

AFTON 345 KV TO WESTMESA 345 KV
FIRM TRANSMISSION SERVICE
REQUEST STUDY

System Operations Department
System Planning Section
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1.0 EXECUTIVE SUMMARY

On October 24, 2001, XXXXXXXXXXXXXXXXXXXXXXXXXX (XXX) submitted a Request to El Paso Electric Company (EPE) for Firm Transmission Service between a Point of Delivery (POD) at Afton 345 kV Substation to a Point of Receipt (POR) at WestMesa 345 kV Substation. The Request was in the amount of 135 MW commencing January 1, 2003. EPE accepted 30 MW and denied 105 MW of XXX's request due to insufficient available transmission capacity on the requested path and offered to perform a Transmission Service Request Study. This Study is to determine the modifications necessary in the EPE system to accommodate the full requested transmission service. Pursuant to this, an *Agreement for a Transmission Service Facilities Study* was signed on December 12, 2001.

The purpose of this Study is to determine any impacts of providing an additional 105 MW (135 MW total) of firm transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation through the Arroyo-WestMesa (EP) 345 kV line and to determine the facilities required to mitigate these impacts. This Transmission Service Request was made in connection with the interconnection of XXX's Afton Generating Station, located at Afton 345 kV Substation (between EPE's Luna-Newman 345 kV line), to be placed in-service in the 2003 time frame. EPE performed a Generator Interconnection Facilities Study for the generator in 2001 to determine the facilities required to interconnect the generator.

For this Study, Heavy Summer (HS) and Light Winter (LW) benchmark cases were developed for the year 2003. These benchmark cases also included proposed generators that are ahead of the Transmission Service Request in EPE's queue and may have an impact on the request for transmission service. These included the following: 1) 613.9 MW of generation interconnected at the Luna 345 kV Substation (LUNA), and 2) 500 MW of generation interconnected at the Newman 115 kV Substation (NEW). Four variations of each benchmark case (HS and LW) were analyzed in this study by switching combinations of the proposed generating stations on or off. This was done in order to study a wide range of operating scenarios that may occur if and when these new generators are interconnected into the EPE transmission system.

Variation #1 was the existing EPE system without any new generation. Variation #1 was developed to provide a comparison of how the EPE system will operate when all new generation is off-line. **Variation #2** analyzed the EPE system with the Afton (135 MW) generation on-line and the other two generating stations (LUNA and NEW) off-line. **Variation #3** analyzed the EPE system with Afton and LUNA generation on-line and NEW generation off-line. **Variation #4** analyzed the EPE system with Afton, LUNA, and NEW generation all on-line. Generation output for the Afton generating station was modeled as being sent to the WestMesa 345 kV Substation through the EP line, and outputs from each of the other two generating stations were modeled as being distributed evenly throughout the Western Systems Coordinating Council (WSCC).

In addition to these “*Variations*”, a powerflow sensitivity analysis was performed on the 2003HS AFTON ONLY variation (Variation #2) to determine all violations of the Arroyo Phase Shifting Transformer (PST) angle range that may occur during different operating conditions. The PST is designed for a $\pm 34^\circ$ -angle range. If this range is exceeded in any operating scenario, the PST will need to be replaced with a new PST having a wider angle range in order to achieve the desired 135 MW flow through the EP line.

This study was performed to identify all impacts on the EPE system as a result of providing firm transmission service for the Afton generation output from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. Any facilities needed to correct impacts to the EPE transmission system were evaluated and estimates of the costs of these facilities were provided. Please note, however, that the costs contained in this Study are estimates and may change when detailed engineering is performed for the modifications. Additionally, these costs do not include any environmental or regulatory costs. Criteria violations to other New Mexico systems were also noted but not corrected.

Results of the study show that impacts occur to the EPE system when 105 MW in addition to the previously accepted 30 MW of firm transmission service is provided from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. System modifications that are included in the Study will correct these impacts and estimated costs for the modifications to EPE’s system are provided. Specifically, a new Phase Shifting Transformer (PST) with increased taps allowing for a wider-angle range is required at the Arroyo 345 kV Substation to replace the existing Arroyo PST. This is needed because the PST exceeds its designed angle limits when the additional 105 MW (for a total of 135 MW) of Afton generation is sent north through the EP line. Also, a third 345/115 kV autotransformer at EPE’s Diablo Substation is needed to correct overloading of the other two Diablo autotransformers during a contingency condition.

