

EL PASO ELECTRIC COMPANY (EPE)
GENERATOR INTERCONNECTION SYSTEM IMPACT STUDY
FOR PROPOSED XXXXXXXXXXXXXXXXXXXX GENERATION
ON THE AMRAD-ARTESIA 345 KV LINE

El Paso Electric Company
System Planning Department
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TABLE OF CONTENTS

1.0	Executive Summary	Page	1
2.0	Introduction.....	Page	9
	2.1 Performance Criteria	Page	10
	2.1.1 Voltage Violation Criteria	Page	11
	2.1.2 Loading Violation Criteria	Page	11
3.0	Methodology	Page	12
	3.1 Assumptions	Page	12
	3.2. Procedure.....	Page	12
	3.2.1 Base Case Development and Description of Cases.....	Page	12
	3.2.2 List of Contingencies	Page	13
	3.2.3 Transient Stability Analysis	Page	13
4.0	Powerflow Analysis Results	Page	14
	4.1 2010 Study Year	Page	14
	4.1.1 2010 Benchmark Case.....	Page	14
	4.1.2 2010 Generation Interconnection Case.....	Page	15
	4.2 2011 Study Year.....	Page	15
	4.2.1 2011 Benchmark Case.....	Page	15
	4.2.2 2011 Generation Interconnection Case.....	Page	15
	4.3 2013 Study Year.....	Page	16
	4.3.1 2013 Benchmark Case.....	Page	16
	4.3.2 2013 Generation Interconnection Case.....	Page	16
	4.3.3 2013 Light Load Sensitivity Case.....	Page	17
5.0	Transient Stability Analysis Results.....	Page	18
	5.1 2013 Base Case	Page	18
	5.1.1 Springerville-Luna 345 kV Line Fault Simulation	Page	19
	5.1.2 West Mesa-Arroyo 345 kV Line Fault Simulation	Page	20
	5.1.3 Greenlee-Hidalgo 345 kV Line Fault Simulation	Page	20
	5.1.4 Luna-Diablo 345 kV Line Fault Simulation	Page	20
	5.1.5 Afton-Newman 345 kV Line Fault Simulation	Page	20
	5.1.6 Caliente-Newman 345 kV Line Fault Simulation	Page	20
	5.1.7 Amrad-Artesia 345 kV Line Fault Simulation	Page	20
	5.1.8 Amrad 115 kV Bus Fault Simulation	Page	20
	5.2 2013 Generation Interconnection Case.....	Page	21
	5.2.1 Springerville-Luna 345 kV Line Fault Simulation	Page	21
	5.2.2 West Mesa-Arroyo 345 kV Line Fault Simulation	Page	21
	5.2.3 Greenlee-Hidalgo 345 kV Line Fault Simulation	Page	21
	5.2.4 Luna-Diablo 345 kV Line Fault Simulation	Page	21
	5.2.5 Afton-Newman 345 kV Line Fault Simulation	Page	21
	5.2.6 Caliente-Newman 345 kV Line Fault Simulation	Page	22
	5.2.7 XXX-Amrad 345 kV Line Fault Simulation	Page	22
	5.2.8 XXX-Artesia 345 kV Line Fault Simulation	Page	22
	5.2.9 Simulation of Loss of All XXX Generation	Page	22
	5.2.10 XXX-Picante 345 kV Line Fault Simulation	Page	22
	5.2.11 Amrad 115 kV Bus Fault Simulation	Page	23

TABLE OF CONTENTS

6.0	Cost Estimates	Page	24
6.1	XXX Generator Interconnection Cost Estimates	Page	24
6.2	2010 System Upgrade Cost Estimates	Page	25
6.3	2011 System Upgrade Cost Estimates	Page	25
6.4	2013 System Upgrade Cost Estimates	Page	26
7.0	Disclaimer	Page	27
8.0	Certification	Page	28

APPENDICIES

Generation Interconnection System Impact Study: Study Scope	Appendix 1
EPE's FERC Form 715 Filing	Appendix 2
NERC/WECC Planning Standards	Appendix 3
Powerflow Maps – One-Line Diagrams	Appendix 4
Transient Stability Plots	Appendix 5
Base Case & Contingency Results Detailed Tables	Appendix 6
Detailed Report of Required System Upgrade Cost Estimates	Appendix 7

1.0 EXECUTIVE SUMMARY

In 2007, El Paso Electric Company (EPE) completed a re-study of a *Generation Interconnection Feasibility Study (GIFS)* for XXXXXXXXXXXXX (XXX) which determined impacts to the EPE and surrounding area transmission systems due to the interconnection of XXX's 500 MW wind generation project. This re-study was performed in a Phase-In approach. After reviewing the results of the GIFS, XXX decided to proceed with the next step of the Large Generator Interconnection Procedures (LGIP), the System Impact Study (SIS). As in the GIFS, this SIS was performed as a joint study with review and approval from Public Service Company of New Mexico (PNM).

The purpose of this SIS is to verify the results of the GIFS and determine if any additional impacts are found due to the interconnection of the XXX wind generation. This SIS will also provide XXX with an estimate of the time it will take to construct the required facility upgrades.

The proposed XXX generation was modeled as a 500 MW Wind Project interconnected into EPE's control area approximately fifty-three (53) miles east of the Amrad Substation on the Amrad-Artesia 345 kV line. This Study again analyzed the interconnection in a Phase-In approach as follows:

- 200 MW in 2010
- 350 MW in 2011
- 500 MW in 2013

Each case was studied using the criteria and methodologies described in a Section 2.1 of this report. The study periods analyzed were the 2010, 2011, and 2013 peak summer seasons. Additionally, a light winter scenario was developed for the 2013 study year to determine the impacts to the surrounding transmission systems due to the loss of the XXX generation during light load conditions. This study did not analyze the availability of transmission service required for the delivery of the proposed XXX generation. Analyses performed in this SIS include powerflow and transient stability analyses.

In addition, EPE hired General Electric Energy Consulting (GE) to perform additional studies relating to the interaction the XXX wind turbines will have with the Static Var Compensator (SVC) at EPE's Amrad Substation and with the High Voltage Direct Current (HVDC) converter station at Artesia Substation. Studies relating to the XXX wind turbine interaction with the SVC and HVDC include the following:

- Control interactions and Stability
- Subsynchronous torsional interaction
- Temporary overvoltages
- Breaker transient recovery voltages

The Final Report of this Study will be submitted to XXX under separate cover.

Cases developed and used for the powerflow and transient stability analyses are described below:

Benchmark Cases

Three cases with all existing third party generation and without the XXX generation were developed. The three benchmark cases modeled the 2010, 2011 and 2013 Heavy Summer (HS) study periods. Third party generation modeled in these cases included the following:

1. 570 MW of existing generation (Luna Energy Facility) interconnected at Luna 345 kV Substation and scheduled to WECC.
2. 141 MW of existing generation (Afton) interconnected at Afton 345 kV Substation and scheduled through EPE's Arroyo PST.
3. 160 MW of existing generation interconnected at Tri-State Generation and Transmission Association, Inc.'s (TSGT) Hidalgo 115 kV Substation and scheduled to WECC.
4. 80 MW of existing generation interconnected at PNM's Lordsburg 115 kV Substation and scheduled to WECC.
5. 94 MW of generation (presently being constructed) interconnected at Afton 345 kV Substation and scheduled to WECC.

Results of the analyses in the Benchmark Cases show that some criteria violations occur without the XXX generation interconnected into the existing EPE control area. Power flow analyses revealed some low voltage and thermal overload violations without the proposed XXX generation. System upgrades required to eliminate violations in the Benchmark Case are the responsibility of the utility who owns the element requiring the upgrade and were not assigned to the XXX project. Please refer to *Section 4.1.1* of this report for an explanation of what will be done to mitigate these criteria violations.

