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ORIGINAL

# TEN-YEAR TRANSMISSION PLAN

## 2015 - 2024

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### Docket No. E00000D-15-0001

### JANUARY 29, 2015

**SOUTHWEST TRANSMISSION COOPERATIVE, INC.**

**TEN-YEAR TRANSMISSION PLAN**

**2015 – 2024**

Prepared for the

**ARIZONA CORPORATION COMMISSION**

**Docket No. E-00000D-15-0001**

**TRANSMISSION PLANNING**

**JANUARY 29, 2014**

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# **SOUTHWEST TRANSMISSION COOPERATIVE, INC.**

## **TEN-YEAR TRANSMISSION PLAN**

### **GENERAL INFORMATION**

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

This report contains transmission projects that SWTC anticipates may be constructed over the next ten-year period. As noted in A.R.S. section 40-360.02.F, the plans contained in this report are tentative information only and are subject to change at any time at the discretion of SWTC. SWTC anticipates that any changes to this plan will likely to be due to changes in load forecasts, environmental constraints, economic considerations, other utilities’ plans, regulatory and legal developments, as well as future regional and federal mandates. All 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. One of the responsibilities of the CAOC is to review 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. Conceptual projects, or those that have not been vetted by the CAOC for placement into a CWP, may be included in ten year plan filings but will be listed as conceptual projects with tentative or “to-be-determined” (“TBD”) in-service dates. TBD as used in this document means that in addition to the project not being yet vetted by the CAOC, it can also mean that the project is still in negotiations with other entities.

This specific report is divided into two sections, as outlined in the Table of Contents on page 2. Section I describes planned transmission lines and projects SWTC may construct over the ten-year plan period, whose nominal 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.

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

Due to the continued downturn in the economy and the easing of development in the Member System's certificated service areas, there are currently no planned transmission projects needed for load growth in this ten year plan filing.

## **REGIONAL PLANNING**

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

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

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

- Operating Committee ("OC")
- Planning Coordination Committee ("PCC")

- Technical Studies Subcommittee (“TSS”)
- System Review Work Group (“SRWG”).

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

SWTC continues its involvement in the regional transmission planning activities of WestConnect. WestConnect coordinates its efforts with other regional planning entities within the Western Interconnection and its most recent efforts have focused on compliance with the provisions of the Federal Energy Regulatory Commission (“FERC”) Order No. 1000 “Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities” that was issued July 21, 2011.

WestConnect received a FERC Order on September 18, 2014 that contained 36 compliance items with a compliance filing date of November 17, 2014. WestConnect entities made their compliance filing on November 17, 2014 and are proceeding with a draft study for an abbreviated planning cycle that starts January 1, 2015. The Study Plan is expected to be made final and posted no later than January 30, 2015. WestConnect has been working with the Subregional Planning Groups (SPCs), such as SWAT, on data collection and modeling processes.

The existing Planning Management Committee (“PMC”) will be remade under a new Planning Participation Agreement (“PPA”) that was also filed on November 17, 2014 that will replace the May 23, 2007 WestConnect Project Agreement for Subregional Transmission Planning (“STP Agreement”), as amended on January 14, 2009. The responsibilities of the PMC going forward under this new PPA will include development of a Regional Transmission Study Plan, development of an annual budget for the Regional planning process activities and functions, development of planning models, identification of Regional transmission needs, submittal of projects to meet Regional transmission needs and identification of beneficiaries and cost

allocation. The structure of the PMC will initially include three standing subcommittees: (1) the Planning Subcommittee, (2) the Cost Allocation Subcommittee and (3) the Legal Subcommittee. Within the Planning Subcommittee are two working groups, the Expansion Planning Working Group that will perform benefits analyses and such other functions as defined and directed by the PMC, and the Power Flow Working Group that will perform power flow, voltage, stability, short circuit and transient analyses and such other functions as defined and directed by the PMC.

At the WestConnect Annual Planning Workshop, held November 20, 2014, SWTC presented a draft of its 2015-2024 Ten-Year Transmission Plan for inclusion into the 2015 WestConnect Transmission Plan. The WestConnect plan is scheduled for approval at the February 19, 2015 WestConnect Annual Planning Meeting. There are no substantive differences between the ten year plan filed with WestConnect and this ten year plan filing.

