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Tucson Electric Power Company

P.O. Box 711, Tucson, AZ 85702

August 7, 2008

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

Re: **Docket No. E-00000D-07-0376**

Docket Control:

Tucson Electric Power Company ("TEP") hereby submits its amended Reliability-Must-Run ("RMR") study. TEP submitted its original RMR study, per Staff request, to Commission Staff directly on January 31, 2008.

Arizona Corporation Commission
DOCKETED
AUG - 7 2008
DOCKETED BY

Sincerely,

Jessica Bryne

Jessica Bryne
Regulatory Services

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AZ CORP COMMISSION
DOCKET CONTROL

cc: Ernest Johnson, ACC
Prem Bahl, ACC
Ed Beck, TEP
Compliance, ACC (cover letter only)

TEP

A UniSource Energy Company

A STUDY OF SIMULTANEOUS IMPORT LIMIT, RELIABILITY MUST-RUN GENERATION, MAXIMUM LOAD SERVING CAPABILITY, COMMON CORRIDOR OUTAGES & EXTREME CONTINGENCIES

Prepared
for
Arizona Corporate Commission
Utilities Division
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Originally submitted Jan 31, 2008
Amended on August 6, 2008

Executive Summary

Background

Every two years, since 2002, the Arizona Corporate Commission (ACC) requires the Arizona utilities to study their electrical power systems at various system conditions in accordance with the WECC/NERC reliability criteria. The system conditions for the study consists of simultaneous import limit (SIL), maximum load serving capability (MLSC), reliability must-run generation (RMR), common corridor (CC) outages and/or extreme contingencies (EC) for specific years given by the ACC. The ACC would also like information on the environmental outputs, generators and generation sensitivity, transmission import limit, and alternative solutions.

Purpose

The purpose of this study is to assess the TEP's electrical power system under a variety of system conditions required by the ACC based on WECC/NERC reliability criteria (pre and post contingency criteria).

Scope

The ACC's required system conditions studied for this year are as follows:

- SIL for 2008, 2011, and 2016
- MLSC for 2008, 2011, and 2016.
- Peak/RMR for 2011 and 2016
- CC outages for 2008
- EC for 2008

There are two additional requirements the ACC would like TEP to evaluate:

- A comparison of 2008 SIL remote generation and projected transmission ownership/scheduling rights to Tucson during the 2008 – 2009 period.
- Cost estimates of running RMR generation, purchasing equivalent energy from market resources and necessary upgrades to eliminate RMR.

Conclusions

The following conclusions are result from this study:

- TEP is able to serve loads and meet WECC/NERC reliability criteria under the system conditions of MLSC and Peak/RMR as presented in Ttable 1 below.
- TEP can survive double contingencies involving parallel lines in the Springerville – Vail corridor under the 2008 system condition.
- TEP can survive loss of all EHV transformers at any of the EHV substations: Tortolita, South, and Vail under the 2008 system condition.

- The total remote generation needed for the 2008 SIL system condition is 122 MW higher than TEP's projected owned scheduling capability to Tucson during the 2008 – 2009 period but TEP can purchase transmission from the market to Pinal West.
- It is not cost justified to upgrade the transmission system to eliminate RMR generation in 2011 and 2016 because ~~the annual cost estimate of running RMR generation is equal to the cost of purchasing power from market resources.~~ the cost estimates of transmission upgrades significantly outweigh the annual incremental cost estimates of RMR generation.

Year	SIL (No Local Generation On-line) MW	MLSC (All Local Generation On-line Less Spinning Reserve) MW	Peak Load /RMR Generation MW	Annual Incremental RMR Generation Cost ~~/ Cost of Remote Resource Purchases~~	Cost Estimates of Upgrades to Eliminate RMR Generation
2008	1950	2425	2417 / N/A	N/A	N/A
2011	2250	2875	2629/320	$425,944	$88,569,600 – $126,056,000
2016	2650	3125	3010/315	$275,855	$380,045,000 – $553,358,000

Table 1. Results of SIL, MLSC, Peak/RMR & Cost Estimates of RMR Generation & Upgrades

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Introduction

Background

In order to assess the Arizona utilities' electrical power systems in accordance with WECC/NERC reliability criteria, the ACC requires the Arizona utilities to study their systems at SIL, MLSC, and Peak every two years. For the SIL, MLSC, and Peak evaluations, normal operating study procedures are followed; in addition, common corridor outages and extreme contingencies (all transformers at an EHV substation) are studied. RMR generation is determined for the Peak loads. The requirements also include information on the environmental outputs, generators and generation sensitivity, transmission import limit, and alternative solutions.