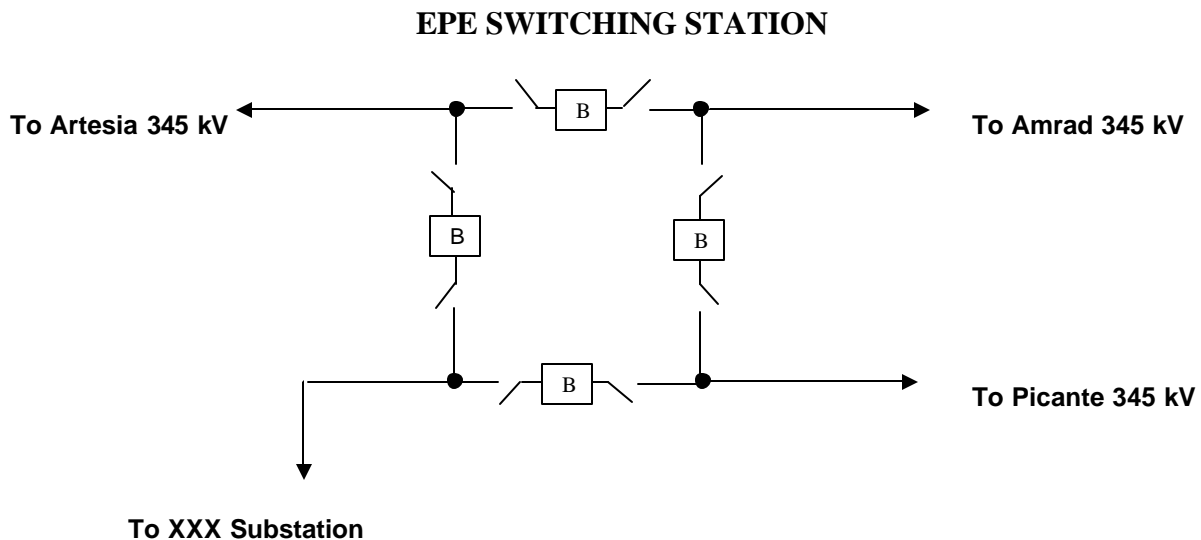
2010 Generation Interconnection Case

The 2010 Generation Interconnection Case modeled the 2010 Benchmark Case with the XXX generation output at 200 MW and interconnected into the EPE control area. As determined in the GIFS, a new line from the XXX 345 kV Substation to one of EPE's 345 kV substations was also modeled in this case. The GIFS recommended a new 345 kV line from XXX to Caliente substation, but after discussions with EPE's Transmission, Substation, and Relaying (TSR) Department, it was determined that there are no bays available at the Caliente 345 bus to bring in another 345 kV line. Therefore, the SIS performed the powerflow analysis modeling a new line from XXX to EPE's future Picante 345 kV Substation, which is scheduled to be in-service before the summer peak of 2010.

Results of the analyses in this scenario indicate that no criteria violations occur on the transmission system with the XXX generation interconnected and producing an output of 200 MW and with the new XXX-Picante 345 kV line.

In addition to the cost for a new XXX-Picante 345 kV line, costs associated with the physical and electrical interconnection of the XXX generation to the Amrad-Artesia 345 kV line will be charged to XXX. A switching station will be required to interconnect the XXX Substation to the EPE control area. The XXX Generation Interconnection cost breakdown is shown in *Section 6.1* of this report. Please note that this estimate includes costs for engineering, procurement and construction of the 345kV switching station based on 2007 dollars. It does not include costs for

land acquisition, access road to the substation, ROW, sales tax or bond costs. The estimate is for the switching station only and does not include the cost of the new XXX Substation. A one-line diagram showing the proposed configuration of the interconnection is shown below.



The interconnection of 200 MW of XXX generation in 2010 will require the following system upgrades:

- New XXX-Picante 345 kV line
- 2-54 MVAR line reactors (1 on each end of the XXX-Picante 345 kV line)
- XXX Interconnection Costs

Cost estimates for the 2010 Generation Interconnection scenario are listed in the “**SYSTEM UPGRADE COSTS FOR 200 MW OF XXX GENERATION IN 2010**” table at the end of this section and in **Section 6.2** of this report. In recent years, equipment and material costs have fluctuated on a monthly basis. As a result, the costs given in this report are good faith estimates for present market conditions. EPE hired Burns and McDonnell to provide these estimates along with the construction time estimate. Costs may change in the future depending on market forces.

2011 Generation Interconnection Case

The 2011 Generation Interconnection Case modeled the 2011 Benchmark Case with the XXX generation output at 350 MW and interconnected into the EPE control area. Results of the analysis in this scenario indicate that one additional criteria violation occurs on a neighboring transmission system in the 2011 case. Tri-State Generation and Transmission Association’s (TSGT) Elephant Butte-Picacho 115 kV line loads to 101.1% of its emergency rating during an outage of the Luna 345/115 kV autotransformer.

PNM has stated that they will have a load shedding scheme in place for the Luna 345/115 kV transformer in 2008. If there is an outage of the Luna 345/115 kV transformer, then the PD Ivanhoe load is tripped.

Further analysis showed that when this load shedding scheme is implemented during a contingency of the Luna 345/115 kV autotransformer, the overload of the Elephant Butte-Picacho 115 kV line is eliminated. Therefore, no additional system upgrades are needed for the 2011 Generation Interconnection scenario.

2013 Generation Interconnection Case

The 2013 Generation Interconnection Case modeled the 2013 Benchmark Case with the XXX generation interconnected into the EPE control area and an output of 500 MW. In this scenario, a third 224 MVA (emergency rating) 345/115 kV autotransformer at Arroyo Substation will be required due to overloading above its emergency rating during a single contingency of either of the other two Arroyo autotransformers. When the XXX generation is interconnected, the percent loading of one of the Arroyo autotransformers is 105.8% of its emergency rating during an outage of the other Arroyo autotransformer. The percent loading of the Arroyo autotransformer is 91.1% of its emergency rating during the same outage when the XXX generation is not interconnected. Therefore, this system impact is due to the addition of the 500 MW of XXX generation. Presently, only one 224 MVA 345/115 kV autotransformer exists at Arroyo Substation. The second Arroyo autotransformer is scheduled to be in service before the 2008 summer peak season.

Additionally, a third autotransformer at Caliente Substation will be needed due to an overload of one of the Caliente autotransformers during an outage of the second Caliente autotransformer. During this outage, the other Caliente autotransformer loads to 111.3% of its emergency rating. Without the XXX generation, the Caliente autotransformer only loads to 92.8% of its emergency rating. Therefore, this system impact is again due to the addition of the XXX 500 MW generation.

The 2013 light winter case analysis revealed excessive voltage deviations when the XXX generation is lost due to an outage. The previous XXX Feasibility Study results indicated that when the XXX generation output is at 200 MW (2010 case) and at 350 MW (2011 case), the voltage increases are still within the maximum voltage deviation criteria. However, when the XXX generation output is increased to 500 MW (2013 case), the Artesia 345 kV bus voltage increases to 1.0813 p.u., an increase of 5.5% and the Amrad 345 kV bus increases to 1.0653 p.u., a 3.6% increase during the same outage. These voltages are well above the 1.07 p.u. maximum voltage criterion for Artesia and the 1.05 p.u. voltage criterion at Amrad. Because of these violations, a Static Var Compensator (SVC) will be needed to eliminate these criteria violations. The analysis showed that increasing the reactive Var limits on the existing SVC at Amrad from +25/-50 MVAR to +25/-100 MVAR will eliminate these criteria violations. However, in requesting a cost estimate for this upgrade, it was determined that since the existing SVC at Amrad is over 25 years old, it would be less expensive and more efficient to install a new +50/-100 MVAR SVC than to modify the existing one. The new SVC would also provide more dynamic Var range than if the existing SVC at Amrad was modified. Therefore, the cost estimate obtained for this upgrade is for a new +50/-100 MVAR SVC at Amrad.

Cost estimates for the system upgrades required in 2013 are listed in the ***“INCREMENTAL SYSTEM UPGRADE COSTS FOR 500 MW OF XXX GENERATION IN 2013”*** table at the end of this section and in ***Section 6.4*** of this report. In addition, the XXX generation project will be required to comply with the Low Voltage Ride-Through (LVRT) Capability Standards. These

Standards are shown in *Appendix C* of the Generation Interconnection System Impact Study: Study Scope document located in *Appendix I*.

