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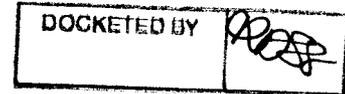
**Tucson Electric Power Company**  
P.O. Box 711, Tucson, AZ 85702  
One South Church Avenue, Suite 200, Tucson, Arizona 85701

February 25, 2011

Arizona Corporation Commission  
**DOCKETED**

FEB 25 2011

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



Re: 2010 Southeast Arizona Transmission System Study Report  
Docket No. E-00000D-11-0017, Decision No. 72031 (December 10, 2010)

Pursuant to Decision No. 72031 (December 10, 2010), Arizona Public Service Company, Southwest Transmission Cooperative, and Tucson Electric Power Company ("TEP") were ordered to conduct additional analysis of potential 230 kV and 138 kV voltage deviations in Southeastern Arizona as noted in the 2009 Southeast Arizona Transmission System ("SATS") study report and file an update based on the 2010 SATS by February 28, 2011. TEP hereby files, on behalf of all SATS participants, the 2010 SATS study report.

If you have any questions regarding this filing please contact me at (520) 884-3680.

Sincerely,

Jessica Bryne  
Regulatory Services

cc: Steve Olea, Director, ACC  
Prem Bahl, ACC  
Jacque Cook, SWTC (via email)  
Barbara McMinn, APS (via email)

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**2010 SOUTHEAST ARIZONA  
TRANSMISSION SYSTEM  
STUDY REPORT**

**February 2011**

## Executive Summary

The Southeast Arizona Transmission System (SATS) study group, consisting of Transmission Providers, Transmission Customers, Distribution Providers, and other interested parties, has performed and reviewed analyses of the transmission system in Southeast Arizona to determine if the North American Electric Reliability Corporation (NERC) Reliability Standards and Western Electricity Coordinating Council (WECC) System Performance Criteria can be met for the planned system. Tasks completed as part of the SATS 2010 Study Plan include development of power flow cases to represent the planned system for selected years between 2011 and 2016 and 2020, revision of load forecasts, evaluation of the planned system including projects deferred from previous years, and identification of planned and potential projects for the 2011 through 2020 time period.

Each entity provided updated load forecasts for the 2011 – 2020 time period and these updated forecasts were reflected in the base cases developed for the SATS study. These forecasts reflect only a minor change from the 2009 forecasts provided by the same entities. The aggregate SATS forecasts for the years 2011 through 2020 were within 100 MW (or 3%) of the forecasts provided in 2009.

The Cochise County Study Group (CCSG) completed the technical studies required as part of the fifth Biennial Transmission Assessment (BTA) order issued by the Arizona Corporation Commission (ACC) as part of the 2009 SATS study effort. However, the group membership was retained in anticipation of follow-up orders by the ACC following release of the sixth BTA in 2010. This order was issued in December of 2010 and the CCSG will address the applicable sections of the sixth BTA order in 2011.

Power flow analysis for the SATS footprint was conducted using the base cases developed for the years 2011, 2012, 2015, and 2020. These base cases included planned projects that were expected to be in service prior to the system peak for each year. With the planned projects and the additional mitigation measures proposed for each year, the transmission system within the SATS footprint meets the NERC Reliability Standards and WECC System Performance Criteria. In addition, planned voltage switched capacitor banks proposed by SWTC in 2013 and 2020 should mitigate any delta-voltage issues identified in the 2009 SATS study. This will be further evaluated in the 2011 SATS study as ordered by the ACC in the sixth BTA.

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## 1. Introduction

The Southeast Arizona Transmission System (SATS) study group consists of entities in the region that provide generation, transmission, and distribution services in Southeast Arizona. Other interested parties include Project Developers, State and Federal Agencies, and neighboring utilities. The SATS study area includes all or portions of Cochise, Graham, Pima, Pinal, and Santa Cruz counties in Arizona. Within this region are generation, transmission and distribution facilities operated by:

- Arizona Public Service (APS)
- Central Arizona Water Conservation District / Central Arizona Project (CAWCD/CAP)
- Duncan Valley Electric Cooperative (DVEC)
- Graham County Electric Cooperative (GCEC)
- Southwest Transmission Cooperative (SWTC)
- Sulphur Springs Valley Electric Cooperative (SSVEC)
- Trico Electric Cooperative (Trico)
- Tucson Electric Power Company (TEP)
- UniSource Energy Services – Electric (UNSE)
- Western Area Power Administration (Western)

Other SATS participants include:

- Arizona Corporation Commission (ACC) Staff
- Arizona Power Authority (APA)
- Arizona Independent Scheduling Administrator (AzISA)
- Black Forest Partners
- El Paso Electric (EPE)
- Environmental Planning Group (EPG)
- Federal Energy Regulatory Commission (FERC) Staff
- Fort Huachuca
- New Mexico Renewable Energy Transmission Authority (NM RETA)
- Public Service Company of New Mexico (PNM)
- Salt River Project
- Southwestern Power Group
- Tessera Solar
- United States Bureau of Reclamation (USBR)
- WestConnect Planning Staff
- Western States Energy Solutions (WSES)