Purpose

The purpose of this report is to present the findings and analysis of the TEP system operated at the SIL, MLSC, and Peak loads, and to study the applicable contingencies in a clear and concise format. Additionally, included in this report are cost estimates of running local generation for RMR, purchasing RMR generation, and necessary upgrades to eliminate RMR generation. Other information regarding environmental outputs, generators and generation sensitivity, transmission import limit, and alternative solutions are also provided in this report.

Scope

TEP's system is evaluated against the SIL, MLSC, and/or Peak conditions for 2008, 2011 and 2016 based on WECC/NERC reliability criteria. Common corridor outages and extreme contingencies are also considered in this study for 2008. A comparison of running local generation for RMR and purchasing generation for RMR with the upgrades is also included in this report. Information regarding environmental outputs, generators and generation sensitivity, transmission import limit, and alternative solutions are also described in this report.

Overview

This report has four main sections starting with the executive summary, followed by the introduction of this study, then the conclusions found after evaluating TEP system against the requirements of the ACC, and finally the discussion of the results, analysis, data and other information related to this study.

Conclusions

The following conclusions ~~are~~ result from this study:

- TEP is able to serve loads and meet WECC/NERC reliability criteria under the system conditions of MLSC and Peak/RMR as presented in ~~t~~Table 2 below.
- TEP can survive double contingencies involving parallel lines in the Springerville – Vail corridor under the 2008 system condition.
- TEP can survive loss of all EHV transformers at any of the EHV substations: Tortolita, South, and Vail under the 2008 system condition.
- The total remote generation needed for the 2008 SIL system condition is 122 MW higher than TEP's projected owned scheduling capability to Tucson during the 2008 – 2009 period but TEP can purchase transmission from the market to Pinal West.
- It is not cost justified to upgrade the transmission system to eliminate RMR generation in 2011 and 2016 because ~~the annual cost estimate of running RMR generation is equal to the cost of purchasing power from market resources.~~ the cost estimates of transmission upgrades significantly outweigh the annual incremental cost estimates of RMR generation.

Year	SIL (No Local Generation On-line) MW	MLSC (All Local Generation On-line Less Spinning Reserve) MW	Peak/RMR Generation MW	Annual Incremental RMR Generation Cost / Cost of Remote Resource Purchases	Cost Estimates of Upgrades to Eliminate RMR Generation
2008	1950	2425	2417 / N/A[1]	N/A	N/A
2011	2250	2875	2629/320	$425,944	$88,569,600 – $126,056,000
2016	2650	3125	3010/315	$275,855	$380,045,000 – $553,358,000

Table 2. Results of SIL, MLSC, Peak/RMR & Cost Estimates of RMR Generation & Upgrades

Discussion

Base Case Descriptions

All the base cases prepared for this RMR study are originally from the approved SWAT base cases with the latest TEP EHV and HV updates. Peak loads represented in base cases are planner's best estimate.

Ten-Year Plan Load Forecast

The 2007 10-year plan load forecast is shown in Table 3 below.

Year	Load Forecast (MW)	Load Forecast + 5% Safety Margin (MW)
2007	2349	2466

[1] RMR analysis was only requested for 2011 and 2016

2008	2417[2]	2537
2009	2486	2610
2010	2556	2684
2011	2629	2760
2012	2702	2837
2013	2777	2916
2014	2853	2996
2015	2931	3077
2016	3010	3161

Table 3. 2007 Ten-Year Plan Load Forecast

Planned Facilities

TEP planned facilities are documented in the Ten-Year Plan. System improvements that support SIL and MLSC increases between 2008 and 2011, and between 2011 and 2016 are detailed in the Appendix A and B.

Import Transmission Elements by Year

TEP's import transmission elements are shown in Ttable 43 with the EHV Pinal West substation in service in June, 2008.