## **8<sup>th</sup> BTA REQUIREMENTS**

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

### **Recommendation #7D:**

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

### **SWTC Response:**

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

**Recommendation #7E:**

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

**SWTC Response:**

SWTC is scheduled to be audited in 2015. The audit period is January 26, 2015 to February 6, 2015. SWTC will report the audit findings in the 9<sup>th</sup> BTA.

**Recommendation #7F:**

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

**SWTC Response:**

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

**Recommendation #7G:**

The requirements for Arizona utilities to include planned transmission reconductor projects,

transformer capacity upgrade projects, and reactive power compensation facility additions at 115 kV and above in future ten year plans.

**SWTC Response:**

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

| <u>Year</u> | <u>Substation</u> | <u>MVAR Quantity</u>                                 |
|-------------|-------------------|--|
| 2015        | Sahuarita         | 14.4   |
| 2015        | Three Points      | 9.45   |
| 2015        | Kartchner         | Split 18.0 into 9.6 & 8.4 and move 8.4 to San Rafael |
| 2016        | Bicknell          | 19.2   |
| 2016        | Butterfield       | 14.4   |
| 2016        | San Rafael        | 10.8 (8.4 moved from Kartchner)                      |

Additional studies conducted in 2015, due to the recently approved 2014 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.

**Recommendation #8A:**

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

**SWTC Response:**

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

**Recommendation #8B:**

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

**SWTC Response:**

This recommendation goes into effect in next year's Ten Year Plan and SWTC is committed to complying with the recommendation at that time.

**Recommendation #8D:**

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

**SWTC Response:**

This recommendation applies only to utilities "with retail load." This limiting language was added to the draft recommendation after SWTC filed comments explaining that, given its status as a transmission only cooperative, it would be difficult (if not impossible) for SWTC to quantify the effects of DG and EE installations. Accordingly, this recommendation is not applicable to SWTC because it does not have "retail load."

## **CHANGES FROM 2014 TEN-YEAR PLAN FILING**

There are minor changes to the projects considered by SWTC for inclusion in this Ten-Year Plan filing over last year's ("2014-2023") Ten-Year Plan filing. These are noted below:

**Saguaro to Tucson 115 kV Line Loop-in To Marana.** SWTC reported in last year's ten year filing that this project had not progressed to a point where a definitive in-service date could be given. The project has now been withdrawn until such time as SWTC is confident of an expected in-service date and is therefore not included in this ten year plan. Potential alternatives to this project are being considered by SWTC, such as the Saguaro to Thornydale and Thornydale to Twin Peaks 115 kV Line Projects, which are briefly discussed in the next Section.

## **ADDITIONAL PROJECTS UNDER CONSIDERATION**

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

A brief description of each of these projects follows, for information purposes only.

SWTC will continue to hold discussions with potential project participants throughout 2015, and if refined project scopes have been established with agreements from project participants, and with approvals from governing boards, these projects may be reflected in next year's ten year plan.

**Apache/Hayden to San Manuel 115 kV Line.** This project has been presented in previous SWTC ten year plans, but was deferred from 2017 to beyond the ten-year plan horizon in last year's ten year plan filing. It was approved by the ACC Line Siting Committee on May 12, 2009 and by the Commission on July 9, 2009 (Case #142, Decision #71218). The project proposes the extension of a new 4.5 mile 115 kV line from the existing SWTC Apache to Hayden 115 kV line to the existing

APS San Manuel Substation. Revised interest in this project is due to a potential Trico Electric Cooperative, Inc. ("Trico") customer in the area. This line project will require the agreement of APS.

**Saguaro to Thornydale 115 kV Line.** This line segment is akin to the Saguaro to North Loop 115 kV line that was presented in the SWTC 2010-2019 ten year plan. It was approved by the ACC Line Siting Committee on October 7, 2009 and by the Commission on November 19, 2009 (Case #149, Decision #71420). The project proposed a new 15 mile 115 kV line between the existing APS Saguaro Substation and SWTC's existing Thornydale Substation. This line project will require the agreement of APS.

