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Tucson Electric Power Company

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August 30, 2012

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

Re: Notice of Filing – Tucson Electric Power Company
Supplemental to the 2012-2021 Ten-Year Plan and Reliability-Must-Run Report
Docket No. E-00000D-11-0017

On January 31, 2012, Tucson Electric Power Company ("TEP") filed its 2012-2021 Ten-Year Plan ("Plan") and Reliability-Must-Run ("RMR") Report pursuant to ARS § 40-360.02. TEP is supplementing its Plan to include TEP's Transmission Planning Process and Guidelines (Attachment A) and TEP 2012 Facility Ratings (Attachment B) which include the internal planning criteria and system ratings as required by Decision No. 63876 (July 25, 2001).

TEP is also supplementing its Plan with the TEP 2011 Annual Transmission Reliability Assessment (redacted Attachment C) which includes technical analyses as required by ARS § 40-360.02.C.7 and also identifies system elements as required above.

In past BTAs, these requirements were included in filed Southeast Arizona Transmission System Study ("SATS") Reports and were inadvertently omitted of the most recent Plan. If you have any questions, please contact me at (520) 884-3680.

Sincerely,

Jessica Bryne

cc: Prem Bahl, Utilities Division, ACC

Attachment
A

Tucson Electric Power

A UniSource Energy Company

TUCSON ELECTRIC POWER COMPANY

TRANSMISSION PLANNING PROCESS AND GUIDELINES

Approved by: {signature on file at TEP}

Date: May 13, 2011

Disclaimer: This document is subject to change and should not be used without contacting TEP Transmission Planning.

Rev. 5

TRANSMISSION PLANNING PROCESS AND GUIDELINES

TRANSMISSION PLANNING PROCESS AND GUIDELINES

TABLE OF CONTENTS

Attachment

TRANSMISSION PLANNING PROCESS AND GUIDELINES

1. Introduction

These guidelines are used by Tucson Electric Power Company's (TEP's) Transmission Planning Department in planning TEP's Extra High Voltage (EHV) transmission system (345 and 500 kV) and High Voltage (HV) local area transmission system (138 kV). This process will result in an assessment that is compliant with the following North American Electric Reliability Corporation (NERC) Standards:

- TPL-001-0
- TPL-002-0
- TPL-003-0
- TPL-004-0

In addition, the TEP Transmission Planning Process and Guidelines will be used to demonstrate compliance with NERC Standards FAC-010-2 and FAC-014-2. FAC-010-2 requires a methodology for determining System Operating Limits (SOLs) for the Planning Horizon. FAC-014-2 requires that the SOLs be established based on that established methodology and also be communicated to specified parties.

In preparation for this study, the TEP Planning Department will consult with the TEP System Control and Reliability (SC&R) to identify any issues observed on the system by the System Operators. The TEP Planning Department will incorporate these operational issues into the planning process. Prior to final study approval, the report will be submitted to the SC&R for review. Upon approval, the SC&R Manager or Superintendent will sign off in the designated area on the approvals section of the report.

TEP will maintain accurate computer models of the TEP system. These models will be utilized for analysis of the TEP system during the planning and operating horizons. Other systems will be modeled using the latest representations provided by those entities or as included in approved Western Electricity Coordinating Council (WECC) base cases.

2. Planning Methodology

TEP plans and operates its system in accordance with NERC Standards, WECC System Performance Criteria, and TEP Internal Reliability Criteria (NERC / WECC / TEP Internal Criteria). The NERC Standards are available at http://www.nerc.com. The WECC Reliability Criteria are available at http://www.wecc.biz. The TEP Internal Criteria are available upon request to any entity that demonstrates a reliability related need for this information.

2.1. Planning Process

TEP performs an annual review of its transmission system performance over a ten-year planning horizon. This results in a schedule for new facilities and upgrades to existing facilities assuring adequate transmission capacity as Tucson continues to grow. The annual review will ensure that the system is planned such that the network can be operated to supply projected customer demands and projected Firm (non-recallable reserved) Transmission Services at all Demand levels over the range of forecast system demands under the conditions defined in NERC Categories A, B and C. The annual review will also evaluate the risks and consequences of a number of extreme contingencies that are listed under NERC Category D. Category D contingencies will be evaluated for the near-term and longer-term planning horizons. The results of the Category D evaluation for the longer-term planning horizon will primarily be used to determine which cases should be developed for the Category C N-1-1 analysis. TEP also takes into account its Tie Open Load Shed (TOLS) scheme when evaluating system performance. TOLS is a Local Area Protection System (LAPS) that responds with direct load-tripping and switching of fast-switched reactive devices to prevent cascading outages in the TEP load pocket and meet NERC / WECC / TEP Internal Criteria. The TOLS scheme is used in place of under-voltage load shedding (UVLS) due to the fast collapse nature of the TEP system and the slow response of UVLS.

TEP's EHV Transmission System is designed to:

- Provide adequate Import Capability to the TEP load pocket.
- Accommodate new generation resources.
- Accommodate long-term firm transmission requests.

2.2. Ten Year Plan

This planning process will result in TEP's Ten Year Plan which is submitted to the Arizona Corporation Commission (ACC) as required by Arizona statute. This plan is updated annually and provided to the ACC by January 31st of each year.

2.3. Far-Term Planning

TEP performs far-term (beyond ten years) planning on an as-needed basis. These studies are used to develop a database of potential projects that will mitigate impacts due to increased loads. These studies are based solely on power flow analysis.

2.4. Regional Planning

2.4.1. WECC

WECC is responsible for coordinating and promoting electric system reliability. In addition to promoting a reliable electric power system in the Western Interconnection, WECC will support efficient competitive power markets, assure open and non-discriminatory transmission access among members, provide a forum for resolving transmission access disputes, and provide an environment for coordinating the operating and planning activities of its members as set forth in the WECC Bylaws.[1]

TEP is a member of WECC and participates in several WECC Committees, Subcommittees, Work Groups, and Task Forces.

2.4.2. WestConnect[2]

WestConnect is composed of utility companies providing transmission of electricity in the southwestern United States. The members work collaboratively to assess stakeholder and market needs and to develop cost-effective enhancements to the western wholesale electricity market. WestConnect is committed to coordinating its work with other regional industry efforts to achieve as much consistency as possible in the Western Interconnection.

WestConnect sub-regional planning groups include: (1) Southwest Area Transmission (SWAT), (2) Colorado Coordinated Planning Group (CCPG), and (3) Sierra Pacific Planning Group (SPPG).

2.4.2.1. SWAT

SWAT is comprised of transmission regulators / governmental entities, transmission users, transmission owners, transmission operators and environmental entities. The goal of SWAT is to promote regional planning in the Desert Southwest.[3] TEP is a member of SWAT and participates in most SWAT subgroups and task force activities.

2.4.2.1.1. Arizona – New Mexico (AZ-NM)

The SWAT AZ-NM regional transmission subcommittee has been formed to study the Eastern Arizona and Western New Mexico regional transmission system, including (but not limited to)

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1 http://www.wecc.biz – About WECC
2 http://www.westconnect.com/aboutwc.php
3 http://www.westconnect.com/planning_swat.php

the Four Corners, Springerville and Greenlee/Hidalgo areas.[4]

2.4.2.1.2. Central Arizona Transmission System (CATS)

The SWAT CATS subcommittee was formed by re-combining the CATS-EHV[5] and CATS-HV[6] subcommittees. The CATS subcommittee was formed to study EHV and HV transmission needs in Central Arizona.

2.4.2.1.3. Colorado River Transmission (CRT)

The SWAT CRT subcommittee has been formed to study the area within the geographic region from Palo Verde to the Colorado River and southern Nevada to Yuma, Arizona.[7]

2.4.2.1.4. Southeast Arizona Transmission Study (SATS)

The SWAT SATS subcommittee has been formed to study the Southeastern Arizona region.[8] The SATS study area includes all or part of Pima, Pinal, Cochise, and Santa Cruz counties.

2.4.2.2. Other WestConnect Parties

Other WestConnect sub-regional planning groups are the CCPG and the SPPG. More information about these groups can be found on the WestConnect website at http://westconnect.com.

2.5. Load Forecasts

TEP loads are based on the TEP Corporate Forecast developed by TEP's Economic Forecasting and Margin Analysis group and allocated to distribution buses based on distribution factors from TEP's Distribution Planning group. Load projections for other entities within WECC are based on the load data in the WECC base cases or using the latest data provided by those entities.

[4] http://www.westconnect.com/planning_swat_anm.php
[5] http://www.westconnect.com/planning_swat_catehv.php
[6] http://www.westconnect.com/planning_swat_cathv.php
[7] http://www.westconnect.com/planning_swat_crt.php
[8] http://www.westconnect.com/planning_swat_sats.php

2.6. Evaluations

TEP evaluates projects based on power flow and transient stability studies. If multiple projects are being evaluated, an analysis is performed to determine the project with the least cost for TEP. The evaluations will cover the critical system conditions specified in Section 2.6.1 and study years deemed appropriate. The analysis will be conducted for at least two years in the Near-Term Planning Horizon and one year in the Longer-Term Planning Horizon unless changes to system conditions do not warrant such analyses. Other years will be evaluated as needed to address identified marginal conditions that may have longer lead-time solutions.

2.6.1. Contingencies

After considering all contingencies applicable to NERC Categories B, C and D, a list of contingencies for the annual review will be developed. The criteria for developing the list of contingencies are included in Section 2.6.2, which includes all TEP Category B and C EHV contingencies. The rationale for the contingencies selected for evaluation and an explanation of why the remaining simulations would produce less severe system results will be documented within TEP's technical study report.

2.6.2. Power Flow Studies

Power flow analysis is performed to find thermal overloads and identify potential voltage stability problems during normal and emergency operation based on the NERC / WECC / TEP Internal Criteria. At a minimum, TEP evaluates system performance under normal (NERC Category A) conditions and for the following NERC / WECC Category B, C, and D contingencies. The annual review will demonstrate that the system performance meets Table I performance requirements from the NERC TPL Standards (Transmission System Standards – Normal and Emergency Conditions) for Category A, B and C contingencies. See Attachment 1 for a copy of Table 1.

- Category B Contingencies

  1) Loss of any single EHV or HV transmission line or transmission transformer in the TEP Planning Authority (PA) area.
  2) Loss of any tie line or tie transformer between the TEP PA area and neighboring PA areas.
  3) Loss of any single generating unit in the TEP PA area.

4) Loss of all shunt devices protected by a single breaker in the TEP PA area except shunt capacitors at TEP's Northeast Loop Substation.[9]

- Category C Contingencies

1) Loss of a bus section resulting in the loss of two or more transmission lines or transmission transformers in the TEP PA area.

2) Non-bus-tie breaker failure resulting in the loss of two or more transmission lines or transmission transformers in the TEP PA area.

3) Any two EHV or HV circuits on a multi-circuit tower line in the TEP PA area.

4) Any two adjacent EHV or HV circuits in a common right-of-way in the TEP PA area.

5) A Category B outage, system adjusted (element now is Initially Out of Service (IOS)), followed by another Category B outage for critical circuits as identified in under Category D Contingencies, number 1). TEP will conduct screening analysis to determine which elements will be IOS for evaluation for N-1-1 performance.

- Category D Contingencies

1) All remaining pairs of Category B elements (except shunt devices) not identified in Category C.

2) All other multi-circuit EHV or HV tower lines or multi-circuit corridors in the TEP PA area.

3) Loss of all transmission transformation at a single substation in the TEP PA area.

4) Bus-tie breaker failure resulting in the loss of three or more transmission lines or transmission transformers in the TEP PA area.

Contingencies involving direct current (dc) elements are not included in the TEP assessment of its system or in determining SOLs for the Planning Horizon because TEP does not own or operate any dc facilities.

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[9] Outages of the shunt capacitors at TEP's Northeast Loop substation will have negligible impact due to the response of the SVC located at this facility. The outage of the SVC will be simulated.

Evaluations will be conducted for peak and off-peak scenarios. Peak evaluations beginning from ALIS conditions will be conducted with TEP's Planning Required Local Generation (PRLG)[10] with Sundt Units 1-4 on-line. PRLG with Sundt Units 1-4 on-line is the SOL for the Planning Horizon. Peak evaluations beginning with one element initially out of service (IOS) will be conducted with all local generation committed and dispatched at maximum output except DMP CT#1. The output of this unit will be reduced by approximately 30 MW to model spinning reserve requirements carried locally.

Off-peak evaluations beginning from ALIS conditions will be conducted with no fewer than two Sundt units on-line at maximum output. Off-peak evaluations beginning from IOS conditions will be conducted with no fewer than three Sundt units on-line at maximum output. Off-peak conditions will be evaluated for at least one year in the Near-Term Planning Horizon. Longer-term off-peak cases will only be evaluated if long lead-time projects in addition to those identified in the on-peak analysis are identified in the near-term off-peak analysis.

2.6.3. Transient Stability Studies

Transient stability studies are conducted for normal conditions and on selected contingencies. The selected contingencies include NERC / WECC Category B, C, and D contingencies. The selected contingencies will be determined based on the power flow (steady state) results. If TOLS action is required based on the power flow analysis, it will be included in the switch deck created for the transient stability studies.

2.6.4. Reactive Margin Studies

Reactive margin studies are conducted as needed to demonstrate voltage stability.

2.6.5. Total Transfer Capability

Total Transfer Capability (TTC) is based on TEP's *Available Transfer Capability Implementation Document (ATCID)*. The ATCID is available on TEP's OASIS at http://www.oatioasis.com/tepc/index.html.

2.6.6. Short Circuit

Short circuit studies for the planning horizon are conducted by TEP's Protection, Communications, Automation, and Metering (PCA&M) Department as requested by TEP's Planning Department. Three-phase

[10] PRLG is the minimum amount of local generation necessary to meet NERC / WECC / TEP Internal Criteria for EHV and TOLS-activating outages and is dependent on TEP city bus load, unit commitment, and series compensation levels.

and single-line-to-ground faults are simulated to demonstrate that system protection can adequately clear and isolate faults on the transmission system.

2.7. System Operating Limits for the Planning Horizon

In addition to measuring system performance, SOLs for the Planning Horizon can also be determined using this procedure. The Planning Horizon is assumed to be beyond one year to a maximum of ten years.

SOLs will be determined using only the portion of the assessment starting from all lines in service (ALIS) conditions and evaluating Category B, C, and D contingencies described in Section 2.6.2

Interconnection Reliability Operating Limits (IROLs) are a subset of the SOLs such that if the limit is violated, the consequences could result in adverse impact to the reliability of the Bulk Electric System characterized by at least one of the following:

a. instability

b. uncontrolled separation

c. Cascading Outages

2.7.1. Tie-Open Load Shed (TOLS) Activation Study

TEP's Transmission Planning Process and Guidelines will identify potential contingencies that could be included in TEP's TOLS scheme. However, a TOLS-activation study is undertaken approximately one year prior to installation of system upgrades. This TOLS-activation study will identify all Category B, C, and two-element Category D contingencies that will need remedial action under certain conditions to avoid reaching a stability-related limit. In addition, TOLS Operating studies are conducted for specific operating conditions to determine the Required Local Generation (RLG) for those conditions. These studies are conducted as needed so TEP SC&R can operate the TEP system within stability and thermal limits. These studies result in pre-defined tables to meet Operating Horizon SOLs. In some cases, a two-element category D contingency will be the limiting contingency for determination of RLG.

If different contingencies needing TOLS activation are identified in a new TOLS activation study than were identified in the previous TOLS activation study, the new contingency list will be substituted for the previous contingency list upon implementation of the study results.

RLG is the System Operating Limit for the TEP system. TEP's system is planned such that RLG does not exceed the maximum local generation capability; therefore, IROL T_v is not determined for the Planning Horizon but is limited to 20 minutes for stability and 30 minutes for thermal violations for the Operating Horizon per the WECC Standard TOP-STD-007-0.

3. Planning Assumptions

3.1. General

3.1.1. Loads

TEP loads are based on the TEP Corporate Forecast developed by TEP's Economic Forecasting and Margin Analysis group and allocated to distribution buses based on distribution factors from TEP's Distribution Planning group. For near-term and longer-term planning, the load power factor is assumed to be 0.98. Assessment studies will be performed for selected demand levels over the range of forecast system demands.

3.1.2. Resources and Firm Transfers

TEP resources are dispatched such that all projected firm power resources and contracts are modeled and such that all projected firm transfers are modeled. It is assumed that the WECC base cases include all projected firm transfers and resources for all other entities within WECC.

3.1.3. Data Sources

WECC power flow and stability models are used for TEP planning and operating studies.

3.1.4. Shunt Capacitor and Reactor Locations

TEP owns and operates line reactors on its 345kV transmission network and shunt capacitors on its 138kV and distribution systems. TEP's Engineering Department has identified existing 138 kV substations that can accommodate capacitor banks. In addition, the TEP standard 138 kV substation design for new substations will accommodate up to three capacitor banks each with capacity for 52.8 MVAR of capacitor cans insulated at 143.4 kV. These locations are identified to ensure that adequate reactive power resources are available to meet system performance criteria. In addition TEP owns and operates a Static VAR Compensator (SVC) located at its Northeast Substation. More information about the SVC is included in Section 4.1.1.2.2.