In conclusion, the XXX Generation Interconnection into the EPE control area will require several system upgrades to mitigate the impacts to the EPE and surrounding transmission systems. Incremental cost estimates for the required system upgrades in each of the study years and the construction timelines for each of these upgrades are shown below. A 30% contingency has been added to each of these estimates which were applied before any adder was considered. The detailed report for the cost estimates can be found in *Appendix 7* of this report.

SYSTEM UPGRADE COSTS FOR 200 MW OF XXX GENERATION IN 2010

SYSTEM UPGRADE	ESTIMATED COST (2007\$)
XXX Interconnection Costs	\$ 7,160,000
New XXX-Picante 345 kV line	\$81,646,000
2-54 MVAR line reactors (1-on each end of the XXX-Picante 345 kV line)	\$ 8,198,000
2010 SYSTEM IMPACT COST	\$97,004,000

**INCREMENTAL SYSTEM UPGRADE COSTS FOR 500 MW OF
XXX GENERATION IN 2013**

SYSTEM UPGRADE	ESTIMATED COST (2007\$)
Add 3 rd Caliente 345/115 kV autotransformer	\$ 7,300,000
Add 3 rd Arroyo 345/115 kV autotransformer	\$ 8,419,000
New +50/-100 MVAR SVC at Amrad	\$16,900,000
2013 SYSTEM IMPACT COST	\$32,619,000

**TOTAL SYSTEM UPGRADE COSTS FOR XXX
GENERATION INTERCONNECTION**

SYSTEM UPGRADE	ESTIMATED COST (2007\$)
XXX Interconnection Costs	\$ 7,160,000
New XXX-Picante 345 kV line	\$81,646,000
2-54 MVAR line reactors (1-on each end of the XXX-Picante 345 kV line)	\$ 8,198,000
Add 3 rd Caliente 345/115 kV autotransformer	\$ 7,300,000
Add 3 rd Arroyo 345/115 kV autotransformer	\$ 8,419,000
New +50/-100 MVAR SVC at Amrad *	\$16,900,000
TOTAL SYSTEM IMPACT COST	\$129,623,000

* After further investigation, it was determined that the autotransformer at Amrad does not have the rating capacity necessary to accommodate the required SVC at Amrad. Therefore, a 115/13.8 kV transformer will be needed to connect the SVC to the transmission system. The cost estimate for the new transformer will be included in the project cost estimate in the Facilities Study.

Due to market conditions, material and labor costs have been increasing. The estimates shown above reflect quotes received from construction contractors. These were the most up-to-date costs at the time this report was completed, but are subject to change.

XXX SWITCHING STATION CONSTRUCTION TIMELINE

	ELAPSED MONTHS																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Design	X	X	X	X																						
Procurement			X	X	X	X	X	X	X	X	X	X	X	X	X	X										
Preparation of construction documents and secure contractor															X	X	X	X								
Construction																			X	X	X	X	X	X	X	X

Project to be completed 26 months after authorization of work

XXX AND PICANTE 54 MVAR LINE REACTOR CONSTRUCTION TIMELINE

TASKS	ELAPSED MONTHS																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Design	X	X	X																							
Procurement			X	X	X	X	X	X	X	X	X	X	X	X	X											
Preparation of construction documents and secure contractor															X	X	X									
Construction																		X	X							

Each project to be completed 19 months after authorization of work

XXX-PICANTE 345 KV LINE CONSTRUCTION TIMELINE

ELAPSED MONTHS

TASKS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45							
Route selection	x	x																																																		
ECN Approval process			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x																																
ROW Acquisition																					x	x	x	x	x	x																										
Design																																																				
Procurement																																																				
Prepare docs & secure contractor																																																				
Construction																																																				

Project to be completed 45 months after authorization of work

THIRD 345/115 kV AUTOTRANSFORMER AT ARROYO CONSTRUCTION TIMELINE

TASKS	ELAPSED MONTHS																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Design	X	X	X	X																				
Procurement			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Preparation of construction documents and secure contractor																			X	X	X			
Construction																						X	X	X

Project to be completed 24 months after authorization of work

THIRD 345/115 kV AUTOTRANSFORMER AT CALIENTE CONSTRUCTION TIMELINE

TASKS	ELAPSED MONTHS																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Design	X	X	X	X																				
Procurement			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Preparation of construction documents and secure contractor																			X	X	X			
Construction																						X	X	X

Project to be completed 24 months after authorization of work

INSTALLATION OF NEW +50/-100 MVAR SVC AT AMRAD CONSTRUCTION TIMELINE

TASKS	ELAPSED MONTHS																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Design, Procurement, Installation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						

Project to be completed 18 months after authorization of work

XXX-HVDC-SVC Interaction

The portion of this System Impact Study that analyzed the harmonic and transient responses to the interaction between the HVDC terminal at Artesia and the SVC at Amrad with the XXX generation interconnected is not included in this report. EPE contracted this work to GE Consulting. GE performed analyses on the following:

- Subsynchronous Resonance (SSR) and Subsynchronous Torsional Interaction (SSTI)
- Control Interactions and Coordination
- Temporary Overvoltages and Generator Self-Excitation
- Transient Recovery Voltage

Results of these analyses will be provided under separate cover once the work is completed and it has been reviewed and approved by both EPE and PNM.

2.0 INTRODUCTION

In 2007, El Paso Electric Company (EPE) completed a *Generation Interconnection Feasibility Study (GIFS)* for XXXXXXXXXXXX (XXX) which determined the impacts to the EPE system and surrounding area due to the interconnection of XXX's 500 MW wind generation project in a Phase-In approach. After reviewing the results of the Study, XXX decided to continue with the next phase of the Large Generator Interconnection Procedures (LGIP), the System Impact Study (SIS). As in the GIFS, this SIS was performed as a joint study with review and approval from Public Service Company of New Mexico (PNM).

The purpose of this SIS is to verify the results of the previous Feasibility Study performed for XXX and determine if there are any additional impacts to the EPE and surrounding transmission systems. This Study also provided more detailed cost estimates for the required system upgrades and estimates on the time required to construct the system upgrades.

The proposed generation was modeled as a 500 MW Wind Project interconnected into EPE's control area approximately fifty-three (53) miles east of the Amrad Substation on the Amrad-Artesia 345 kV line. The project was analyzed in a Phase-In approach as follows:

- 200 MW in 2010
- 350 MW in 2011
- 500 MW in 2013

The proposed interconnection point, the Amrad-Artesia 345 kV line, is jointly owned by EPE and Public Service Company of New Mexico (PNM) and operated by EPE. This study identified impacts and recommended upgrades to both the EPE and PNM transmission systems.

The study periods analyzed were the 2010, 2011, and 2013 peak summer seasons. A light winter scenario was also developed for the 2013 study year to determine impacts due to the loss of the XXX generation during light load conditions. Please note that this study did not analyze the availability of any transmission service required for delivery of the proposed XXX generation.

As part of the evaluation process in studying the impact of the XXX interconnection on the EPE and PNM transmission systems, this System Impact Study included powerflow, and transient stability analyses. All recommended system upgrades needed to correct the impacts on the EPE and PNM systems due to the XXX generation interconnection were identified. Estimated costs associated with system upgrades to the EPE transmission system and the estimated schedules to construct these upgrades were also contracted out and provided by Burns and McDonnell. Any system upgrades needed in the neighboring New Mexico transmission system were noted without cost estimates. In addition, GE Energy Consulting was contracted to perform a study that analyzed the harmonic and transient responses to the interaction between the HVDC terminal at Artesia and the SVC at Amrad with the XXX generation interconnected. Results of this study will be provided under separate cover when GE completes the Study.

The system upgrades recommended in this Study will correct the criteria violations to the EPE and PNM transmission systems due to the impacts caused by the proposed XXX generation interconnection.