Year	From	KV	To	KV	CK	Emergency Rating
2008	Saguaro	500	Tortolita	500	1	806 MVA (xfmr)
	Saguaro	500	Tortolita	500	2	806 MVA (xfmr)
	Springerville	345	Vail	345	1	806 MVA (xfmr)
	Winchester	345	Vail	345	1	1110 MVA (1858 Amp - CT/relay)
	Westwing	345	Pinal West	345	1	806 MVA (xfmr)
	Pinal West	500	Pinal West	345	1	806 MVA (xfmr)
2011	Saguaro	500	Tortolita	500	1	806 MVA (xfmr)
	Saguaro	500	Tortolita	500	2	806 MVA (xfmr)
	Springerville	345	Vail	345	1	806 MVA (xfmr)
	Winchester	345	Vail	345	1	1110 MVA (1858 Amp - CT/relay)
	Westwing	345	Pinal West	345	1	806 MVA (xfmr)

[2] As of August 6, 2008 TEP's peak load for 2008 has reached only 2300 MW

	Pinal West	500	Pinal West	345	1	806 MVA (xfmr)
	Pinal-South	500	Tortolita	500	1	806 MVA (xfmr)
2016	Saguaro	500	Tortolita	500	1	806 MVA (xfmr)
	Saguaro	500	Tortolita	500	2	806 MVA (xfmr)
	Springerville	345	Vail	345	1	806 MVA (xfmr)
	Winchester	345	Vail	345	1	1110 MVA (1858 Amp - CT/relay)
	Westwing	345	Pinal West	345	1	806 MVA (xfmr)
	Pinal West	500	Pinal West	345	1	806 MVA (xfmr)
	Pinal-South	500	Tortolita	500	1	806 MVA (xfmr)
	~~Tortolita~~North Loop	345	North Loop	138	1	806 MVA (xfmr)

Table 4~~3~~. Import Transmission Elements by Year

Simultaneous Import Limit (SIL) for 2008, 2011, & 2016

The load serving capability of the SIL condition is determined without local generation on-line; as a result, it is less than the forecast peak loads for those years. VAR deficiency and voltage instability are the limits for the 2008 SIL condition; the critical outage of the SIL 2008 case is the Saguaro – Tortolita 500 kV line # 1 and # 2 (SA-TO 1 & 2). This double outage fails to solve at loads above 1950 MW.

Both 2011 and 2016 SIL cases have a thermal constraint. The limiting outage of 2011 is the Winchester – Vail (WN-VL) 345 kV line; at loads above 2250 MW, loss of this line overloads the Bicknell (BK) 345/230~~230/345~~ kV transformer in the Southwest Transco (SWTC) system.

Similarly, for 2016, Springerville – Vail (SP-VL) 345 kV line is the limiting outage since loss of this line causes an overload on the North Loop – De Moss Petrie (NL-DMP) 138 kV line. Table 5~~4~~ summarizes the critical SIL outage conditions at the load levels that have no constraint.

Year	Load MW	Losses MW	Total Remote Generation Needed MW	Critical Outage	Nature of Constraint
2008	1950	121	2071	SA-TO 1 & 2 500 kV lines	Voltage Stability
2011	2250	145	2395	WN-VL 345 kV line	Thermal (BK ~~230/345~~345/230 kV transformer overloaded)
2016	2650	186	2836	SP-VL 345 kV line	Thermal (NL-DMP 138 kV line overloaded)

Table 5~~4~~. TEP Critical Outages of the SIL Condition for 2008, 2011, & 2016

The addition of the static VAR compensator (SVC) at the Northeast~~Loop~~ 138 kV bus in 2008 eliminates the voltage constraint reported in the 2006 RMR study for the SIL condition caused by loss of the WN-VL 345 kV line.

As required by the ACC, the 2008 SIL remote generation is compared against projected transmission ownership/scheduling rights to Tucson during the 2008 – 2009 period. A new EHV substation, Pinal West, will be in service between WestWing and South substation in June, 2008, so the TTC on Pinal West - South increases to 661 MW from the previous 511 MW due to 150 MW of ownership in the Palo Verde to Pinal West 500 kV line.

TEP projected scheduling rights to Tucson for 2008 are displayed in Table 6~~5~~.

Schedules	Scheduling Capability to Tucson (MW)
Pinal West - South	538
Saguaro - Tortolita	185
Springerville - Vail	1226
Total	**1949**

Table 6~~5~~. TEP Projected Scheduling Rights to Tucson for 2008

Tables 54 and ~~5~~6 show that when local generation is not on-line, TEP is just short of serving the 2008 SIL load with owned scheduling rights. There is available scheduling capability into Pinal West that could be purchased by TEP to schedule additional capacity into Tucson.~~since the scheduling capability to Tucson is 1949 MW, slightly lower than the total remote generation needed, 2071 MW, for the 2008 SIL condition.~~

Reliability Must-Run Generation (RMR) for 2011 & 2016

The RMR generation is determined at the forecast peak loads of 2011 and 2016 with the local generation on-line as necessary.
The worst outage found in the 2011 RMR case is the corridor outage of the SP-VL and WN-VL 345 kV lines. This double outage causes a solution constraint when the RMR generation is 300 MW with the Sundt # 2, # 3, and # 4 on line. This issue is resolved when the Sundt # 1 is also on-line at 20 MW; however, the BK ~~230/345~~345/230 kV transformer is overloaded. This is not an issue because~~ there is an agreement between~~ TEP~~ and SWTC for tripping BK~~ is aware that BK will trip when BK overload reaches the trip setting point of 240 MVA or above. The result shows that the 2011 RMR case is successfully solved with a BK trip.

