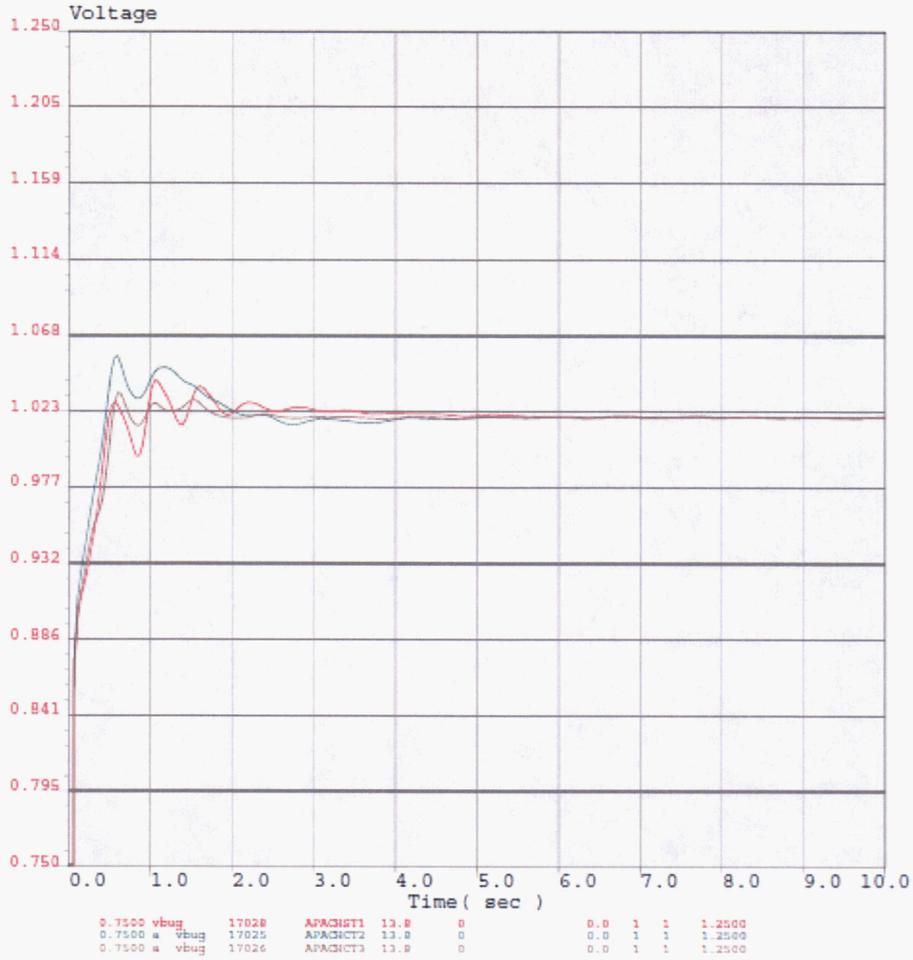
APACHE-BUTERFLD 230kV #1 & BICKNELL-VAIL 345kV #1
230kV Generator Voltage Plots



2012 HS case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE



APACHE-BUTERFLD 230kV #1 & BICKNELL-VAIL 345kV #1
115 kV Generator Voltage Plots



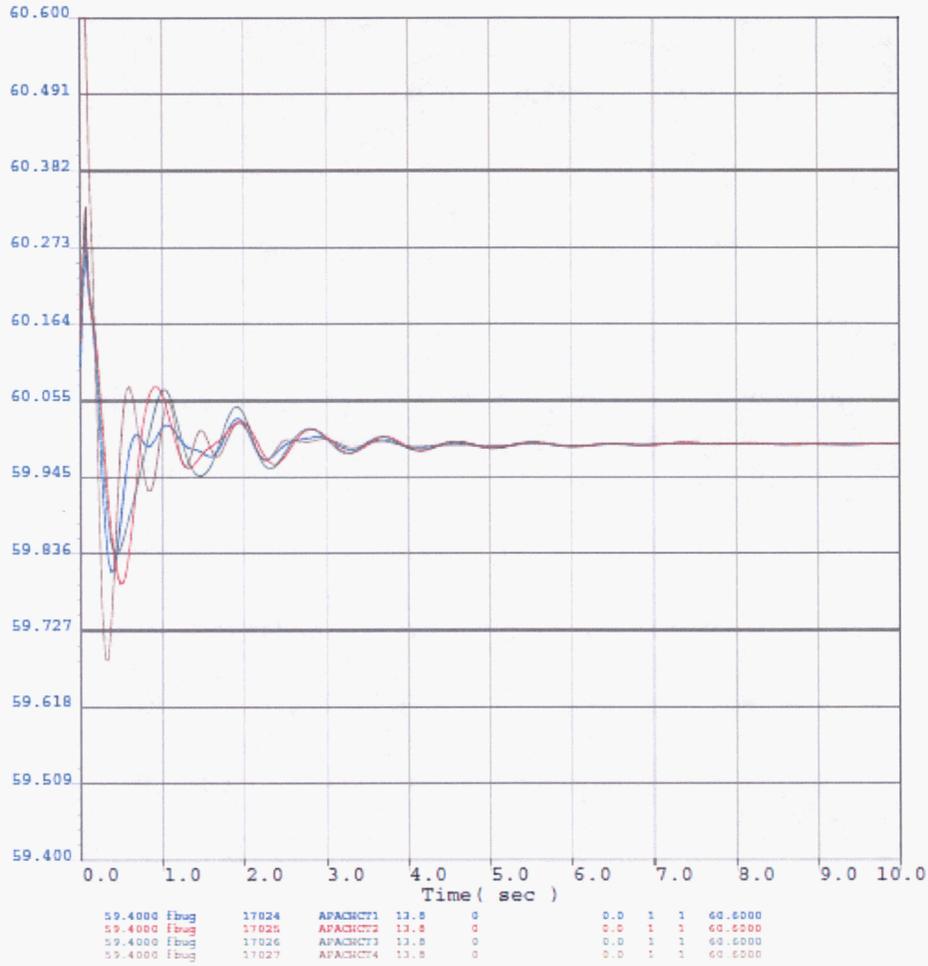
2012 HS case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE



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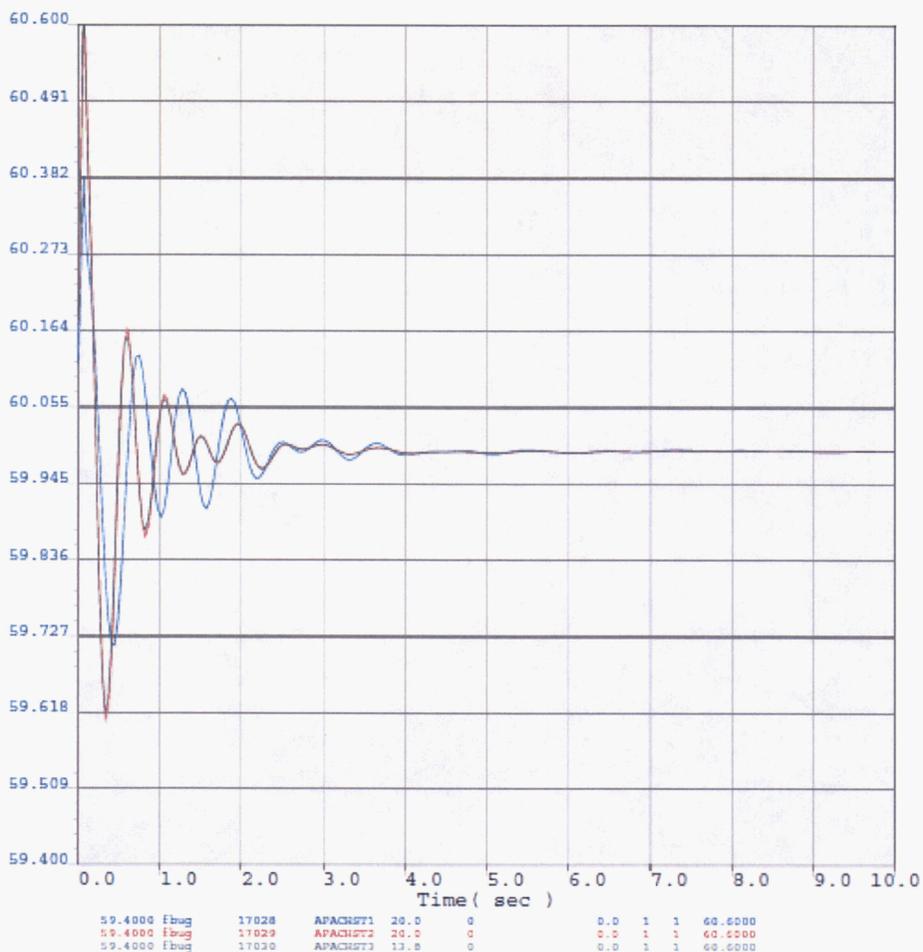
APACHE-BUTTERFLD-230 kV
 2016 Heavy Summer
 Generator Frequency Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