2.1 Performance Criteria

The reliability criteria standards used by EPE in performing this System Impact Study are listed in Section 4 of EPE's FERC Form 715 (*Appendix 2*). This analysis was performed using the GE PSLF program. For pre-contingency solutions, transformer tap phase-shifting transformer angle movement and static Var device switching was allowed. For each contingency studied, all regulating equipment (transformer controls and switched shunts) was fixed at pre-contingency positions. All buses, lines, and transformers in the El Paso and surrounding New Mexico control areas with base voltages of 69 kV and above were monitored.

Pre-contingency flows on lines and transformers must remain at or below the normal rating of the element, and post-contingency flows on network elements must remain at or below the emergency rating. Flows above 100% of an element's rating are considered violations. If only one rating was given for an element, it was used as both the normal and emergency rating.

The minimum and maximum voltages are specified in EPE's FERC Form 715. Voltages that did not meet criteria in the benchmark cases were considered an exception to the criteria for that specific bus and did not have a penalizing effect when evaluating the interconnection.

The performance criteria utilized in monitoring the EPE and New Mexico areas are shown in Table 2-1. The voltage drop criteria are specified as percentages of the pre-contingency voltages. For example, if the pre-contingency voltage at the Luna 345kV bus is 1.030 pu, and the voltage drops to 0.9579 pu during the contingency, the voltage drop would be 7%, calculated as:

$$dv = (V_{pre} - V_{post}) / V_{pre} = (1.030 - 0.9579) / 1.030 = 0.0721/1.030 = 7.0\%$$

Table 2.1: Performance Criteria.

<i>Area</i>	<i>Conditions</i>	<i>Loading Limit</i>	<i>Voltage (p.u.)</i>	<i>Voltage Drop</i>	<i>Comments</i>
EPE	Normal	< Normal Rating	0.95 - 1.05		69kV and above
			0.95 - 1.07		Artesia 345 kV
			0.95 - 1.08		Arroyo 345 kV PST source side
			0.90 - 1.05		Alamo, Sierra Blanca and Van Horn 69kV
	Contingency	< Emergency Rating	0.925 - 1.05	7%	60 kV to 115 kV
			0.95 - 1.07	7%	Artesia 345kV
			0.95 - 1.08	7%	Arroyo 345kV PST source side
			0.90 - 1.05		Alamo, Sierra Blanca and Van Horn 69kV
			0.95 - 1.05	7%	Hidalgo, Luna, or other 345 kV buses
PNM	Normal	< Normal Rating	0.95 - 1.05		Above 1 kV with ALIS
					46 kV buses not monitored
	Contingency	< Emergency Rating	0.95 - 1.05	6%	Above 1 kV
				7%	for southern NM area only
TSGT	Normal	< Normal Rating	0.95 - 1.05		All voltages with ALIS
	Contingency	< Emergency Rating	0.90 - 1.10		All voltages for N-1 contingency conditions

2.1.1 Voltage Violation Criteria

The voltage criteria used in this study is shown in Table 2.1. All voltages 69 kV or above in cases with All Lines In Service (ALIS) must have per unit voltages between 0.95 and 1.05 p.u.

Additionally during ALIS, EPE operational voltages on EPE's 345 kV buses must be maintained between 1.02 p.u. to 1.03 p.u. Under contingency conditions (N-1), voltage drops at any EPE 345 kV bus cannot exceed 7 %. For all cases during contingencies, the per unit (p.u.) voltages cannot exceed 1.05 p.u.

For the New Mexico Areas, PNM requires that for voltage levels above 46 kV, the bus voltages must be maintained between 0.95 p.u. and 1.05 p.u. during N-1 contingencies. Changes in bus voltages from pre- to post-contingency must be no greater than 6%, except for PNM southern New Mexico buses where the changes in bus voltages from pre- to post-contingency must be no greater than 7%.

Tri-State Gas and Transmission (TSGT) requires that all voltages be maintained between 0.95 p.u. and 1.05 p.u. for All Lines in Service (ALIS) conditions, and between 0.90 p.u. and 1.10 p.u. for N-1 contingency conditions. Changes in bus voltages from pre- to post-contingency must be no greater than 6% for TSGT buses served from the PNM system for N-1 contingencies and no greater than 10% for N-2 contingencies. For TSGT buses served from the TSGT system, changes in bus voltages from pre- to post-contingency must be no greater than 8% for N-1 contingencies and no greater than 10% for N-2 contingencies.

2.1.2 Loading Violation Criteria

The loading criteria used in this Study were the WECC loading criteria. An element (transmission line, transformer) cannot be loaded to over 100% of its continuous/normal rating for an ALIS condition. During contingency conditions, the element may not exceed 100 % of its emergency rating.

3.0 METHODOLOGY

3.1 Assumptions

The following assumptions were used in all study scenarios unless otherwise noted.

- Project dollar amounts shown are in 2008 U.S. dollars and were provided by Burns and McDonnell. The cost of the XXX generators and associated equipment is separate and not included in this study.
- This study assumes that space is available in the EPE substations where the system upgrades are recommended to be installed.
- The cost estimates provided include material, labor, and overhead costs for installing new equipment.
- This study did not analyze any transmission service from the interconnection point to any specific point on the grid. It determined system upgrades necessary to deliver the proposed XXX output uniformly into the entire WECC transmission grid.

3.2 Procedure

The analyses in this study included Powerflow and Transient Stability Analyses. Detailed discussions of these analyses are included in this report. A description of the procedures used to complete the analyses is shown below.

3.2.1 Base Case Development and Description of Cases

Cases representing a benchmark and a generation interconnection scenario were modeled for each of the three study years (2010, 2011, and 2013) under summer peak conditions. Additionally, a light winter case was developed for the 2013 study year to determine impacts to the transmission system due to the loss of the XXX generation during light load conditions. Descriptions of the cases analyzed are listed below:

Benchmark Cases:

Benchmark cases were modeled for each of the three study years with all existing third party generation in service and without the XXX generation. The third party generation included the following:

1. 570 MW of generation (Luna Energy Facility) interconnected at the Luna 345 kV bus and scheduled to the WECC grid.
2. 141 MW of generation (Afton CT) interconnected at the Afton 345 kV Substation and scheduled to the PNM area through the Arroyo PST in a South-to-North direction.
3. 160 MW of generation (Pyramid) interconnected at PNM's Hidalgo 115 kV Substation and scheduled to the WECC grid.
4. 80 MW of generation (Lordsburg) interconnected at PNM's Lordsburg 115 kV Substation and scheduled to the WECC grid.
5. 94 MW of generation (Afton ST) interconnected at the Afton 345 kV Substation and scheduled to the WECC grid.

Generation Interconnection Cases:

The Generation Interconnection cases modeled the benchmark cases described above with the proposed XXX generation in service. The XXX generation output was modeled at 200MW in the 2010 Generation Interconnection case, 350 MW in the 2011 Generation Interconnection case, and 500 in the 2013 Generation Interconnection case.

Light Winter Case:

A light winter case was developed for the 2013 study year. It modeled the XXX generation in a 2013 light load scenario. This case was developed to determine the impact on bus voltages if all of the XXX generation is lost during light load conditions. The results of this sensitivity are shown in *Section 4.3.3* of this report.

In order to determine the impacts resulting from the XXX generation interconnection, the results of the benchmark case analyses for each study year were compared against the results of the generation interconnection cases for the same study year.

Single contingency and N-2 breaker failure powerflow analyses were performed on all cases described above. Voltage and/or thermal loading criteria violations in the EPE area were noted and corrected in each of these cases. Violations found on the New Mexico transmission system were noted but not corrected. The one-line diagrams (powerflow maps) that show the results of the powerflow analyses are found in *Appendix 3*. The results of these powerflow analyses in tabular form are found in *Appendix 6*.

3.2.2 List of Contingencies

The same contingencies were evaluated for all cases and are identified in *Appendix A* of the Study Scope provided in *Appendix 1*. These contingencies were selected because they were the ones that caused the most stress on the EPE system in the previous XXX Feasibility Study. In addition, some single contingencies in the PNM control area near the XXX interconnection were evaluated to determine if the XXX generation will cause any additional impacts to the PNM transmission system. N-2 breaker failure contingencies were also analyzed to determine if any operational procedures will need to be developed in the event that the XXX generators are producing their maximum output and a breaker failure occurs on the system.