3.1.5. Phase Shifting Transformers

TEP owns and operates a 138 kV phase shifting transformer at Tortolita. For RLG and LSC studies, the transformer is modeled out of service.

The phase shifting transformer will be modeled in service during off-peak conditions only if necessary to meet restrictions due to TEP's financing with Two-County Industrial Development Bonds.

3.1.6. Standard Conductors

TEP's standard construction and conductor for 345 kV lines is two conductor bundle 954 kcmil ACSR.

The standard conductors for 138 kV lines are the following:

- 954 kcmil ACSR Rail
- 954 kcmil ACSS Rail
- 795 kcmil ACSR Drake
- 1365 kcmil ACAR
- 477 kcmil ACSR Hawk
- 477 kcmil ACSS Hawk

TEP plans to construct all new 138 kV transmission lines using 954 kcmil ACSS Rail.

3.1.7. Substation Design

The TEP guideline for new 138 kV substations is a ring bus configuration designed to accommodate two 138/13.8 kV transformers, two to three 138 kV transmission lines, and three capacitor banks.

Substations designed for three or four transformers are considered in applications where distribution system design and substation characteristics allow.

3.1.8. Load Margins

To demonstrate voltage stability, WECC requires 5% load margin for Category B contingencies and 2.5% load margin for Category C contingencies for load pocket studies. TEP includes a 5% load margin for all contingencies for all operating and planning studies and evaluates thermal loading against this higher load. Including the 5% load margin ensures that TEP system is planned to perform within voltage stability limits.

3.1.9. Facilities

The model will include all existing facilities and planned facilities with an in-service date prior to and including the year and season being evaluated. The assessment shall address any planned upgrades needed to meet the performance requirements of Categories A, B and C.

3.1.10. Protection Systems and Control Devices

Contingencies will take into account the effects of existing and planned protection systems, including any back-up or redundant systems, or control devices. The following protection systems and control devices will be addressed:

- TEP's Tie-Open Load Shed (TOLS) scheme
- Tortolita phase shifting transformer
- Northeast Static VAR Compensator (SVC)
- All elements between breakers will be included in contingencies

3.1.11. Series Compensation

All planning studies will be conducted with "full" compensation on the TEP EHV transmission system unless results indicate a need to bypass selected banks to meet performance measures for IOS conditions. TEP has 4 series capacitor banks installed on the transmission lines in the Springerville – Vail corridor at the following locations:

- Springerville – Vail 345kV line at Greenlee
- Springerville – Vail 345kV line at Vail
- Winchester – Vail 345kV line at Vail
- Springerville – Greenlee 345kV line at Greenlee

"Full" compensation has all of the above in service except the Springerville – Greenlee series capacitor bank. All other series compensated lines within the WECC footprint will be modeled as provided in the WECC approved base case or as modeled by the owner of the series compensated line following a regional review of the WECC approved base case.

3.2. Power Flow Studies

Reliability planning will conduct evaluations on heavy summer cases (including a 5% load margin).

3.3. Transient Stability Studies

Transient stability studies will be conducted for Category B three-phase-to-ground faults with normal clearing and Category D three-phase-to-ground faults with delayed clearing. If the Category D event does not meet Category C performance measures, a single-line-to-ground fault will be simulated.

A 5% load margin will be included for all stability runs.

Per TEP's PCA&M Department, normal clearing is four cycles and delayed clearing is 13 cycles on the TEP EHV transmission system. For the TEP HV system, normal clearing is 5 cycles and delayed clearing is 14 cycles.

3.4. Reactive Margin Studies

Reactive margin studies will be conducted as necessary on the TEP load pocket using the Load Area methodology. V-Q analysis will be conducted at critical buses to demonstrate adequate reactive power resources throughout the TEP load pocket for normal conditions and critical contingencies. The WECC voltage stability guide requires a 5% load margin for Category B contingencies and a 2.5% load margin for Category C contingencies.

3.5. Planned Outage Studies

Planned outages (including maintenance) of any BES equipment (including protection systems and control devices or their components) will be evaluated at the demand level for which such planned outages will be performed. For this study, only outages scheduled for the planning horizon will be evaluated. All planned outages are evaluated during the Operations horizon when scheduled.

3.6. System Operating Limits for the Planning Horizon

SOLs for the Planning Horizon will be determined using the ALIS conditions included in this assessment. The SOLs for the Planning Horizon will not exceed any Facility Ratings for the Bulk Electric System.

3.7. Short Circuit Studies

Three-Phase and single-line-to-ground faults will be simulated. All known generation will be represented.

3.8. Load Modeling

For power flow studies, constant real and reactive power models will be used. For transient stability models, loads will be modeled as 20% motor loads per the WECC guidelines and represented using the *motorw* model in PSLF.

4. System Performance

SOLs for the Planning Horizon will demonstrate transient, dynamic, and voltage stability and loading on all Facilities shall remain within applicable Facility Rating. Planned Facilities that are expected to be in-service in the period being evaluated will be included in the determination of SOLs for the Planning Horizon.

4.1. Power Flow Studies

4.1.1. Normal Conditions

Normal conditions apply to all lines in service (ALIS) and system adjusted with one or more elements initially out of service (IOS). Normal conditions will model established pre-contingency operating procedures as outlined in Sections 4.1.1.1 through 4.1.1.4.

4.1.1.1. Voltage Profile

- TEP EHV bus voltages will be between 1.03 and 1.04 pu, as possible, on a 345 kV or 500 kV base. Exceptions are allowed for fictitious buses to represent connections for transformer terminated lines.
- The TEP 138 kV average bus voltage will be between 1.0210 and 1.0235 pu on a 138 kV base. The average is computed on selected 138 kV buses.
- Individual 138 kV bus voltages will be between 1.0145 and 1.03 pu, as possible, on a 138 kV base.
- Voltages shall be within applicable ratings.

4.1.1.2. VAR Output and Flow Requirements

TEP operates its system with specific VAR requirements. The VAR requirements are set for TEP's local generating units, the Northeast SVC, and VAR flow at the Saguaro/Tortolita interface.

4.1.1.2.1. Generator VAR Output

The following table identifies the MVAR output requirements for TEP's local generating units based on the status of the SVC.

Unit(s)	MVAr Range
Sundt 1-4	-1 to +1 MVAR

Unit(s)	MVAr Range
Sundt CTs 1-2	-1 to +1 MVAR
North Loop CTs 1-4	-1 to +1 MVAR
DMP CT 1	-1 to +1 MVAR

4.1.1.2.2. Northeast SVC VAR Output

The MVAR capability of the Northeast SVC is -75/+200 MVAR and has the ability to control four 50.8 MVAR mechanically switched capacitor banks, for a total VAR range of -75/+403.2 MVAR. The normal output range of the SVC is -30 / +30 MVAR without the capacitor banks included in the SVC model. If the output is less than +30 MVAR, the maximum susceptance output of the SVC will be reduced by the difference between the actual MVAR output and the modeled MVAR output. If the output is greater than -30 MVAR, the minimum susceptance output will be increased by the difference between the actual MVAR output and the modeled MVAR output. The maximum number of capacitors at the Northeast Loop 138 kV bus available for emergency switching by the SVC will be limited by the current Operating guidelines.

4.1.1.2.3. Saguaro / Tortolita Interface

VAR flow should be outbound from Tortolita to Saguaro as measured at the Saguaro 500 kV bus. The VAR flow can be adjusted by switching 138 kV capacitors in the northwest portion of TEP's system and/or by adjusting the tap changers on the Tortolita 500/138 kV transformers. The reference point for the VAR flow may change as the interface is changed by future projects.

4.1.1.3. Line and Transformer Loading

Loading on all transmission lines and transmission transformers must be at or below the continuous rating assuming ALIS or following system adjustment.

4.1.2. Contingency Conditions

TEP evaluates system performance for single and multiple contingencies. Sections 2.6.1 and 2.6.2 describe the Category B, C, and D contingencies evaluated by TEP.

4.1.2.1. Voltage Requirements

TEP's post-contingency 138 kV average bus voltage is to be between 0.98 and 1.05 pu on a 138 kV base.

All voltages will be within applicable ratings and the maximum change in voltage at any bus is 5% for a NERC / WECC Category B outage and 10% for a NERC / WECC Category C outage.

4.1.2.2. Line and Transformer Loading

Loading on all transmission lines and transmission transformers must be at or below the emergency rating following the contingency but prior to system adjustment.

4.1.2.3. Direct Load-Tripping

Direct load-tripping is not allowed to meet the voltage and loading requirements for Category B contingencies but is allowed for Category C and D contingencies.

4.1.2.4. Cascading Outages

Cascading outages are not allowed for Category B and C contingencies.

4.1.3. Tie Open Load Shed (Special Protection Systems)

TEP's TOLS scheme, which is a LAPS, arms fast-switched reactive devices and direct load-tripping for pre-determined contingencies.

The TOLS scheme will arm load for direct load-tripping for Category C and D contingencies as needed to maintain voltage stability and to relieve thermal overloads. The TEP Energy Management System (EMS) will arm load shed based on the amount determined in the TOLS Tables provided to SC&R. Armed load shed may not exactly match the amount required in the TOLS Table but will not be less than the amount specified. The TOLS scheme is simulated in TEP system studies for the Planning Horizon.

4.1.4. Voltage Stability

Inclusion of the 5% load margin ensures that TEP's system is designed to perform within voltage stability limits.

4.2. Transient Stability Studies

Transient stability studies are performed for selected EHV and HV contingencies starting from All Lines in Service or system adjusted initially out of service (IOS) conditions.

4.2.1. Fault Simulation

Three-phase-to-ground faults will be simulated and evaluated. The simulations will include normal clearing for Category B and C contingencies and will run for a minimum of 15 seconds following the disturbance.

4.2.2. System Stability

The system will be considered stable if it meets the following:

- All machines remain synchronized as demonstrated by the relative rotor angles.
- Positive damping exists as demonstrated by the damping of relative rotor angles and voltage magnitude swings.
- Transient voltage dips do not exceed 25% at load buses or 30% at non-load buses or 20% for more than 20 cycles at load buses for Category B disturbances.
- Transient frequency will not drop below 59.6 Hz for 6 cycles or more at load buses for Category B disturbances.
- Transient voltage dips do not exceed 30% at any bus or more than 20% for more than 40 cycles at load buses for Category C disturbances.
- Transient frequency will not drop below 59.0 Hz for 6 cycles or more at load buses for Category C disturbances.

4.3. Reactive Margin Studies

The reactive margin must be positive at all buses and must meet the WECC Reactive Power Margin (RPM) Requirement using the WECC Reactive Power Margin Studies Methodology which is contained in the WECC Voltage Stability Guide.

4.4. Short Circuit Studies

Evaluation of short circuit studies will be based on TEP criteria as determined by TEP's PCA&M Department since the TPL-001-0, TPL-002-0, TPL-003-0, and TPL-004-0 standards do not identify any performance measures for short circuit studies. At a minimum, the fault current shall not exceed 100% of the interruption capability of the breaker for three-phase or single-line-to-ground faults.

5. Report

A final report will document the results and corrective plans from the analyses conducted as required by this document. This report will address any upgrades required to meet Category A, Category B, and Category C performance measures of the NERC / WECC / TEP Internal Criteria. A schedule will be included for any upgrades or new projects that will include at a minimum expected in-service date. These dates will consider lead times necessary to implement the planned project. If issues are identified off the TEP system, TEP will notify the owners of the affected facilities. If multiple parties are involved, TEP will submit these issues to the appropriate regional or sub-regional planning group to address jointly. These plans will be reviewed in subsequent annual assessments. This final report will be sent to WECC, as required by WECC.

In addition to the final report, TEP will provide updates to WECC via Annual Progress Reports to the WECC Staff and to the WECC Technical Studies Subcommittee and by submitting Significant Additions to the WECC Staff. Additional information will be provided to WECC as requested.

6. Methodology Distribution and Comments

Upon initial approval the TEP Transmission Planning Process and Guidelines will be posted on the TEP OASIS at http://www.oatioasis.com/tepc/index.html. The posting will be updated following any changes. In addition it will be distributed to the following:

- Each adjacent Planning Authority (PA)
- Any PA that indicates it has a reliability-related need for this methodology
- Each Reliability Coordinator and Transmission Operator that operates any portion of the TEP PA Area.
- Each Transmission Planner in the PA.

Any recipient of this document that provides documented comments regarding this methodology will be provided a documented response within 45 calendar days of receipt of the comments. The response will indicate if a change is being made or the reason no changes will be made.

7. Communication of System Operating Limits

TEP is a Planning Authority and Transmission Planner. TEP will notify the following of any SOLs, including IROLs, developed for the TEP system:

- TEP's Reliability Coordinator and all Reliability Coordinators that work within the TEP Planning Authority Area or the TEP Transmission Planning Area.
- Adjacent Planning Authorities and any Planning Authority that works within the TEP Transmission Planning Area.
- Adjacent Transmission Planners and any Transmission Planner that works within the TEP Planning Authority Area.
- Transmission Service Providers that work within the TEP Planning Authority Area or TEP Transmission Planning Area or share TEP's portion of the Reliability Coordinator Area.
- Transmission Operators that work within the TEP Planning Authority Area or TEP Transmission Planning Area.

TEP will provide a list of Category C contingencies that result in stability limits and the associated stability limit to the Reliability Coordinators that monitor the facilities associated with the contingencies and limits. If no stability-related Category C contingencies are identified, TEP will so notify the Reliability Coordinator.

8. Version Approvals and History

Version	Date	Action	Change Tracking
0	08/14/08	Effective Date	New
1	09/11/08	Added paragraph four to Section 1, page 1 and added new sentences to Section 5, "If issues are identified off the TEP system, … TEP will submit these issues to the appropriate regional or sub-regional planning group to address jointly." on page 16	Errata
2	12/12/08	Updated Table of Contents. Minor wording changes to the following: Section 1, page 1, paragraph 4; Section 2.1, page 2, paragraph 1; Section 2.6.1, page 5, last sentence; Section 2.6.2, page 6; Section 3.1.5, page 9; Section 3.3, page 11, paragraph 1; Section 3.4, page 11, deleted last sentence; Section 3.5, page 11; Section 4.1.1.2.1, page 13, changed "0 to 1 MVAR" to "-1 to 1 MVAR" in the pertinent sections; Section 4.1.1.3, page 14; and Section 4.1.2.2, page 15. Section 2.6.2, pages 6 and 7, deleted last paragraph and added two new paragraphs.	Errata
3	08/12/2009	Replaced second paragraph of Section 1, page 1; changed Special Protection System (SPS) reference to Local Area Protection System (LAPS); added new Section 2.7.1, Tie-Open Load Shed (TOLS) Activation Study, page 8; added new sentence at the end of Section 3.1.11, page 11; added Section 3.8, Load Modeling, page 12; added three sentences to the last paragraph of Section 4.1.3, page 16; added new Section 7, Communication of System Operating Limits pages 18-19; and moved Version Approvals and History to Section 8.	
4	10/7/2010	Section 2, Changed "WECC Reliability Criteria" to "WECC System Performance Criteria". Replaced Section 2.4.2.1.2 Central Arizona Transmission System – EHV (CATS-EHV) with Central Arizona Transmission System (CATS) Deleted Section 2.4.2.1.3 Central Arizona Transmission System – HV (CATS-HV) which resulted in renumbering of the following sections. Section 2.5 changed "TEP's Economic Forecasting and Research group" to "TEP's Economic Forecast and Marin Analysis group". And added "or using the latest data	

		provided by those entities". Section 2.6 changed "year one through year five and year ten" to "at least two years in the Near-Term Planning Horizon and one year in the Longer-Term Planning Horizon". Section 2.6.2 changed "NERC standards" to "NERC TPL Standards". Section 2.6.2 Bullet 1) under Category B Contingencies changed "TEP-owned and –operated EHV" to "TEP-owned and operated EHV or HV". Section 2.6.2 Bullet 3) and Bullet 4) under Category B Contingencies changed "TEP-owned and operated EHV" to "TEP-owned and operated EHV or HV". Section 2.6.2 Bullet 1 under Category D Contingencies deleted "will be evaluated against Category C performance criteria". Section 2.6.2 Bullet 2 under Category D Contingencies changed "TEP-owned and operated multi-circuit EHV" to "TEP-owned and operated multi-circuit EHV or HV". Section 2.6.2, last paragraph changed "Off-peak conditions will be evaluated for the year five case" to Off-peak conditions will be evaluated for at least one year in the Near-Term Planning Horizon". Section 2.6.6 changed "TEP's Protection, Control, Metering, and Automation (PCM&A)" to "TEP's Protection, Control, Automation, and Metering (PCA&M)" Section 2.7.1 deleted "("TOLS lookup tables")". Section 3.1.1 changed "TEP's Economic Forecasting and Research group" to "TEP's Economic Forecasting and Margin Analysis group". Section 3.1.6 last sentence added "lines". Section 3.1.9 added "and season". Section 3.1.11 added "unless results indicate a need to bypass selected banks to meet performance measures for IOS conditions". Section 3.3 3rd paragraph changed "PCM&A" to "PCA&M" and added last sentence. Table in Section 4.1.1.2.1 deleted 3rd column and changed Title of 2nd column from "SVC in service" to MVAr Range". Section 4.1.1.4 deleted. Section 4.1.3 1st paragraph deleted everything after the 1st sentence. Section 4.1.3 changed "The TOLS scheme will also arm load for direct load-tripping	