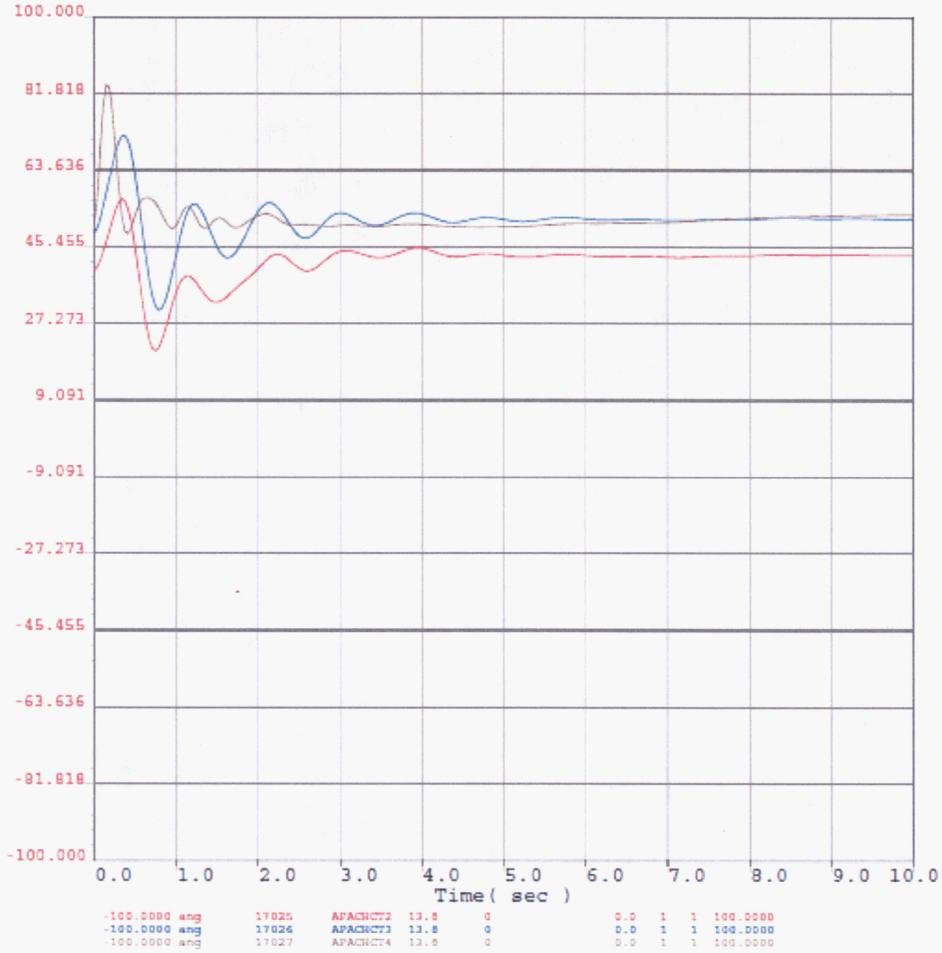


APACHE-BUTTERFLD-230 kV
 2016 Heavy Summer
 Generator Frequency Plots



2016 HS coordinated case
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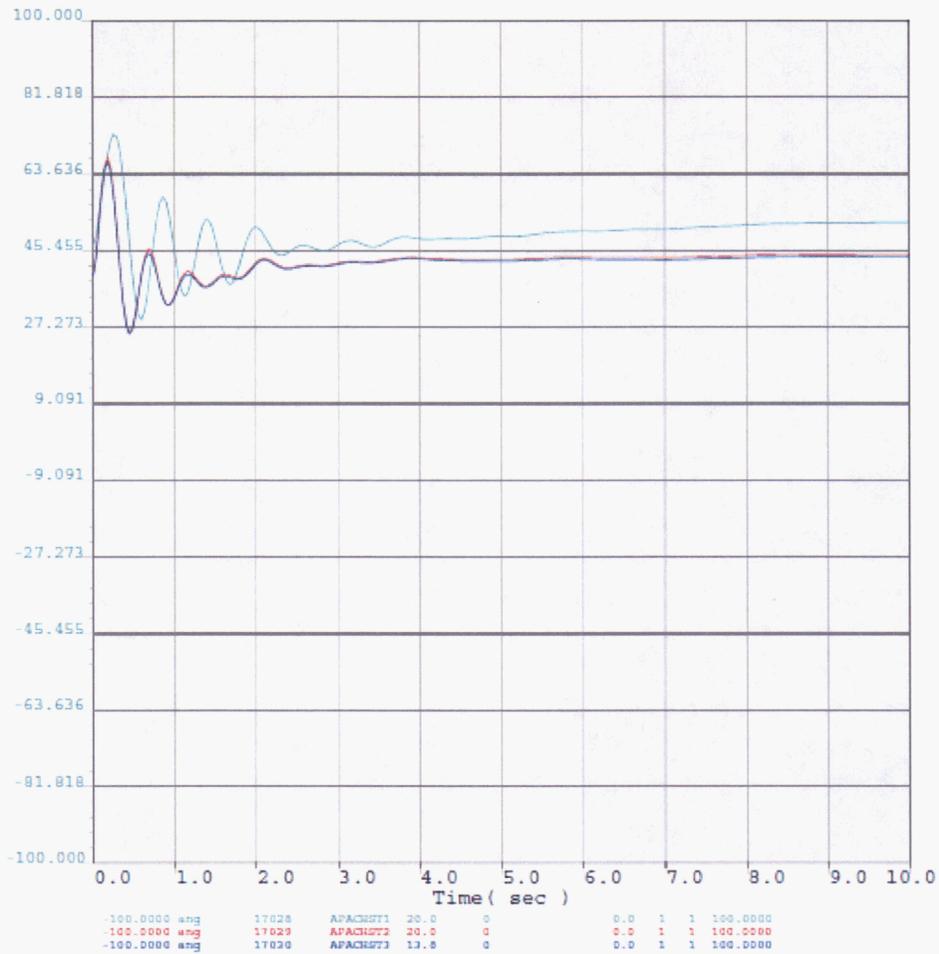
APACHE-BUTTERFLD-230 kV
 2016 Heavy Summer
 Generator Angle Plots



2016 HS coordinated case
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 developed from WECC 2014 HS3-SA APPROVED BASE CASE