The 2016 RMR is thermally limited for loss of the SP-VL 345 kV line; it overloads the North Loop – West Ina (NL-WI) 138 kV line at 100.2 % when the RMR generation is 305 MW with the Sundt # 1, # 2, # 3, and # 4 on line. The RMR generation required to protect against overload on this line is 315 MW. Table 7~~6~~ presents the RMR condition results of 2011 and 2016.

Year	Peak Load	Losses MW	Total Generation	RMR MW	Critical Outage	Nature of Constraint

	MW		Needed MW			
2011	2629	155	2784	320	SP-VL & WN-VL 345 kV lines	Voltage Stability
2016	3010	193	3203	315	SP-VL 345 kV line	Thermal (NL-WI 138 kV line overloaded)

Table 76. TEP Critical Outages of the RMR Condition for 2011 & 2016

Generation Sensitivity Analysis for 2011 & 2016 RMR Conditions

Generation location and VAR outputs drive generation sensitivity. Both 2011 and 2016 RMR cases require the same Sundt Unit commitment labeled as 1234 in tTabless 86 and 79 with the total RMR generation of 320 MW for 2011 and 315 MW for 2016. Gas turbines are not required to be on-line for the RMR unit commitment except for other unit combinations to achieve the same total RMR generation. Sundt # 1 is not substituted for Sundt # 2 as a comparison in any combinations that include Sundt # 2 because they are equivalent in cost. In order to minimize operating cost, TEP operates Sundt steam units and gas turbines in the following order of preference:

- Steam units: Sundt # 4, # 3, # 2, #1
- Gas turbines: DMP, Irvington CT/Sundt CT, North Loop CT

Table 87 below shows that most of the Sundt Unit combinations have the same results; however, due to the location of generation and/or VAR outputs, the case 234d has a solution problem for loss of the SP-VL and WN-VL 345 kV lines. The case 234d also has a thermal overload on the Northeast Loop – Rillito (NE-RIL) 138 kV line when the BK 345/230230/345 kV transformer trips. Therefore a 234d combination is not considered as an acceptable generation scenario.

The results are displayed in Ttable 87.

Case Name	Sundt # 1 MW	Sundt # 2 MW	Sundt # 3 MW	Sundt # 4 MW	DMP MW	Irvington CT/Sundt CT MW	North Loop CT MW	Loss of SP – VL & WN – VL with BK Overloaded	BK Trip
1234	20	75	105	120				solved	solved
123di	74	75	105		44	22		solved	solved
124di	70	75		120	44	11		solved	solved
234d		73	105	120	22			not solved	solved, NE-RIL overloaded at 103.9 %
23din		66	105		44	44	61	solved	solved

12din	74	75			44	44	83	solved	solved
24din		73		120	44	44	39	solved	solved
34din			101	120	44	44	11	solved	solved

Table 87. Generation Sensitivity for 2011 RMR Condition

The issue of the 2016 RMR is the thermal overloads on the NL-WI and NL-DMP 138 kV lines, caused by the outage of the SP-VL 345 kV line. The percentage of loading of those lines is varied due to the location of generation and/or VAR outputs. The best unit combination is Sundt # 1, # 2, # 4, and DMP, corresponding to the case 124d; the worst unit combination is Sundt # 1, # 2, DMP, Sundt CT, and North Loop CT, corresponding to the case 12din. The detailed results of the 2016 RMR condition are shown in tTable 89.