		for Category C and D contingencies, as needed. Direct load tripping is armed as needed to maintain voltage stability and to relieve thermal overloads" to "The TOLS scheme will arm load for direct load-tripping for Category C and D contingencies as needed to maintain voltage stability and to relieve thermal overloads". Section 4.2 changed "Transient stability studies are performed primarily for EHV contingencies and All Lines in Service or system adjusted initially out of service (IOS) conditions" to "Transient stability studies are performed for selected EHV and HV contingencies starting from All Lines in Service or system adjusted initially out of service (IOS) conditions" and deleted the 2nd sentence. Section 4.2.1 changed "10 seconds" to "15 seconds". Section 4.2.2, 3rd and 4th bullets changed "single contingencies" to Category B disturbances". Section 4.2.2 4th and 5th bullets changed "contingencies" to "disturbances". Section 4.4 changed "PCM&A" to "PCA&M".		
5	5/13/2011	Changed "Operations Department" to "System Control and Reliability" or "SC&R" throughout the document. Section 2.1, paragraph 1 Changed "Category D contingencies will only be evaluated for the near-term planning horizon." to "Category D contingencies will be evaluated for the near-term and longer-term planning horizons. The results of the Category D evaluation for the longer-term planning horizon will primarily be used to determine which cases should be developed for the Category C N-1-1 analysis." Section 2.6.2, Paragraph 1, Sentence 2 Added the phrase "At a minimum". Category B Contingencies Bullet 1 Deleted "TEP owned and Operated" and added "in the TEP Planning Authority (PA) area." Bullet 2 Deleted "with a neighboring utility" and added between the TEP PA area and neighboring PA areas." Bullet 3 Deleted "TEP owned and Operated" and added "in the TEP (PA) area." Bullet 4 with footnote 9 added Category C Contingencies Bullet 1 Deleted "TEP owned" and added in		

		the TEP PA area." Bullet 2 Changed "Breaker failure" to "Non-bus-tie breaker failure" and deleted "TEP owned and operated" and added "in the TEP PA area." Bullet 3 Deleted "TEP owned and operated" and added "in the TEP PA area." Bullet 4 Deleted "TEP owned and operated" and added "in the TEP PA area." Bullet 5 Added "(IOS)" and changed "which will be evaluated for N-1-1 performance" to "which elements will be IOS for evaluation for N-1-1 performance." Category D Contingencies Bullet 1 Added "(except shunt devices)". Bullet 2 Deleted "TEP owned and operated" and added "in the TEP PA area." Bullet 3 Deleted "TEP owned and operated" and added "in the TEP PA area." Bullet 4 added Section 2.6.5 Changed "Total Transfer Capability (TTC) is based on TEP's *Transfer Capability Methodology* (FAC-012-1) and TEP's *Attachment C – Available Transfer Capability Methodology* which includes a Total Transfer Capability Methodology. This document is available on TEP's OASIS" to "Total Transfer Capability (TTC) is based on TEP's Available Transfer Capability Implementation Document (ATCID). The ATCID is available on TEP's OASIS". Section 3.1.8, Paragraph 1, Sentence 1 Deleted "The" and replaced with "To demonstrate voltage stability," Sentence 2 added "for all contingencies" and "and evaluates thermal loading against the higher load." Section 4, Sentence 2 Added "that are expected to be in-service in the period being evaluated".	

Attachment

B

Revision No.: 5 **Revision Date: 6/13/12**

TEP EHV Transmission Line Ratings

LINE #	LINE NOTATION								CIRCUIT RATING (MVA)			
	S1 ID	series cap ID	series cap bypassed? (1)	S2 ID	Ckt	sec	LINE WIRE SIZE MCM	LENGTH (MI)	CONTINUOUS MVA	CONTINUOUS AMP	EMERGENCY MVA	EMERGENCY AMP
1	SJ			MC	1	1	954 ACSR Rail	90	777	1300	1016	1700
		SC	NO			2	Series Capacitor					
2	SJ			MC	2	1	954 ACSR Cardinal	90	777	1300	1014	1697
		SC	NO			2	Series Capacitor					
3	MC			SP	1	1	954 ACSR Rail	107	925	1548	1110	1858
4	MC			SP	2	1	954 ACSR Rail	107	925	1548	1110	1858
5	SP			CO	1		954 ACSR Cardinal	22	1195	2000	1195	2000
6	SP			GL	1	1	954 ACSR Cardinal	110	925	1548	1110	1858
		SC	YES			2	Series Capacitor					
7	SP			VL	1	1	954 ACSR Cardinal	110	666	1115	908	1520
		SC1	NO			2	Series Capacitor					
						3	954 ACSR Cardinal	130				
		SC2	NO			4	Series Capacitor					
						5	954 ACSR Cardinal	0				
8	GL			WN	1	1	954 ACSR Rail	88	925	1548	1110	1858
8a	WN			VL	1	1	954 ACSR Rail	41	896	1500	1110	1858
		SC	NO			2	Series Capacitor					
						3	954 ACSR Rail					
9	VL			SO	1	1	954 ACSR Rail	14	925	1548	1110	1858
10	WW			PW	1	1	954 ACSR Rail	60	925	1548	1110	1858
10	PW			SO	1	1	954 ACSR Rail	118	925	1548	1110	1858
11	SA			TO	1	1	2156 ACSR Bluebird	1	1039	1200	1247	1440
12	SA			TO	2	1	2156 ACSR Bluebird	1	1039	1200	1247	1440

Notes:

Revision No.: 5 **Revision Date: 6/13/12**

TEP EHV Transformer Ratings

Station	Unit #	High Side kV	Low Side kV	Transformer Circuit Ratings Continuous (MVA)	Emergency (MVA)
Coronado	T1	500	345	672	806
Pinal West	T1	500	345	672	806
Westwing	T1	500	345	672	806
Tortolita	T1	500	138	672	940
Tortolita	T2	500	138	672	940
Tortolita	T3	500	138	672	940
South	T2	345	138	672	806
South	T3	345	138	672	806
Vail	T1	345	138	672	806
Vail	T2	345	138	672	806

TEP 138 kV Transmission Line Ratings

LINE #	LINE NOTATION					CIRCUIT RATING (MVA)			
						CONTINUOUS		EMERGENCY	
	Sub1	Sub2	Ckt	LINE WIRE SIZE MCM	LENGTH (MI)	MVA	AMP	MVA	AMP
101	IR	RB	1	795 ACSR Drake		382	1600	382	1600
102	IR	VL	2	795 ACSR Drake	11.05	287	1200	287	1200
103	VL	CI	1	795ACSR Drake		394	1650	394	1650
				1365 ACAR					
104	VL	FH	1	795ACSR Drake	8.20	306	1280	306	1280
				954 ACSS 45/7 Rail	43.80				
105	IR	SO	1	795 ACSR Drake	16.10	370	1547	370	1547
106	SO	ASR	1	795 ACSR Drake	5.60	306	1280	306	1280
107	SO	CYP	1	795 ACSR Drake	15.10	382	1600	382	1600
108	VL	LR	1	1365 ACAR	4.60	287	1200	287	1200
109	SO	MV	1	795 ACSR Drake	12.81	287	1200	287	1200
110	DP	NL	1	795 ACSR Drake	14.00	287	1200	287	1200
111	IR	TU	1	795 ACSR Drake	10.87	347	1452	347	1452
112	DC	WI	1	795 ACSR Drake	3.50	311	1301	311	1301
150	TU	DC	1	795 ACSR Drake	7.31	311	1301	311	1301
113	EL	RO	1	795 ACSR Drake	4.65	287	1200	287	1200
				954 ACSS 45/7 Rail	2.45				
114	NL_EXP	RI	1	795 ACSR Drake	10.14	382	1600	382	1600
115	EL	NE	1	795 ACSR Drake	6.90	382	1600	382	1600
117	TO	NL_EXP	2	954 ACSS 45/7 Rail	14.30	540	2259	606	2535
118	TO	NL_EXP	1	954 ACSS 45/7 Rail	14.30	540	2259	606	2535
120	RI	LC	1	795 ACSR Drake	5.40	287	1200	287	1200
121	ST	RO	1	795 ACSR Drake	5.60	250	1046	250	1046
122	TO	RV	1	954 ACSR Rail	8.95	376	1574	376	1574
				1365 ACAR					
156	TO	NL	3	954 ACSS 45/7 Rail	12.60	540	2259	606	2535
123	SN	NE	1	477 ACSS, Hawk	8.80	389	1626	389	1626
				954 ACSS 45/7 Rail					
124	RI	NE	1	795 ACSR Drake	6.16	370	1547	370	1547
126	EL	SN	1	954 ACSR Rail	5.28	227	950	227	950
127	DP	NE	1	1365 ACAR	5.76	380	1590	380	1590
128	RV	LC	1	954 ACSR Rail	4.41	343	1434	343	1434
129	DR	MV	1	954 ACSR Rail	6.60	287	1200	287	1200
130	IR	DR	1	795 ACSR Drake	2.62	287	1200	287	1200
131	IR	SC	1	795 ACSR Drake	9.90	348	1456	348	1456
132	NL_EXP	WI	1	795 ACSR Drake	5.82	382	1600	382	1600
136	RB	VL	1	795 ACSR Drake		287	1200	287	1200
139	DP	SC	1	795 ACSR Drake	3.80	287	1200	287	1200
140	22	IR	1	954 ACSR Rail	3.40	382	1600	382	1600
141	SO	GV	1	954 ACSR Rail	14.59	309	1294	309	1294
145	22	EL	1	954 ACSS-HS "RAIL"	5.15	478	2000	478	2000
146	PO	LR	1	795 ACSR Drake		400	1673	400	1673
147	EL	PO	1	795 ACSR Drake		369	1544	369	1544
160	CI	ST	1	795 ACSR Drake		418	1749	418	1749
161	TO	NL	1	954 ACSS 45/7 Rail		478	2000	478	2000
	GV	CR	1			311	1301	311	1301

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Attachment

C

Tucson Electric Power

A UniSource Energy Company

Tucson Electric Power Company

2011 Annual Transmission Reliability Assessment

December 2011

Prepared by Transmission Planning

Transmission Planning Approval

{signature on file at TEP}

System Control & Reliability Department Approval

{signature on file at TEP}

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Table of Contents

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1. Executive Summary

Tucson Electric Power Company's (TEP's) Transmission Planning Department performed reliability studies to assess the performance of TEP's Extra High Voltage (EHV) and High Voltage (HV) transmission system. Performance was evaluated against the North American Electric Reliability Corporation (NERC) Standards and Western Electricity Coordinating Council (WECC) System Performance Criteria. Specifically, the following NERC standards are addressed in this assessment:

- TPL-001-0 – System Performance Under Normal Conditions
- TPL-002-0 – System Performance Following Loss of a Single Bulk Electric System (BES) Element
- TPL-003-0 – System Performance Following Loss of Two or More BES Elements
- TPL-004-0 – System Performance Following Extreme BES Events
- FAC-010-1 – System Operating Limits for the Planning Horizon
- FAC-014-2 – Establish and Communicate System Operating Limits

The reliability of TEP's EHV transmission system was assessed for the near-term (years one through five) and longer-term (years six through ten) planning horizons. Evaluations were conducted for one near-term off-peak case, two near-term on-peak cases, and one longer-term on-peak case. The near-term off-peak analysis was conducted for 2014 light autumn conditions. The near-term on-peak analysis was conducted for 2013 heavy summer and 2016 heavy summer conditions. The longer-term on-peak analysis was conducted for the 2021 heavy summer conditions. The 2014 light autumn scenario was selected since it is in the middle of the near-term planning horizon and a WECC-approved base case with off-peak conditions was available. The 2013 heavy summer case was evaluated because it has the highest peak loading prior to the planned in-service date of the Pinal Central – Tortolita 500 kV line (2014). The 2016 heavy summer case was selected because it is the last year in the near-term planning horizon. The 2021 heavy summer case was selected because it is ten years out from the current year. A list of planned EHV and HV projects included in the assessment is located in Appendix B. This assessment is performed on an annual basis to reflect any changes, such as load forecasts and system configurations. All the associated files and materials used to perform this assessment are available on Filenet/WebXtra, the TEP Electronic Content Management System.

The TEP system was modeled using the best information available for forecasted loads and existing and planned facilities at the time the study was conducted. Loads were based on the TEP Corporate Forecast developed by TEP's Economic Forecasting and Margin Analysis Group and included a 5% load margin to accommodate the WECC voltage stability requirement. Planned substations and transmission projects were based on TEP's 5-Year Capital Budget and Ten-Year Plan but facility ratings reflected existing 2011 ratings. TEP's evaluations were performed for selected demand levels over the range of forecast system demands.

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This assessment included power flow (steady state), transient stability, and voltage stability analysis for the 2013, 2014, 2016, and 2021 time frames. The evaluation for each year was conducted with All Lines in Service (ALIS) and with selected TEP EHV transmission lines or transformers initially out of service (IOS). IOS conditions assume that operator adjustments have been made and the system meets pre-contingency voltage and thermal requirements, except there is one element out of service. For this assessment, system adjustments include increasing local generation to maximum output levels allowed for TEP long-range planning studies, switching capacitor banks and adjusting scheduled voltages to bring the generator and Static VAR Compensator (SVC) VAR output levels within the normal range, bypassing series compensation and switching the Springerville – Vail 345 kV line and Vail T2 345/138 kV transformer into the 345 kV bus at the Vail Substation. Substations with adequate space for additional 138 kV capacitor banks are identified in the cases developed for this study. By identifying these reactive power resources in the models, the studies ensure that adequate reactive resources are available to meet system performance. IOS case conditions were determined based on power flow analysis or engineering judgment. Power flow based IOS conditions were based on contingencies that caused overloads above the continuous rating of another line or transformer with the maximum local generation allowed for TEP's planning studies. TEP would normally evaluate the system for planned outages at the load levels during the scheduled outage. However, there were no outages scheduled for the near-term or longer-term Planning Horizon.

1.1. Power Flow Summary

Power Flow analysis was conducted for 2014 off-peak conditions and 2013, 2016, and 2021 peak conditions. TEP plans its system to meet heavy summer conditions with Sundt units 1-3 committed and dispatched to their maximum levels and DMP CT #1 committed and dispatched to 44MW for a total local generation level of 294 MW. For off-peak conditions TEP evaluates the system with Sundt units 3 and 4 committed and dispatched to maximum output levels for a total local generation level of 225 MW.

TEP has a Local Area Protection Scheme (LAPS) and invokes it as necessary to meet the applicable performance measures. This LAPS includes the Tie-Open Load Shed (TOLS) scheme, sending a signal to Southwest Transmission Cooperative (SWTC) to trip the Avra – Sandario 115 kV line, and allowing the Bicknell 345/230 kV transformer to trip based on its protection settings that are PRC-023 compliant. The LAPS is invoked for Category C and D contingencies as deemed necessary. SWTC and TEP have agreed to these actions to maintain system reliability. These actions are included in the evaluation to demonstrate that the BES meets the performance measures with the use of existing and planned protection and control devices.

System adjustments for some IOS cases included bypassing series compensation in the Springerville – Vail 345 kV line (Express Line), switching the Express Line into the Vail 345 kV bus via a bus tie breaker, and reducing the output of Bowie generation. Without these adjustments, lines and transformers would have been loaded above their continuous ratings for the IOS Category A conditions.

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1.1.1. Near-Term Off-Peak Analysis

Analysis was conducted for ALIS conditions and with certain elements IOS for 2014 Light Autumn conditions. For this case, TEP's local generation was set at 225 MW with Sundt Units 3 and 4 dispatched at maximum for ALIS. All IOS cases were run with a minimum of Sundt Units 2, 3 and 4 committed and dispatched to the unit maximums for a total of 300 MW per TEP Planning Proccesses and Guidelines. There were no voltage deviation violations for any TEP contingencies beginning from ALIS or IOS conditions. In this case, the Category D contingency [redacted], failed to solve. This is a historical issue that does not appear when the owners in that area properly model the reactive power capability of their generating units in the area. No other issues were found for ALIS or IOS conditions. These studies were conducted with approximately 55% of TEP's local generation dispatched. Additional local generation can be dispatched if necessary, further demonstrating that TEP's BES is sufficient for off-peak conditions.

1.1.2. Peak Analysis

The TEP system was evaluated at peak conditions for the 2013, 2016, and 2021 time periods. For ALIS conditions, TEP's local generation was set at 294 MW with Sundt units 1-3 and DMP CT#1 committed, which is 54% of total local generation. For IOS conditions, local generation was set at 419 MW with Sundt units 1-4 and DMP CT#1 committed, which is 77% of local generation. Additional local generation is available which provides additional margin to be able to meet the NERC Standards and WECC Criteria.

1.1.2.1. 2013 Heavy Summer

Starting from ALIS conditions and 294 MW of local generation dispatched there are two contingencies that failed to solve, 17 transmission facilities were loaded above their applicable rating and no voltage deviations for outage conditions. Starting with one element IOS and 419 MW of local generation dispatched 10 transmission facilities were overloaded and there were no voltage deviation violations. These results are discussed in detail in Section 5 including mitigation showing TEP is compliant with the NERC TPL Standards.