3.2.3 Transient Stability Analysis

Transient Stability analyses were performed to verify that the NERC/WECC Disturbance Performance criteria for the Minimum Transient Frequency Standard and the Transient Voltage Dip Standard will be met when the XXX generation is interconnected into the EPE system. The Transient Voltage Dip Standard for a Category B disturbance allows for up to a 25% drop at load buses and up to a 30% drop at non-load buses. The Minimum Transient Frequency Standard states that the frequency shall not fall below 59.6 Hz for 6 cycles of more at a load bus for a Category B disturbance. The plots showing the results of these analyses can be seen in *Appendix 5*.

4.0 POWER FLOW ANALYSIS RESULTS

The cases described in section 3.2.1 of this report were developed for use in the Powerflow Analyses. The cases developed represented 2010, 2011, and 2013 study years. These cases represent scenarios in which the EPE system may operate with and without the XXX Generation Interconnection. The tables below show the results of each of the study years analyzed.

4.1 2010 Study Year

The Benchmark and Generation Interconnection cases were analyzed in the 2010 study year. The Generation Interconnection case modeled the XXX generation output at 200 MW. The tables below show the criteria violations found in each of the cases analyzed for the 2010 study year.

4.1.1 2010 Benchmark Case

The 2010 Benchmark case modeled the system as it is projected to exist in 2010 without the XXX generation interconnection. The following criteria violations were found in the benchmark case

2010HS BENCHMARK CASE CRITERIA VIOLATIONS

CONTINGENCY	VOLTAGE CRITERIA VIOLATION		OVERLOADED LINE OR TRANSFORMER		% LOADING
	BUS	PU VOLTAGE	FROM	TO	
Caliente-Picante 345 kV Line			GR 115	VISTA_# 115	105.2
Luna 345/115 kV autotransformer	6 buses in PNM area with voltages below 0.925 pu		LORDSBRG 69	LORDSBRG 115	107.0

The table above shows voltage and thermal criteria violations that occur in the 2010 Benchmark Case.

The Global Reach (GR) –Vista 115 kV line overload during a contingency of the Caliente-Picante 345 kV line is a criteria violation that will exist once the Picante Substation is constructed in 2010. EPE plans to reconductor this line to eliminate the criteria violation before the 2010 HS period. The violation is not due to the XXX generation and XXX is not responsible for the cost to reconductor the line.

For the criteria violations during the Luna 345/115 kV transformer contingency, there is a load shedding scheme that Public Service Company of New Mexico (PNM) plans to implement in 2008. If the Luna 345/115 kV transformer is lost or if the loading on the Luna 345/115 kV transformer is greater than 100% and the Central 115 kV voltage is below 0.9338 per unit, then the PD Ivanhoe load is tripped. PNM also plans on installing two 15 MVAR shunt capacitors at Mimbres 115 kV station by summer 2009 to mitigate the criteria violations for the Luna 345/115 kV autotransformer contingency. Again these criteria violations are not due to the XXX generation and XXX is not responsible for the upgrades described above. These mitigation procedures apply to all scenarios where the Luna autotransformer criteria violations exist.

4.1.2 2010 Generation Interconnection Case

The 2010 HS Generation Interconnection Case simulated the 2010 Benchmark Case with the XXX generation interconnected into the EPE control area and included a new 345 kV line from the XXX switching station to EPE’s new Picante 345/115 kV Substation that was determined to be needed in the previous Feasibility Study. No thermal overload or voltage criteria violations were found in this scenario during single contingencies (N-1) or breaker failure (N-2) contingencies.

4.2 2011 Study Year

The 2011 Benchmark and Generation Interconnection cases modeled the system upgrades needed in the 2010 Study Year. The Generation Interconnection case modeled the XXX generation output at 350 MW. Therefore, this case included the new XXX-Picante 345 kV line that was modeled in the 2010 Generation Interconnection case. The tables below show the criteria violations found in each of the cases analyzed for the 2011 study year.

4.2.1 2011 Benchmark Case

The 2011 Benchmark case modeled the system as it is projected to exist in 2011. The criteria violations for the 2011 Benchmark case are shown below.

2011 HS BENCHMARK CASE CRITERIA VIOLATIONS

CONTINGENCY	VOLTAGE CRITERIA VIOLATION		OVERLOADED LINE OR TRANSFORMER		% LOADING
	BUS	PU VOLTAGE	FROM	TO	
Caliente-Picante 345 kV Line			GR 115	VISTA_# 115	111.5

As in the 2010 Benchmark case, the Global Reach–Vista 115 kV line overload during a contingency of the Caliente-Picante 345 kV line is a criteria violation that will exist once the Picante Substation is constructed. EPE plans to reconductor this line to eliminate the criteria violation before the 2010 HS period. The violation is not due to the XXX generation and XXX is not responsible for the cost to reconductor the line.

4.2.2 2011 Generation Interconnection Case

The 2011 HS Generation Interconnection Case simulated the 2011 Benchmark Case with the XXX generation interconnected into the EPE control area at a generation output of 350 MW. The table below shows the criteria violation found when 350 MW of XXX Generation is interconnected into the EPE control area in the 2011 HS case.

**2011 HS GENERATION INTERCONNECTION CASE CRITERIA VIOLATIONS
(XXX GENERATION AT 350 MW)**

CONTINGENCY	VOLTAGE CRITERIA VIOLATION		OVERLOADED LINE OR TRANSFORMER		% LOADING
	BUS	PU VOLTAGE	FROM	TO	
Luna 345/115 kV autotransformer	9 buses in PNM area with voltages below 0.925 pu		EL_BUTTE 115	PICACHO 115	101.1

As can be seen in the table above, one additional criteria violation was found due to the XXX generation in 2011. Tri-State Generation and Transmission Association's (TSGT) Elephant Butte-Picacho 115 kV line loads to 101.1% of its emergency rating during an outage of the Luna 345/115 kV autotransformer. However, with PNM's load shedding scheme in place, this criteria violation is eliminated. Therefore, no additional upgrades are needed in 2011.

4.3 2013 Study Year

The 2013 Benchmark and Generation Interconnection cases modeled the system upgrades needed in the 2010 and 2011 Study Years. The XXX generation output in the Generation Interconnection case was modeled at 500 MW. Again, this case included the new XXX-Picante 345 kV line that was modeled in the 2010 and 2011 Generation Interconnection cases. The tables below show the criteria violations found in each of the cases analyzed for the 2013 study year.

4.3.1 2013 Benchmark Case

The 2013 Benchmark case modeled the EPE and New Mexico transmission systems as they are projected to exist in 2013. The following criteria violations were found in the 2013 benchmark case.

2013HS BENCHMARK CASE CRITERIA VIOLATIONS

CONTINGENCY	VOLTAGE CRITERIA VIOLATION		OVERLOADED LINE OR TRANSFORMER			% LOADING
	BUS	PU VOLTAGE				
			FROM	TO		
All Lines in Service	Moriarity 69	0.9435	Cuchillo 115	Cuchillo 25	130.9	
	Moriarity 115	0.9413	Moriarity 69	Moriarity 115	115.7	
	Willard 115	0.9420	Socorro 69	Socorro 115	103.4	
	Estancia 115	0.9368	Rowe 25	Rowe Tap 115	100.4	
	West Mesa 230	1.0530	Panorama 115	Panorama 13	100.2	
Luna 345/115 kV autotransformer	17 buses in PNM area with voltages below 0.925 pu					

As can be seen in the table above, some thermal overload and voltage criteria violations were found in the PNM and TSGT areas with all lines in service (ALIS). These criteria violations were noted in this report as existing problems before the XXX generation is interconnected into the EPE control area. Therefore any costs associated with system upgrades needed to correct these violations are the responsibility of the utility who owns the facility where the criteria violation occurs.