The analysis also shows an overloading of PNM’s Luna-Mimbres 115 kV transmission line (at a 133 MVA line rating) during contingency conditions. The study recommends an upgrade of this line to correct the criteria violation. Since this transmission line does not belong to EPE, a cost estimate for its upgrade was not provided. The line owners, PNM and TNMP must be contacted for further analysis on this upgrade.

A list of the recommended system modifications to the EPE transmission system along with their estimated costs is shown in the following section of this report (*Section 2.0*).

2.0 COST ESTIMATES

The following estimated costs are for system modifications required to correct criteria violations to the EPE transmission system as a result of providing an additional 105 MW (135 MW total) of firm transmission service from the Afton 345 kV Substation to the WestMesa 345 kV Substation through the EP line. The Afton generation interconnection was modeled as one 135 MW unit interconnected at Afton 345 kV Substation on the Newman-Luna 345 kV line. These costs are estimates and may change when detailed engineering for the modifications are made. Project dollar amounts shown are in year 2002 U.S. dollars.

<u>SYSTEM MODIFICATION</u>	<u>COST*</u>
1a. Additional 345/115 kV transformer (200 MVA) at Diablo Sub	\$1.89 million
1b. 345 kV & 115 kV breakers w/structures, switches, & bus work	<u>\$1.73 million</u>
Subtotal:	\$3.62 million
2. New PST at Arroyo 345 kV to allow $\pm 75^\circ$ angle range	\$10.00 million
Total:	\$13.62 million

* Labor costs normally estimated at 25% of capital costs have not been included.

3.0 INTRODUCTION

This Transmission Service Request Study was performed in response to a Request for Firm Transmission Service from XXXXXXXXXXXXXXXXXXXXXXXXXX (XXX) in the amount of 135 MW commencing on January 1, 2003. The transmission service requested was between a Point of Delivery (POD) at Afton 345 kV Substation to a Point of Receipt (POR) at WestMesa 345 kV Substation. EPE accepted 30 MW and denied 105 MW of XXX's request due to insufficient available transmission capacity on the requested path and offered to perform this Transmission Service Request Study. This Study determined all impacts to the EPE system as a result of providing this firm transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation through the WestMesa-Arroyo 345 kV (EP) line. Modifications required to mitigate these impacts along with estimated costs were also provided in this Study. The study analyzed the 2003 Heavy Summer and 2003 Light Winter time periods.

The Study benchmark cases used in this analysis included proposed generation that is ahead of the Transmission Service Request in the study queue and may have an impact on the requested service. These included the following: 1) 613.9 MW of generation interconnected at the Luna 345 kV Substation (LUNA), and 2) 500 MW of generation interconnected at the Newman 115 kV Substation (NEW). Four variations of each benchmark case were analyzed in this study by switching combinations of the proposed generating stations on or off. This was done in order to study a wide range of operating scenarios that may occur when these new generators are interconnected into the EPE transmission system. **Variation #1** was the "Base Case", modeling the EPE system with all new generators off-line. **Variation #2** was the "AFTONONLY" case and analyzed the EPE system with Afton (135 MW) generation on-line and LUNA and NEW off-line. **Variation #3** was the "AFTONLUNA" case and analyzed the EPE system with Afton and LUNA generation on-line and NEW generation off-line. **Variation #4** was the "AFTONLUNANEW" case and analyzed the EPE system with Afton, LUNA, and NEW generation all on-line.

Generation output from the Afton Generating Station was modeled as being sent to the WestMesa 345 kV Substation through the EP line, and outputs from the other two generating stations, when operating, were modeled as being distributed evenly throughout the Western Systems Coordinating Council (WSCC). In addition to these "Variations", a powerflow sensitivity analysis was performed on the 2003HS AFTONONLY variation (Variation #2) to determine all violations of the Arroyo Phase Shifting Transformer (PST) angle range that may occur during different operating conditions.