**Tombstone Junction Project.** This project involves looping the SWTC Butterfield to San Rafael 230 kV line into a new Tombstone Junction Substation with a 230/69 kV transformation to the existing SSVEC Tombstone Junction Substation. A new 7.5 mile double-circuit 69 kV line will be constructed to the existing APS Boothill Substation with a 115/69 kV transformation at Boothill. The project as proposed will enhance system reliability, increase transfer capability and voltage support for the interconnected transmission system in Southeast Arizona and will require a Certificate of Environmental Compatibility ("CEC") for the loop-in of the 230 kV line into the new Tombstone Junction Substation. SWTC held meetings in June and December of 2014 with APS and SSVEC to review preliminary studies regarding potential effects of this project. Finalization of study work is underway with more meetings planned for 2015.

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

**Thornydale to Twin Peaks 115 kV Line. Thornydale to Twin Peaks 115 kV Line.** This line segment is akin to the North Loop to Rattlesnake 115 kV line that was also presented in the SWTC 2010-2019 ten year plan. It was approved by the ACC Line Siting Committee on February 10, 2010 and by the Commission on April 14, 2010 (Case #152, Decision #71649).

The project proposes a new 8 mile 115 kV line between SWTC's Thornydale Substation and the CAP Twin Peaks Substation. This line project will require the agreement of CAP.

**CAP 115 kV Line Tap to SWTC Sandario Substation.** This line segment is akin to the CAP 115 kV Line Loop-in Project that was presented in the SWTC 2010-2019 ten year plan. It was also approved by the ACC Line Siting Committee on February 10, 2010 and by the Commission on April 14, 2010 (Case #152, Decision #71649) as part of the North Loop to Rattlesnake 115 kV Line Project. The project proposes that a new 0.6 mile 115 kV line to be tapped off of the existing CAP Sandario to Brawley 115 kV line to tie to the existing SWTC Sandario Substation. This line project will require the agreement of CAP.

**Valencia to CAP Black Mountain 115 kV line.** This line segment is akin to the Valencia to CAP Black Mountain 115 kV Line Project that was also presented in the SWTC 2010-2019 ten year plan. It was approved by the ACC Line Siting Committee on February 10, 2010 and by the Commission on April 14, 2010 (Case #152, Decision #71649) as part of the North Loop to Rattlesnake 115 kV Line Project. The project proposes a new 2.6 mile 115 kV line that will extend from the existing SWTC Valencia Substation to tie to the turning structure of the 115 kV CAP line that heads directly north 2 miles to the existing CAP Black Mountain Substation. This line project will require the agreement of CAP.