1.1.2.2. 2016 Heavy Summer

Starting from ALIS conditions and 294 MW of local generation dispatched there are four contingencies that failed to solve, 24 transmission facilities overloaded and five voltage deviation violations. These results are discussed in detail in Section 5 including mitigation showing TEP is compliant with the NERC TPL Standards. Starting with one element IOS and 419 MW of local generation dispatched nine transmission facilities were overloaded and there were no voltage deviation violations. These results are discussed in detail in

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Section 5 including mitigation showing TEP is compliant with the NERC TPL Standards.

1.1.2.3. 2021 Heavy Summer

Starting from ALIS conditions and 294 MW of local generation dispatched nine contingencies failed to solve, 26 transmission facilities overloaded and six buses had voltage deviation violations. Starting with one line initially out of service and 419 MW of local generation dispatched 10 transmission facilities were overloaded and three buses had voltage violations. These results are discussed in detail in Section 5 including mitigations showing TEP is compliant with the NERC TPL Standards.

1.2. Transient Stability Summary

Transient stability studies were conducted for each year on the same ALIS and system adjusted IOS cases used in the power flow analysis. These transient stability studies show that the planned TEP system for ALIS and IOS conditions are compliant with the performance measures of the applicable standards and criteria. Worst Condition Analysis (WCA) was conducted to determine if voltages and frequencies meet NERC and WECC performance requirements and rotor angle plots were examined to determine if generators maintained synchronization. Transient stability was demonstrated for the peak and off-peak conditions evaluated. In some instances, rotor angle plots and WCA output indicated potential instability but in each case, the potential violations occurred during the recovery period immediately after the fault was cleared, while TOLS was responding, or on part of the system that was isolated due to the disturbance. The results of the transient stability analysis for the 2014 light autumn and 2013, 2016, and 2021 heavy summer conditions shows that the planned TEP EHV and HV transmission system for these time periods meets the transient stability performance measures of the applicable standards and criteria.

1.3. Voltage Stability Summary

The WECC requires a 5% load margin for Category B contingencies and a 2.5% load margin for Category C contingencies to demonstrate voltage stability. In these evaluations, thermal overloads are ignored but the power flow must solve with the appropriate load margin following the contingency. Since TEP includes a 5% load margin for all cases, voltage stability is demonstrated for all Category B and C contingencies.

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2. Introduction

Tucson Electric Power Company's (TEP's) Transmission Planning Department performed reliability studies to assess the performance of TEP's Extra High Voltage (EHV) and High Voltage (HV) transmission system. Performance was evaluated against the North American Electric Reliability Corporation (NERC) Standards and Western Electricity Coordinating Council (WECC) System Performance Criteria. Specifically, the following NERC standards are addressed in this assessment:

- TPL-001-0.1 – System Performance Under Normal Conditions
- TPL-002-0b – System Performance Following Loss of a Single BES Elements
- TPL-003-0a – System Performance Following Loss of Two or More BES Elements
- TPL-004-0 – System Performance Following Extreme BES Events
- FAC-010-2.1 – System Operating Limits for the Planning Horizon
- FAC-014-2 – Establish and Communicate System Operating Limits

This assessment was performed based on the *TEP Transmission Planning Process and Guidelines* (Revision 5) and included power flow (steady state), transient stability, and voltage stability studies for the near-term (years one through five) and the longer-term (years six through ten) planning horizons.

TEP is a participant in the Southeast Arizona Transmission System (SATS) study group. If multiple entities are involved in an identified contingency that results in violations of the performance measures, the proposed mitigation will be referred to the SATS group for further evaluation and discussion. Each of the Transmission Providers participating in the SATS effort have agreed to participate and support the ongoing analysis and study efforts of the subregional transmission planning groups in the WestConnect footprint as stated in the WestConnect Project Agreement for Subregional Transmission Planning.

3. Evaluations

TEP evaluates projects for near term (years one through five) and longer term (years six through ten) planning horizons based on power flow and transient stability studies. These studies are conducted annually unless changes to system conditions do not warrant such analyses. The evaluations in this assessment cover critical system conditions for the years selected. Off peak load conditions were evaluated for a 2014 light autumn scenario. Heavy summer conditions for the years 2013, 2016, and 2021 were selected for peak analysis and evaluation. The 2014 light autumn scenario was selected since it is in the middle of the near-term planning horizon and a WECC-approved base case with off-peak conditions was available. The 2013 heavy summer case was evaluated because it has the highest peak loading prior to the planned in-service date of the Pinal Central – Tortolita 500 kV line (2014). The 2016 heavy summer case was selected because it is the last year in the near-term planning horizon. The 2021 heavy summer case was selected because it is ten years out from the current year. TEP's EHV and HV transmission system is designed to serve summer peak demands and the off-peak analysis for the year 2014 demonstrate the ability of the TEP system to reliably meet off-peak conditions.

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3.1. Contingencies

TEP considers all contingencies applicable to NERC and WECC Categories B, C, and D when developing contingency lists for power flow (steady state) analysis. The following criteria are used to create the contingency lists for the TEP Assessment.

- Category B Contingencies
  1. Loss of any single EHV or HV transmission line or transmission transformer in the TEP Planning Authority (PA) Area.
  2. Loss of any tie line or tie transformer between the TEP PA area and neighboring PA areas.
  3. Loss of any single generating unit in the TEP PA Area.
  4. Loss of all shunt devices protected by a single breaker in the TEP PA area except shunt capacitors at TEP's Northeast Loop Substation.[1]
- Category C Contingencies
  1. Loss of a bus section resulting in the loss of two or more transmission lines or transmission transformers in the TEP PA area.
  2. Non-bus-tie breaker failure resulting in the loss of two or more transmission lines or transmission transformers in the TEP PA area.
  3. Any two EHV or HV circuits on a multi-circuit tower line in the TEP PA area.
  4. Any two adjacent EHV or HV circuits in a common right-of-way in the TEP PA area.
  5. A Category B outage, system adjusted (element now is Initially Out of Service (IOS)), followed by another Category B outage for critical circuits as identified in under Category D Contingencies, number 1). TEP will conduct screening analysis to determine which elements will be IOS for evaluation for N-1-1 performance.
- Category D Contingencies
  1. All remaining pairs of Category B elements (except shunt devices) not identified in Category C.
  2. All other multi-circuit EHV or HV tower lines or multi-circuit corridors in the TEP PA area.
  3. Loss of all transmission transformation at a single substation in the TEP PA area.
  4. Bus-tie breaker failure resulting in the loss of three or more transmission lines or transmission transformers in the TEP PA area.

[1] Outages of the shunt capacitors at TEP's Northeast Loop substation will have negligible impact due to the response of the SVC located at this facility. The outage of the SVC will be simulated.

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The final contingency list includes all applicable Category B and C contingencies. TEP does not own or operate any direct current (dc) facilities so no dc elements are included in the contingency list.

Two master contingency lists were created for the 2011 Annual Reliability Assessment. One list was developed for ALIS conditions and one list was developed for IOS conditions. The ALIS contingency list contained all EHV and HV transmission elements that would fall under the Category B, Catgeory C, and Category D contingencies identified above except for item 5 under Category C contingencies. An IOS contingency list containing each single EHV and HV element was developed to anlyze Catgeory C contingencies identified under item 5. These contingencies included either TEP elements or tie-lines to the TEP system. Since this is a generic list available for use in all cases for this assessment, out of service elements were included in the list. Only those contingencies where all elements in the contingency are in-service produced results. These lists are included as Attachments 1 and 2.

3.2. Power Flow Studies

Power flow analysis is performed to identify thermal overloads on transmission elements and potential voltage stability problems during normal and emergency conditions. Power flow studies are conducted for ALIS and system adjusted IOS conditions. The analysis beginning with ALIS is conducted with TEP local generation set at 294 MW, with Sundt units 1 – 3 dispatched at maximum and DMP at 44 MW. Since the transmission system is planned to meet the NERC Standards, WECC System Performance Criteria and TEP Internal Criteria under ALIS conditions, the System Operating Limit (SOL) is 294 MW of local generation at the forecasted peak load. The analysis for IOS conditions is conducted with 419 MW of local generation, with Sundt units 1 – 4 dispatched at maximum and DMP at 44 MW. Eight standard IOS cases are developed for TEP compliance studies. These eight cases are:

1. Cholla – Saguaro 500kV line
2. Pinal Central – Tortolita 500kV line[2]
3. Pinal West – South 345 kV line
4. Saguaro – Tortolita #2 500kV line
5. South 345/138 kV Transformer #2 or #3
6. Springerville – Vail 345kV line
7. Vail 345/138kV Transformer #1
8. Winchester – Vail 345kV line

[2] Planned in-service date of 5/1/2014

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In addition to these cases, IOS cases will be developed for the following:

1. any element where the loss of that element causes another element to be loaded above its continuous rating with maximum local generation on;
2. Any TEP elements in N-2 (Category C or D) contingencies that need load shed for ALIS conditions.

For the development of IOS cases, only one scenario is developed for equivalent outages. For example, Saguaro – Tortolita #1 is equivalent to Saguaro – Tortolita #2 so only one IOS case (Saguaro – Tortolita #2) is developed.

3.3. Transient Stability Studies

Transient stability studies are conducted for selected disturbances beginning from ALIS and IOS conditions. For ALIS conditions, transient stability analysis is conducted for Category B, C and D contingencies. Category B contingencies include three-phase faults with normal clearing. Category C disturbances simulate three-phase faults with delayed clearing, simultaneous loss of two lines in a common corridor, simultaneous three-phase faults with normal clearing on adjacent circuits beginning from ALIS, or three-phase faults with normal clearing beginning from IOS conditions. Three-phase faults are used as a screening tool to simplify the study process. If three-phase faults do not meet the Category C performance measures, single-phase faults are then simulated and analyzed. Any disturbance that fails the three-phase screening process but passes the single-phase analysis is then studied only as a single-phase fault in future assessments. Category D contingencies include loss of multiple transformers at a single substation that do not have a common mode of failure. The complete disturbance lists for the 2013 heavy summer, 2014 light autumn, 2016 heavy summer, and 2021 heavy summer cases are found in Attachments 3 – 5.

3.4. Voltage Stability Studies

The WECC requires a 5% load margin for Category B contingencies and a 2.5% load margin for Category C contingencies to demonstrate voltage stability. In these evaluations, thermal overloads are ignored but the power flow must solve with the appropriate load margin following the contingency. Since TEP includes a 5% load margin for all cases and meets all performance measures for Category B and C contingencies, voltage stability is demonstrated.

4. Assumptions

4.1. Data Sources

All cases used in this analysis were developed from WECC approved power flow and stability models. Table 1 shows the WECC case that was used for the analysis for each year.

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Year	WECC Case
2013 Heavy Summer	14HS3SA
2014 Light Autumn	14LA1SA
2016 Heavy Summer	14HS3SA
2021 Heavy Summer	21HS1A

Table 1. WECC Base Cases

The 2013 and 2016 cases were developed from the Arizona 2014 heavy summer seed case which was developed from the WECC approved 14HS3SA case. In addition to TEP review, the WECC case was reviewed and detailed representations were provided by Arizona Public Service (APS), Salt River Project (SRP), Southwest Transmission Cooperative (SWTC) and Western Area Power Administration (Western) to create the Arizona 2014 heavy summer seed case. TEP and SWTC then further coordinated to update the 2014 heavy summer case to reflect 2013 and 2016 heavy summer cases for their systems.

4.2. Loads and Load Margins

TEP loads are based on the TEP Corporate Forecast developed by TEP's Economic Forecasting and Margin Analysis Group and allocated to distribution buses based on distribution percentages from TEP's Distribution Planning Group. For near-term and longer-term planning, the load power factor is assumed to be 0.98. TEP's assessment includes analysis conducted for peak and off-peak conditions. Consequently, TEP's analysis is performed for selected demand levels over the range of forecast system demands.

The WECC requires a 5% load margin for Category B contingencies and a 2.5% load margin for Category C contingencies for load pocket studies to demonstrate voltage stability. TEP includes a 5% load margin in all operating and planning studies to ensure compliance with voltage stability requirements and thermal performance requirements.

4.3. Resources and Firm Transfers

TEP resources are dispatched such that all projected firm power resources and contracts are modeled and such that all projected firm transfers are modeled. In addition, for ALIS conditions, TEP's local generation is set at 294 MW with Sundt units 1-3 dispatched at maximum levels and DMP CT #1 dispatched at 44 MW. Since TEP's system is designed to meet NERC Transmission Planning Standards and WECC Criteria, this is the System Operating Limit for the Planning Horizon. For IOS conditions, TEP's local generation is set at 419 MW with Sundt units 1-4 dispatched at maximum and DMP CT #1 dispatched at 44 MW. It is assumed that the

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WECC base cases include all projected firm transfers and resources for all other entities within the WECC region.

4.4. Reactive Devices

TEP owns and operates line reactors on its 345 kV transmission network and shunt capacitors on its 138 kV and distribution systems. TEP's Engineering Department has identified existing 138 kV substations that can accommodate additional capacitor banks. In addition, the TEP standard 138 kV substation design will accommodate up to three capacitor banks each with capacity for 52.8 MVAR of capacitor cans insulated at 143.4 kV. These locations are identified to ensure that adequate reactive power resources are available to meet system performance criteria. Any capacitors modeled in the case but not currently available for use or part of TEP's 5-year capacitor plan will only be used if all existing and planned capacitors are modeled in-service. These capacitors will then be identified as mitigation needed to meet TEP system voltage requirements.

TEP also owns and operates a Static VAR Compensator (SVC) located at its Northeast Substation. The MVAR capability of the Northeast SVC is -75 / +200 MVAR, and it has the ability to control four approximately 50 MVAR mechanically switched capacitor banks, for a total VAR range of -75 / +400 MVAR. The normal output range of the SVC is -30 / +30 MVAR without the capacitor banks included in the SVC model. If the output is less than +30 MVAR, the maximum susceptance output of the SVC will be reduced by the difference between the modeled MVAR output and the top of the bandwidth. If the output is greater than -30 MVAR, the minimum susceptance output will be increased by the difference between the modeled MVAR output and the bottom of the bandwidth. For the cases analyzed in this assessment, two (2) mechanically switched 138 kV capacitors at Northeast were always in service.

4.5. Protection Systems and Control Devices

4.5.1. Substation Configuration

The assessment will take into account the effects of existing and planned protection systems, including any back-up or redundant systems, and control devices. TEP's EHV substation layouts are ring bus or breaker-and-a-half and 138 kV substation layouts are main-and-transfer, ring bus, breaker-and-a-half, and double-breaker-double-bus. The EHV substations with a ring bus layout are designed such that they can be converted to a breaker-and-a-half layout when expansion limits are reached. With normal operation of the protection system only one element will be removed from service in each configuration. If delayed clearing or breaker failure occurs a maximum of two elements will be removed from service except for the 138 kV main-and-transfer substations.

4.5.2. Tie-Open Load Shed

The TEP Tie-Open Load Shed (TOLS) scheme is a Local Area Protection Scheme (LAPS) that arms fast-switched reactive devices and customer load in anticipation of a forced outage. The fast-switched reactive devices are available for arming only if the Northeast SVC is out of service. Customer load is armed for direct load tripping only for Category C and D contingencies included in the TOLS scheme. In addition, TEP will provide a signal to SWTC to trip the Avra – Sandario 115 kV line if needed and the Bicknell 345/230 kV transformer is allowed to trip based on its protection settings to meet system performance criteria. The effects of the Avra – Sandario trip or the Bicknell trip are included in each applicable scenario to ensure that performance measures are met with these elements removed from service.

4.6. Facilities

The models developed for this assessment included all existing facilities and planned facilities with an in-service date prior to the year being evaluated. The assessment shall identify any planned upgrades needed to meet the performance requirements for Categories A, B and C conditions.

Planned outages (including maintenance) of any BES equipment (including protection systems and control devices or their components) will be evaluated at the demand level for which such planned outages will be performed. TEP does not have any outages planned for the near-term or longer-term Planning Horizon. Planned outages for the Operating Horizon are evaluated as necessary closer to the scheduled outage.

4.7. Fault Clearing

Transient stability studies will be conducted for two types of faults:

- three-phase-to-ground fault with normal clearing
- three-phase-to-ground fault with delayed clearing

If the three-phase-to-ground fault with delayed clearing shows a violation of Category C performance measures, the disturbance will be re-run with a single-line-to-ground (SLG) fault to determine if it meets the performance measures.

A 5% load margin will be included for all stability runs.

Per TEP's Protection, Communications, Automation, and Metering (PCA&M) Department, normal clearing for TEP HV transmission system is 5 cycles and delayed clearing is 14 cycles. For the TEP EHV system normal clearing is 4 cycles and delayed clearing is 13 cycles.

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4.8. Normal Conditions

Normal conditions apply to all lines in service (ALIS) and with one or more elements IOS. Normal conditions will model established pre-contingency operating procedures as outlined in Sections 4.9.1 through 4.9.5.

4.8.1. Voltage Profile

- TEP EHV bus voltages will be between 1.03 and 1.04 pu, as possible, on a 345 kV or 500 kV base. Exceptions are allowed for fictitious buses that represent connections for transformer terminated lines.
- The TEP 138 kV average bus voltage will be between 1.0210 and 1.0235 pu on a 138 kV base. The average is computed on selected 138 kV buses.
- Individual 138 kV bus voltages will be between 1.0145 and 1.03 pu, as possible, on a 138 kV base.
- Voltages shall be within applicable ratings.