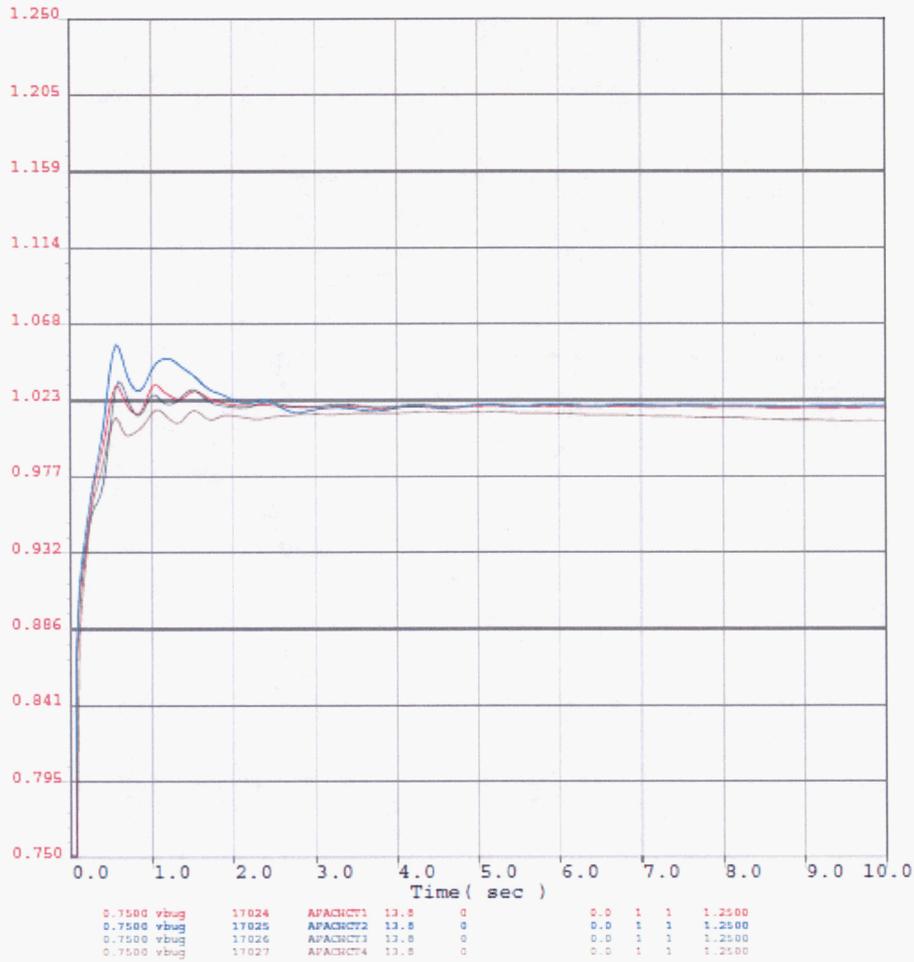


APACHE-BUTTERFLD-230 kV
 2016 Heavy Summer
 Generator Angle Plots



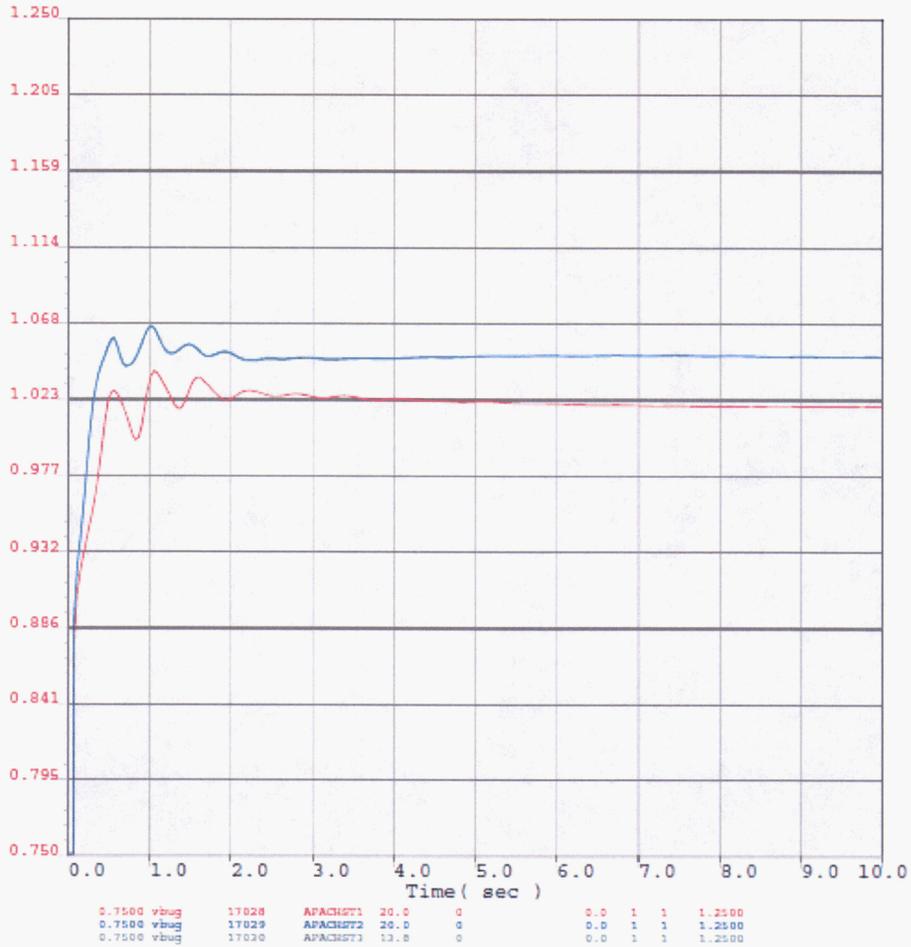
2016 HS coordinated case
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 developed from WECC 2014 HS1-SA APPROVED BASE CASE

APACHE-BUTTERFLD-230 kV
 2016 Heavy Summer
 Generator Voltage Plots



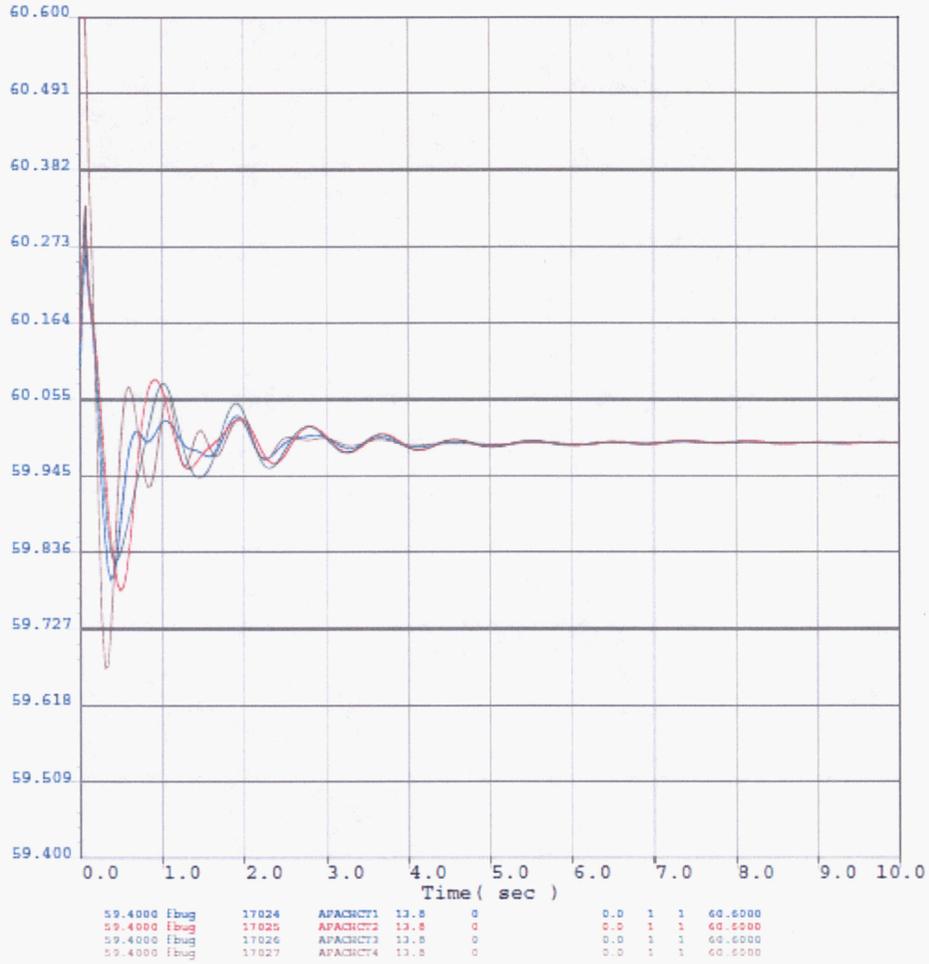
2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

APACHE-BUTTERFLD-230 kV
 2016 Heavy Summer
 Generator Voltage Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

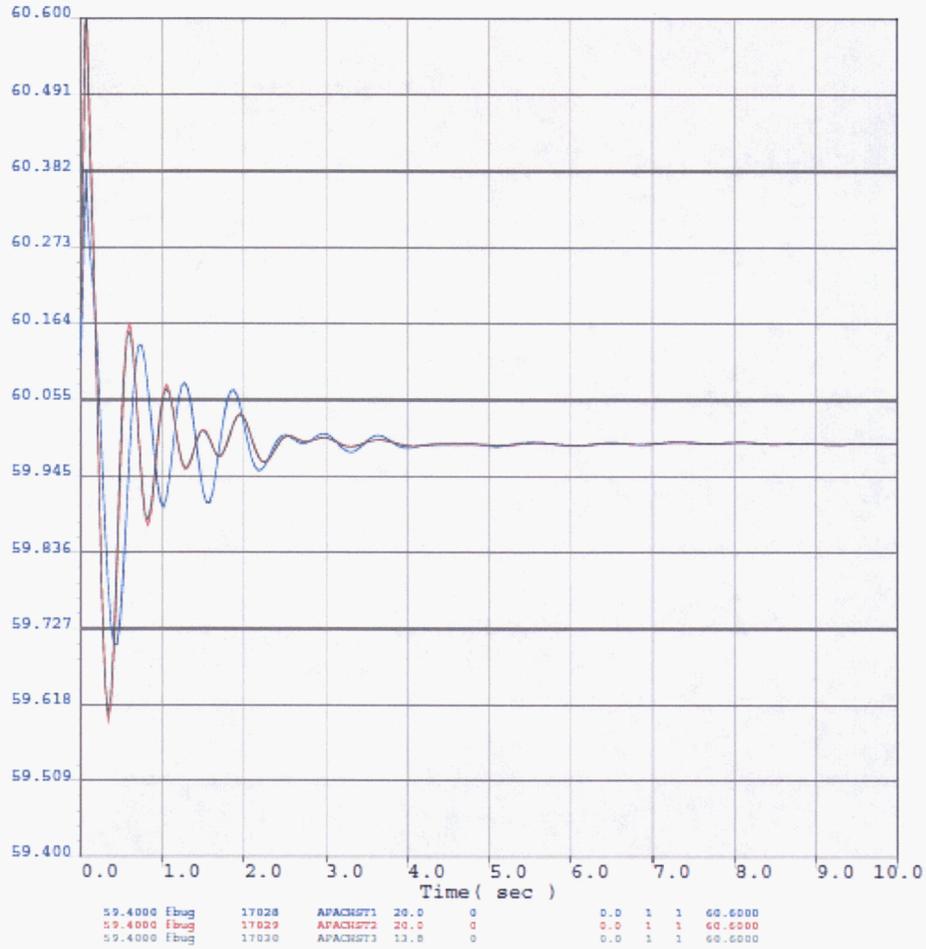
APACHE-REDTAIL 230.0 kV
 2016 Heavy Summer
 Generator Frequency Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE



APACHE-REDTAIL 230.0 kV
 2016 Heavy Summer
 Generator Frequency Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

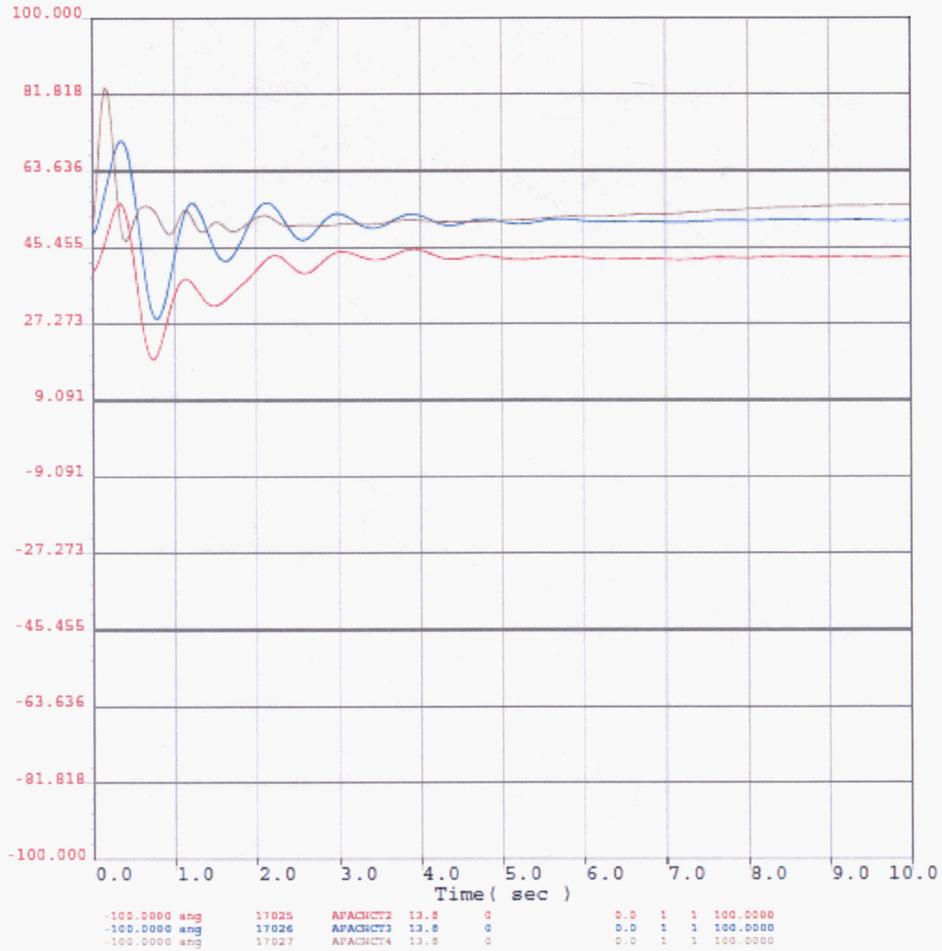


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APACHE-REDTAIL 230.0 kV
 2016 Heavy Summer
 Generator Angle Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

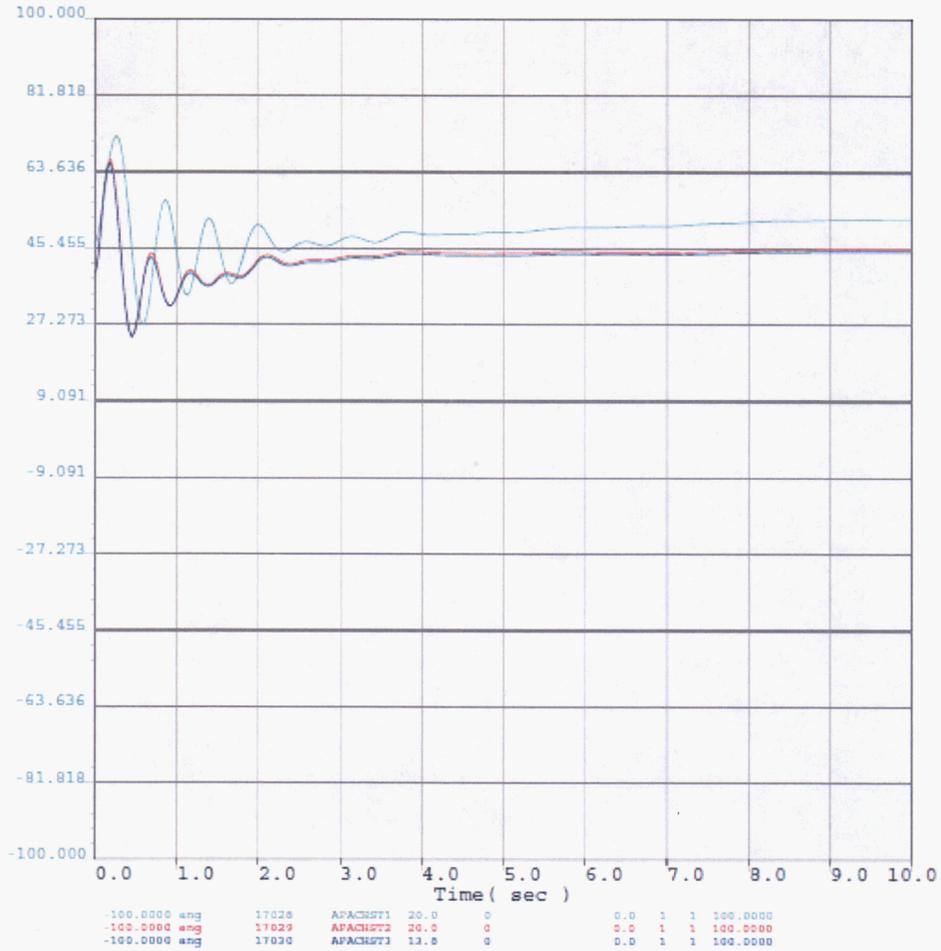


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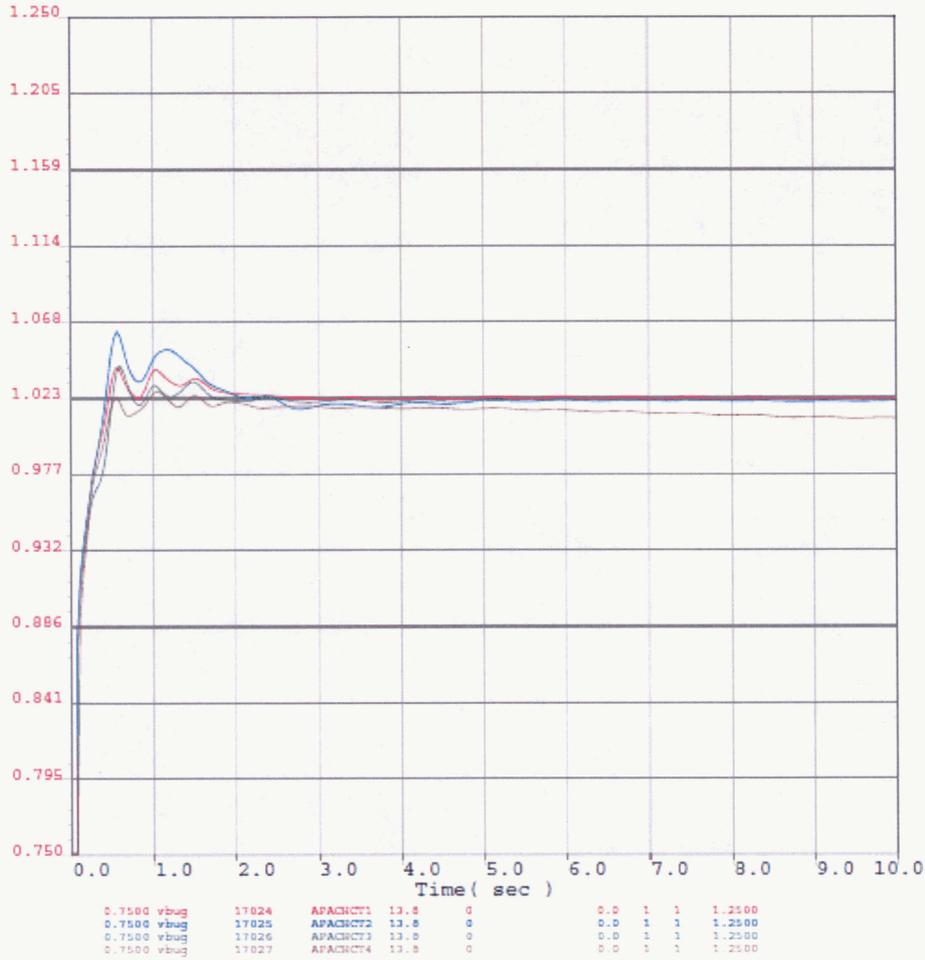
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APACHE-REDTAIL 230.0 kV
 2016 Heavy Summer
 Generator Angle Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