## **PROJECT MAPS**

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

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

Figure 1 - SWTC Northern Area

Figure 2 - SWTC Southern Area

Figure 3 - SWTC Western Area

Figure 4 – SWTC California and Northwest Arizona Areas

FIGURE 1  
SWTC NORTHERN AREA SYSTEM

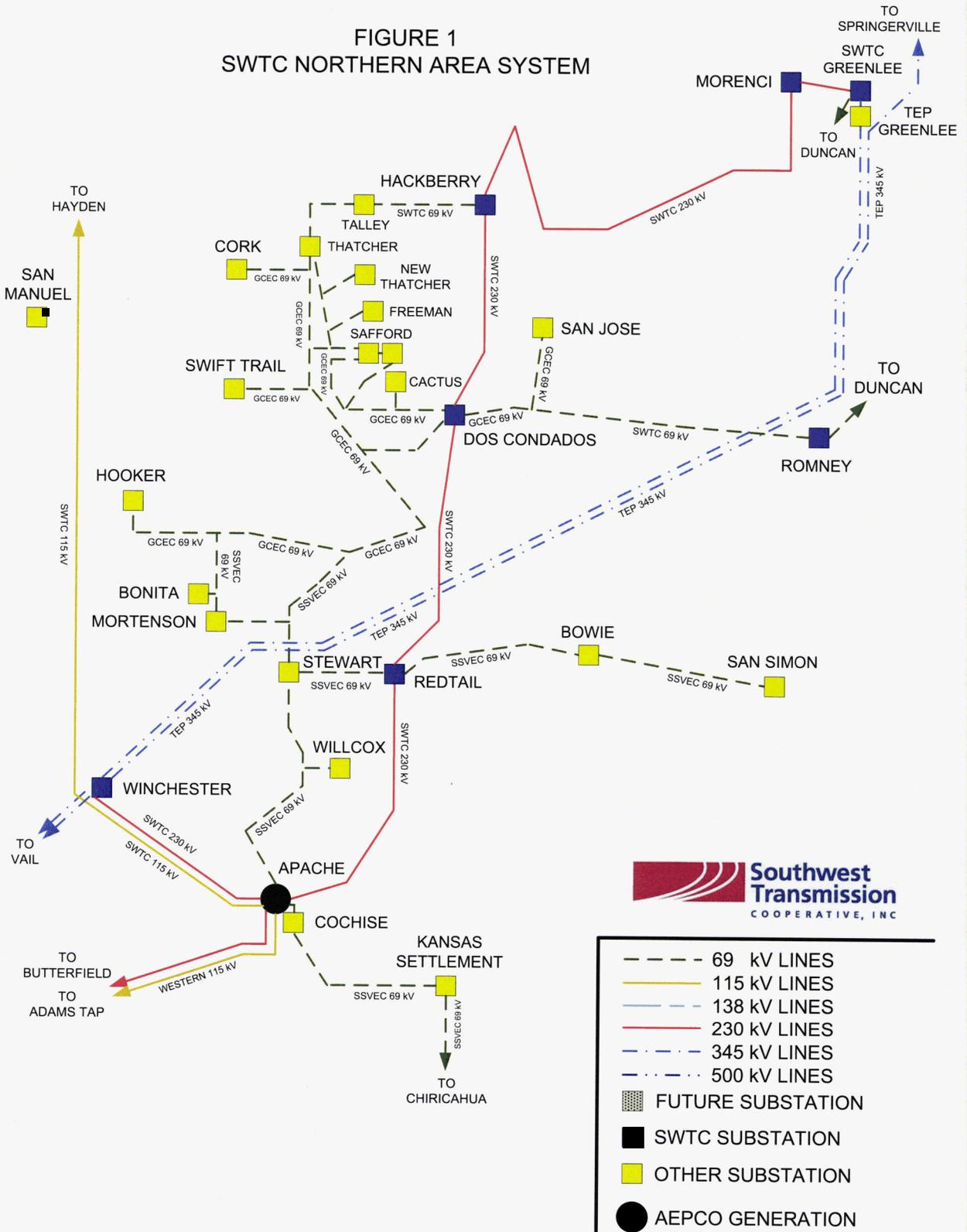




FIGURE 3  
SWTC WESTERN AREA SYSTEM

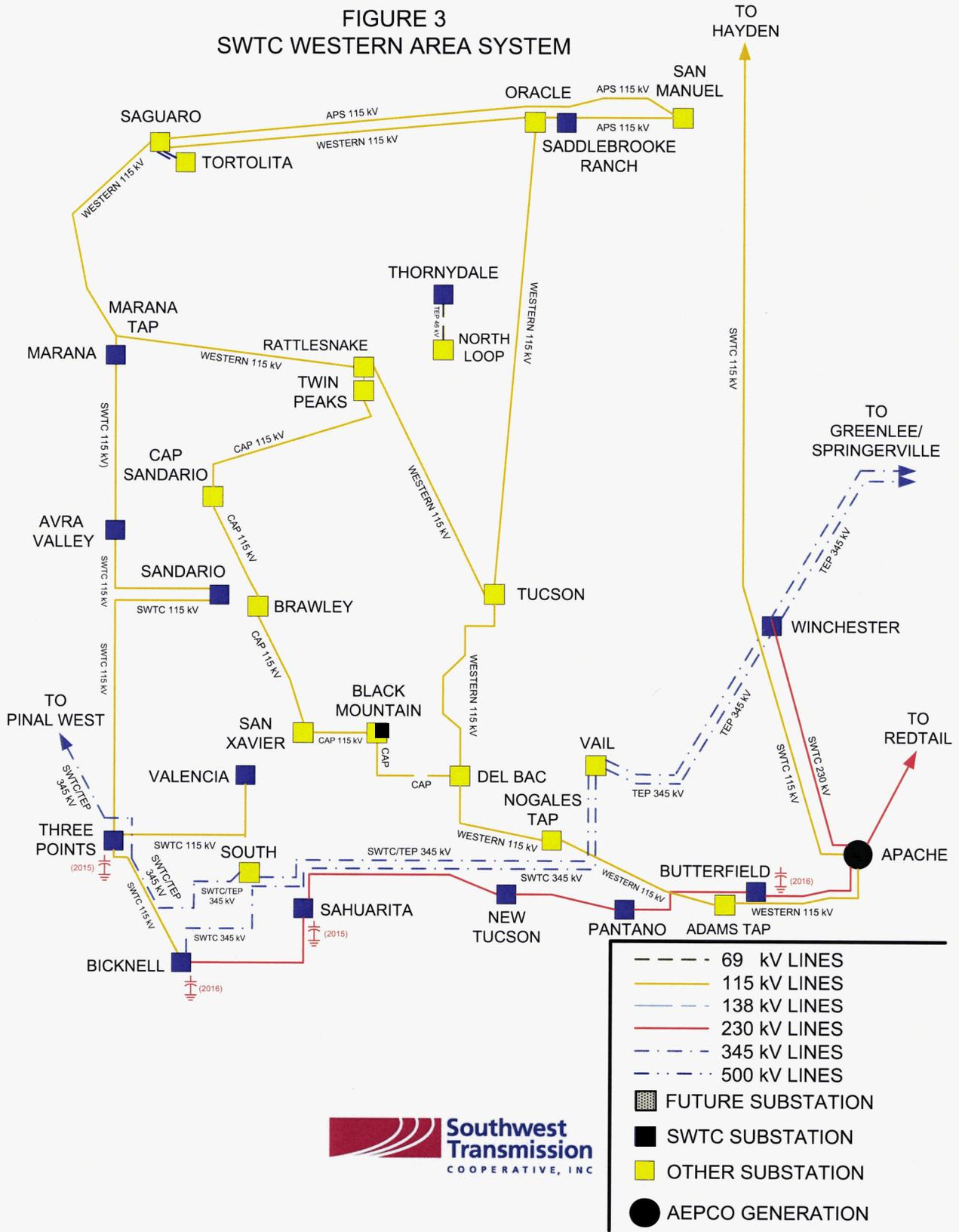
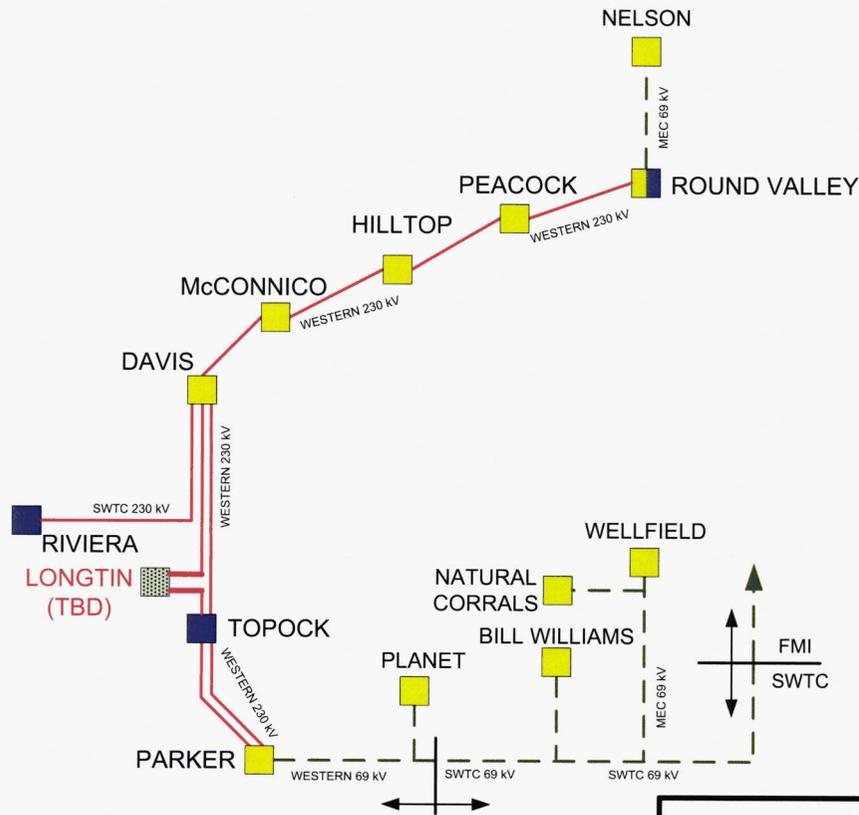