## 2. Study Scope

The SATS 2010 Study Plan was originally approved by the SATS participants on January 21, 2010 and approved by the Southwest Area Transmission (SWAT) Subregional Planning Group (SPG) on February 16, 2010. The SATS 2010 Study Scope included:

- 1) A presentation of the study plan and subsequent findings to SWAT, WestConnect, and local stakeholders;
- 2) Revised load forecasts;
- 3) Development of base cases for 2010 study;
- 4) A study to determine impacts of deferring previously planned projects;
- 5) An investigation of alternative configurations to mitigate high flows on the Winchester 345/230 kV transformer, Apache – Bicknell 230 kV line, and Bicknell 345/230 kV transformer caused by EHV system contingencies;
- 6) Development and evaluation of alternatives to the two joint Tortolita – North Loop 345 kV proposals based on the SPPR three Terminal proposal;
- 7) Development and evaluation of alternatives for joint SWTC/TEP substation(s) to supply TEP/Trico loads south of Tucson;
- 8) Identification of potential projects in the SATS footprint;
- 9) A VAR Margin Study – 230 kV and above buses.

The 2010 SATS study effort focused on the impacts of deferring previously planned projects. As such, items 5 – 7 have been deferred and will be evaluated in the 2011 SATS Study, time permitting, after addressing applicable orders from the ACC in the 6<sup>th</sup> BTA. Item 9 was eliminated from the 2010 study plan and will not be carried forward in the 2011 study.

In addition, the Cochise County Study Group (CCSG), Southline Project Coordination Review Group (Southline PCRG), SunZia Southwest Transmission Project (SunZia), Bowie Power Station (Bowie) and the SATS-Northwest (SATS-NW) group have been reporting activities to SATS. Each of these efforts will result in separate study reports. The CCSG activities have been limited this year while waiting on the response of the Commission regarding the technical report filed in 2010. With the 6<sup>th</sup> Biennial Transmission Assessment (BTA) order this group will have more activities to respond to the order. The Southline PCRG has conducted initial studies associated with the project and reported the results to the SATS group. The Southline PCRG will submit the results and the PCRG report to the appropriate Western Electricity Coordinating Council (WECC) committees and subcommittees. SunZia provided regular updates of their activities in Phase 2 of the WECC Three Phase Rating Process. Bowie provided updates regarding permitting extensions for the CEC. The SATS-NW group has been looking at load serving capability in the northwest portion of the SATS footprint.

### **3. Load Forecasts**

The SATS area load forecast was provided for years 2010 through 2020. The 2010 forecasted load for the SATS area ranged from 3194 MW in 2010 to 3916 MW in 2020. As shown in Figure 1, the 2010 load forecast is similar to the 2009 forecast. All loads were within 100 MW (or 3%) of the previous forecast. The greatest difference is in the forecasted load for 2015.