4.8.2. VAR Output and Flow Requirements

TEP operates its system with specific VAR requirements set for TEP's local generating units, the Northeast SVC, and VAR flow at the Saguaro/Tortolita interface. Table 2 identifies the MVAR output requirements for TEP's local generating units.

Unit(s)	MVAR Range
Sundt 1-4	-1 to +1 MVAR
Sundt CTs 1-2	-1 to +1 MVAR
North Loop CTs 1-4	-1 to +1 MVAR
DMP CT 1	-1 to +1 MVAR

Table 2. Normal MVAR Output for TEP Local Generating Units

The Northeast SVC has a normal operating range of -30 / + 30 MVAR. For the 2013 case, the Saguaro/Tortolita Interface VAR flow should be outbound from the Tortolita Substation into the Saguaro Substation. For the 2014, 2016, and 2021 cases, the VAR flow should be from the Tortolita 138 kV bus to the Tortolita 500 kV bus. Presently, The Saguaro 500 kV – Tortolita 138 kV circuits are transformer terminated lines and the only 500 kV metering point is located at Saguaro. Following the Tortolita expansion, a Tortolita 500 kV switchyard will exist and TEP will have the ability to monitor the VAR flow at this bus.

4.8.3. Line and Transformer Loading

Loading on all transmission lines and transmission transformers must be at or below the continuous rating for ALIS or IOS conditions.

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4.8.4. Series Compensation

All planning studies for normal conditions will be conducted with "full" compensation on the TEP EHV transmission system, unless otherwise stated. TEP has four series capacitor banks installed on the transmission lines in the Springerville – Vail corridor at the following locations:

- Springerville – Vail 345 kV line at Greenlee (18%)
- Springerville – Vail 345 kV line at Vail (20%)
- Winchester – Vail 345 kV line at Vail (90%)
- Springerville – Greenlee 345 kV line at Greenlee (39%)

"Full" compensation has all of the above in service except the Springerville – Greenlee series capacitor bank.

For certain IOS conditions, system adjustment may require bypassing some or all series compensation and switching the Springerville – Vail 345 kV line and the Vail T2 345/138 kV transformer into the 345 kV bus in the Vail Substation via a bus tie breaker. If this switching is necessary, each of the above series capacitors are modeled but may be bypassed to meet system performance measures.

4.9. Emergency Conditions

TEP evaluates system performance for single and multiple contingencies as identified in Section 3.1. Sections 4.9.1 through 4.9.5 identify the performance criteria for the contingencies evaluated.

4.9.1. Voltage Requirements

TEP's post-contingency 138 kV average bus voltage is to be between 0.98 and 1.05 pu on a 138 kV base.

All voltages will be within applicable ratings and the maximum change in voltage at any bus is 5% for a NERC/WECC Category B contingency and 10% for a NERC/WECC Category C contingency.

4.9.2. Line and Transformer Loading

Loading on all transmission lines and transmission transformers must be at or below the emergency rating following the contingency but prior to system adjustment.

4.9.3. Direct Load-Tripping

Direct load-tripping of firm demand is not allowed to meet voltage and loading requirements for Category B contingencies but is allowed for Category C and D contingencies.

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4.9.4. Cascading Outages

Cascading outages are not allowed for Category B and C contingencies.

4.9.5. Transient Voltage Stability

Three-phase-to-ground faults and line trips not related to a fault were simulated and evaluated for selected Category B, C, and D disturbances. The simulations were conducted for a minimum of 15 seconds following the disturbance. The system was considered stable if it met the following requirements:

- All machines remain synchronized as demonstrated by their relative rotor angles.
- Positive damping exists as demonstrated by the damping of relative rotor angles and voltage magnitude swings.
- Transient voltage dips do not exceed 25% at load buses or 30% at non-load buses for single contingencies
- Transient voltage dips do not exceed 20% for more than 20 cycles at load buses for single contingencies.
- Transient frequency will not drop below 59.6 Hz for 6 cycles or more at load buses for single contingencies.
- Transient voltage dips do not exceed 30% at any bus or more than 20% for more than 40 cycles at load buses for Category C contingencies.
- Transient frequency will not drop below 59.0 Hz for 6 cycles or more at load buses for Category C contingencies.

5. Results

In all cases, there are a few isolated buses and fictitious buses that show violations. Since the buses are isolated due to the contingency or is a fictititous bus there is no need for mitigation.

In all cases, review of the Apache CT1 rotor angle plots showed slight oscillations following certain disturbances. This issue has been discussed with SWTC and they have noted that this is a PSLF program issue. SWTC has replaced the controls on this unit but the updated models will not be available for use until the 2012 assessment.

In the on peak cases, DMP CT #1 shows oscillations for any disturbance. These oscillations have not appeared in previous analyses and if the DMP CT #1 is turned off, the oscillations do not appear. This indicates an issue with the DMP CT model. This unit was tested in late 2011 but the new models will not be available until early 2012. These updated models will be used for future assessments.

For transient stability studies, all facilities in Arizona and New Mexico were monitored, however plots were only generated for selected facilities. Transient stability plots of bus voltages, frequencies, and rotor angles for each case are included as attachments. A complete list of the plotted facilities for the analysis can be found in Appendix G.

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5.1. Off-Peak Analysis

5.1.1. System Operating Limits for the Planning Horizon

TEP's Planning Process and Guidelines state that off-peak analysis will be conducted with no fewer than two Sundt steam units on-line at maximum output. For the 2014 Light Autumn case, TEP's local generation dispatch included Sundt steam units 3 and 4 dispatched to their maximum output levels for a combined output of 225 MW. There were no violations of the NERC TPL-001 through TPL-004 reliability criteria for this cases. Therefore, the SOL for the Planning Horizon for these off-peak conditions is no greater than 225 MW.

5.1.2. 2014 Light Autumn

5.1.2.1. System Description

The WECC approved 14LA1-SA case was used as the base model for this projected time frame. The nominal load modeled was 750 MW and the actual load was 787.5 MW. The following are the major TEP projects and uprates planned for the 2012 – 2014 timeframe:

- Vail 345 kV / 138 kV Transformer #3 (2012)
- Express Bus Tie Breaker (2012)
- North Loop – DMP line uprate to 1749 A (2012)
- Midvale – Drexel line uprate to minimum of 1208 A (2012)
- South – Irvington Ring line uprate to 1583 A (2012)
- South – Midvale line uprate to 1441 A (2012)
- North Loop – Rillito line uprate to 1749 A (2012)
- Irvington – Twenty Second line uprate to 1967 A (2012)
- Vail Series Capacitor Replacement on the Springerville to Vail 345 kV line (2013)
- New Craycroft-Barril load-serving substation (2013)
- New DMP – Tucson 138 kV line (2013)
- New Harrison load-serving substation (2013)
- New Toro Switching Station (2013)
- North Loop 138 kV Yard Expansion Phase 2 (2013)
- Irvington – Tucson line uprate to 1463 A (2013)
- North Loop 138 kV Yard Expansion Phase 3 (2014)
- New Duval Clear 138 kV Switchyard (2014)
- New Canoa Ranch load-serving substation (2014)
- New Orange Grove load-serving substation (2014)
- Vail – Valencia 115 kV to 138 kV Conversion (2014)
- North Loop – West Ina line uprate to 1749 A (2014)

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5.1.2.2. Power Flow Results and Mitigation

Powerflow analysis was conducted on the 2014 light autumn ALIS base case as well as eight IOS base cases. Powerflow summary results for the 2014 light autumn cases can be found in Appendix C.

5.1.2.2.1. *Category A – All Lines in Service*

With all facilities in service or with one element IOS the TEP EHV and HV transmission system for 2014 light autumn conditions meets the steady state performance requirements of TPL-001-0.1. All facilities were within normal voltage and thermal limits.

5.1.2.2.2. *Category B – Single Contingencies*

All the single contingency power flow simulations solved and all bus voltages were within voltage limits. There are no overloads or voltage deviation violations for Category B contingencies. Therefore, The TEP 2014 planned EHV and HV transmission system under light autumn conditions demonstrates compliance with the TPL-002-0b0b steady state performance measures.

5.1.2.2.3. *Category C – Multiple Contingencies*

All the Category C multiple contingency power flow simulations solved and all bus voltages were within voltage limits. There were no overloads or voltage deviation violations caused by the multiple contingencies in this category. Therefore, The TEP 2014 planned EHV and HV transmission system under light winter conditions demonstrates compliance with the TPL-003-0a steady state performance measures.

5.1.2.2.4. *Category D – Multiple Contingencies*

All the Category D multiple contingency power flow simulations solved and all bus voltages were within voltage limits, with two exceptions; [redacted] contingency. The [redacted] is a historical issue that does not appear when the owners in that area properly model the reactive power capability of their generating units in the area. Neither of these facilities are owned by TEP. A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation is currently underway. This study will be used to determine mitigation plans for the [redacted] contingency. TEP has demonstrated compliance with TPL-004-0 by evaluating Category D contingencies for risks and consequences.

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5.1.2.3. Transient Stability Results and Mitigation

Transient stability analysis was conducted on the same 2014 Light Autumn ALIS and IOS base cases used in the power flow analysis. Table 3 summarizes the number of disturbances simulated for each category for the ALIS and IOS cases. A complete list of disturbances for the 2014 Light Autumn cases can be found in Attachment 4. Transient stability plots of bus voltages, frequencies, and rotor angles for the 2014 Light Autumn analysis are included as Attachments 36 – 62.

Category	ALIS	IOS
A	1	1
B	29	0
C	31	29
D	4	0

Table 3. 2014 Light Autumn Disturbance Category Summary

5.1.2.3.1. *Category A – All Lines in Service*

A flat line response was achieved for all monitored facilities with no disturbance and all facilities in service or with one element initially out of service. The TEP 2014 planned EHV and HV transmission system under light autumn conditions demonstrates compliance with the TPL-001-0.1 transient stability performance measures.

5.1.2.3.2. *Category B – Normal Clearing Events*

Worst Condition Analysis (WCA) was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Except as previously noted in section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category B disturbances. The TEP 2014 planned EHV and HV transmission system under light autumn conditions demonstrates compliance with the TPL-002-0b transient stability performance measures.

5.1.2.3.3. *Category C – Normal Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery and while TEP's LAPS was responding. After the LAPS responded, there were no violations of voltage dip and frequency dip criterion. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category C disturbances. Therefore, no further investigation was performed or required. The TEP 2014 planned EHV and HV transmission system under light autumn conditions demonstrates compliance with the TPL-003-0a transient stability performance measures for normal clearing events.

5.1.2.3.4. *Category C – Delayed Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery and while TEP's LAPS was responding. After the LAPS responded, there were no violations of voltage dip and frequency dip criterion. Except as previously noted in Section 5, Evaluation of the rotor angles found that all generating units remained synchronized for the Category C disturbances. The TEP 2014 planned EHV and HV transmission system under light autumn conditions demonstrates compliance with the TPL-003-0a transient stability performance measures for delayed clearing events.

5.1.2.3.5. *Category D – Normal Clearing Events*

WCA was performed to determine if the Category C system performance measures identified in Section 4.9.5 for voltages and frequencies were met for the Category D disturbances. No voltage or frequency criteria violations were identified. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery or while TEP's LAPS was responding. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category D disturbances. TEP has demonstrated compliance with TPL-004-0 by evaluating Category D disturbances for risks and consequences.

5.1.2.4. Voltage Stability Results and Mitigation

TEP includes a 5% load margin in all studies. All powerflow contingencies solved with the 5% load margin which demonstrates voltage stability criteria have been met. No further plans are needed to meet these criteria.

5.1.2.5. 2013 Light Winter Conclusions

Power flow (steady-state) and transient stability analysis was conducted for 2014 Light Autumn conditions. There were no violations of NERC Planning Standards or WECC System Performance Criteria. Therefore, as planned, the TEP EHV and HV transmission system meets the performance requirements of TPL-001-0.1, TPL-002-0b, TPL-003-0a, and TPL-004-0 and no mitigation

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is needed. In addition, more local generation is available which provides additional margin to be able to meet the NERC Standards and WECC Criteria.

5.2. *Near-Term Peak Analysis*

5.2.1. 2013 Heavy Summer

5.2.1.1. System Description

This case was developed from the WECC approved 14HS3-SA case. This case was adjusted to model TEP's anticipated 2013 summer peak with a 5% load margin. The nominal load modeled was 2430 MW and the actual load was 2551.5 MW. The following are the major TEP projects planned for the 2012 – 2013 timeframe that will be in-service prior to peak of 2013:

- Vail 345 kV / 138 kV Transformer #3 (2012)
- Express Bus Tie Breaker (2012)
- North Loop – DMP line uprate to 1749 A (2012)
- Midvale – Drexel line uprate to minimum of 1208 A (2012)
- South – Irvington Ring line uprate to 1583 A (2012)
- South – Midvale line uprate to 1441 A (2012)
- North Loop – Rillito line uprate to 1749 A (2012)
- Irvington – Twenty Second line uprate to 1967 A (2012)
- Vail Series Capacitor Replacement on the Springerville to Vail 345 kV line (2013)
- New Craycroft-Barril load-serving substation (2013)
- New DMP – Tucson 138 kV line (2013)
- New Harrison load-serving substation (2013)
- New Toro Switching Station (2013)
- North Loop 138 kV Yard Expansion Phase 2 (2013)
- Irvington – Tucson line uprate to 1463 A (2013)

5.2.1.2. Power Flow Results and Mitigation

Powerflow analysis was conducted on the 2013 heavy summer ALIS base case as well as nine IOS base cases. Powerflow summary results for the 2013 heavy summer case can be found in Appendix D.

5.2.1.2.1. *System Operating Limits*

TEP's local generation was set at 294 MW for on peak ALIS cases with Sundt units 1 - 3 dispatched to maximum and DMP dispatched to 44 MW. TEP's transmission system is designed to meet NERC Transmission Planning Standards and WECC criteria with this level of generation so this is the System Operating Limit for 2013 during peak conditions. The following results are based on this level of generation.

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5.2.1.2.2. *Category A – All Lines in Service*

With all facilities in service or with one element IOS the TEP EHV and HV transmission system as planned for 2013 meets the steady state performance requirements of TPL-001-0.1 under heavy summer conditions. All facilities were within normal voltage and thermal limits.

5.2.1.2.3. *Category B – Single Contingencies*

All the single contingency power flow simulations solved and all bus voltages were within voltage limits. There are five overloaded transmission facilities and no voltage deviation violations for Category B contingencies. The overloaded transmission facilities are:

(1) Greenlee-SW 345 kV / 230 kV Transformer 1
(2) CINIZA – WINGATE 115 kV line
(3) ENRON_TS – GALUPPG 115 kV line
(4) PEGS – CINIZA 115 kV line
(5) WINGATE – ENRON_TS 115 kV line

The overload on the Greenlee-SW transformer is due to the loss of the [redacted] line. A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation is currently underway. This separate study will be used to determine mitigation plans for this issue. The next four overloads are due to the loss of the [redacted] transformer, which is not owned or operated by TEP but connects to a TEP bus. [redacted] has informed TEP that upgrades are planned, including a 2nd transformer, that will mitigate these overloads. Therefore, the TEP 2013 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the steady state performance requirements of TPL-002-0b.

5.2.1.2.4. *Category C – Multiple Contingencies*

All the Category C multiple contingency power flow simulations solved and all bus voltages were within voltage limits. There was one overloaded transmission facility and no voltage deviation violations for Category C contingencies in both ALIS and IOS conditions. The overloaded transmission facility is the Greenlee-SW – Greenlee 345 / 230 kV Transformer 1. A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation is currently underway. This separate study will be used to determine mitigation plans for this issue. Therefore, the TEP 2013 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the steady state performance requirements of TPL-003-0a.

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5.2.1.2.5. *Category D – Multiple Contingencies*

Two Category D contingencies failed to solve beginning from ALIS conditions. The contingencies that failed to solve are:

[redacted]

The contingency involving the [redacted] lines will be evaluated as part of a separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation. This study will be used to determine mitigation plans for this issue. The [redacted] Corridor was evaluated with 419 MW of generation dispatched. This contingency solves at that level of generation. In the event that this corridor is threatened, i.e., wildfire, TEP will consider running additional local generation to avoid potential problems due to this outage.

For Category D contingencies, 16 transmission facilities were overloaded. These overloaded facalities are:

(1) Greenlee-SW 345 kV / 230 kV Tranformer 1
(2) Springerville – Vail 345 kV line
(3) Vail 345 kV / 138 kV Transformer 2
(4) Tortolita 500 kV / 138 kV Transformers 1 & 2
(5) South – Midvale 138 kV line
(6) Sandario – Three Points 138 kV line
(7) North Loop – Rillito 138 kV line
(8) La Canada – Rillito 138 kV line
(9) Tortolita – Rancho Vistoso 138 kV line
(10) Rancho Vistoso – La Canada 138 kV line
(11) Marana Tap – Saguara East 115 kV line
(12) CINIZA – WINGATE 115 kV line
(13) ENRON_TS – GALLUPPG 115 kV line
(14) PEGS – CINIZA 115 kV line
(15) WINGATE – ENRON_TS 115 kV line

TEP has demonstrated compliance with TPL-004-0 by evaluating Category D contingencies for risks and consequences. Some of the overloads will be mitigated by the projects listed in the above section. A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation is currently underway. The results of

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this study will be used to determine mitigation plans for the Greenlee-SW transformer overload. Overloads (12) through (15) are due to the loss of the [redacted] transformer and another element. [redacted] has informed TEP that upgrades are planned, including a 2nd transformer, which will mitigate these overloads.