Case Name	Sundt # 1 MW	Sundt # 2 MW	Sundt # 3 MW	Sundt # 4 MW	DMP MW	Irvington CT/Sundt CT MW	North Loop CT MW	Loading on NL-WI %	Loading on NL-DMP %
1234	15	75	105	120				99.9	99.2
123di	69	75	105		44	22		99.3	98.1
124d	75	75		121	44			99.3	98.0
234d		68	105	120	22			99.4	98.5
23din		72	105		44	44	50	102.5	101.9
12din	69	75			44	44	83	104.8	104.7
24din		68		120	44	44	39	101.8	101.0
34din			96	120	44	44	11	99.9	98.8

Table 98. Generation Sensitivity for 2016 RMR Condition

Upgrades Needed to Eliminate 2011 & 2016 RMR Generation

TEP could purchase power from market resources instead of running local generation for RMR; however, this scenario requires transmission upgrades so that TEP still could serve loads and meet WECC/NERC reliability criteria.
When local generation is not on-line for RMR, VARs normally available from local generators are not available and the system heavily relies on the power imports from the Springerville corridor, Westwing – Pinal West- South, and the Saguaro-Tortolita corridor, all EHV lines. The Springerville corridor has a larger power import than the others; as a result, the double outage of Winchester – Vail and Springerville – Vail 345 kV lines in the Springerville corridor, results in voltage collapse. Adding a second WN-VL 345 kV line parallel to the existing one resolves the voltage stability issue; however, thermal overloads then occur due to both single and double outages. Therefore, in order to eliminate the 2011 RMR generation and still meet WECC/NERC reliability criteria, the following upgrades are recommended:

- Adding a second Winchester – Vail 345 kV line parallel to the existing one.
- Up-rating the West Ina – North Loop 138 kV line to 330 from 311 MVA for its emergency rating.
- Up-rating the Rancho Vistoso - La Canada 138 kV line to 353 from 342.8 MVA for its emergency rating.
- Putting in a second 138/345 kV transformer parallel to the existing Vail T1 transformer.

The necessary upgrades above are determined based on the output results of the 2011 RMR system condition without local generation on-line. The cost for those upgrades is estimated to be between $88,569,600 and $126,056,000.

Also, in the 2016 RMR case, all double outages of the Springerville corridor fail to solve when local generation is not on-line for the RMR. Assuming that the second Winchester – Vail 345 kV line is already put in parallel to the existing one as an upgrade of the 2011 RMR case, a second Springerville – Greenlee - Winchester 345 kV line must also be added parallel to the existing ones in order to eliminate the RMR generation. The cost for this upgrade is estimated to be between $380,045,000 and $553,358,000. Table 109 displays the cost estimates of the transmission upgrades to eliminate the RMR generation of those years.

Year	Cost Estimates	
	Base	High
2011	$88,569,600	$126,056,000
2016	$380,045,000	$553,358,000

Table 109. Cost Estimates for Transmission Upgrades to Eliminate 2011 & 2016 RMR Generation

RMR Generation VS. Purchasing Power plus Transmission Upgrades

In order to compare the cost of running RMR generation for the existing/planned system and the cost of purchasing power from market resources plus the cost of transmission upgrades, the RMR hours, RMR energy and RMR annual costs have been determined by a~~a~~ TEP~~'s~~ cost analyst.~~; the results are shown in table 10.~~

The RMR hours are determined through an hourly comparison of the forecasted retail load to the SIL (MWs). Given an hourly load forecast, all hours above the SIL are identified to be RMR hours. An estimate was derived for the 2011 and 2016 forecast year that estimated the amount of RMR generation. The RMR cost estimates are calculated based on the differential between the forecasted on-peak power price (Palo Verde Price Index) and the dispatch price (NYMEX Natural Gas Index) of the Sundt and DMP units. The RMR calculations are demonstrated in Table 11.

Unit Heat Rate Characteristics				
(A)	HR-Sundt Steam Gas (MBTU/MWh)		12.486	
(B)	HR-DMP CT (MBTU/MWh)		11.195	
Dec 2007 – Natural Gas Pricing & Unit Dispatch Cost			**2011**	**2016**
(C)	Natural Gas Pricing ($/MBTU)		9.07	9.11
(D)	Sundt Gas Steam Dispatch Price ($/MWh)	(A) x (C)	113.18	113.79
(E)	DMP Gas Turbine Dispatch Price ($/MWh)	(B) x (C)	101.48	102.03
Dec 2007 – Whole Sale Market Pricing & Incremental RMR Cost Impact			**2011**	**2016**
(F)	Average Wholesale Pricing On-Peak ($/MWh)		73.83	74.24
(G)	Incremental RMR Dispatch Cost – Sundt Steam Gas ($/MWh)	(D) - (F)	39.35	39.55
(H)	Incremental RMR Dispatch Cost – DMP Gas Turbine ($/MWh)	(E) - (F)	27.65	27.79
RMR Unit Capacity & RMR Generation			**2011**	**2016**
(I)	Sundt Steam Gas (MW)		20	20
(J)	DMP Gas Turbine (MW)		40	40
(K)	Annual RMR Hours (Calculated from Histogram)		225	145
(L)	Sundt Steam Gas (MWh)	(I) x (K)	4,500	2,900
(M)	DMP Gas Turbine (MWh)	(J) x (K)	9,000	5,800
	Total RMR MWh	**(L) + (M)**	**13,500**	**8,700**
Incremental RMR Generation Costs			**2011**	**2016**
(N)	Sundt Steam Gas ($)	(G) x (L)	177,090	114,699
(O)	DMP Gas Turbine ($)	(H) x (M)	248,854	161,156
(P)	**Annual Total**	**(N) + (O)**	**425,944**	**275,855**