As previously stated in the 2010 and 2011 study years, the criteria violations found during the Luna 345/115 kV autotransformer outage are eliminated with the PNM load shedding scheme in place.

4.3.2 2013 Generation Interconnection Case

The 2013 HS Generation Interconnection Case simulated the 2013 Benchmark Case with the XXX generation interconnected into the EPE control area at a generation output of 500 MW. The table below shows the criteria violation found when 500 MW of XXX Generation is interconnected into the EPE control area in the 2013 HS case.

**2013 HS GENERATION INTERCONNECTION CASE CRITERIA VIOLATIONS
(XXX GENERATION AT 500 MW)**

CONTINGENCY	VOLTAGE CRITERIA VIOLATION		OVERLOADED LINE OR TRANSFORMER		% LOADING
	BUS	PU VOLTAGE	FROM	TO	
Caliente 345/115 kV Autotransformer			CALIENTE 115	CALIENTE 345	111.3
Arroyo 345/115 kV autotransformer			ARROYO 115	ARROYO 345	105.8

As can be seen in the table above, additional criteria violations were found due to the 500 MW XXX generation in 2013. One of EPE’s Caliente 345/115 kV autotransformers loads to 111.3% of its emergency rating during an outage of the other Caliente autotransformer. Additionally, one of the Arroyo 345/115 kV autotransformers loads to 105.8% of its emergency rating during an outage of the other Arroyo autotransformer. These criteria violations are caused by the additional 500 MW of XXX generation. New 345/115 kV autotransformers will be needed at Arroyo and Caliente to correct these violations.

4.3.3 Light Load Sensitivity Case

A light load sensitivity case was analyzed for the 2013 study year to determine the impact of the loss of the XXX generation during light load conditions. The previous XXX Feasibility Study results indicated that when the XXX generation output is at 200 MW (2010 case) and at 350 MW (2011 case), the voltage increases are still within the maximum voltage deviation criteria. Therefore, these two study years were not analyzed for light load conditions. However, for the 2013 study year, the analysis revealed excessive voltage deviations when the XXX generation is lost due to an outage during light load conditions. In the 2013 light load case, the Artesia 345 kV bus voltage increases to 1.0813 p.u. during a contingency of the entire XXX generation. This is a voltage increase of 5.5%. The Amrad 345 kV bus increases to 1.0653 p.u., a 3.6% increase during the same outage. These voltages are well above the 1.07 p.u. maximum voltage criterion at Artesia and the 1.05 p.u. maximum voltage criterion at Amrad. Because of this, more reactive Vars on the EPE system will be needed to eliminate these criteria violations in the event that the entire XXX generation is lost. The analysis showed that increasing the reactive Var limits on the existing SVC at Amrad from +25/-50 MVAR to +25/-100 MVAR will eliminate the criteria violations. However, in requesting a cost estimate for this upgrade, it was determined that since the existing SVC at Amrad is over 25 years old, it would be less expensive to install a new +50/-100 MVAR SVC than to modify the existing one. The new SVC would also provide more dynamic Var range than if the existing SVC at Amrad was modified. Therefore, the cost estimate obtained for this upgrade is for a new +50/-100 MVAR SVC at Amrad.

In conclusion, results of the Powerflow analyses indicate that some system upgrades will be required on the EPE transmission system in order to eliminate criteria violations caused by the interconnection of the XXX generation at various phased-in generation output levels. Listed below are the facilities needed to correct all criteria violations caused by the XXX generation interconnection at the three phase-in output levels. Costs associated with the facility upgrades needed to interconnect the XXX project can be found in *Section 6.0* of this report

**SYSTEM UPGRADES NEEDED
FOR 200 MW OF XXX GENERATION IN 2010**

1. New XXX-Picante 345 kV Line
2. 2-54 MVAR line reactors (one on each end of the XXX-Picante 345 kV line)
3. XXX Interconnection Costs

**INCREMENTAL SYSTEM UPGRADES NEEDED
FOR 350 MW OF XXX GENERATION IN 2011**

1. No new upgrades needed.

**INCREMENTAL SYSTEM UPGRADES NEEDED
FOR 500 MW OF XXX GENERATION IN 2013**

1. Third Caliente 345/115 kV autotransformer
2. Third Arroyo 345/115 kV autotransformer
3. New Amrad SVC with a +50/-100 MVAR range

5.0 TRANSIENT STABILITY ANALYSIS RESULTS

Transient Stability analyses were performed in order to verify that the scenarios modeled in this Study comply with the North American Electric Reliability Council (NERC) and the Western Electricity Coordinating Council (WECC) Planning Standards. The NERC/WECC Planning Standards can be found in Part 1 of the document “WECC Reliability Criteria” and are attached as *Appendix 3* of this report.

Analyses were performed simulating three-phase 3.5 cycle faults on each of the 2013 Base and Generation Interconnection cases. Faults were simulated on each of the following:

- Springerville-Luna 345 kV line
- West Mesa-Arroyo 345 kV line
- Greenlee-Hidalgo 345 kV line
- Luna-Diablo 345 kV line
- Afton-Newman 345 kV line
- Caliente-Newman 345 kV line
- Amrad-Artesia 345 kV line (Base Case only)
- XXX-Amrad 345 kV line (Generation Interconnection Case only)
- XXX-Artesia 345 kV line (Generation Interconnection Case only)
- Loss of all XXX generation (Generation Interconnection Case only)
- XXX-Picante 345 kV line (Generation Interconnection Case only)
- Amrad 115 kV bus

Results of these analyses are listed below.

5.1 2013 Base Case

The Base Case simulated the EPE system as it is projected to exist in 2013 without the XXX generation interconnected to it. Results of the Transient Stability analyses for each of the simulations described above are listed below. *Appendix 5* contains plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the 2013 Base Case.

5.1.1 Springerville-Luna 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for a Base Case, three-phase fault simulation of the Springerville-Luna 345 kV line are shown on *pages 1-2 of Appendix 5*. No criteria violations were found in this simulation.

5.1.2 West Mesa-Arroyo 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for a Base Case, three-phase fault simulation of the West Mesa-Arroyo 345 kV line are shown on *pages 3-4 of Appendix 5*. No criteria violations were found in this simulation.

5.1.3 Greenlee-Hidalgo 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for a Base Case, three-phase fault simulation of the Greenlee-Hidalgo 345 kV line are shown on *pages 5-6 of Appendix 5*. No criteria violations were found in this simulation.

5.1.4 Luna-Diablo 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for a Base Case, three-phase fault simulation of the Luna-Diablo 345 kV line are shown on *pages 7-8 of Appendix 5*. No criteria violations were found in this simulation.

5.1.5 Afton-Newman 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for a Base Case, three-phase fault simulation of the Afton-Newman 345 kV line are shown on *pages 9-10 of Appendix 5*. No criteria violations were found in this simulation.

5.1.6 Caliente-Newman 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for a Base Case, three-phase fault simulation of the Caliente-Newman 345 kV line are shown on *pages 11-12 of Appendix 5*. No criteria violations were found in this simulation.

5.1.7 Amrad-Artesia 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for a Base Case, three-phase fault simulation of the Amrad-Artesia 345 kV line are shown on *pages 13-14 of Appendix 5*. No criteria violations were found in this simulation.

5.1.8 Amrad 115 kV Bus

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for a Base Case, three-phase fault simulation of the Amrad 115 kV bus are shown on *pages 15-16 of Appendix 5*. No criteria violations were found in this simulation.

5.2 2013 Generation Interconnection Case

The Generation Interconnection Case simulated the EPE system as it is projected to exist in 2013 with 500 MW of XXX generation interconnected to the EPE control area. Results of the Transient Stability analyses for each of the simulations described in Section 5.0 are listed below. *Appendix 5* also contains plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the 2013 Generation Interconnection Case.

5.2.1 Springerville-Luna 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the Springerville-Luna 345 kV line are shown on *pages 17-18 of Appendix 5*. No criteria violations were found in this simulation.