As part of the evaluation process, EPE conducted powerflow, and Q-V reactive power margin analyses. Results of the analyses show that some criteria violations in the EPE area occur when EPE provides firm transmission service to XXX for the delivery of the Afton generation output from Afton 345 kV Substation to West Mesa 345 kV Substation, through the EP line. System modifications and estimated costs for these modifications have been provided which will correct the criteria violations. In addition, the analysis

shows that a system modification will be needed to correct a criteria violation on the PNM system. This criteria violation was noted in the study, but was not corrected.

3.1 Assumptions

The following assumptions are consistent for all study scenarios unless otherwise noted:

- Project dollar amounts shown are in year 2002 U.S. dollars.
- Estimated costs only include costs of the system modifications required to correct criteria violations determined in this Study. All other costs associated with the interconnection of the generator are not included.
- This study assumes that EPE substation space is available for the system modifications recommended.
- The cost estimates use EPE prices and may change when detailed engineering is done for any modifications.
- The cost estimates given in this Study do not include any environmental or regulatory costs.

3.2 Criteria

The reliability criteria standards used by EPE in performing this study are readily acceptable standards and are listed in Section 4 of EPE's FERC Form 715 (*Appendix 1*). The capacity rating of the PNM Luna-Mimbres 115 kV transmission line has been up-rated to 133 MW in this Study. Therefore, any criteria violations on this line will exceed this rating.

3.3 Procedure

As previously mentioned this Transmission Service Request Study included powerflow, and Q-V reactive margin analyses. Detailed discussions for each topic have been included in this report. The following procedures were used in conducting this study:

3.3.1 Base Case Development

For this Study, Heavy Summer (HS) and Light Winter (LW) benchmark cases were developed for the year 2003. These benchmark cases included proposed generators that are ahead of the requested firm Transmission Service in EPE's study queue and may impact the requested service. These generators included the following: 1) 613.9 MW of generation interconnected at the Luna 345 kV Substation (LUNA), and 2) 500 MW of generation interconnected at the Newman 115 kV Substation (NEW).

Four variations of each benchmark case (HS and LW) were analyzed by switching the proposed generating units on or off. This was done in order to study a wide range of operating scenarios that may occur when these new

generators are interconnected into the EPE transmission system. **Variation #1** was the “Base Case” and modeled the EPE system with all new generation off-line. **Variation #2** was the “AFTONONLY” case and analyzed the EPE system with the Afton (135 MW) generation on-line and the other two generating stations (LUNA and NEW) off-line. **Variation #3** was the “AFTONLUNA” case and analyzed the EPE system with Afton and LUNA generation on-line and NEW generation off-line. **Variation #4** was the “AFTONLUNANEW” case and analyzed the EPE system with Afton, LUNA, and NEW generation all on-line.

Generation output for the Afton Generating Station was modeled as being sent to the WestMesa 345 kV Substation through the EP line, and outputs from each of the other two generating stations, when operating, were modeled as being distributed evenly throughout the Western Systems Coordinating Council (WSCC).

This Study was performed to determine all impacts that may occur on the EPE system if EPE provides an additional 105 MW (135 MW total) of firm transmission service from the Afton 345 kV Substation to the WestMesa 345 kV Substation through the EP line. The Study determined system modifications that will correct the criteria violations found to be impacts due to providing the requested firm transmission service.

Load and resource documents for the 2003HS and 2003 LW base cases are included in *Appendix 2*. EPE powerflow maps (one-line diagrams) are included in *Appendix 3*.

3.3.2 List of Contingencies

The same contingencies were evaluated for all Variations of the 2003HS and 2003 LW cases. A list of these contingencies can be found in *Appendix 4*.

3.3.3 Q-V Analysis

Reactive margin Q-V analyses were performed on all Variations of the 2003 HS case to verify that the WSCC criteria for reactive power margin will be met under the worst contingency on the EPE system. A procedure developed by WSCC was used to determine the reactive power margin. As outlined in this procedure, load in the EPE area was increased by 5% and the worst contingency was analyzed to determine the reactive margin on the system. The margin is determined by identifying the critical (weakest) bus on the system during the worst contingency. The critical bus is the most reactive deficient bus. Q-V curves are developed and the minimum point on the curve is the critical point. If the minimum point of the Q-V curve is positive, the system is reactive power deficient. If it is negative, then the system has sufficient reactive power margin and meets the WSCC criteria.