APACHE-REDTAIL 230.0 kV
 2016 Heavy Summer
 Generator Voltage Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WCC 2014 HS3-SA APPROVED BASE CASE

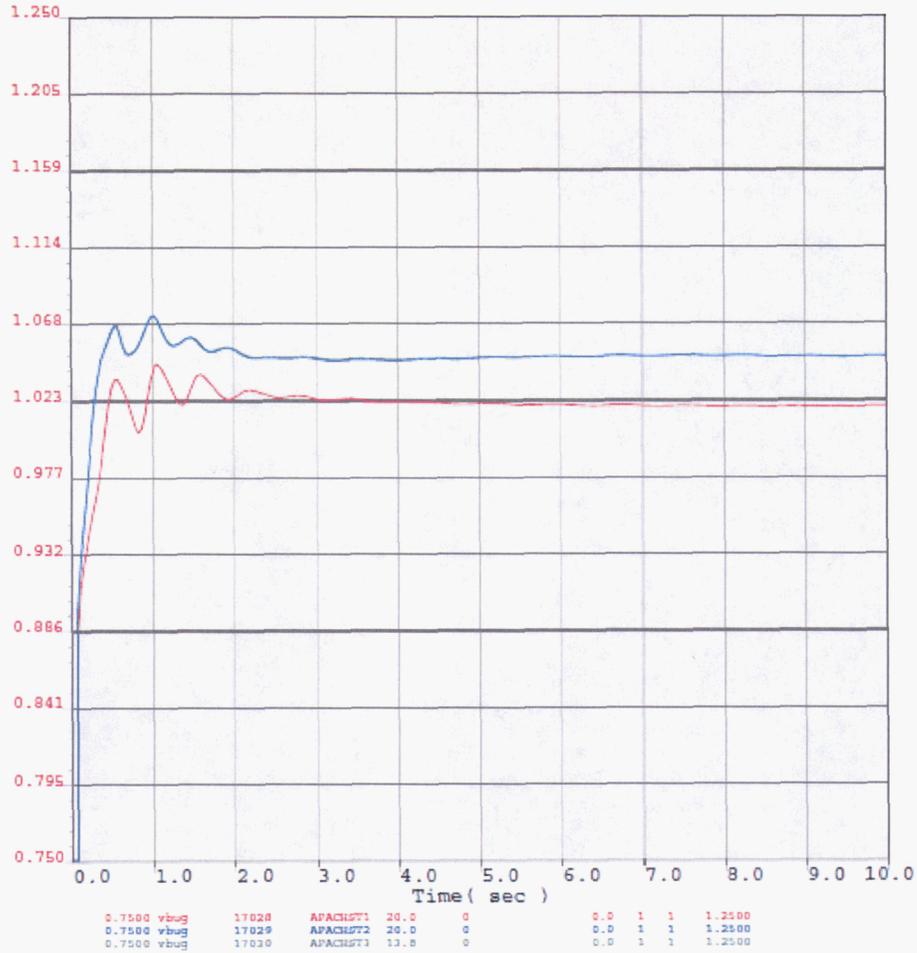


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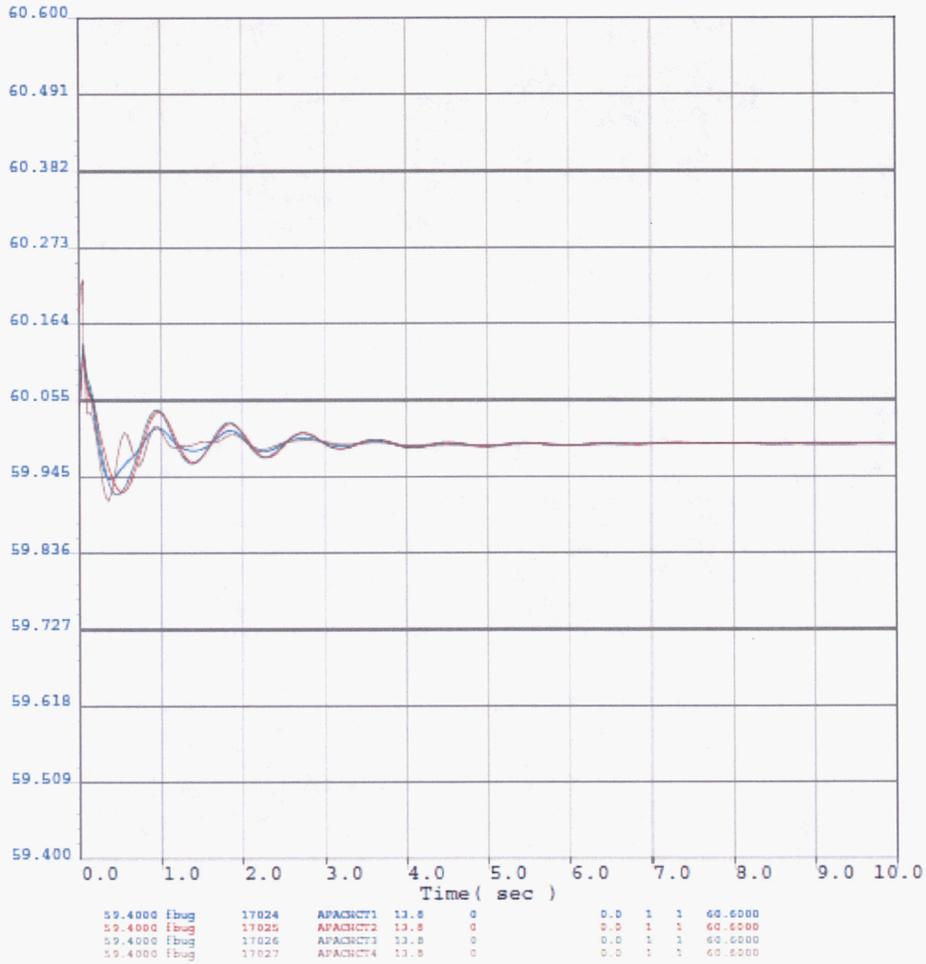
APACHE-REDTAIL 230.0 kV
 2016 Heavy Summer
 Generator Voltage Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE



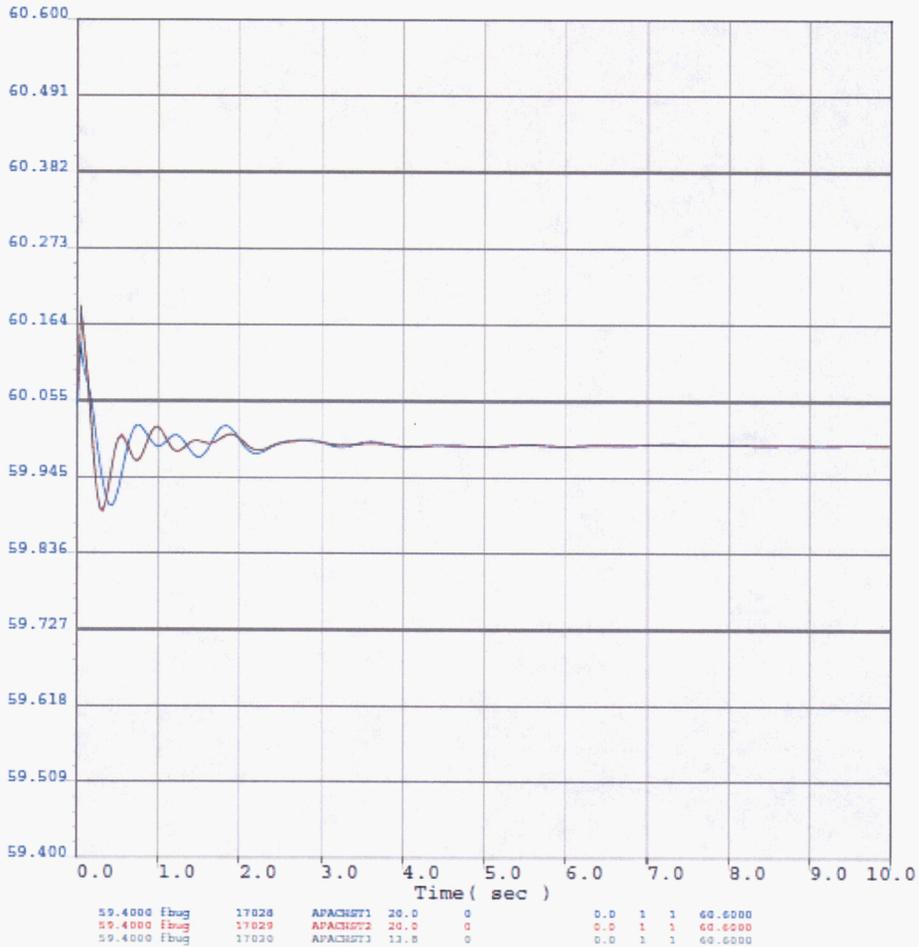
BICKNELL-VAIL 345 kV
 2016 Heavy Summer
 Generator Frequency Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

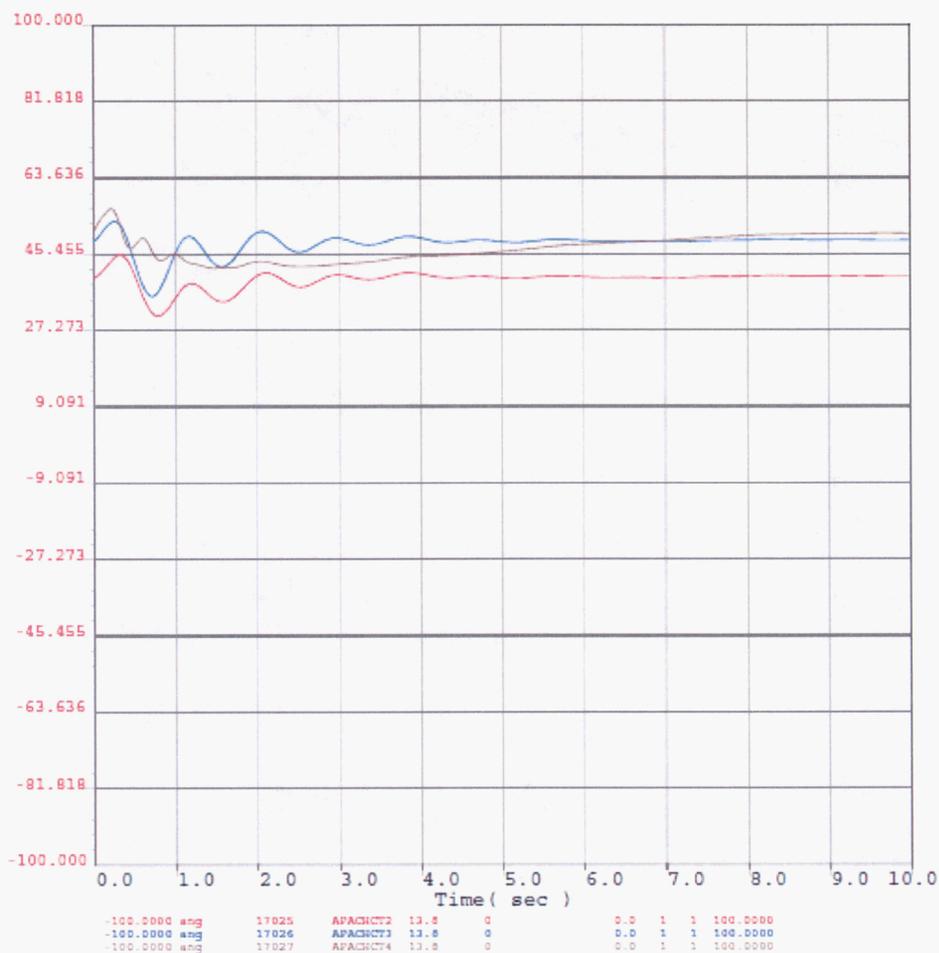


BICKNELL-VAIL 345 kV
 2016 Heavy Summer
 Generator Frequency Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

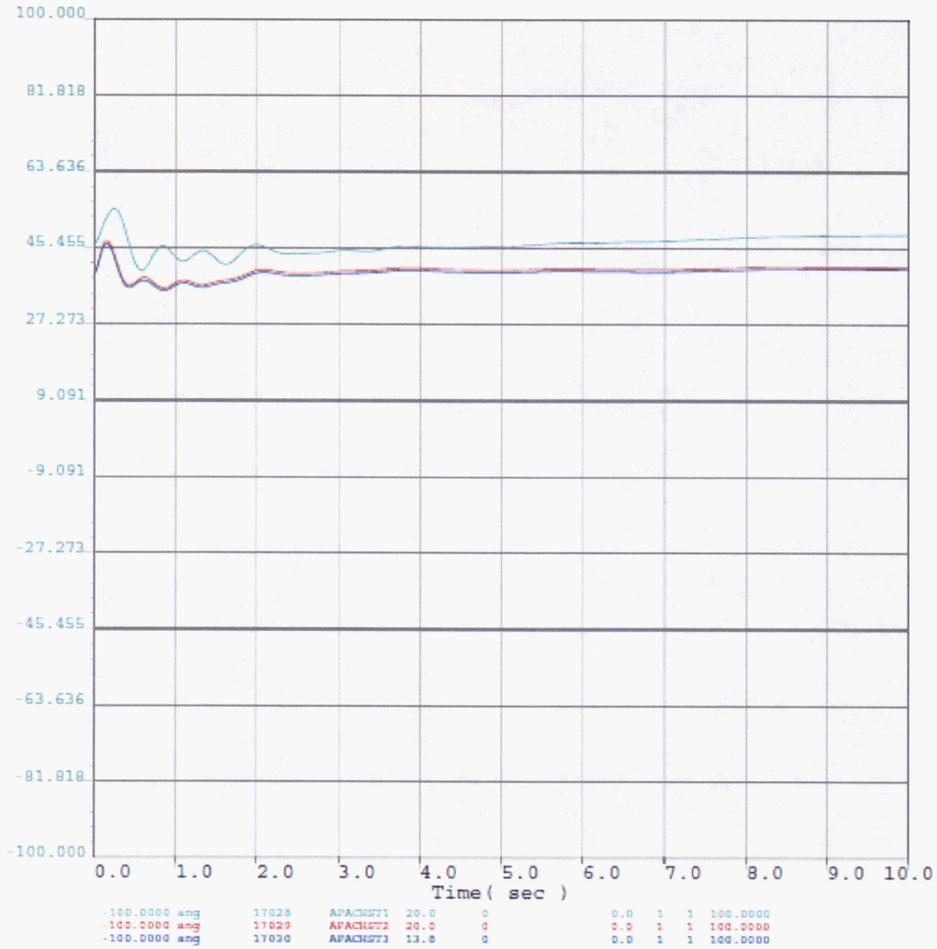
BICKNELL-VAIL 345 kV
 2016 Heavy Summer
 Generator Angle Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