Figure 1. SATS Area Load Forecast

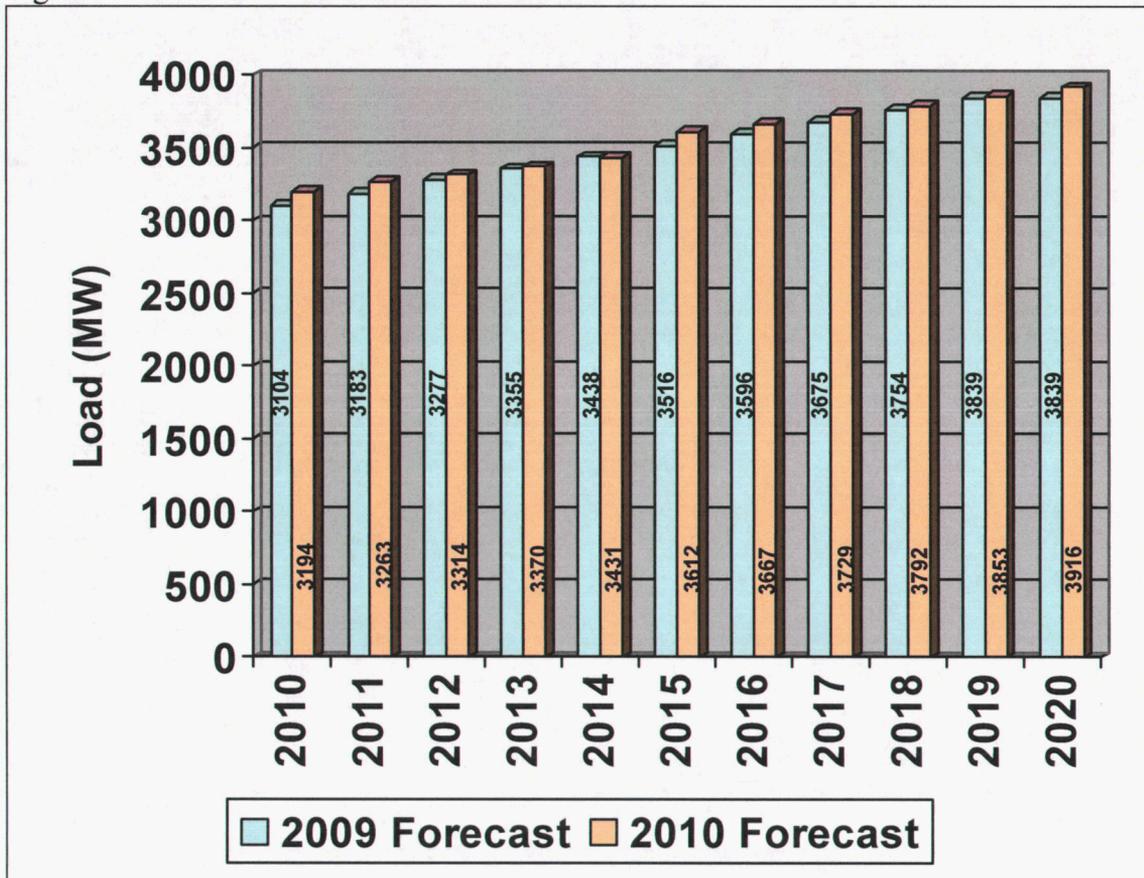
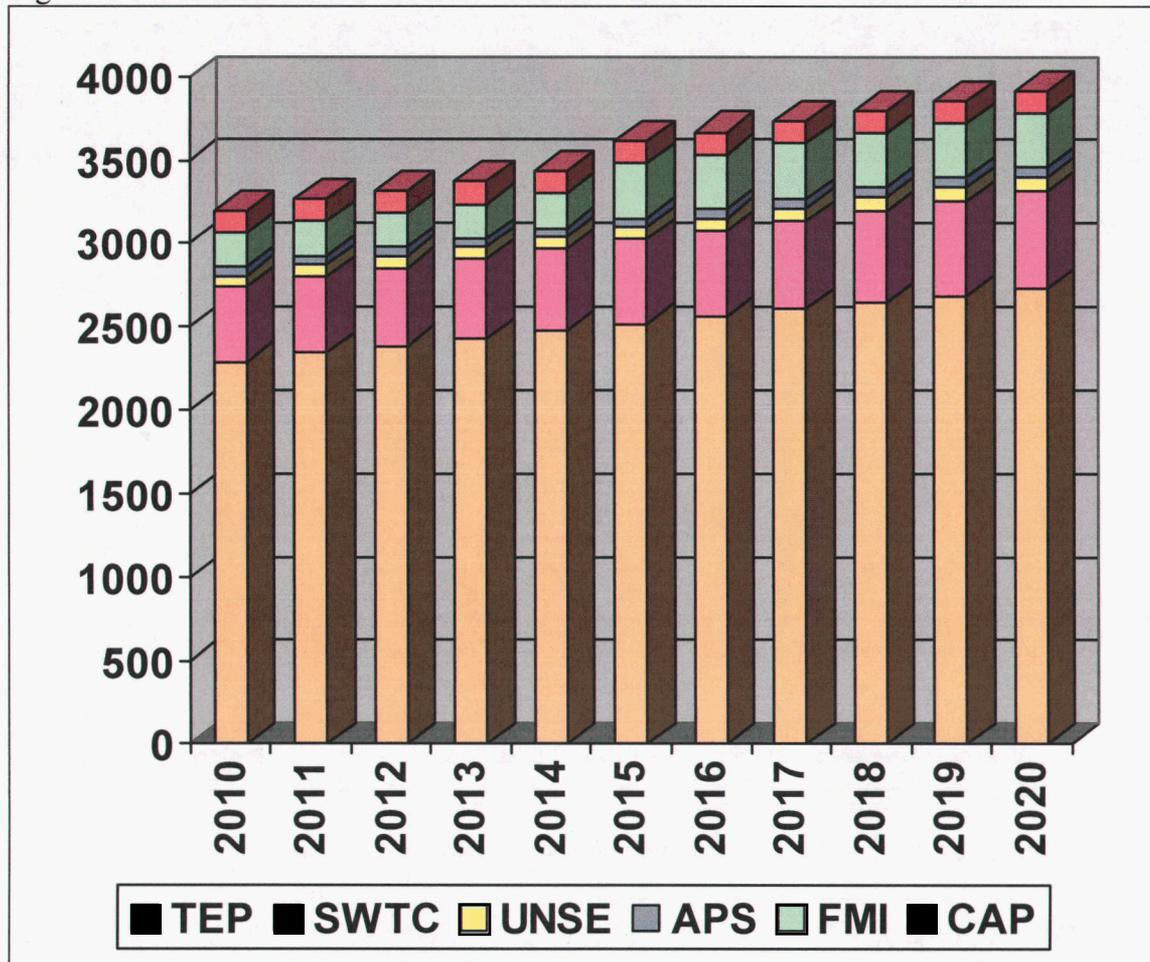


Figure 2 shows the SATS area load for each the entities in the SATS footprint. The SWTC forecasted load represents the loads of its cooperative members located in the SATS area. The members included in SATS are Trico, SSVEC, GCEC and DVEC.