Table 11. RMR Calculations for 2011 & 2016

The methodology used above is an hourly estimate between the difference in spot market prices at Palo Verde and the RMR dispatch of TEP's gas fired generation. Since this methodology uses a Palo Verde spot market price, it does not factor in market demand charges for generation, transmission wheeling costs, and costs for transmission losses. These additional costs for remote generation would reduce the annual RMR cost estimate.

In 2008, TEP implemented a new production cost model, "Planning & Risk" developed by Global Energy Decisions (GED). This model has the capability to model hourly transmission constraints including hourly RMR requirements. TEP plans to utilize this model for subsequent RMR studies.

The RMR results are summarized in Table 12.

~~Incremental RMR Generation Costs~~	2011	2016
SIL	2250	2650
MLSC	2875	3125
Peak Load	2629	3010
RMR Hours	225	145
RMR MWh	13,500	8,700
Annual Incremental RMR Generation Costs ~~Total~~	$425,944	$275,855

Table 120. Annual Incremental RMR Generation Costs for ~~Running~~ 2011 & 2016 ~~RMR Generation~~

The annual incremental RMR generation cost ~~of running RMR generation~~ is less than $500,000 per year and it is ~~equal~~significant less than ~~to~~ the cost of ~~purchasing power from market resources, per a TEP's cost analyst~~transmission upgrades shown in Table 10 ~~. Furthermore, the cost of transmission upgrades is significantly high~~; therefore, it is not cost justified to upgrade the transmission system to eliminate the RMR generation.

Effectiveness & Comparative Analysis of Alternative Solutions

Upgrading the transmission system to eliminate the need for RMR generation would not be cost justified because the cost ~~of running RMR generation is equal to the cost of purchasing power from market resources.~~estimates of transmission upgrades ~~are~~ significantly outweigh the cost estimates of running RMR generation.

RMR Environmental Output Estimates for 2011 & 2016

All the environmental outputs are estimated based on the 2011 and 2016 RMR generation found in this study. Table 131 and 142 show these estimated RMR environmental outputs.

2011 RMR Environmental Output	Estimated SO2	Estimated NOx	Estimated PM	Estimated CO
Sundt Steam Gas (lbs)	34	11,403	299	6,763,450
DMP Gas Turbine (lbs)	61	3,034	964	12,117,121

Table 13~~1~~. 2011 RMR Environmental Outputs

2016 RMR Environmental Output	Estimated SO2	Estimated NOx	Estimated PM	Estimated CO
Sundt Steam Gas (lbs)	22	7,349	193	4,358,668

Table 14~~2~~. 2016 RMR Environmental Outputs

Maximum Load Serving Capability (MLSC) for 2008, 2011, & 2016

The MLSC is determined with all local generation on-line less spinning reserve. The MLSC for 2008, 2011, and 2016 are thermally limited by single contingencies (n-1).

It is found that the outage of the Pinal West – South (PW-SO) 345 kV line which overloads SWTC's Avra – Marana (AV-MA) 115 kV line is the critical outage of the 2008 MLSC condition.

Both 2011 and 2016 MLSC conditions have the same limiting outage of the Springerville – Vail 345 kV line, which overloads the North Loop – West Ina (NL-WI) 138 kV line. It is also found that at the load of 2875 MW the double outage of the SP-VL and WN-VL 345 kV lines overloads the SWTC's BK 345/230~~230/345~~ kV transformer at 104.4 % for the 2011 MLSC condition. That overload is below the trip setting point of 240 MVA and therefore the BK does not trip~~; however, it is acceptable, per an agreement between TEP and SWTC~~. Table 1~~3~~5 shows the critical MLSC outage conditions at the load levels that have no thermal constraint.