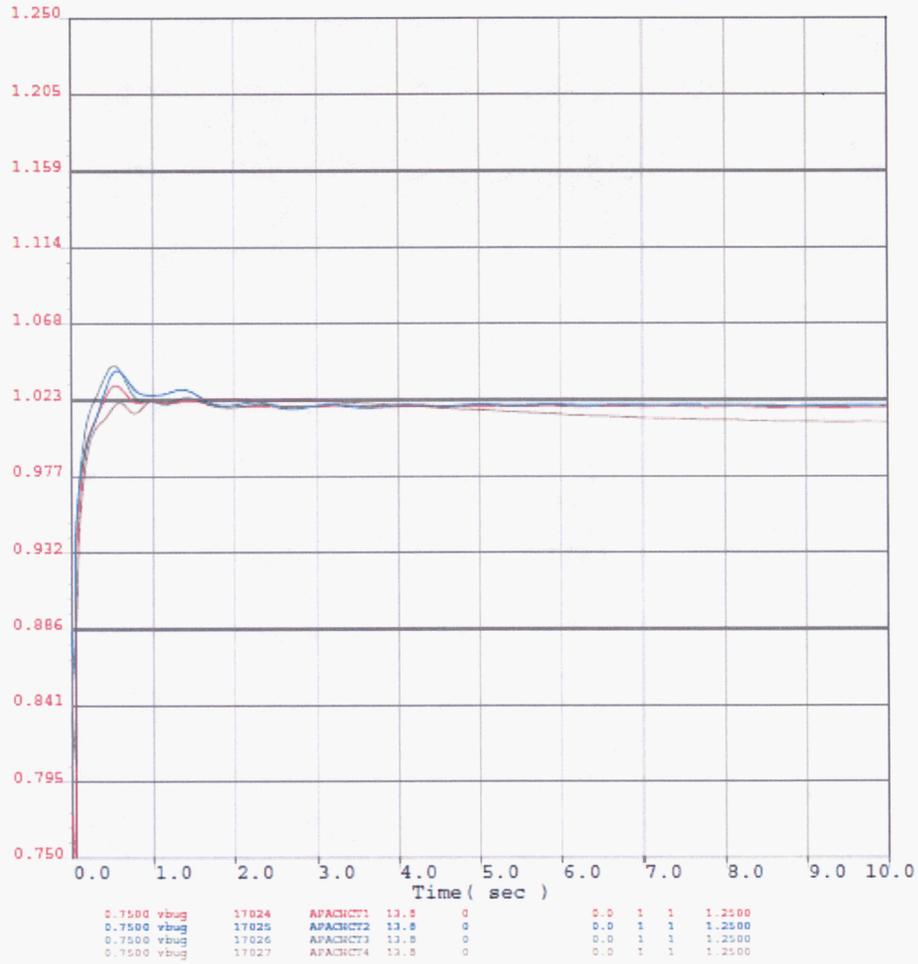


BICKNELL-VAIL 345 kV
 2016 Heavy Summer
 Generator Angle Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE

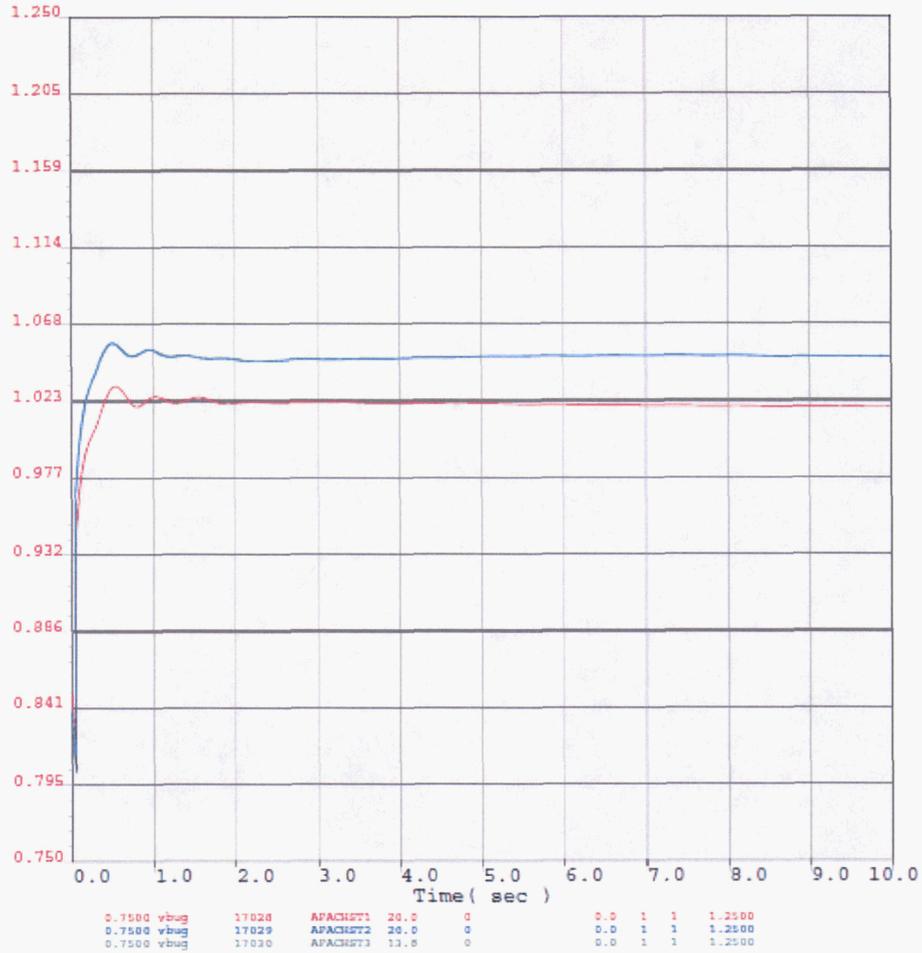
BICKNELL-VAIL 345 kV
 2016 Heavy Summer
 Generator Voltage Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE



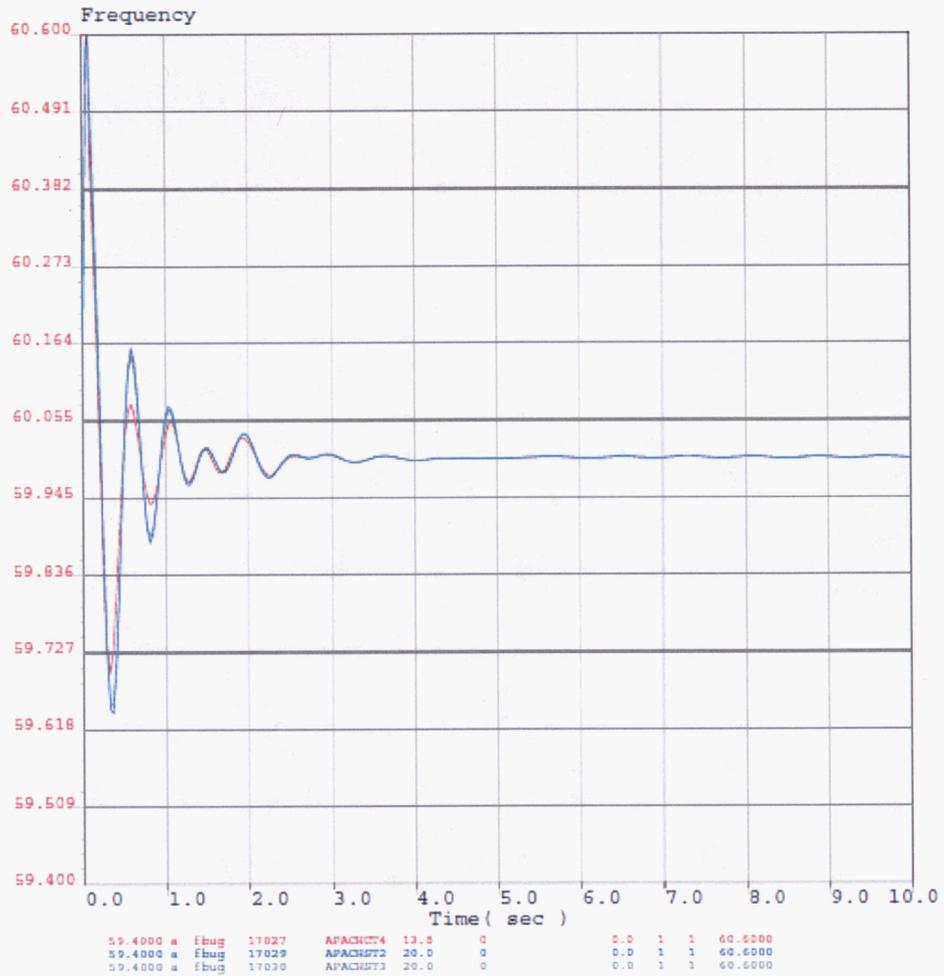
BICKNELL-VAIL 345 kV
 2016 Heavy Summer
 Generator Voltage Plots



2016 HS coordinated case
 developed from Coordinated AZ 2014 HS Seed Case
 developed from WECC 2014 HS3-SA APPROVED BASE CASE