Figure 2. Combined Load Forecast for SATS Entities



#### 4. Power Flow Case Development

The SATS study was conducted using the jointly coordinated Arizona seed cases developed under the direction of the CATS group. These cases were developed for heavy summer conditions for the years 2012, 2015, and 2020. Each of these cases originated from a WECC-approved base case.

#### 5. Study Results

Power flow studies for the SATS footprint were conducted by SWTC and TEP for the years 2011, 2012, 2015 and 2020. TEP's system analysis for the Required Local Generation (RLG) was determined based on TEP Internal Criteria. SWTC and TEP have determined that the most limiting conditions to be NERC Category A, B, C, or D condition. SWTC's Internal Planning Criteria are posted on SWTC's Open Access Same-Time Information System (OASIS) site at <http://www.oatioasis.com/SWTC/index.html>. TEP's Planning Process and Guidelines are posted on TEP's OASIS site at <http://www.oatioasis.com/tepc/index.html>.

## 5.1. 2011 Heavy Summer

For this study, the new facilities planned to be in-service prior to summer peak for the 2011 time frame are:

- TEP
  - Tortolita 500/345 kV transformer #3<sup>1</sup>
- SWTC
  - New Tucson 230/24.9 kV Substation
- Western
  - None
- APS
  - None

### 5.1.1. Thermal Loading

TEP's RLG for the 2011 Heavy Summer case is 408 MW. With this level of generation, there is one transformer overloaded due to a Category B contingency and one 138 kV line overloaded for a Category C contingency. Loss of the Greenlee – Copper Verde 345 kV line causes an overload of the SWTC Greenlee 345/230 kV transformer. SWTC and FMI have an agreement in place to reduce FMI load when the loading of this transformer begins to reach overload conditions. Load reduction for this outage will no longer be necessary when SWTC adds a parallel transformer in 2015. Increasing TEP local generation is not effective in reducing the flow through this transformer. The Category C contingency of the Los Reales – Vail and Vail – Cienega 138 kV lines causes the Irvington – 22<sup>nd</sup> Street 138 kV line to overload. The Irvington – 22<sup>nd</sup> Street 138 kV line is planned for reconductoring in 2012 but work planned in advance of the reconductoring will result in a higher rating that will be sufficient for 2011 summer peak conditions.

SWTC power flow analysis found that two 115 kV lines and one 345/230 kV transformer became overloaded under emergency conditions. The Avra – Marana 115 kV line overloads for Category B and C contingencies and the Avra – Sandario 115 kV line overloads for category C contingencies. Some Category C contingencies were on the TEP system and did not take into account the actions of the local area protection scheme. The Avra – Marana 115 kV line is scheduled to be upgraded in 2012 and will mitigate these overloads. The Avra – Sandario 115 kV line is scheduled to be upgraded in 2012. In the interim, any overloads that are caused by outages on the TEP system will be protected through actions taken by the local area protection scheme. The SWTC Greenlee 345/230 kV transformer overloads for the Category C contingency of the Greenlee – Winchester and Greenlee – Copper Verde 345 kV lines. A 2<sup>nd</sup> transformer is scheduled to be in-service by 2015. In the interim Operator instructions are in place to alert a large mining load to be reduced to alleviate the overload conditions.

Overload conditions for 2011 summer peak conditions are summarized in Table 1.

<sup>1</sup> Tortolita 500/345 kV transformer #3 will not be operated in parallel with Tortolita 500/138 kV transformers #1 & #2 until 2014. Prior to then, it will be available as a backup that can be placed in service as part of the system adjustment process if either of the other transformers is forced out of service.