FIGURE 4  
SWTC CALIFORNIA & NORTHWEST ARIZONA AREA SYSTEMS

**ANZA (CALIFORNIA) AREA**



**MOHAVE (NORTHWEST ARIZONA) AREA**



|     |                   |
|-----|-------------------|
| --- | 34.5 kV LINES     |
| --- | 69 kV LINES       |
| --- | 115 kV LINES      |
| --- | 138 kV LINES      |
| --- | 230 kV LINES      |
| ■   | FUTURE SUBSTATION |
| ■   | SWTC SUBSTATION   |
| ■   | OTHER SUBSTATION  |
| ●   | AEPco GENERATION  |

## **SECTION I - PLANNED TRANSMISSION LINES**

**(None)**

## **SECTION II - INTERNAL PLANNING CRITERIA AND FACILITY RATINGS**

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

## **1.0 Introduction**

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

## **2.0 Statement of Limitations**

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

- 2.1** The facilities addressed in this document include transmission conductors, transformers, relay protective devices, terminal equipment and compensation devices.
- 2.2** This methodology addresses Normal and Emergency ratings for the facilities that comprise SWTC's BES.
- 2.3** This Facility Ratings Methodology considers the ratings provided by equipment manufacturers, The Institute of Electrical and Electronics Engineers, Inc., (IEEE) and American National Standards Institute (ANSI) standards, ambient conditions for solar input, temperature and wind speed, design criteria, operating limitations, and other assumptions, as applicable.

- 2.4** The ratings for all of SWTC BES facilities, including but not limited to lines, transformers, and shunt compensation devices shall respect the most limiting applicable Equipment Rating of the individual equipment that comprises that facility.
- 2.5** In cases where a facility is jointly owned, the operator of the facility determines the rating and shares the rating with the other joint owners. SWTC is a joint owner in two transmission lines: The Vail to Westwing 345 kV line, which it co-owns with Tucson Electric Power (TEP) (project operator), and the Hassayampa to Pinal West 500 kV line, which it co-owns with Electrical District 2 (ED2), Electrical District 3 (ED3), Electrical District 4 (ED4), Salt River Project (SRP) (project operator) and TEP. SWTC is also a co-owner with TEP (project operator) in the Pinal West 500/345 kV transformer. Information on co-owned facilities is included in Appendices A and B.
- 2.6** In cases where a facility is owned in segments (such as a transmission line owned by one party with the breaker being owned by a different party), each owner will determine the rating for their segment and coordinate with the others to determine the most limiting segment. The rating for the most limiting segment will be used for the entire facility.

### **3.0 Facility Rating Methodologies for Transmission Facilities**

The following sections describe the rating methodology for SWTC facilities.

#### **3.1 Generation Facilities**

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

#### **3.2 Overhead Conductors**

In 2014, SWTC updated its overhead conductor rating methodology based upon the parameters outlined in Table 2 below. The calculations for normal operating conditions use the design criteria of 75°C, and the emergency operating conditions use a conductor design temperature rating of 100°C. SWTC incorporates the calculations used in the IEEE Standard 738 "IEEE Standard for Calculating the Current-Temperature of Bare Overhead Conductors," in its analysis of determining the current-temperature relationship of its conductors, given the parameters noted in Table 2.<sup>1</sup>

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<sup>1</sup> Information on SWTC Conductor Ratings also found in the following reference documents:

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

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

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

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

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

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

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

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

- a. The thermal ratings from Table 1, used by SWTC to rate its transmission lines, are considered to be conservative. The emergency ratings are set at 130% of the normal rating based on ratings developed for each transmission line according to IEEE Standard 738. If through internal studies it is determined that a line will become stability limited, (at a value lower than the thermal limit) its rating will be based on its particular stability limit.
- b. The weather parameters for development of the existing conductor thermal ratings are based on the values for wind direction, absorptivity, and wind speed as noted in Table 2 above. The conductor ratings are based on a 75°C operating temperature with a 4 ft. per second wind speed and a 40°C air temperature. Emergency ratings, as shown in Appendix A, are based on a 100°C operating temperature with a 4 ft. per second wind speed and a 40°C air temperature. SWTC can exceed its normal ratings for up to 30 minutes. Where a transmission line, or line section, is constructed or upgraded with more than one size conductor, the overall line rating is determined by the rating of the most limiting sized conductor. If other equipment (switches, series capacitors, etc) in series with the transmission conductor is more limiting, the lowest limitation defines the transmission line rating.
- c. Rigid Bus and Strain Bus design are determined by the Rural Utilities Service (RUS) Design Guide for Rural Substations Bulletin 1724E-300 (Bulletin) and NESC as a minimum. The design involves many factors, which are spelled out in the Bulletin. For new 115 kV substations, SWTC uses a standard schedule 40 aluminum pipe conductor size of 3" and for