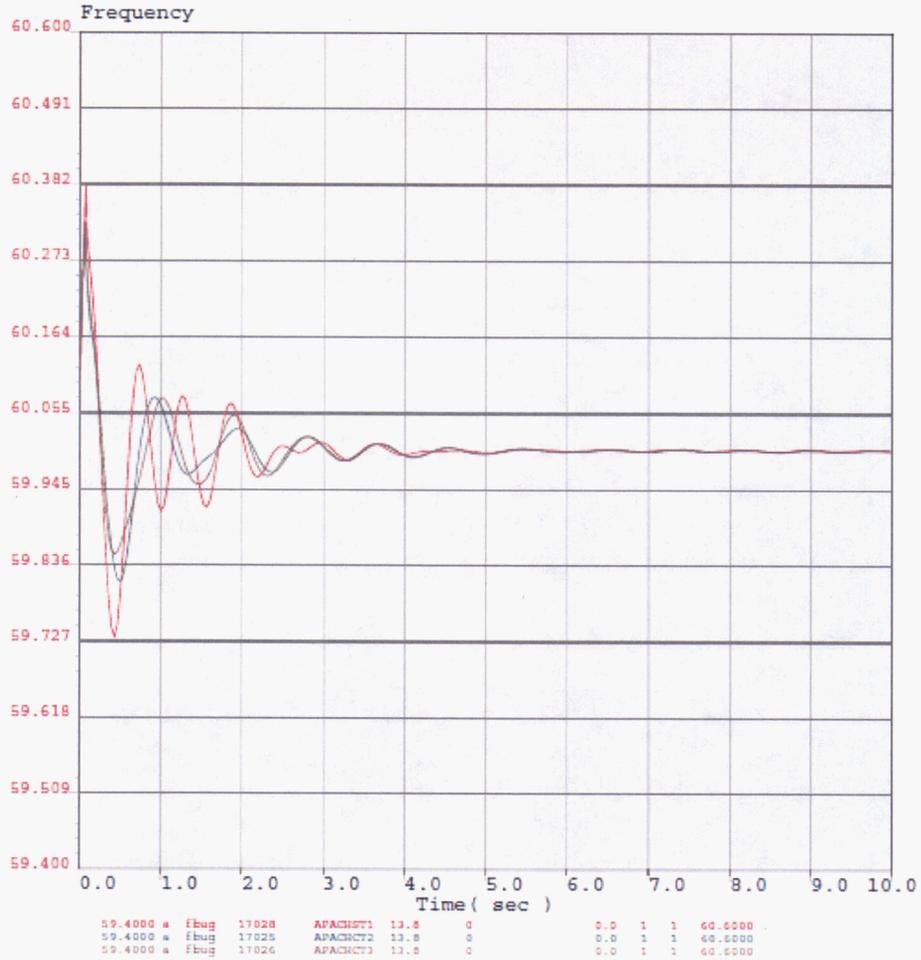
APACHE-BUTERFLD 230kV #1 & BICKNELL 345/230kV #1
230kV Generator Frequency Stability Plots



2016 HS coordinated case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE



APACHE-BUTERFLD 230kV #1 & BICKNELL 345/230kV #1
115kV Generator Frequency Stability Plots



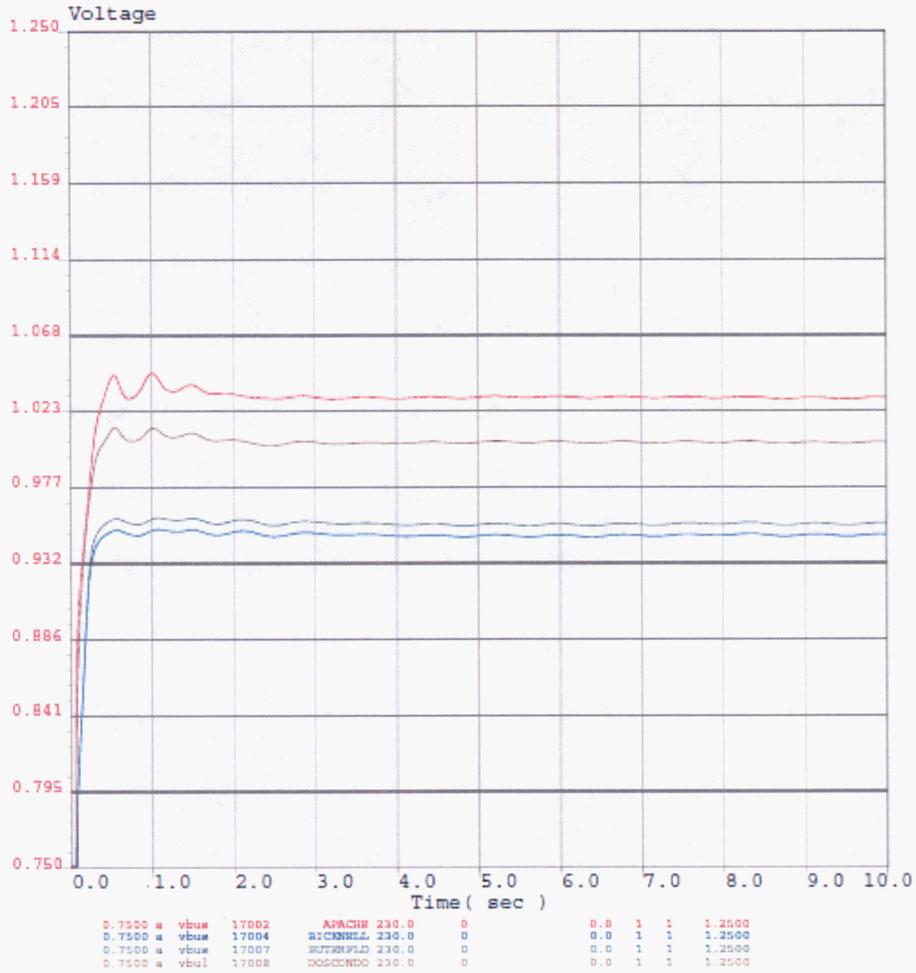
2016 HS coordinated case
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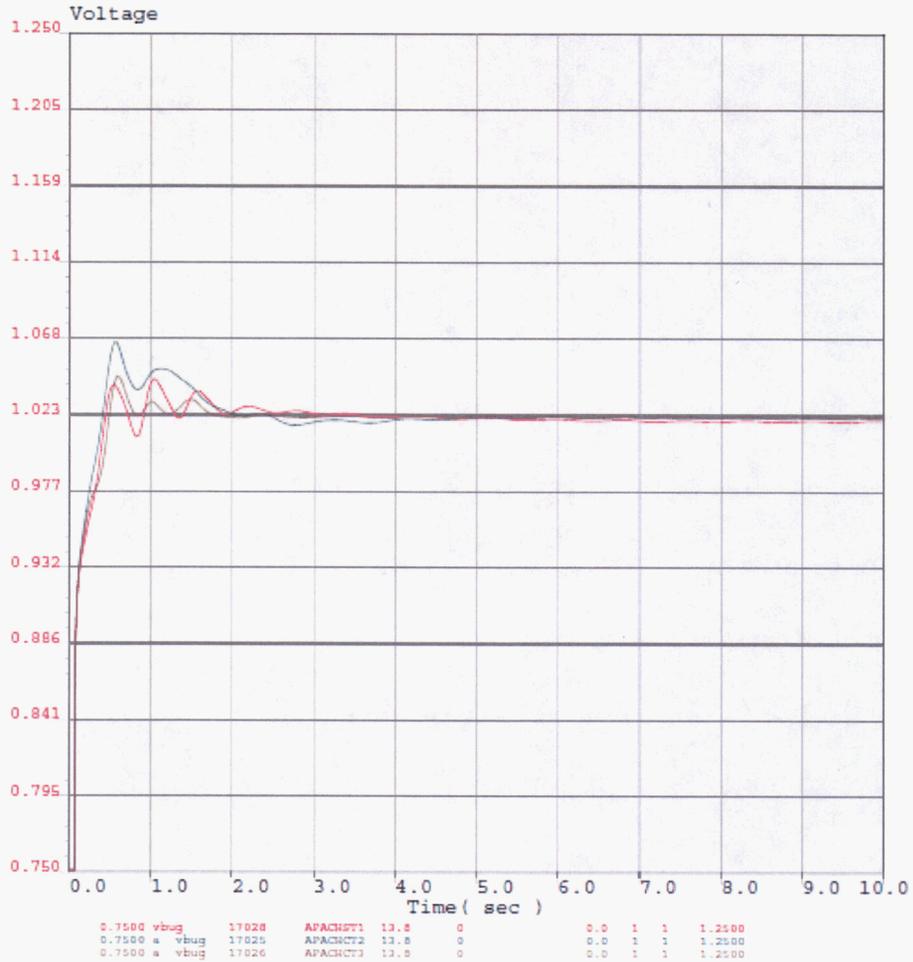
APACHE-BUTERFLD 230kV #1 & BICKNELL-VAIL 345kV #1
230kV Voltage Stability Plots



2016 HS coordinated case
developed from Coordinated AZ 2014 HS Seed Case
developed from WSCC 2014 HS3-SA APPROVED BASE CASE



APACHE-BUTERFLD 230kV #1 & BICKNELL 345/230kV #1
115kV Generator Voltage Plots



2016 HS coordinated case
developed from Coordinated AZ 2014 HS Seed Case
developed from WECC 2014 HS3-SA APPROVED BASE CASE



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