Table 1. 2011 Overload Summary

Element	Number of Occurrences	Max PCT OL	Rating	Worst Outage	Proposed Mitigation
Marana – Avra 115	5	113.0	78.88 MW	Cat B: PW – SO	Line upgrade in 2012
	7	143.0		Cat C: SPR – GL & PW – SO	
Avra – Sandario 115	2	125.3	78.88 MW	Cat C: SPR – GL & PW – SO	Line upgrade in 2012
Greenlee-SW 345/230 xfmr	1	116.9	241 MVA	Cat B: GL – CV	Operator instructions in place to alert large mine to shed load; 2nd transformer at Greenlee in 2015
	1	133.7		Cat C: GL – WN & GL – CV	
Irvington – 22 <sup>nd</sup> Street 138	4	125.0	1434 A	Cat C: Los Reales – Vail 138 & Vail – Cienega 138	Line uprate in 2011; Reconductor in 2012

### 5.1.2. Voltage Summary

Voltage violations are seen on the 115 kV system from Marana Tap to Sandario, due to the loss of the Western Area Power Administration (Western) Saguaro East to Marana Tap 115 kV line or the SWTC Marana Tap to Marana 115 kV line. The Western outage of the Saguaro East to Marana Tap 115 kV line occurs for contingencies on the Saguaro East to Marana Tap to Rattlesnake to Tucson 115 kV line due to breaker configuration. SWTC is studying solutions to minimize the loss of these Western lines under this outage scenario. SWTC has been in discussions with Western on its study efforts and may initiate additional discussions towards a cost-effective solution with Western in 2011. Voltage deviations are seen on the above noted 115 kV buses due to the above mentioned 115 kV outages, which will be resolved through the placement of voltage switched capacitor banks on the system, currently scheduled to occur in 2013.

Voltage deviations are also seen on 230 kV system at the Butterfield, Pantano, and San Rafael buses due to an outage of the Apache to Butterfield 230 kV line, which will be resolved through the placement of voltage switched capacitor banks on the system, currently scheduled to occur in 2013.

The bus voltages at these 115 kV and 230 kV buses under outage conditions are within acceptable limits as per SWTC internal planning criteria, and there is no loss of load. The voltage violations are mitigated with the upgrade of the Marana Tap to Marana 115 kV line in 2011 (post-summer peak), and the upgrade of the Marana to Avra 115 kV line in 2012.

The proposed 115 kV upgrades and the proposed addition of voltage switched capacitor banks on the system in the 2013 time frame resolve the delta-voltage violations.

TEP analysis did not identify any voltage issues for 2011.

## 5.2. 2012 Heavy Summer

For this study, the new facilities planned to be in-service prior to summer peak for the 2012 time frame are:

- TEP
  - New Canoa Ranch load-serving substation
  - Vail 345/138 kV transformer #3
  - Conversion of the Nogales to Valencia 115 kV line to 138 kV and with extension to Vail<sup>2</sup>
  - Vail 345 kV Express Bus Tie Breaker
  - New Rosemont load served via a radial line interconnecting with the South to Green Valley 138 kV line
  - North Loop 138 kV yard expansion Phase 2
- SWTC
  - Marana Tap to Marana 115 kV Line Upgrade (2011- post summer peak)
  - Marana to Avra 115 kV Line Upgrade
  - Avra to Sandario Tap 115 kV Line Upgrade
- Western
  - None
- APS
  - None

### 5.2.1. Thermal Loading

With system changes identified in Section 5.2, TEP's RLG for the 2012 Heavy Summer case is 225 MW. The limiting condition is the Category C loss of both Saguaro – Tortolita 500/138 kV transformer-terminated lines. With lower local generation levels, this contingency results in an overload of the Saguaro – Marana Tap 115 kV line that cannot be alleviated with the TEP load shed.

With this level of generation, no lines were overloaded for any TEP Category B contingencies and only three TEP 138 kV lines were overloaded for TEP Category C contingencies. These three lines are the Irvington – 22<sup>nd</sup> Street, North Loop – Rillito, DMP – Northeast Loop 138 kV lines. TEP plans include projects that will result in higher ratings for each of these lines in 2011. Table 2 summarizes the thermal overload issues along with the planned upgrades to resolve the problems.

SWTC power flow analysis for 2012 was similar to the 2011 analysis except the Avra – Marana 115 kV line did not overload because of the upgrade, however the SWTC Greenlee 230/345 kV transformer continued to be overloaded but the worst Category B contingency is the Copper Verde – Frisco 230 kV line. The same mitigation proposed for the 2011 overloads still applies for 2012.

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<sup>2</sup> Vail T3 and conversion of the Nogales – Valencia 115 kV line with the extension to Vail has been deferred to the 4<sup>th</sup> Quarter of 2012. Vail T3 was not needed for reliability purposes before 2013 and the 115 kV to 138 kV line conversion with the extension to Vail will still be in-service prior to the deadline ordered by the ACC.

The 2012 overload issues are summarized in Table 2.