5.2.2 West Mesa-Arroyo 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the West Mesa-Arroyo 345 kV line are shown on *pages 19-20 of Appendix 5*. No criteria violations were found in this simulation.

5.2.3 Greenlee-Hidalgo 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the Greenlee-Hidalgo 345 kV line are shown on *pages 21-22 of Appendix 5*. No criteria violations were found in this simulation.

5.2.4 Luna-Diablo 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the Luna-Diablo 345 kV line are shown on *pages 23-24 of Appendix 5*. No criteria violations were found in this simulation.

5.2.5 Afton-Newman 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the Afton-Newman 345 kV line are shown on *pages 25-26 of Appendix 5*.

Criteria violations were found in this simulation on the XXX generator models. The frequency at each of the XXX generators drop to 57.33 Hz. This is lower than the minimum disturbance criteria of 59.0 Hz. The voltage dip on each of these generators was 55.4%, which is greater than the maximum transient voltage dip criteria of 30%. Due to these violations, the XXX generators tripped during the three-phase fault simulation.

Since the criteria violations occur only at the XXX generators, it is assumed that these violations are due to incorrect transient stability data for the XXX generator models that were provided for this analysis by XXX. If this project is implemented, XXX should review the transient stability data for accuracy.

5.2.6 Caliente-Newman 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the Caliente-Newman 345 kV line are shown on *pages 27-28 of Appendix 5*.

Criteria violations were found in this simulation on the XXX generator models. The frequency at each of the XXX generators drop to 57.97 Hz. This is lower than the minimum disturbance criteria of 59.0 Hz. The voltage dip on each of these generators was 55.2%, which is greater than the maximum transient voltage dip criteria of 30%. Due to these violations, the XXX generators tripped during the three-phase fault simulation.

Since the criteria violations occur only at the XXX generators, it is assumed that these violations are due to incorrect transient stability data for the XXX generator models that were provided for this analysis by XXX. If this project is implemented, XXX should review the transient stability data for accuracy.

5.2.7 XXX-Amrad 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the XXX-Amrad 345 kV line are shown on *pages 29-30 of Appendix 5*. No criteria violations were found in this simulation.

5.2.8 XXX-Artesia 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the XXX-Artesia 345 kV bus are shown on *pages 31-32 of Appendix 5*. No criteria violations were found in this simulation.

5.2.9 Loss of All XXX Generation

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a simulation of the loss of the entire XXX generation are shown on *pages 33-34 of Appendix 5*. No criteria violations were found in this simulation.

5.2.10 XXX-Picante 345 kV Line

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the XXX-Picante 345 kV line are shown on *pages 35-36 of Appendix 5*.

Criteria violations were found in this simulation on the XXX generator models. The frequency at each of the XXX generators drop to 56.77 Hz. This is lower than the minimum disturbance criteria of 59.0 Hz. The voltage dip on each of these generators was 57.8%, which is greater than the maximum transient voltage dip criteria of 30%. Due to these violations, the XXX generators tripped during the three-phase fault simulation.

Since the criteria violations occur only at the XXX generators, it is assumed that these violations are due to incorrect transient stability data for the XXX generator models that were provided for this analysis by XXX. If this project is implemented, XXX should review the transient stability data for accuracy.

5.2.11 Amrad 115 kV Bus

The plots of the worst case deviations of generator bus voltage (vbug) and generator bus frequency (fbug) for the XXX 500 MW generation interconnection and a three-phase fault simulation of the Amrad 115 kV bus are shown on *pages 37-38 of Appendix 5*. No criteria violations were found in this simulation.

In conclusion, results of the Transient Stability analyses indicate that some frequency and voltage dip criteria violations may occur at the XXX generators during three-phase fault simulations of the XXX-Picante, Caliente-Newman, and Afton-Newman 345 kV lines. Since the violations occurred only at the XXX generators, it is possible that some of the transient stability data provided by XXX for their generator models may be incorrect.

If this project is installed, XXX will need to review the transient stability data it provided to EPE to determine if it is accurate. If there are no problems with the data, then XXX will need to implement a System Protection Scheme (SPS) to protect its generators in the event that the simulated three-phase faults that caused the criteria violations do occur in reality.

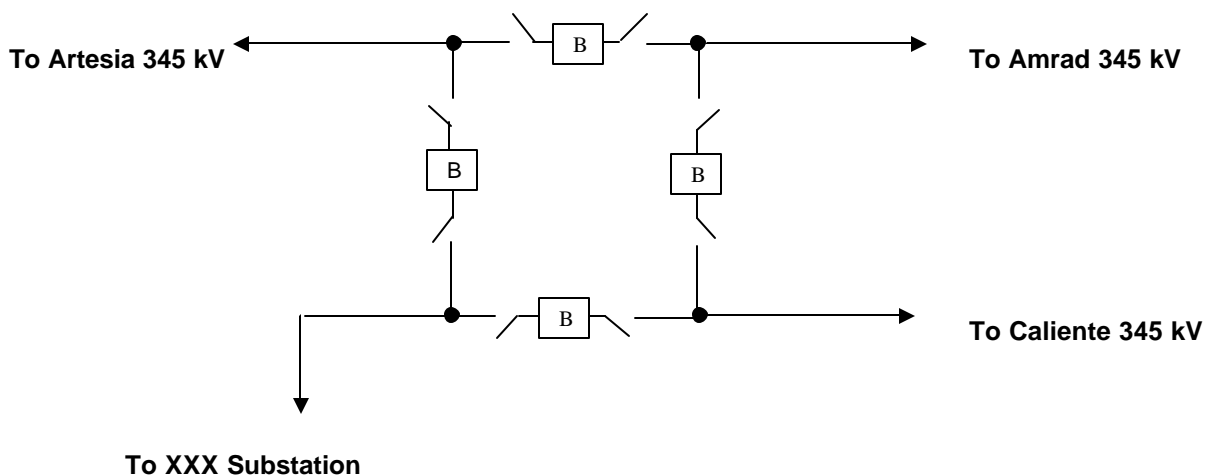
6.0 COST ESTIMATES

The following good faith cost estimates are for system upgrades required to meet WECC reliability criteria if the XXX generation is interconnected into the EPE control area on the Amrad-Artesia 345 kV line. Estimated costs for each study year are listed separately. Project dollar amounts are shown in 2007 U.S. dollars and were provided by Burns and McDonnell (BMcD). A 30% contingency was added to each of these estimates and was applied before any adder was considered.

Due to market conditions, material and labor costs have been increasing. The estimates shown below reflect quotes received from construction contractors. These were the most up-to-date costs at the time this report was completed, but are subject to change.

6.1 XXX Generator Interconnection Cost Estimates

The estimated cost to physically and electrically interconnect the proposed XXX generation by constructing a Switching Station on the Amrad-Artesia 345 kV line is **\$7.16 million**. The diagram below shows the configuration of the proposed 345 kV switching station.



For a detailed account of the materials, labor and other costs included in this cost estimate, please refer to the report in *Appendix 7*.

6.2 2010 System Upgrade Cost Estimates

In the 2010 Generator Interconnection scenario, a 55-mile line from the XXX interconnection point into the Picante 345 kV Substation is needed along with 54 MVAR line reactors on each end of the line to reduce the large voltage swings that will occur when switching the line in or out of service. This study assumes that substation space will be available at the future Picante Substation to connect the new 345 kV line. The addition of the new XXX-Picante 345 kV line will provide better system reliability and eliminate criteria violations caused by the additional 200 MW of XXX generation. The new line will also provide additional transmission capability to the XXX generation project when it is expanded to 500 MW. The table below shows the estimated costs of the required system upgrades if XXX interconnects 200 MW of generation into the EPE control area in 2010.