Year	MLSC MW	Losses MW	Total Generation Needed MW	Critical Outage	Nature of Constraint
2008	2425	127	2552	PW-SO 345 kV line	Thermal (AV-MA 115 kV overloaded)
2011	2875	161	3036	SP-VL 345 kV line	Thermal (NL-WI 138 kV line overloaded)
2016	3125	189	3314	SP-VL 345 kV line	Thermal (NL-WI 138 kV line overloaded)

Table 1~~3~~5. TEP Critical Outages of the MLSC Condition for 2008, 2011, & 2016

Common Corridor Outages for 2008

The common corridor outages studied for 2008 are as follows:

- Springerville – Greenlee and Springerville – Vail 345 kV lines.
- Greenlee – Winchester and Springerville – Vail 345 kV lines.
- Winchester – Vail and Springerville – Vail 345 kV lines.

TEP's normal operating procedures include the ability to survive these corridor outages via the Tie Open Load Shed scheme. Study results show that TEP can survive these contingencies under the 2008 system condition.

Extreme Contingencies for 2008

The extreme contingencies studied for 2008 are loss of all EHV transformers at a substation; the substations that TEP has EHV transformers are Tortolita, South, and Vail. Surviving the loss of all transformers at a substation is included in TEP's normal operation planning, and study results show that TEP can survive these contingencies under the 2008 system condition.

TEP Local Generating Units Data

Table 146 shows the data of TEP local generators.

Base Loadable	**Min Dispatch**	**Max Dispatch**	**Qmin**	**Qmax**
Sundt Unit #1	10 MW	75 MW	-15 MVar	80 Mvar
Sundt Unit #2	10 MW	75 MW	-15 Mvar	80 Mvar
Sundt Unit #3	15 MW	105 MW	-15 Mvar	65 Mvar
Sundt Unit #4	20 MW	125 MW	-30 Mvar	120 Mvar
DMP GT #1*	40 MW	73 MW	-10 Mvar	47 Mvar
Peaking	**Min Dispatch**	**Max Dispatch**	**Qmin**	**Qmax**
Sundt/Irvington GT #1	22 MW	22 MW	-10 MVar	15 MVar
Sundt/Irvington GT #2	22 MW	22 MW	-10 MVar	15 MVar
N. Loop GT #1**	17 MW	17 MW	-5 MVar	5 MVar
N. Loop GT #2	22 MW	22 MW	-10 MVar	15 MVar
N. Loop GT #3	22 MW	22 MW	-10 MVar	15 MVar
N. Loop GT #4	22 MW	22 MW	-10 MVar	15 MVar

Table 146. TEP Local Generating Units Data

* The DMP GT is included as a dispatchable unit as opposed to a peaking unit because the MVar capacity combined with location can have a significant benefit for voltage stability.

** N. Loop GT #1 is a jet engine with little MVar capacity.

Sundt Unit MW minimums and maximums have been adjusted to reflect operation on McKinley Coal.

TEP Generating Unit Maintenance Schedule

A maintenance schedule of the remote and local generators from 2008 through 2013 is shown in Ttable 157.

TEP Plants	2008	2009	2010	2011	2012	2013
Four Corners						
# 4	10/7-10/16		1/12-4/9			
# 5	2/19-6/3	10/20-10/29		5/3-5/20		
Navajo						
# 1	2/2-3/2			2/5-4/3		
# 2			1/30-3/28			2/2-3/3
# 3		1/24-3/22 4/10-4/12			2/4-3/4	
San Juan						
# 1	9/13-11/2		10/2-10/24		10/6-10/28	
# 2		1/31-3/22		3/5-3/27		
# 3	1/25-3/23					
# 4						
Springerville						
# 1	4/13-4/19	3/16-4/17		7day tune-up	25 day-spring	
# 2	11/7-11/13		3/13-4/03		7 day tune-up	25 day-spring
# 3	5/13-5/31 (T)	25 day-fall			25 day-fall	
H.W.Sundt						
# 1	1/12-3/2		2/13-2/28			2/9-2/24
# 2		2/7-2/22		2/12-3/27		3/9-3/24
# 3	3/1-3/30		3/6-3/21		4/14-4/29	
# 4		1/10-2/1			3/3-4/15	
Palo Verde						
# 1	10/4-11/12					
# 2	3/29-5/7	10/3-11/7				
# 3		4/4-5/15				
H.W. Sundt ICT's						
# 1	2/24-3/1	10/4-10/10	10/3-10/9			
# 2	3/2-3/8	10/11-10/17	10/10-10/16			
North Loop ICT's						
# 1	1/20-1/26	10/18-10/24	10/17-10/23			
# 2	1/27-2/2	10/25-10/31	10/24-10/30			
# 3	2/3-2/9	11/1-11/7	10/31-11/6			
# 4	2/10-2/16	11/8-11/14	11/7-11/13			
DMP GT	9/28-11/1	2/8-2/14	2/7-2/13			
LEF Unit 1CC		Apr-18 day HGF		major inspection		
LEF Unit 2CC		Nov-18 day HGF		major inspection		