5.2.1.3. Transient Stability Results and Mitigation

Transient stability analysis was conducted on the same 2013 heavy summer ALIS and IOS base cases used in the power flow analysis. Table 4 summarizes the number of disturbances simulated for each category for the ALIS and IOS cases. A complete list of disturbances for the 2013 heavy summer cases can be found in Attachment 3. Transient stability plots of bus voltages, frequencies, and rotor angles for the 2013 heavy summer analysis are included as Attachments 6 – 35.

Category	ALIS	IOS
A	1	1
B	28	0
C	31	28
D	4	0

Table 4. 2013 Heavy Summer Disturbance Category Summary

5.2.1.3.1. *Category A – All Lines in Service*

A flat line response was achieved for all monitored facilities with no disturbance and all facilities in service or with one element initially out of service. The TEP 2013 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-001-0.1 transient stability performance measures.

5.2.1.3.2. *Category B – Normal Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category B disturbances. The TEP 2013 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-002-0b transient stability performance measures.

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5.2.1.3.3. *Category C – Normal Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category C disturbances. The faulting of the Saguaro bus followed by the subsequent loss of both Saguaro – Tortolita 500 kV lines shows a violation in the WCA. Further investigation shows that this dip is during the system recovery period and while TEP's LAPS was responding. After the LAPS responded, there were no violations of voltage dip and frequency dip criterion. The TEP 2013 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-003-0a transient stability performance measures for normal clearing events.

5.2.1.3.4. *Category C – Delayed Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery and while TEP's LAPS was responding. After the LAPS responded, there were no violations of voltage dip and frequency dip criterion. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category C disturbances. The TEP 2013 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-002-0b transient stability performance measures for delayed clearing events.

5.2.1.3.5. *Category D – Normal Clearing Events*

WCA was performed to determine if the Category C system performance measures identified in Section 4.9.5 for voltages and frequencies were met for the Category D disturbances. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery and while TEP's LAPS was responding. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category D disturbances. TEP has demonstrated compliance with TPL-004-0 by evaluating Category D disturbances for risks and consequences.

5.2.1.4. Voltage Stability Results and Mitigation

TEP includes a 5% load margin in all studies. All powerflow contingencies solved with the 5% load margin which demonstrates voltage stability criteria have been met. No further plans are needed to meet these criteria.

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5.2.1.5. 2013 Heavy Summer Conclusions

Power flow (steady-state) and transient stability analysis was conducted for 2013 Heavy Summer conditions. There were no violations of NERC Planning Standards or WECC System Performance Criteria. Therefore, as planned, the TEP EHV and HV transmission system meets the performance requirements of TPL-001-0.1, TPL-002-0b, TPL-003-0a, and TPL-004-0 and no mitigation is needed. In addition, more local generation is available which provides additional margin to be able to meet the NERC Standards and WECC Criteria.

5.2.2. 2016 Heavy Summer

5.2.2.1. System Description

A 2016 heavy summer case was developed from the WECC approved 14HS3-SA case for this analysis. This case was adjusted to model TEP's anticipated 2016 summer peak with a 5% load margin. The nominal load modeled was 2453.2 MW and the actual load was 2575.9 MW. The following are the major TEP projects planned for the 2015 – 2016 timeframe:

- Reconfigure Tortolita – Rancho Vistoso line to North Loop – Rancho Vistoso (2015)
- Irvington – Drexel line uprate to 1456 A (2015)
- Vail Series Capacitor Replacement on the Winchester to Vail 345 kV line (2015)
- McKinley Series Capacitor Replacement on the San Juan to McKinley 345 kV lines 1 & 2 (2016)
- North Loop – Rillito line uprate to 1749 A (2016)
- New Anklam load-serving substation (2016)

It should be noted that the SunZia Southwest Transmission Project (SunZia) and Southline Project were not included in this analysis. Inclusion of one or both of these projects may alter proposed projects in future assessments.

5.2.2.2. Power Flow Results and Mitigation

Powerflow analysis was conducted on the 2016 heavy summer ALIS base case as well as 11 IOS base cases. Powerflow summary results for the 2016 heavy summer case can be found in Appendix E.

5.2.2.2.1. *System Operating Limits*

TEP's local generation was set to 294 MW for on peak ALIS cases using Sundt units 1 – 3 dispatched to maximum and DMP dispatched to 44 MW for a generation of 294 MW. TEP's transmission system is designed to meet NERC Transmission Planning Standards and WECC criteria with this level of generation so this is the System Operating Limit for 2016 during peak conditions. The following results are based on this level of generation.

5.2.2.2.2. *Category A – All Lines in Service*

With all facilities in service or with one element IOS the TEP EHV and HV transmission system as planned for 2016 meets the steady state performance requirements of TPL-001-0.1 under heavy summer conditions. All facilities were within normal voltage and thermal limits.

5.2.2.2.3. *Category B – Single Contingencies*

All the single contingency power flow simulations solved and all bus voltages were within voltage limits. There were four overloaded elements and five buses with voltage deviation violations.

The loss of the [redacted] Transformer, which is not owned or operated by TEP but connects to a TEP bus, causes overloads on the following elements:

(1) CINIZA – WINGATE 115 kV line
(2) ENRON_TS – GALLUPPG 115 kV line
(3) PEGS – CINIZA 115 kV line
(4) WINGATE – ENRON _TS 115 kV line

[redacted] has informed TEP that upgrades, including a 2nd transformer, are planned which will mitigate the overloads caused by the loss of the [redacted] Transformer. The loss of the [redacted] line causes voltage deviations greater then 5% on the following buses:

(1) Canoa Ranch 138 kV bus
(2) Greenvalley 138 kV bus
(3) Hartt 138 kV bus
(4) Rosemont 138 kV bus
(5) San Rita South – South 138 kV bus

TEP performed the 2011 compliance assessment based on the best available information at the time the studies were conducted. The customer has indicated a desire to re-study the project with the load power factor increased to 0.98 instead of 0.90. It is anticipated that this re-study will determine the proper amount of capitors to be co-located with a STATCOM at the San Rita South (now Toro) switchyard to mitigate any voltage concerns due to this load. Therefore, the TEP 2016 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the steady state performance requirements of TPL-002-0b.

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5.2.2.2.4. *Category C – Multiple Contingencies*

All the Category C contingency power flow simulations solved and all bus voltages were within voltage limits. There were two overloaded transmission facilities and no voltage deviation violations following contingencies beginning from ALIS conditions. The overloaded transmission facilities were:

(1) North Loop – DMP 138 kV line
(2) North Loop – Rillito 138 kV line

All Category C contingencies for the IOS cases solved and all bus voltages were within voltage limits. There are five overloaded tranmsision facilities and no voltage deviation violations for the IOS cases. The following IOS cases had overloaded transmission facilities:

<u>Greenlee – Winchester IOS</u>

(1) Copper Verde 345 kV / 230 kV Transformers 1 & 2
(2) Greenlee-SW 345 kV / 230 kV Transformer 2
(3) North Loop – Rillito 138 kV line

<u>Pinal West – South IOS</u>

(1) Northeast Loop – Rillito 138 kV line
(2) North Loop – Rillito 138 kV line

<u>Springerville – Greenlee</u>

(1) North Loop – Rillito 138 kV line

<u>Springerville – Vail</u>

(1) North Loop – Rillito 138 kV line

<u>Winchester – Vail</u>

(1) North Loop – Rillito 138 kV line

A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation is currently underway. This study will be used to determine mitigation plans for the Greenlee-SW and Copper Verde transformer overloads.

The North Loop – Rillito line will be uprated in 2016 through the replacement of the switch at Rillito which alleviates all the overloads with the exception of the one in the Springerville – Vail IOS case. Budget studies show the reconfiguration of the Tortolita – Rancho Vistoso line to North Loop – Rancho Vistoso in 2015 alleviates this overload so no further mitigation is recommended.

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Therefore, the TEP 2016 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the steady state performance requirements of TPL-003-0a.

5.2.2.2.5. *Category D – Multiple Contingencies*

Four Category D contingencies failed to solve beginning from ALIS conditions. All buses were within voltage limits with 21 overloaded transmission facilities and five voltage deviation violations

The contingencies that failed to solve were:

[redacted]

A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation is currently underway. This study will be used to determine mitigation plans for the loss of the [redacted] lines. The loss of the [redacted] and the loss of the [redacted] will be recommended for TOLS, since loadshed allows these two contingencies to solve. The [redacted] Corridor was evaluated with 419 MW of generation dispatched. This contingency solves at that level of generation. In the event that this corridor is threatened, i.e., wildfire, TEP will consider running additional local generation to avoid potential problems due to this outage.

The following are the transmission facilities overloaded:

(1) Vail 345 kV / 138 kV Transformer 2
(2) Marana Tap – Saguaro East 115 kV line
(3) Northeast Loop – Rillito 138 kV line
(4) Tortolita 500kV / 138 kV Transformers 1, 2, & 3
(5) North Loop – Rillito 138 kV line
(6) North Loop – West Ina 138 kV line
(7) Tortolita – Rancho Vistoso 138 kV line
(8) North Loop – DMP 138 kV line

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(9) West Ina – Del Cerro 138 kV line
(10) Northeast Loop – DMP 138 kV line
(11) La Canada – Orange Grove 138 kV line
(12) La Canada – Rancho Vistoso 138 kV line
(13) Orange Grove – Rillito 138 kV line
(14) Copper Verde 345 kV / 230 kV Transformers 1 & 2
(15) CINIZA – WINGATE 115 kV line
(16) ENRON_TS – GALLUPPG 115 kV line
(17) PEGS – CINIZA 115 kV line
(18) WINGATE – ENRON _TS 115 kV line

There are no performance measures for Category D contingencies but they must be evaluated for risks and consequences. Overloads (1) through (13) will be mitigated with planned TEP projects or with TEP operating procedures to run additional local generation when 1 of the elements in the contingency is out of service. The Copper Verde Transformer overloads will be further evaluated as part of the study evaluated load expansion in the vicinity of the Greenlee Substation. Based on discussions with [redacted], overloads (15) through (18) will be mitigated with planned projects. TEP has demonstrated compliance with TPL-004-0 by evaluating Category D contingencies for risks and consequences.

5.2.2.3. Transient Stability Results and Mitigation

Transient stability analysis was conducted on the same 2016 ALIS and IOS base cases used in the power flow analysis. Table 5 summarizes the number of disturbances simulated for each category for the ALIS and IOS cases. A complete list of disturbances for the 2016 heavy summer cases can be found in Attachment 4. Transient stability plots of bus voltages, frequencies, and rotor angles are included as Attachments 63 - 98.

Category	ALIS	IOS
A	1	1
B	29	0
C	30	29
D	4	0

Table 5. 2016 Heavy Summer Disturbance Category Summary

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5.2.2.3.1. *Category A – All Lines in Service*

A flat line response was achieved for all monitored facilities with no disturbance and all facilities in service or with one element initially out of service. The TEP 2016 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-001-0.1 transient stability performance measures.

5.2.2.3.2. *Category B – Normal Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category B disturbances. The TEP 2015 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-002-0b transient stability performance measures.

5.2.2.3.3. *Category C – Normal Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery, while TEP's LAPS was responding, or are an isolated or fictitious bus. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category C disturbances. For this reason no further investigation was performed or required. The TEP 2015 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-003-0a transient stability performance measures for normal clearing events.

5.2.2.3.4. *Category C – Delayed Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery, while TEP's LAPS was responding, or are an isolated or fictitious bus. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category C disturbances. The TEP 2015 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-003-0a transient stability performance measures for delayed clearing events.

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5.2.2.3.5. *Category D – Normal Clearing Events*

WCA was performed to determine if the performance measures identified in Section 4.9.5 for voltages and frequencies were met for the Category D disturbances. No voltage or frequency criteria violations were identified. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery, while TEP's LAPS was responding, or are an isolated or fictitious bus. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category D disturbances. TEP has demonstrated compliance with TPL-004-0 by evaluating Category D disturbances for risks and consequences.

5.2.2.4. Voltage Stability Results and Mitigation

TEP includes a 5% load margin in all studies. All powerflow contingencies solved with the 5% load margin which demonstrates voltage stability criteria have been met. No further plans are needed to meet these criteria.

5.2.2.5. 2015 Heavy Summer Conclusions

Power flow (steady-state) and transient stability analysis was conducted for 2016 Heavy Summer conditions. There were no violations of NERC Planning Standards or WECC System Performance Criteria. Therefore, as planned, the TEP EHV and HV transmission system meets the performance requirements of TPL-001-0.1, TPL-002-0b, TPL-003-0a, and TPL-004-0 and no mitigation is needed. Additional local generation is available which provides additional margin to be able to meet the NERC Standards and WECC Criteria.

5.3. *Longer-Term Peak Analysis*

5.3.1. 2021 Heavy Summer

5.3.1.1. System Description

The WECC approved 21HS1A case was used as the base model for this projected time frame. This model was adjusted to model TEP's anticipated 2021 summer peak with a 5% margin. The nominal load modeled was 2632 MW and the actual load was 2763.6 MW. The following are the major TEP projects planned for the 2017 – 2021 timeframe:

- New Hartt load serving substation (2017)
- New Kino load serving substation (2017)
- New East Ina load serving substation (2017)
- New Corona load serving substation (2017)
- New Marana load serving substation (2017)
- New University of Arizona Tech Park load serving substation (2017)
- New Naranja – La Canada 138 kV line (2017)

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- Greenlee Series Capacitor Replacement on the Springerville to Greenlee 345 kV line (2017)
- New Medina load serving substation (2018)
- North Loop – Naranja uprate to 1784 A (2020)
- New Raytheon load serving substation (2020)
- New Spencer load serving substation (2020)
- New University of Arizona Med load serving substation (2020)
- New Naranaja load serving substation (2020)

5.3.1.2. Power Flow Results and Mitigation

Powerflow analysis was conducted on the 2021 heavy summer ALIS base case as well as 11 IOS base cases. Powerflow summary results for the 2021 heavy summer cases can be found in Appendix F.

5.3.1.2.1. *Category A – All Lines in Service*

With all facilities in service or with one element IOS, the TEP EHV and HV transmission system as planned for 2021 meets the steady state performance requirements of TPL-001-0.1 under heavy summer conditions. All facilities are within normal voltage and thermal limits.

5.3.1.2.2. *Category B – Single Contingencies*

All the single contingency power flow simulations solved and all bus voltages were within voltage limits. There are three overloaded elements and six buses with voltage deviation violations for Category B contingencies. The following transmission facilities are overloaded:

(1) Greenlee-SW 345 kV / 230 kV
(2) BUCKMAN – NORTON_2 115 kV line

The following buses have voltage violations:

(1) Bicknell 230 kV bus
(2) Pantano 230 kV bus
(3) Sahuarita 230 kV bus
(4) New Tucson 230 kV bus
(5) Pantano 115 kV bus
(6) Kartchner 115 kV bus

A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Susbtation is currently underway. This study will be used to determine mitigation plans for the overloaded Greenlee-SW transformer. TEP has informed PNM and EPE of the slight overload on the BUCKMAN – NORTON_2 line since it was caused by an outage of a line owned by an entity other than TEP. The voltage deviation violations are caused by the loss of the [redacted] line, which results in

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increased flows on the SWTC 230 kV system. Tripping Bowie generation reduces this flow resulting in voltage deviations that do not exceed criteria. Therefore, the TEP 2021 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the steady state performance requirements of TPL-002-0b.