**SYSTEM UPGRADE COSTS FOR
200 MW OF XXX GENERATION IN 2010**

SYSTEM UPGRADE	ESTIMATED COST (2007\$)
XXX Interconnection Costs	\$ 7,160,000
New XXX-Picante 345 kV line	\$ 81,646,000
2-54 MVAR line reactors (1-on each end of the XXX-Caliente 345 kV line)	\$ 8,198,000
TOTAL SYSTEM IMPACT COST	\$97,004,000

6.3 2011 System Upgrade Cost Estimates

Results of the analysis in this scenario indicate that one additional criteria violation occurs on a neighboring transmission system in the 2011 case. Tri-State Generation and Transmission Association's (TSGT) Elephant Butte-Picacho 115 kV line loads to 101.1% of its emergency rating during an outage of the Luna 345/115 kV autotransformer.

However, Public Service Company of New Mexico (PNM) has stated that they should have a load shedding scheme in place for the Luna 345/115 kV transformer in 2008. If there is an outage of the Luna 345/115 kV transformer, then the PD Ivanhoe load is tripped. Further analysis showed that when this load shedding scheme is implemented during a contingency of the Luna 345/115 kV autotransformer, the overload of the Elephant Butte-Picacho 115 kV line is eliminated. Therefore, no additional facility upgrades will be needed in the 2011 Generation Interconnection scenario.

6.4 2013 System Upgrade Cost Estimates

In the 2013 XXX Generation Interconnection scenario, three additional facility upgrades are needed to eliminate criteria violations caused by the 500 MW of XXX generation output. Installing a third 224 MVA, 345/115 kV autotransformer at Arroyo Substation will be needed due to thermal overloading of one of the Arroyo autotransformers during a single contingency of the other Arroyo autotransformer.

A third 224, 345/115 kV autotransformer at Caliente Substation will also be needed due to thermal overloading during a single contingency of the other Caliente autotransformer.

The 2013 Light load sensitivity case also revealed a voltage criteria violation during the loss of the XXX generation during light load conditions. Voltages at Amrad and Artesia 345 kV buses were well above the maximum voltage criteria when the loss of all the XXX generation was simulated. The control area will require additional reactive power in the area to eliminate these violations. Extending the reactive Var limit on the existing Amrad SVC from -50 MVAR to -100 MVAR will eliminate the criteria violation. However, in requesting a cost estimate for this upgrade, it was determined that since the existing SVC at Amrad is over 25 years old, it would be less expensive to install a new +50/-100 MVAR SVC than to modify the existing SVC. The new SVC would also provide more dynamic Var range than if the existing SVC at Amrad was modified. Therefore, the cost estimate obtained for this upgrade is for a new +50/-100 MVAR SVC at Amrad.

The table below shows the incremental good faith estimated costs of required system upgrades if XXX interconnects 500 MW of generation into the EPE control area in 2013.

**INCREMENTAL SYSTEM UPGRADE COSTS FOR
500 MW OF XXX GENERATION IN 2013**

SYSTEM UPGRADE	ESTIMATED COST (2007\$)
Add 3 rd Arroyo 345/115 kV autotransformer	\$ 8,419,000
Add 3 rd Caliente 345/115 kV autotransformer	\$ 7,300,000
New Amrad SVC with a range of +50 to -100 MVAR *	\$16,900,000
2013 SYSTEM IMPACT COST	\$32,619,000

* After further investigation, it was determined that the autotransformer at Amrad does not have the rating capacity necessary to accommodate the required SVC at Amrad. Therefore, a 115/13.8 kV transformer will be needed to connect the SVC to the transmission system. The cost estimate for the new transformer will be included in the project cost estimate in the Facilities Study.

In conclusion, the interconnection of the XXX generation into the EPE control area will require several system upgrades to mitigate the impacts to the EPE and surrounding transmission systems. Total cost estimates for these system upgrades range from **\$97.004 million** in 2010 to **\$129.623 million** in 2013. A detailed account of the cost estimates and the construction timeline for these required system upgrades can be found in **Appendix 7** of this report.

In addition, the XXX generation project will be required to comply with the Low Voltage Ride-Through (LVRT) Capability Standards. These Standards are shown in **Appendix C** of the Generation Interconnection System Impact Study: Study Scope document located in **Appendix 1**.

7.0 DISCLAIMER

This study assumes that transmission service has not been obtained by XXX to deliver its generation output. Therefore, this Study modeled the XXX power output as being distributed evenly across the entire WECC electrical grid. Whenever XXX determines where it will deliver its generation output to, XXX will have to purchase the required transmission service from the appropriate entity and a Transmission Service Study will be performed to determine the impacts of the XXX interconnection and transmission path of the XXX generation on the EPE and surrounding transmission systems. This study makes no warranties as to the existence or availability of any transmission service XXX will need in order to deliver its generation output. Also, the transfer capacities of certain transmission lines and paths within the southern New Mexico transmission system are limited by contracts between the New Mexico transmission owners and any use of the transfer capacities above the contractual limits will require approval by the contractual parties and renegotiation of the applicable contract(s).

If any of the project data used in this study and provided by XXX varies significantly from the actual data once the XXX equipment is installed, the results from this study will need to be verified with the actual data at the Project developer's expense. Once XXX determines the model of the wind turbines it intends to interconnect into the EPE control area, it will need to provide the short-circuit model equivalent of those wind turbines for further study. Additionally, any major change to the southern New Mexico system will require a re-evaluation of this Study.

8.0 CERTIFICATION

In 2007, El Paso Electric Company (EPE) completed a re-study of the *Generation Interconnection Feasibility Study (GIFS)* for XXXXXXXXXXXXXXXX (XXX) in a Phase-In approach. That study determined impacts to the EPE and surrounding area transmission systems due to the interconnection of XXX's 500 MW wind generation project. Because the project impacted Public Service Company of New Mexico's (PNM) transmission system, the Study was also reviewed and approved by PNM.

After reviewing the results of the GIFS re-study, XXX decided to proceed with the next step of the Large Generator Interconnection Procedures (LGIP) and requested that EPE perform a System Impact Study (SIS). As in the GIFS, this SIS was performed as a joint study with review and approval from PNM.

The purpose of this SIS is to verify the results of the GIFS and determine if any additional impacts are found due to the interconnection of the XXX wind generation. This SIS will also provide XXX with an estimate of the time it will take to construct the required facility upgrades.

The proposed XXX generation was modeled as a 500 MW Wind Project interconnected into EPE's control area approximately fifty-three (53) miles east of the Amrad Substation on the Amrad-Artesia 345 kV line. This Study again analyzed the interconnection in a Phase-In approach as follows:

- 200 MW in 2010
- 350 MW in 2011
- 500 MW in 2013

El Paso Electric Company (EPE) performed a Generation Interconnection Feasibility Study (GIFS) for XXXXXXXXXXXXXXXX (XXX) pursuant to XXX's letter requesting to interconnect its Guadalupe Mountain Wind Project to EPE's control area, dated March 25, 2006. That Study determined the impacts to the EPE and surrounding transmission systems due to the interconnection of the XXX generation in the 2010 time period.

After reviewing the results of the GIFS, XXX requested that EPE re-study the GIFS using a Phase-In approach as follows:

- 200 MW in 2010
- 350 MW in 2011
- 500 MW in 2013

This study recommends system upgrades required to correct impacts due to the addition of the proposed XXX generation and estimated costs for installing those required system upgrades using the Phase-In approach requested by XXX. The powerflow and transient stability data used to model the XXX generation was supplied by XXX. EPE performed powerflow, and transient stability analyses in this study.

EPE hired Burns and McDonnell to provide the cost estimates and the construction project timelines for the required facility upgrades determined in this Study.

In addition, EPE hired General Electric Energy Consulting (GE) to perform additional studies relating to the interaction the XXX wind turbines will have with the Static Var Compensator (SVC) at EPE's Amrad Substation and with the High Voltage Direct Current (HVDC) converter station at Artesia Substation. Studies relating to the XXX wind turbine interaction with the SVC and HVDC include the following:

- Control interactions and Stability
- Subsynchronous torsional interaction
- Temporary overvoltages
- Breaker transient recovery voltages

Once the Interaction Study being performed by GE is completed and approved by EPE, the report showing the results of the Study will be submitted to XXX under separate cover.

Name: Dennis H. Malone

Title: Manager, System Planning

Signature: _____

Date: _____

Investigating Engineer: David Gutierrez