Table 2. 2012 Overload Summary

Element	Number of Occurrences	Max PCT OL	Rating	Worst Outage	Proposed Mitigation
Avra – Sandario 115	1	100.7	78.88 MW	Cat B: PW – SO	Line upgrade in 2012
	2	116.1		Cat C: AP – BF & AP – WN	
Greenlee-SW 345/230 xfmr	2	104.5	241 MVA	Cat B: CV – Frisco	Operator instructions in place to alert large mine to shed load; 2nd transformer at Greenlee in 2015
	1	138.3		Cat C: GL – WN & GL – CV	
22 <sup>nd</sup> – Irvington 138	20	123.4	1434 A	Cat C (N-2): Los Reales – Vail & Vail Cienega	Line uprate in 2011.
N. Loop – Rillito 138	8	104.9	1600 A	Cat C (N-1-1): N. Loop – W. Ina & Tortolita – Rancho Vistoso	Line Uprate in 2011.
DMP – Northeast 138	9	130.6	1200 A	Cat C (N-1-1): N. Loop – Rillito & Tortolita – Rancho Vistoso	Breaker replacement in 2011 will increase line rating to 1590 A.

### 5.2.2. Voltage Summary

SWTC analysis did not identify any voltage violations with the SWTC system. Delta-voltage violations are again seen on the 115 kV system due to the loss of the Saguaro East to Marana Tap to Rattlesnake to Tucson 115 kV line that are tripped off for the loss of any single element between Saguaro East and Tucson. These are resolved through the proposed 115 kV upgrades and the proposed addition of voltage switched capacitor banks on the system in 2013. Delta-voltage violations seen at the Butterfield, Pantano, Kartchner, and San Rafael buses for loss of the Apache to Butterfield 230 kV line are also resolved through the proposed addition of voltage switched capacitor banks on the system in 2013.

As in the 2011 summary, the bus voltages at these buses under outage conditions are within acceptable limits as per SWTC internal planning criteria, and there is no loss of load.

TEP analysis did not identify any voltage concerns with the TEP system. Delta-voltage violations were seen on the TEP system in the Green Valley transmission system. Each of these violations involved an outage of the Rosemont Point of Interconnection (POI) – South 138 kV line. This problem was addressed in a separate study and it was determined that a 12.5 MVAR STATCOM and 4 mechanically switched capacitors under the control of the STATCOM would be required to mitigate this condition.

### **5.3. 2015 Heavy Summer**

For this study, the new facilities planned to be placed in-service after summer peak in 2012 and prior to summer peak in 2015 time frame are:

- TEP
  - New DMP to Tucson 138 kV line (2013)
  - DMP to North East Loop 138 kV line uprate to 1700 Amp rating (2013)
  - New Harrison load-serving substation (2013)
  - New Craycroft-Barril load-serving substation (2013)
  - North Loop 138 kV Yard Expansion Phase 3 (2013)
  - Vail Series Capacitor Replacement on the Springerville to Vail 345 kV line (2013)
  - Tortolita Substation expansion to include 500 kV yard (2013)
  - New Duval CLEAR 138 kV Switchyard (2013)
  - New Canoa Ranch to Duval CLEAR line (2013)
  - North East Loop to Rillito 138 kV line uprate to 2259 continuous / 2535 emergency A (2014)
  - New Orange Grove load-serving substation (2014)
  - Pinal Central to Tortolita 500 kV transmission line (2014)
  - Vail Series Capacitor Replacement on the Winchester to Vail 345 kV line (2015)
  - Rancho Vistoso to La Canada 138 kV line uprate to 1750 A (2015)
- SWTC
  - Capacitor bank additions at Avra, Hackberry, and New Tucson (2013)
  - Apache/Hayden to San Manuel 115 kV Line (2014)
  - Sandario Tap to Three Points 115 kV Line Upgrade (2015)
  - Bicknell 345/230 kV Transformer Replacement (2015)
  - Greenlee 2<sup>nd</sup> 345/230 kV Transformer (2015)
- Western
  - None
- APS
  - None
- Others
  - Bowie Power Station – Phase 1 (2015)

#### **5.3.1. Thermal Loading**

With system changes identified in Section 5.3, TEP's RLG for the 2015 Heavy Summer case is 490 MW. The limiting condition is the Category C (N-1-1) loss of the Vail – South 345 kV line and the Robert Bills Wilmot – Vail 138 kV line. With lower local

generation levels, this contingency causes an overload of the Irvington – Tech Park 138 kV line. With this local generation and operation of the local area protection scheme, there are no overloads of TEP or neighboring facilities for any Category B or C contingency. Outages involving the Winchester – Vail 345 kV line require tripping the Bowie Power Plant to avoid overloads on the SWTC Apache – Butterfield 230 kV line. The need for this action will continue to be evaluated due to the re-rate of the Apache to Butterfield 230 kV line that is scheduled to occur by 2012.

SWTC power flow analysis identified the same overload issues as the TEP analysis but did not include actions of the local area protection scheme as a potential mitigation measure.

The 2015 overload issues are summarized in Table 3.