Table 157. TEP Generating Unit Maintenance Schedule Updated on Jan 14, 2008

APPENDIX A: System Improvement between 2008 and 2011

- Pinal South – Tortolita 500 kV line
- South – Gateway 345 kV #1 & #2 lines
- Catalina – Rancho Vistoso 138 kV line
- Canoa Ranch – Green Valley 138 kV line
- Craycroft – Snyder 138 kV line
- Craycroft – NE. Loop 138 kV line
- Cienega – Vail 138 kV #1 & #2 lines
- Cienega – Spanish Trail 138 kV line
- Naranja – Rancho Vistoso 138 kV line
- Naranja – North Loop 138 kV line
- Coronado – Coronado 500/345 #2 xfmr
- Springerville generator #4
- Tortolita – Tortolita 500/138 kV # 3 xfmr
- Springerville – Coronado 345 kV line's ratings are increased to 1195 MVA and 1434 MVA from 755 MVA and 906 MVA, respectively.

APPENDIX B: System Improvement between 2011 and 2016

- Tortolita – North Loop 345 kV line
- Tortolita – Tortolita 500/345 kV xfmr
- North Loop – North Loop 345/138 kV xfmr
- Vail – Vail_Nog 345/138 kV xfmr
- SS NO1 – N. Loop 138 kV line
- SS NO1 – Marana 138 kV line
- SS NO4 – N. Loop 138 kV line
- SS NO4 – Rillito 138 kV line
- Orange Grove – Rillito 138 kV line
- Orange Grove – La Canada 138 kV line
- Orange Grove – SS NO6 138 kV line
- SS NO14 – NE. Loop 138 kV line
- SS NO14 – DMP 138 kV line
- SS NO 17 – Irvington 138 kV line
- SS NO 17 – Vail 138 kV line
- SS NO 20 – Spanish Trail 138 kV line
- SS NO 20 – Cienega 138 kV line
- SS NO 22 – Mid Vale 138 kV line
- SS NO 22 – South 138 kV line
- Swan SO – SS NO 26 138 kV line
- Swan SO – Corona 138 kV line
- SS NO 26 – South 138 kV line
- SS NO 27 – Cienega 138 kV line
- SS NO 27 – Vail 138 kV line
- Downtown – Tucson 138 kV line
- SS NO 29 – Hart 138 kV line
- Springerville – Vail 345 kV line's ratings are increased to 1195 MVA and 1434 MVA from 717 MVA and 860 MVA (section 1, 3 & 5), from 733 MVA and 992 MVA (section 2), and from 666 MVA and 908 MVA (section 4)

- Pinal West – CS1 345 kV line
- DMP – Tucson 138 kV line's rating is increased to 540.9 MVA and 606.2 MVA from 352.3 MVA and 478 MVA.
- E. Loop – Houghton 138 kV line.
- Irvington – Tech Park 138 kV line
- Irvington – Kino 138 kV line
- Irvington – SS NO 17 138 kV line
- Mid Vale – Spencer 138 kV line
- N. Loop – Marana 138 kV line
- Rancho Vistoso – Catalina 138 kV line's rating is increased to 540.9 and 606.2 MVA from 352.3 & 478 MVA, respectively.
- Robert – Houghton 138 kV line is increased to 419 MVA from 311 MVA.
- Snyder – E. Loop 138 kV line's rating is increased to 286.8 MVA to 342.8 MVA.
- South – Hart 138 kV line
- Tortolita – N. Loop #1 & #2 138 kV line's ratings are increased to 540.9 MVA and 606.2 MVA from 312.2 MVA.
- Tortolita – Marana 138 kV line
- Tucson – Kino 138 kV line.
- Twenty Second – E. Loop 138 kV line's rating is increased to 350 MVA from 225 MVA.
- Vail – Spanish Trail 138 kV line's rating is increased to 419 MVA from 382.4 MVA.
- Canoa Ranch – Cyprus 138 kV line.
- Tech Park – Vail 138 kV line
- Irvington – Corona 138 kV line
- Hart – Green Valley 138 kV line
- Vail – Vail_Nog 138 kV line
- South – CS1 345 kV line
- Vail2 – Vail 345/138 kV xfmr
- Tortolita – Tortolita 500/138 kV xfmr