Prior experience has shown that the worst contingencies impacting reactive power margin in the EPE area are the Springerville-Luna (SL), Luna-Diablo (LD), and Greenlee-Hidalgo (GH) 345 kV lines and the buses most impacted are the 345 kV buses at Arroyo, Newman, Caliente, Diablo, Luna, and Hidalgo. A Q-V analysis of these three 345 kV line contingencies on the 2003HS Benchmark Case determined that the LD contingency was the worst contingency impacting the system reactive power margin. Therefore this contingency was used to evaluate reactive power margins for all other Variations. In addition, the Newman-Afton and Luna-Afton 345 kV line contingencies were analyzed to make sure that there were not any negative impacts to the system reactive margin due to the interconnection of the Afton generation on the Luna-Newman 345 kV line. Q-V plots were created showing the margins available at the 345 kV buses listed above. The Q-V analysis plots and reactive power margins can be found in **Appendix 5**.

Please note that the reactive power margins for the 135 MW firm transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation determined in this Study are dependent upon the Afton Generating Station being on-line and generating the power, real and reactive, utilized by the transmission service. If this transmission service is utilized for any other purpose than for power generated by Afton Generating Station, the reactive power margins with the transmission service must be re-evaluated and a dynamic reactive source on the southwest New Mexico 345 kV system may be required.

4.0 POWERFLOW ANALYSIS RESULTS

Powerflow analyses were performed on the 2003 HS and 2003 LW Base Cases. These cases were modeled to simulate the transmission system with all proposed generation that is ahead of the Transmission Service Request in the queue and may have an impact on the request. Variations of these cases were developed by switching the proposed generating units on or off. This was done in order to study a wide range of operating scenarios that may occur when these new generators are interconnected into the EPE transmission system. **Variation #1** was the EPE system with all new generation turned off. **Variation #2** analyzed the EPE system with the Afton (135 MW) generation on-line and the other two generating stations (LUNA and NEW) off-line. **Variation #3** analyzed the EPE system with Afton and LUNA generation on-line and NEW generation off-line. **Variation #4** analyzed the EPE system with Afton, LUNA, and NEW generation all on-line. Voltage and/or loading criteria violations were determined for EPE and noted for other New Mexico utilities. These violations are shown in the Base Case and Contingencies Tables listed in *Appendix 6*.

Contingency (N-1) powerflow analyses were then performed for all cases. A list of the contingencies analyzed is shown in *Appendix 4*. For both the base case and contingency analyses, criteria violations were determined and modifications were evaluated to correct the violations. Contingencies that resulted in voltage and loading problems for non-EPE utilities were also noted in the tables of *Appendix 6*.

In addition to the powerflow analyses on the variations to the base cases, a sensitivity analysis was performed on the 2003 HS AFTON ONLY (Variation #2) case. This analysis was performed to determine all violations of the tap limits on the Arroyo Phase Shifting Transformer (PST). The Arroyo PST was designed with an angle range of $\pm 34^\circ$. The natural flow of power on the Arroyo-WestMesa (EP) line is from north to south. When power is forced to flow in the opposite direction (south to north), it forces the PST to increase its angle in order to hold the desired flow. This analysis was performed to determine if the maximum tap range was reached. If the maximum tap range is reached, a new PST with an increased angle range will be required in order to provide the desired MW flow through the EP line. Results of the powerflow and sensitivity analyses are listed below.

4.1 2003 HS Base Case (Variation #1)

The 2003 Heavy Summer (HS) base case was developed and base case and contingency powerflow analyses were performed. The EPE system was represented with 2003 HS loads and without any new generation on-line. This case simulated the EPE system, as it will exist in the summer of 2003 with all other proposed generation off-line. In this case, there were no EPE facilities with criteria violations with all lines in service. There were some criteria violations in the Tri-State and PNM areas that were noted but not corrected. The table below shows the overload criteria violations with all lines in service for the 2003 HS Base Case.