Table 3. 2015 Overload Summary

Element	Number of Occurrences	Max PCT OL	Rating	Worst Outage	Proposed Mitigation
Apache – Butterfield 230	1	107.9	368.1 MW	Cat B: WN – VL 345	Resolved through Apache generation re-dispatch; Bowie trip; Line planned for re-rate in 2012
	2	106.0		Cat C: SP – VL & WN – VL 345	

As per the proposed order of the 6<sup>th</sup> BTA by the ACC, in which SWTC has been asked to “determine if a re-rating of the Apache to Butterfield 230 kV line is an acceptable measure until the line is upgraded in 2016,” SWTC has performed this study which shows that the “re-rate” planned by 2012 will mitigate an overload of the Apache to Butterfield 230 kV line for the Category B and C outages listed above, well beyond the ten year plan timeframe. Study results were provided to the ACC in January of 2011, along with the SWTC Ten Year Plan filing. In the interim, the overload of the Apache to Butterfield 230 kV line, as a result of the Category B and C outages noted above, can be resolved through Apache generation re-dispatch.

### 5.3.2. Voltage Summary

SWTC analysis did not identify voltage or delta-voltage violations with the SWTC system.

TEP analysis did not identify any voltage concerns with the TEP system. However, there are delta-voltage violations on the SWTC system for loss of the Winchester – Vail 345 kV line. The voltage changes by more than 5% at the New Tucson, and Pantano 230 kV buses and at the Pantano and Kartchner 115 kV buses. The largest change is 7.45%. This analysis did not include the capacitor banks proposed by SWTC at the Avra Valley, Hackberry, and New Tucson substations that are scheduled for 2013. These capacitor

banks will be switched in service based on voltage and should mitigate any delta-voltage concerns identified in this study. This will be further evaluated in the SATS 2011 study.

#### **5.4. 2020 Heavy Summer**

For this study, the new facilities planned to be in-service prior to summer peak for the 2020 time frame are:

- TEP
  - Irvington to Robert Bills Wilmot to Vail 138 kV line reconductor (2016)
  - Vail 345/138 kV transformers #4 (2016)
  - New Marana load serving substation (2016)
  - New Naranja load serving substation (2016)
  - New Tech Park load serving substation (2016)
  - New Spencer load serving substation (2016)
  - New Corona load serving substation (2016)
  - New Anklam load serving substation (2016)
  - New Hartt load serving substation (2017)
  - New Kino load serving substation on a new Irvington – Tucson 138 kV line (2017)
  - New East Ina load serving substation and new Orange Grove – East Ina 138 kV line (2017)
  - DMP to North East Loop 138 kV line reconductor (2018)
  - New Medina load serving substation (2018)
  - New Raytheon load serving substation (2019)
  - New UA Med load serving substation (2019)
- SWTC
  - Capacitor bank additions at Redtail and San Rafael (2020)
- Western
  - None
- APS
  - None

##### **5.4.1. Thermal Loading**

With system changes identified in Section 5.4, TEP's RLG for the 2020 Heavy Summer case is 175 MW. The limiting condition is the Category B outage of the Springerville - Vail 345 kV line. With lower local generation levels, this contingency causes an overload of the Winchester – Vail 345 kV line. There are no other overloads for TEP Category B or C contingencies. Any overloads that were identified could be mitigated with use of TEP's LAPS.

SWTC did not identify any overloads in the 2020 timeframe.

##### **5.4.2. Voltage Summary**

SWTC analysis did not identify any voltage violations. With the placement of 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 loss of the Apache to Redtail 230 kV line are resolved.

TEP analysis identified only one TEP outage which resulted in a violation of the delta-voltage criteria. Loss of the Winchester – Vail 345 kV line resulted in a voltage change of 6.3% at SWTC's Kartchner 115 kV bus. The capacitor banks at Avra Valley, Hackberry, New Tucson, Redtail, and San Rafael planned for 2013 and 2020 were not included in this analysis by TEP and will be included in future efforts. These capacitor banks will be switched in service based on voltage and should mitigate any delta-voltage concerns identified in this study. This will be further evaluated in the SATS 2011 study.

## **6. Sixth Biennial Transmission Assessment**

As part of the sixth BTA, the ACC ordered APS<sup>3</sup>, SWTC, and TEP to “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” study and “finalize mitigation plans if needed for this voltage concern in ten-year plan filings for the 7<sup>th</sup> BTA by January 31, 2012.” The 2009 SATS report identified delta-voltage violations at the following buses: Bicknell 230 and 115, New Tucson 230, Pantano 230 and 115, Sahuarita 230, Kartchner 115, Canez 138, Sonoita 138, and Valencia 138. The 2010 analysis of the SATS system did not identify any delta-voltage issues on the Canez, Sonoita, Valencia 138 kV, or Sahuarita 230 kV buses. Delta-voltage violations have continued to be seen on other SWTC 230 kV and 115 kV buses. However, SWTC has identified new voltage switched capacitor banks that will be placed in-service to mitigate these issues and included these capacitor banks in their analysis. TEP analysis was completed without these capacitor banks. This should be sufficient to mitigate the delta-voltage concerns but will be further evaluated as part of the 2011 SATS study effort.