5.3.1.2.3. *Category C – Multiple Contingencies*

Beginning with ALIS, two Category C contingencies failed to solved and all bus voltages were within voltage limits. Also, there are four overloaded transmission facilities and five buses with voltage deviation violations for Category C contingencies. The following are the contingencies that failed to solve:

[redacted]

Adding these two contingencies to TOLS to allow load shed allows them to solve without further mitigation. The following are the overloaded transmission facilities:

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) North Loop – Naranja 138 kV line
(3) BUCKMAN – NORTON_2 115 kV line

A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation is currently underway. This study will be used to determine mitigation plans for the overload of the Greenlee-SW transformer. The North Loop – Naranja line will be uprated prior to the 2021 year so this overload will be alleviated. TEP has informed PNM and EPE of the slight overload on the BUCKMAN – NORTON_2 line since it involves outage of a line owned by an entity other than TEP. The following are the buses with voltage deviation violations:

(1) Pantano 230 kV bus
(2) Sahuarita 230 kV bus
(3) New Tucson 230 kV bus
(4) Pantano 115 kV bus
(5) Kartchner 115 kV bus

The voltage deviation violations are caused by the loss of the Winchester – Vail line and another element, which results in increased flows on the SWTC 230 kV system. Tripping Bowie generation reduces this flow resulting in voltage deviations that do not exceed criteria. All Category C contingencies for the IOS cases solved and all bus voltages were within voltage limits. There are 10 overloaded tranmsision facilities and three

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buses with voltage deviation violations for the IOS cases. The following IOS cases had overloaded transmission facilities:

Cholla – Saguaro IOS

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) Vail 345 kV / 138 kV Transformer 2
(3) BUCKMAN – NORTON_2 115 kV line

Pinal Central – Tortolita IOS

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) Vail 345 kV / 138 kV Transformer 2

Pinal West – South IOS

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) Vail 345 kV / 138 kV Transformer 2
(3) North Loop – Naranja 138 kV line
(4) BUCKMAN – NORTON_2 115 kV line

Saguaro – Tortolita IOS

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) Vail 345 kV / 138 kV Transformer 2
(3) BUCKMAN – NORTON_2 115 kV line

South Transformer 2 IOS

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) Vail 345 kV / 138 kV Transformer 2
(3) BUCKMAN – NORTON_2 115 kV line

Springerville – Coronado IOS

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) Vail 345 kV / 138 kV Transformer 2
(3) BUCKMAN – NORTON_2 115 kV line

Springerville – Vail IOS

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) Vail 345 kV / 138 kV Transformer 2
(3) North Loop – Naranja 138 kV line
(4) BUCKMAN – NORTON_2 115 kV line

Vail Tranformer 1 IOS

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) Vail 345 kV / 138 kV Transformer 2
(3) BUCKMAN – NORTON_2 115 kV line

Winchester – Vail IOS

(1) Winchester – Apache 230 kV line
(2) Winchester 345 kV / 230 kV transformer

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(3) North Loop – Naranja 138 kV line

Winchester – Willow IOS

(1) Greenlee-SW 345 kV / 230 kV Transformers 1 & 2
(2) Copper Verde 345 kV / 230 kV Transformers 1 & 2
(3) Copper Verde – Frisco 230 kV line
(4) Morenci – Greenlee-SW 230 kV line
(5) North Loop – Naranja 138 kV line

A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation is currently underway. This study will be used to determine mitigation plans for the issues in this area. TEP has informed PNM and EPE of the slight overload on the BUCKMAN – NORTON_2 line since it involves outage of a line owned by an entity other than TEP. The North Loop – Naranja line will be uprated prior to 2021 which will alleviate this overload. The overloads on the Winchester – Apache line and Winchester 345/230 kV transformer in the Winchester – Vail IOS will be alleviated by tripping gerneration at the Bowie Power Station. Therefore, the TEP 2021 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the steady state performance requirements of TPL-003-0a.

5.3.1.2.4. *Category D – Multiple Contingencies*

Seven Category D contingencies failed to solved and all bus voltages were within voltage limits. Also, there are 25 overloaded transmission facilities and four buses with voltage deviation violations for Category D contingencies. The following contingencies failed to solve:

[redacted]

A separate study to evaluate system impacts due to load expansion in the vicinity of the Greenlee Substation is currently underway. This study will be used to determine mitigation plans for the issue in this area. The [redacted], [redacted], [redacted] and [redacted] all solve with loadshed. The proposed

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mitigation is adding these contingencies to TOLS. Contingency (6) or (7) will solve with Bowie generation tripped. In the event that one of these elements are IOS local generation will be increased and a Bowie trip will be available as mitigation.

The following are the list of overloaded facitlites for Category D contingincies:

(1) Winchester – Vail 345 kV line
(2) Springerville – Vail 345 kV line
(3) Vail 345 kV / 138 kV Transformer 2
(4) Irvington – Tech Park 138 kV line
(5) Vail – Tech Park 138 kV line
(6) Tortolita 500 kV /138 kV Transformers 1, 2, & 3
(7) North Loop – Naranja 138 kV line
(8) North Loop – Rillito 138 kV line
(9) Greenlee- SW 345 kV / 230 kV Transformers 1 & 2
(10) Copper Verde 345 kV / 230 kV Transformers 1 & 2
(11) Frisco – Copper Verde 230 kV line
(12) Morenci – Greenlee-SW 230 kV line
(13) Winchester – Apache 230 kV line
(14) Winchester 345 kV / 230kV Transformer 1
(15) BUCKMAN – NORTON_2 115 kV line
(16) ALLISONT – YAH-TA-HEY 115 kV line
(17) YAH-TA-HEY – GALLUPPG 115 kV line
(18) CINIZA – PEGS 115 kV line
(19) GALLUPPG – ENRONTS 115 kV line
(20) WINGATE – CINIZA 115 kV line
(21) ENRON_TS – MENDOZAT 115 kV line

There are no performance measures for Category D contingencies but they must be evaluated for risks and consequences. Overloads (1) through (8) will be mitigated with planned TEP projects or with TEP operating procedures to run additional local generation when 1 of the elements in the contingency is out of service. Overloads (9) through (12) are being evaluated as part of the load expansion study for the Greenlee area. Overloads (13) and (14) will be alleviated by tripping Bowie. PNM and EPE have been informed of the slight overload on line (15). [redacted] has informed TEP that upgrades are planned, including a [redacted] transformer, that will mitigate overloads (16) through (21).

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The following buses show voltage deviation violations:

(1) Kartchner 115 kV bus
(2) Pantano 115 kV bus
(3) Pantano 230 kV bus
(4) New Tucson 230 kV bus

The voltage deviation violations are caused by the loss of the [redacted] and another element, which results in increased flows on the SWTC 230 kV system. Tripping Bowie generation reduces this flow resulting in voltage deviations that do not exceed criteria.

TEP has demonstrated compliance with TPL-004-0 by evaluating Category D contingencies for risks and consequences

5.3.1.3. Transient Stability Results and Mitigation

Transient stability analysis was conducted on the same 2021 heavy summer ALIS and IOS base cases used in the power flow analysis. Table 6 summarizes the number of disturbances simulated for each category for the ALIS and IOS cases. A complete list of disturbances for the 2021 heavy summer cases can be found in Attachment 5. Transient stability plots of bus voltages, frequencies, and rotor angles are included as Attachments 99 – 134.

Category	ALIS	IOS
A	1	1
B	30	0
C	25	30
D	4	0

Table 6. 2021 Contingency Category Summary

5.3.1.3.1. *Category A – All Lines in Service*

A flat line response was achieved for all monitored facilities with no disturbance and all facilities in service or with one element initially out of service. The TEP 2021 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-001-0.1 transient stability performance measures.

5.3.1.3.2. *Category B – Normal Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Except as

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previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category B disturbances. The TEP 2021 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-002-0b transient stability performance measures.

5.3.1.3.3. *Category C – Normal Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. No voltage or frequency criteria violations were identified. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category C disturbances. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery and while TEP's LAPS was responding. After the LAPS responded, there were no violations of voltage dip and frequency dip criterion. The TEP 2021 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-003-0a transient stability performance measures for normal clearing events.

5.3.1.3.4. *Category C – Delayed Clearing Events*

WCA was performed to determine if the system performance measures identified in Section 4.9.5 for voltages and frequencies were met. Except as previously noted in Section 5, evaluation of the rotor angles found that all generating units remained synchronized for the Category C disturbances. Some WCA results show voltage and/or frequency violations, but further investigation confirms these occurred during system recovery and while TEP's LAPS was responding. After the LAPS responded, there were no violations of voltage dip and frequency dip criterion. The TEP 2021 planned EHV and HV transmission system under heavy summer conditions demonstrates compliance with the TPL-003-0a transient stability performance measures for delayed clearing events.

5.3.1.4. Voltage Stability Results and Mitigation

TEP includes a 5% load margin in all studies. All powerflow contingencies solved with the 5% load margin which demonstrates voltage stability criteria have been met. No further plans are needed to meet these criteria.

5.3.1.5. 2020 Heavy Summer Conclusions

Power flow (steady-state) and transient stability analysis was conducted for 2021 Heavy Summer conditions. There were no violations of NERC Planning Standards or WECC System Performance Criteria. Therefore, as planned, the TEP EHV and HV transmission system meets the performance requirements of TPL-001-0.1, TPL-002-0b, and TPL-003-0a and no mitigation is needed.

In addition, more local generation is available which provides additional margin to be able to meet the NERC Standards and WECC Criteria.

6. Review of 2010 Projects

The 2010 Annual Reliability Assessment included 36 projects previously identified to meet reliability criteria or to serve load and the study results showed no additional projects were required to meet reliability criteria. A summary of changes for these projects follows:

- 3 – Completed
- 1 – In Progress
- 1 – Accelerated
- 12 – No Change
- 12 – Deferred
- 7 – Eliminated

The project deferrals and eliminations are due to changes in the TEP load forecast due to the economic downturn, deferral of projects by other entities, or TEP's plans to run additional local generation. As economic conditions improve, these projects could be accelerated in future years.

The list of planned projects by in-service dates is included in Appendix B. This list identifies changes from the 2010 Annual Reliability Assessment.

7. Conclusions

This assessment demonstrates that TEP can meet the performance measures of the NERC Planning Standards and WECC System Performance Criteria with the planned projects at the forecasted load. No deficiencies in the planned system were identified in this assessment and no mitigation measures beyond the planned projects are required.

This assessment will be updated annually to reflect the latest load forecast and anticipated future transmission projects. TEP's reliability assessments and corrective plans will be provided annually to WECC as required by WECC. Projects identified in this assessment will be reviewed annually to determine continued need for the projects.

REDACTED

Appendix A – Station Names and Abbreviations

500 kV Stations

Saguaro – SA
Tortolita – TO

345 kV Stations

Coronado - CO
Greenlee – GL
McKinley – MC
Pinal West – PW
Saguaro – SA
San Juan – SJ
Springerville – SP
South – SO
Tortolita - TO
Vail – VL
Westwing – WW
Winchester – WN

230 kV Stations

Apache – AP
Butterfield – BFLD
Bicknell – BK
North Tucson – NTUC
Pantano – PAN
Saguaro – SA
Sahuarita – SAH

138 kV Stations

De Moss Petrie – DMP
Drexel – DL
East Loop – EL
Irvington – IR
La Canada – LC
Los Reales – LR
Midvale – MV
Northeast - NE
North Loop – NO
Pantano – PO
Rancho Vistoso – RV
Rillito – RI
Roberts Wilmot – RB
Santa Cruz – SC

REDACTED

South – SO
Tech Park – TP
Tucson – TU
Vail – VL
West Ina – WI

115 kV Stations

Adams Tap – ADM
Apache – AP
Saguaro West – SA_W

Transformers

Any transformer will be indicated by a capital T followed by a number.

REDACTED

Appendix B – Planned Projects[3]

2011

- Tortolita 500/138 kV transformer #3 (2nd quarter 2011) - completed
- North Loop – Tortolita 138 kV quad circuit (2nd quarter 2011) – deferred from 2010 - completed
- Irvington – 22nd 138 kV line reconductor (2nd quarter 2011) -- eliminated
- Canoa Ranch load-serving substation (3rd quarter 2011) – completed
- McKinley 345kV Reactor Add (4th quarter 2011) — in progress

2012

- Vail 345/138 kV Transformer #3 Addition (2nd quarter 2012) – accelerated from 2019

2013

- DMP – Tucson 138 kV line (1st quarter 2013) – deferred from 2010
- DMP – North East Loop 138 kV line uprate to 1700 Amp rating (2nd quarter 2013) – eleminated
- Harrison load-serving substation (2nd quarter 2013)
- Craycroft – Barril load-serving substation (2nd quarter 2013)
- Vail Series Capacitor Replacement on the Springerville to Vail 345 kV line (2nd quarter 2013)
- Rosemont load-serving substation and associated 138 kV line from the proposed San Rita South Switchyard (1st quarter 2013) – deferred by developer from 2012
- North Loop 138 kV Yard Expansion Ph2 (2nd quarter 2013) – deferred from 2012
- Duval Clear 138 kV Switchyard (4th quarter 2013)

2014

- North Loop 138kV Yard Expansion Ph 3 (2nd quarter 2014) – deferred from 2013
- Tortolita Substation expansion to include a 500 kV yard (2nd quarter 2014) – deferred from 2010
- Vail – Nogales 138 kV line to connect the UNSE transmission system to the TEP transmission system (2nd quarter 2014) – deferred from 2012
- Canoa Ranch – Duval Clear 138 kV line (4th quarter 2014) – deferred from 2013
- North East Loop – Rillito 138 kV line uprate to 2259/2535 Amp rating (2nd quarter 2014) – eliminated
- Orange Grove load-serving substation (2nd quarter 2014)

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[3] Projects are included in the model only if they are in-service prior to the year and season being evaluated. For on-peak cases, projects must be scheduled in the 1st or 2nd quarter to be included.

REDACTED

- Pinal Central – Tortolita 500 kV transmission line (2nd quarter 2014) – deferred from 2013

2015

- Vail Series Capacitor Replacement on the Greenlee to Vail 345 kV line (2nd quarter 2015)
- Reconfigure Tortolita – Rancho Vistoso 138 kV line to North Loop – Rancho Vistoso 138 kV line (2nd quarter 2015)

2016

- Irvington – Robert Bills-Wilmot 138 kV line reconductor (2nd Quarter 2016) – eliminated
- Anklam load-serving substation (2nd Quarter 2016)

2017

- Marana load serving substation (2nd Quarter 2017) – deferred from 2016
- Corona load-serving substation (2nd Quarter 201) – deferred from 2016
- Tech Park load-serving substation (2nd Quarter 2017) – deferred from 2016
- Irvington – Tech Park / Tech Park – Vail 138 kV line reconductor (2nd Quarter 2017) – eliminated
- Hart load-serving substation (2nd Quarter 2017)
- Kino load serving substation on a new Irvington – Tucson 138 kV line (2nd Quarter 2017) – deferred from 2015
- East Ina load serving substation and Orange Grove – East Ina 138 kV line (2nd Quarter 2017) – deferred from 2013
- Reconductor 138 kV between North Loop and Rillito substations (2nd Quarter 2017) – eliminated
- New Naranja – La Cananda 138 kV Line (2nd quarter 2017)

2018

- Medina load-serving substation (2nd Quarter 2018)
- DMP – North East Loop reconductor (2nd Quarter 2018) - eliminated

2020

- Spencer load-serving substation (2nd Quarter 2020) – deferred from 2016
- Naranja load-serving substation (2nd Quarter 2020) – deferred from 2016
- Raytheon load-serving substation (2nd Quarter 2020) – deferred from 2019
- UA Med load-serving substation (2nd Quarter 2020) – deferred from 2019

REDACTED

Appendix C – 2014 Power Flow Summary Results

2014 LIGHT AUTUMN ALIS OVERLOADS

Contingency Processor Version: contproc2011-1.p

Case Name: G:\DT4_a\NERC\2011 Case Study\14 LA\14la_tep.sav

Contingency List: G:\DT4_a\BUDGET_STUDIES\2011CB_Y412-16\ContLists\2011_mstr_cont-1a.pin

CATEGORY A																				
FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT									
NONE																				

CATEGORY B																				
FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT				
NONE																				

CATEGORY C																				
FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT	FROM	TO	CKT	
NONE																				

CATEGORY D																				
FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT	FROM	TO	CKT	
11017	ARROYO	345	11014	ARR__PS	345	1	1	101	466.4	462	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
12007	BELEN_PG	115	12008	BERNARDO	115	1	1	102.3	-401.2	392.1	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
12073	SOCORROP	115	12028	EL_BUTTE	115	1	1	102.4	308.5	301.23	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

REDACTED

2014 LIGHT AUTUMN NO SOLVES

Contingency Processor Version: contproc2011-1.p

Case Name: G:\DT4_a\NERC\2011 Case Study\14 LA\14la_tep.sav

Contingency List: G:\DT4_a\BUDGET_STUDIES\2011CB_Y412-16\ContLists\2011_mstr_cont-1a.pin

Outage	Solve	Average	DS	LS	TOLS	SVC	B/Q	MSC	PD	MSG	CAPT	Outage_From	Outage_To	ck_O	Outage_From	Outage_To	ck_O	Cat	Pmis	Qmis
556	0	0.5555	DS	0	-	309.5	Q	-	0	DS NO LAPS	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	DN	9999.99	9999.99
738	0	0.5555	DS	0	-	89.2	Q	-	0	DS NO LAPS	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	DN	9999.99	9999.99

REDACTED

Appendix D – 2013 Power Flow Summary Results

2013 HEAVY SUMMER ALIS OVERLOADS
Contingency Processor Version: contproc2011-1.p
Case Name: G:\DT4_a\NERC\2011 Case Study\13 HS\az13hs_tep_294.sav
Contingency List: G:\DT4_a\NERC\2011 Case Study\lists\2011_mstr_cont-1a-13.pin

CATEGORY A																			
FRO M	FROMNAME	kV	TO	TONAME	kV	CK T	FREQ	PCT_OL	OVERLOA D	RATING	UNIT								
NONE																			

CATEGORY B																			
FRO M	FROMNAME	kV	TO	TONAME	kV	CK T	FREQ	PCT_OL	OVERLOA D	RATING	UNIT	CASE	OUTAGE #	FROM	TO	C K T			
17010	GREEN-SW	345	17009	GREEN-SW	230	1	1	123.3	297	241	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]			
12017	CINIZA	115	12089	WINGATE	115	1	1	133	387.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]			
12097	ENRON_TS	115	12030	GALLUPPG	115	1	1	118.9	346.3	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]			
12056	PEGS	115	12017	CINIZA	115	1	1	140.6	409.5	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]			
12089	WINGATE	115	12097	ENRON_TS	115	1	1	125.5	-365.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]			