new 230 kV substations, SWTC uses an aluminum pipe conductor size of 4". There is currently no case on the SWTC system where the rigid bus or strain bus is a limiting factor for any of SWTC's transmission line ratings. The ratings of the Aluminum rigid bus or pipe conductor are based on IEEE Standard 605-1998 "IEEE Guide for Design of Substation Rigid-Bus Structures, using an emissivity of 0.5, with Sun, at a 40°C temperature rise above 40°C Ambient for normal operating conditions, and a 60°C temperature rise above 40°C Ambient for emergency operating conditions.

### **3.2.1 Transmission Line Ratings**

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

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

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

in SWTC's Transmission Vegetation Management Plan (TVMP).

### 3.3 Transformers

SWTC owns the following types of power transformers:

- a. Load serving transformers with LTC
  - Conventional
  - Auto
- b. Tie Autotransformers

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

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

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

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

### 3.4 Relay Protective Devices

None of SWTC BES facilities have ratings that are limited by protection or monitoring devices. SWTCs relays will not trip (trip on Zone 3) due to normal

or emergency load current (See PRC-023-1 Transmission Relay Loadability). New facilities and protection schemes are reviewed by SWTC to ensure that loadability requirements are met.

### **3.5 Terminal Equipment (switches, breakers, etc)**

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

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

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

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

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

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

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

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

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

### 3.6 Compensation Devices

a. Shunt compensations

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

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

b. Series compensation

SWTC has no series compensation devices on its system.

### 4.0 Internal Planning Criteria for Facility Ratings

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

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

- 1) **Nominal Operating Limit**
  - Transmission lines should not be loaded greater than 100% of the thermal rating of the conductors.
  - Transformers, circuit breakers, current transformers, and other equipment should not be loaded above their continuous nameplate rating.
  - Transmission system voltages should not fall below 0.95 per unit (p.u.) of nominal rating nor rise above 1.05 p.u. of nominal rating.
  - For long range planning system studies, an appropriate power factor for the planning period will be used.
  - For operating system studies, an appropriate power factor for the operating planning period will be used.
  
- 2) **Emergency Operating Limit**
  - Transmission lines should not be loaded greater than the specified emergency rating of the conductors. (See Appendix A)
  - Transformers should not be loaded greater than the specified emergency rating of the transformers. (See Appendix B)
  - Circuit breakers, current transformers, and other equipment should not be loaded above their continuous nameplate rating, except as permitted under applicable standards. (See Appendices C, D, and E)
  - Transmission system voltages should not fall below 0.90 p.u. of nominal rating nor rise above 1.10 p.u. of nominal rating.
  - For long range planning system studies, an appropriate power factor for the planning period will be used.
  - For operating system studies, an appropriate power factor for the operating planning period will be used.

## **5.0 Establishment and Communication of Facility Ratings**

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

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

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

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

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

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

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

Notes:

- 1) SRP is the operating agent for the Hassayampa to Pinal West 500 kV line and has determined its line ratings. SWTC owns 7.305% of this line.
  - 2) TEP is the operating agent for Pinal West to Vail and Pinal West to Westwing 345 kV lines and have determined their line ratings. SWTC owns 24% of these lines.
  - 3) Dos Condados to Hackberry and Hackberry to Morenci 230 kV Lines limited by 1272 AAC conductor.
  - 4) Davis to Riviera 230 kV Line limited by 1272 ASCR conductor Normal Conditions and limited by 1200A disconnect switch Emergency Conditions.
  - 5) Apache to Hayden 115 kV Line limited by 477 AAC conductor at Apache (SWTC Rating) and Hayden (SRP Rating).
  - 6) Marana to Avra and Avra to Sandario 115 kV Lines limited by 795 AAC conductor at Avra.
- <http://azgt/sites/azgt/powerpln/Managed Documents/Transmission Planning/ACC Ten Year Plan Filings/2015/ACC10YRPlan2015-2024.docx>