## **7. Conclusions**

The transmission system in the SATS footprint can reliably meet the needs of Southeastern Arizona with the projects proposed by the SATS participants. Overloads on the TEP 138 kV system and the SWTC 230 kV system were noted in the study, but these overloads will be mitigated with planned projects, operating procedures, or automated actions. In addition, the delta-voltage deviation issues identified in the study are addressed by shunt capacitors that will be switched in-service during low voltage conditions. It is anticipated that the outage scenarios resulting in excessive delta-voltage deviations will result in voltages that will trigger switching the capacitors in-service. As load forecasts change, the planned mitigation may be altered. Reduced forecasts may allow deferment of projects while increased forecasts may require acceleration of projects.

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<sup>3</sup> APS does not own or operate any 230 kV or 138 kV in the SATS footprint.

Proposed projects for the SATS Area for the 2011 – 2015 time-frame are:

- 2011
  - SWTC – New Tucson 230/24.9 kV Substation
  - SWTC – Marana Tap to Marana 115 kV Line Upgrade (post-summer peak)
  - TEP – Tortolita 500/345 kV transformer #3
- 2012
  - SWTC – Marana to Avra 115 kV Line Upgrade
  - SWTC – Avra to Sandario Tap 115 kV Line Upgrade
  - TEP – New Canoa Ranch load-serving substation
  - TEP – Vail 345/138 kV transformer #3
  - TEP/UNSE – Conversion of the Nogales to Valencia 115 kV line to 138 kV and with extension to Vail
  - TEP – Vail 345 kV Express Bus Tie Breaker
  - TEP – New Rosemont load served via a radial line interconnecting with the South to Green Valley 138 kV line
  - TEP – North Loop 138 kV yard expansion Phase 2
- 2013
  - SWTC – Capacitor bank additions at Avra, Hackberry, and New Tucson
  - TEP – Vail Series Capacitor Replacement on the Springerville to Vail 345 kV line
  - TEP – New Craycroft-Barril load-serving substation
  - TEP – North Loop 138 kV Yard Expansion Phase 3
  - TEP – Tortolita Substation expansion to include 500 kV yard
  - TEP – New Duval CLEAR 138 kV Switchyard
  - TEP – New Canoa Ranch to Duval CLEAR line
  - TEP – New DMP to Tucson 138 kV line
  - TEP – DMP to North East Loop 138 kV line uprate to 1700 Amp rating
  - TEP – New Harrison load-serving substation
- 2014
  - TEP – North East Loop to Rillito 138 kV line uprate to 2259 continuous / 2535 emergency A
  - TEP – New Orange Grove load-serving substation
  - TEP – Pinal Central to Tortolita 500 kV transmission line
  - SWTC – Apache/Hayden to San Manuel 115 kV line
- 2015
  - SWTC – Bicknell 345/230 kV Transformer Replacement
  - SWTC – Greenlee 2<sup>nd</sup> 345/230 kV Transformer
  - SWTC – Sandario Tap to Three Points 115 kV Line Upgrade
  - TEP – Vail Series Capacitor Replacement on the Winchester to Vail 345 kV line
  - TEP – Rancho Vistoso to La Canada 138 kV line uprate to 1750 A
  - Bowie Power Station – Phase 1
  - SunZia Southwest Transmission Project
  - Southline Transmission Project

In addition to the above proposed projects, various TEP and SWTC lines will be updated as needed. These projects will increase the ratings of the lines by raising conductors where line clearances or hardware limits the rating of the line but otherwise will not change any line parameters. The SunZia and Southline projects were not included in the 2010 analysis but are planned to be included in the 2011 SATS study effort.

Other projects proposed by 2020 are:

- TEP – Irvington to Robert Bills Wilmot to Vail 138 kV line reconductor (2016)
- TEP – Vail 345/138 kV transformers #4 (2016)
- TEP – New Marana load serving substation (2016)
- TEP – New Naranja load serving substation (2016)
- TEP – New Tech Park load serving substation (2016)
- TEP – New Spencer load serving substation (2016)
- TEP – New Corona load serving substation (2016)
- TEP – New Anklam load serving substation (2016)
- TEP – New Hartt load serving substation (2017)
- TEP – New Kino load serving substation on a new Irvington to Tucson 138 kV line (2017)
- TEP – New East Ina load serving substation and new Orange Grove to East Ina 138 kV line (2017)
- TEP – DMP to North East Loop 138 kV line reconductor (2018)
- TEP – New Medina load serving substation (2018)
- TEP – New Raytheon load serving substation (2019)
- TEP – New UA Med load serving substation (2019)
- SWTC – Capacitor bank additions at Redtail and San Rafael (2020)
- Bowie Power Station – Phase 2 (2020)