CATEGORY C																			
FRO M	FROMNAME	kV	TO	TONAME	kV	CK T	FREQ	PCT_OL	OVERLOA D	RATING	UNIT	CASE	OUTAGE #	FROM	TO	C K T	FROM	TO	CKT
17010	GREEN-SW	345	17009	GREEN-SW	230	1	2	161	388	241	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

CATEGORY D																			
FRO M	FROMNAME	kV	TO	TONAME	kV	CK T	FREQ	PCT_OL	OVERLOA D	RATING	UNIT	CASE	OUTAGE #	FROM	TO	C K T	FROM	TO	CKT
17010	GREEN-SW	345	17009	GREEN-SW	230	1	83	136.1	327.9	241	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16104	SPRINGERVILL E	345	16106	VAIL2	345	1	3	100.3	1524.6	1519.52	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16220	VAIL	138	16106	VAIL2	345	1	16	106	854.4	806	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12017	CINIZA	115	12089	WINGATE	115	1	86	133	387.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12097	ENRON_TS	115	12030	GALLUPPG	115	1	86	119	346.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12056	PEGS	115	12017	CINIZA	115	1	86	140.6	409.5	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12089	WINGATE	11	1209	ENRON_TS	115	1	86	125.5	-365.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

REDACTED

		5	7																
16216	SOUTH	138	16206	MIDVALE	138	1	5	107.7	-1400.8	1301.13	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLITA	138	16000	TORTOLITA	500	1	74	113.5	1067.3	940	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLITA	138	16001	TORTOLITA2	500	1	74	113.5	1067.3	940	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17089	SNDARIO	115	17022	THREEPNT	115	1	4	108.4	-429.3	396.11	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16999	NL. EXP	138	16210	RILLITO	138	1	7	103.8	1661.2	1599.85	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16205	LACANADA	138	16210	RILLITO	138	1	1	107.7	-1707	1585.62	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16209	RANVISTO	138	16205	LACANADA	138	1	2	139.3	1999	1435.01	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLITA	138	16209	RANVISTO	138	1	2	149.5	2351.7	1573.07	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17013	MARANATP	115	14356	SAG.EAST	115	1	2	100.7	-929.9	923.76	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

2013 HEAVY SUMMER ALIS NO SOLVES

Contingency Processor Version: contproc2011-1.p

Case Name: G:\DT4_a\NERC\2011 Case Study\13 HS\az13hs_tep_294.sav

Contingency List: G:\DT4_a\NERC\2011 Case Study\lists\2011_mstr_cont-1a-13.pin

Outage	Solve	Average	DS	LS	TOLS	SVC	B/Q	MSC	PD	MSG	CA PT	Outage_From	Outage_To	ck_O	Outage_From	Outage_To	ck_O	Cat	Pmis	Qmis
556	0	0.5555	DS	0	-	-69.1	Q	-	0	DS NO LAPS	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	D N	9999.99	9999.99
12246	0	0.5555	DS	0	-	369.4	Q	-	0	DS NO LAPS	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	-	D N	0	0.1

2013 HEAVY SUMMER IOS OVERLOADS

FROM	FROM NAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT	FROM	TO	CKT	IOS
17010	GREEN-SW	345	17009	GREEN-SW	230	1	1	159.5	384.4	241	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	ALL
12017	CINIZA	115	12089	WINGATE	115	1	1	133	387.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	ALL
12097	ENRON_TS	115	12030	GALLUPPG	115	1	1	118.9	346.3	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	ALL
12056	PEGS	115	12017	CINIZA	115	1	1	140.6	409.5	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	ALL
12089	WINGATE	115	12097	ENRON_TS	115	1	1	125.5	-365.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	ALL

REDACTED

Appendix E – 2016 Power Flow Summary Results

2016 HEAVY SUMMMER ALIS OVERLOADS
Contingency Processor Version: contproc2011-1.p
Case Name: G:\DT4_a\NERC\2011 Case Study\16HS\16hs_tep-294.sav
Contingency List: G:\DT4_a\NERC\2011 Case Study\lists\2011_mstr_cont-1a-16.pin

CATEGORY A																		
FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT							
NONE																		

CATEGORY B																		
FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT		
12017	CINIZA	115	12089	WINGATE	115	1	1	133	387.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]		
12097	ENRON_TS	115	12030	GALLUPPG	115	1	1	118.9	346.2	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]		
12056	PEGS	115	12017	CINIZA	115	1	1	140.6	409.5	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]		
12089	WINGATE	115	12097	ENRON_TS	115	1	1	125.5	-365.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]		

CATEGORY C																		
FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT	FROM	TO	CKT
17007	BUTTERFIELD	230	17002	APACHE	230	1	2	100	-1081.6	1081.9	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16999	NORTH LOOP EXP	138	16200	DMP	138	1	2	111.7	-1785.5	1598.17	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16999	NORTH LOOP EXP	138	16210	RILLITO	138	1	3	101.3	1619.9	1599.85	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

REDACTED

CATEGORY D																					
FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT	FROM	TO	CKT
16220	VAIL	138	16106	VAIL2	345	1	20	104.9	845.4	806	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12017	CINIZA	115	12089	WINGATE	115	1	102	133	387.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12097	ENRON_TS	115	12030	GALLUPPG	115	1	102	118.9	346.2	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12056	PEGS	115	12017	CINIZA	115	1	102	140.6	409.5	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12089	WINGATE	115	12097	ENRON_TS	115	1	102	125.5	-365.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16900	COPPERVR	345	16901	COPPERVR	230	1	1	103.2	231.1	224	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16900	COPPERVR	345	16901	COPPERVR	230	2	1	103.2	231.1	224	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17013	MARANATP	115	14356	SAG.EAST	115	1	5	105.3	-972.3	923.76	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16210	RILLITO	138	16208	NE.LOOP	138	1	10	117.2	-1812.8	1547.13	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLITA	138	16000	TORTOLIT	500	3	1	103.7	975.2	940	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLITA	138	16000	TORTOLIT	500	2	1	103.7	975.2	940	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLITA	138	16000	TORTOLIT	500	1	1	103.7	975.2	940	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16999	NORTH LOOP EXP	138	16210	RILLITO	138	1	102	120.2	1923.8	1599.85	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16999	NORTH LOOP EXP	138	16221	WESTINA	138	1	9	113.6	1815.9	1598.17	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLITA	138	16209	RANVISTO	138	1	7	163.1	2566.1	1573.07	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16999	NL. EXP	138	16200	DMP	138	1	9	115.5	-1846.3	1598.17	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16221	WESTINA	138	16229	DELCERRO	138	1	2	106.5	-1386.3	1301.13	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16200	DMP	138	16208	NE.LOOP	138	1	1	109.5	1740.1	1589.81	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16204	IRVNGTN	138	16218	TUCSON	138	1	3	100	1452	1451.74	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16205	LACANADA	138	16251	ORNGROVE	138	1	2	135.9	-1948.3	1434.17	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16251	ORNGROVE	138	16210	RILLITO	138	1	1	127.7	1831.5	1434.17	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16209	RANVISTO	138	16205	LACANADA	138	1	2	154.1	2211.3	1435.01	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

REDACTED

2016 HEAVY SUMMER ALIS NO SOLVE
Contingency Processor Version: contproc2011-1.p
Case Name: G:\DT4_a\NERC\2011 Case Study\16HS\16hs_tep-294.sav
Contingency List: G:\DT4_a\NERC\2011 Case Study\lists\2011_mstr_cont-1a-16.pin

Outage	Solve	Average	DS	LS	TOLS	SVC	B/Q	MSC	PD	MSG	CAPT	Outage_From	Outage_To	ck_O	Outage_From	Outage_To	ck_O	Cat	Pmis	Qmis
556	0	0.5555	DS	0	-	368	Q	-	0	DS NO LAPS	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	DN	9999.99	9999.99
12224	0	0.5555	DS	0	-	368	Q	-	0	DS NO LAPS	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	DN	0.01	0.06
12236	0	0.5555	DS	0	-	86.1	Q	-	0	DS NO LAPS	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	DN	9999.99	9999.99
12246	0	0.5555	DS	0	-	368	Q	-	0	DS NO LAPS	0	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	DN	0.01	0.09

2016 HEAVY SUMMER IOS OVERLOADS

FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT	FROM	TO	CKT	IOS CASE
12017	CINIZA	115	12089	WINGATE	115	1	1	133	387.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	ALL
12056	PEGS	115	12017	CINIZA	115	1	1	140.6	409.5	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	ALL
12089	WINGATE	115	12097	ENRON_TS	115	1	1	125.5	-365.4	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	ALL
12097	ENRON_TS	115	12030	GALLUPPG	115	1	1	118.9	346.2	291.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	ALL
16210	RILLITO	138	16208	NE.LOOP	138	1	2	100	-1547.2	1547.13	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	PWSO
16900	COPPERVR	345	16901	COPPERVR	230	1	1	106.1	237.6	224	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	GLWN
16900	COPPERVR	345	16901	COPPERVR	230	2	1	106.1	237.6	224	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	GLWN
16999	NORTH LOOP EXP	138	16210	RILLITO	138	1	1	105	1679.9	1599.85	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	GLWN
16999	NORTH LOOP EXP	138	16210	RILLITO	138	1	2	108.7	1739.8	1599.85	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	PWSO
16999	NORTH LOOP EXP	138	16210	RILLITO	138	1	2	112.5	1799.6	1599.85	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	SPGL
16999	NORTH LOOP EXP	138	16210	RILLITO	138	1	2	112.5	1799.6	1599.85	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	SPVL
16999	NORTH LOOP EXP	138	16210	RILLITO	138	1	2	109.3	1749.2	1599.85	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	WNVL

REDACTED

17010	GREEN-SW	345	17009	GREEN-SW	230	2	1	100.2	241.5	241	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	GLWN

Appendix F – 2021 Power Flow Summary Results

2021 HEAVY SUMMER ALIS OVERLOADS
Contingency Processor Version: contproc2011-1.p
Case Name: g:\dt4_a\nerc\2011 case study\21hs\wecc case\21hs_tep_294_r1.sav

Contingency List: g:\dt4_a\nerc\2011 case study\lists\2011_mstr_cont-1a.pin

CATEGORY A

FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT								

CATEGORY B

FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT			
13301	BUCKMAN	115	10231	NORTON_2	115	1	125	100.1	-578.2	577.35	Amps	Y	[redacted]	[redacted]	[redacted]	[redacted]			
17010	GREEN-SW	345	17009	GREEN-SW	230	1	1	101.3	195.6	193	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]			
17010	GREEN-SW	345	17009	GREEN-SW	230	2	1	101.6	196.1	193	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]			

CATEGORY C

FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT	FROM	TO	CKT
13301	BUCKMAN	115	10231	NORTON_2	115	1	130	100.3	-579.1	577.35	Amps	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17010	GREEN-SW	345	17009	GREEN-SW	230	1	1	112.3	216.8	193	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17010	GREEN-SW	345	17009	GREEN-SW	230	2	1	112.6	217.3	193	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16220	VAIL	138	16233	TECHPARK	138	1	2	100	-1749	1748.79	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16999	NL. EXP	138	16245	NARANJA	138	1	3	111.6	1756.3	1573.91	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

CATEGORY D

FROM	FROMNAME	kV	TO	TONAME	kV	CKT	FREQ	PCT_OL	OVERLOAD	RATING	UNIT	CASE	OUTAGE #	FROM	TO	CKT	FROM	TO	CKT
13301	BUCKMAN	115	10231	NORTON_2	115	1	6475	103.5	597.5	577.35	Amps	Y	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17010	GREEN-SW	345	17009	GREEN-SW	230	1	111	148.5	286.6	193	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17010	GREEN-SW	345	17009	GREEN-SW	230	2	111	148.9	287.4	193	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16109	WINCHSTR	345	16105	VAIL	345	1	13	103.7	1926	1857.56	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16104	SPRINGR	345	16106	VAIL2	345	1	8	101.3	1538.8	1519.52	Amp	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

REDACTED

											s								
16220	VAIL	138	16106	VAIL2	345	1	107	108.3	872.7	806	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16900	COPPERVR	345	16901	COPPERVR	230	1	2	125.3	280.8	224	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16900	COPPERVR	345	16901	COPPERVR	230	2	2	125.3	280.8	224	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16902	FRISCO	230	16901	COPPERVR	230	1	1	111.4	-1398.6	1255.11	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17014	MORENCI	230	17009	GREEN-SW	230	1	1	116.6	1411.1	1209.93	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17105	WINCHSTR	230	17002	APACHE	230	1	1	103.7	-1254.7	1209.93	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16109	WINCHSTR	345	17105	WINCHSTR	230	1	1	119.1	500.1	420	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16233	TECHPARK	138	16204	IRVNGTN	138	1	3	104.6	-1829.3	1748.79	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16220	VAIL	138	16233	TECHPARK	138	1	7	109.5	-1914.7	1748.79	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLIT	138	16000	TORTOLIT	500	3	1	101.1	950	940	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLIT	138	16000	TORTOLIT	500	2	1	101.1	950	940	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16217	TORTOLIT	138	16000	TORTOLIT	500	1	1	101.1	950	940	MVA	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16999	NL. EXP	138	16245	NARANJA	138	1	49	113.3	1783.9	1573.91	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
16999	NL. EXP	138	16210	RILLITO	138	1	4	101.9	1630.2	1599.85	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
10009	ALLISONT	115	10382	YAHTAHEY	115	1	1	109.5	-588.4	537.19	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
10382	YAHTAHEY	115	12030	GALLUPPG	115	1	1	144.4	-580.1	401.64	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12017	CINIZA	115	12056	PEGS	115	1	1	102	-409.5	401.64	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12030	GALLUPPG	115	12097	ENRON_TS	115	1	2	126.3	-507.3	401.64	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12089	WINGATE	115	12017	CINIZA	115	1	1	108.8	-437.1	401.64	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12097	ENRON_TS	115	10533	MENDOZAT	115	1	1	102.1	492.2	481.96	Amps	N	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

REDACTED

2021 HEAVY SUMMER VOLTAGE DEVIATION VIOLATIONS
Contingency Processor Version: contproc2011-1.p
Case Name: g:\dt4_a\nerc\2011 case study\21hs\wecc case\21hs_tep_294_r1.sav
Contingency List: g:\dt4_a\nerc\2011 case study\lists\2011_mstr_cont-1a.pin

CATEGORY A

Bus #	Bus Name	kV	Vpu	Vang	Base Vpu	Vdif	FREQ	OUTAGE	FROM	TO	CKT			
NONE														

CATEGORY B

Bus #	Bus Name	kV	Vpu	Vang	Base Vpu	Vdif	FREQ	OUTAGE	FROM	TO	CKT			
17004	BICKNELL	230	0.9674	-3.65	1.0215	5.29	1	[redacted]	[redacted]	[redacted]	[redacted]			
17015	PANTANO	115	0.9695	0.34	1.0379	6.59	1	[redacted]	[redacted]	[redacted]	[redacted]			
17016	PANTANO	230	0.9572	4.4	1.015	5.69	1	[redacted]	[redacted]	[redacted]	[redacted]			
17039	KARTCHNR	115	0.9116	-9.3	1.001	8.93	1	[redacted]	[redacted]	[redacted]	[redacted]			
17102	SAHUARIT	230	0.9618	-1.24	1.0191	5.63	1	[redacted]	[redacted]	[redacted]	[redacted]			
17676	NEWTUCSN	230	0.9573	2.44	1.016	5.78	1	[redacted]	[redacted]	[redacted]	[redacted]			

CATEGORY C

Bus #	Bus Name	kV	Vpu	Vang	Base Vpu	Vdif	FREQ	OUTAGE	FROM	TO	CKT	FROM	TO	CKT
17015	PANTANO	115	0.9027	-0.89	1.0379	13.03	2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17016	PANTANO	230	0.9036	3.78	1.015	10.98	2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17039	KARTCHNR	115	0.8182	-12.12	1.001	18.26	2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17102	SAHUARIT	230	0.9127	-4.83	1.0191	10.45	2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17676	NEWTUCSN	230	0.9038	0.81	1.016	11.04	2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

CATEGORY D

Bus #	Bus Name	kV	Vpu	Vang	Base Vpu	Vdif	FREQ	OUTAGE	FROM	TO	CKT	FROM	TO	CKT
17039	KARTCHNR	115	0.8162	-5.71	1.001	18.46	14	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17015	PANTANO	115	0.9013	5.56	1.0379	13.16	1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17016	PANTANO	230	0.9026	10.25	1.015	11.08	1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
17676	NEWTUCSN	230	0.9056	7.4	1.016	10.87	1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

REDACTED

Appendix G –Transient Stability Monitored Buses

All buses in Arizona, New Mexico, and Southern Nevada were recorded in the channel files created for the Transient Stability studies for. Frequency and voltage plots were created for all TEP EHV and 138 kV buses and selected neighboring substation.

Rotor angle plots were created for the all units at the following generating stations:

1) Springerville
2) Cholla
3) Coronado
4) San Juan
5) Apache
6) Sundt
7) DeMoss Petrie (DMP)
8) North Loop
9) Palo Verde
10) Bowie