Please note that the % loading is a percentage of the normal rating for the table shown below.

**Overload Criteria Violations for 2003 HS Base Case
With All Lines In Service**

LINE	OWNER	RATING (MVA)	FLOW (MVA)	% LOADING
ALAMOGPG 115/25 kV XFMR	Tri-State	5.0	7.8	155.9
WILLARD 115/35 kV XFMR	Tri-State	9.4	11.8	125.1
MEJIA_T-NORTON_1 115 kV line	PNM	115.5	123.8	104.5
SOCORROP 115/25 kV XFMR	Tri-State	10.0	10.48	103.9

There were also criteria violations during contingency conditions in the PNM area. The table below shows the overload criteria violations for the benchmark case during contingency conditions. Please note that the % loading is a percentage of the emergency rating for the table shown below.

**Overload Criteria Violations for 2003HS Base Case
During Contingency Conditions**

CONTINGENCY	OVERLOADED LINE / TRANSFORMER	OWNER	% LOADING
SAN JUAN-B-A 345 kV line	HERNANDZ-NORTON_2 115 kV line	PNM	145.3
	HERNANDZ-OJO 115 kV line	PNM	137.1
FC-WESTMESA 345 kV line	HERNANDZ-NORTON_2 115 kV line	PNM	127.2
	HERNANDZ-OJO 115 kV line	PNM	124.3

For a detailed listing of all the criteria violations in the 2003 HS Variation #1 case, please refer to the “2003 HS Base Case” Table in **Appendix 6**.

4.2 2003 LW Base Case (Variation #1)

The 2003 Light Winter (LW) base case was developed and base case and contingency powerflow analyses were performed. The EPE system was represented with 2003 LW loads and with all new generation on-line. This case simulated the EPE system, as it will exist in the winter of 2003 with all other proposed generation off-line. In this case, there were no EPE facilities with criteria violations with all lines in service. There were two criteria violations in the Tri-State area that were noted but not corrected. The table below shows the overload criteria violations with all lines in service for the 2003 LW Base Case. Please note that the % loading is a percentage of the normal rating for the table shown below.

**Overload Criteria Violations for 2003 LW Base Case
With All Lines In Service**

LINE	OWNER	RATING (MVA)	FLOW (MVA)	% LOADING
ALAMOGPG 115/25 kV XFMR	Tri-State	5.0	6.8	135.6
WILLARD 115/35 kV XFMR	Tri-State	9.4	10.1	107.8

There were no criteria violations during contingency conditions in the 2003 LW Base Case.

4.3 2003 HS AFTON ONLY Case (Variation #2)

The 2003 HS AFTON ONLY case was developed and base case and contingency powerflow analyses were performed. The EPE system was represented with 2003 HS loads and with 135 MW of Afton generation on-line and sending the 135 MW output from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. This case simulated the EPE system, as it will exist in the summer of 2003 with the Afton generator on-line and all other proposed generation off-line. In this case, there were no EPE facilities with criteria violations with all lines in service. There were some criteria violations in the Tri-State and PNM areas that were noted but not corrected. The table below shows the overload criteria violations with all lines in service for the 2003 HS AFTON ONLY case. Please note that the % loading is a percentage of the normal rating for the table shown below.

Overload Criteria Violations for 2003 HS AFTON ONLY Case With All Lines In Service

LINE	OWNER	RATING (MVA)	FLOW (MVA)	% LOADING
ALAMOGPG 115/25 kV XFMR	Tri-State	5.0	7.8	155.9
WILLARD 115/35 kV XFMR	Tri-State	9.4	11.7	125.0
MEJIA_T-NORTON_1 115 kV line	PNM	115.5	125.4	105.8
SOCORROP 115/25 kV XFMR	Tri-State	10.0	10.4	103.9

There were also criteria violations during contingency conditions in the PNM area. The table below shows the overload criteria violations for the 2003 HS AFTON ONLY case during contingency conditions. Please note that the % loading is a percentage of the emergency rating for the table shown below.

Overload Criteria Violations for 2003 HS AFTON ONLY Case During Contingency Conditions

CONTINGENCY	OVERLOADED LINE / TRANSFORMER	OWNER	% LOADING
SAN JUAN-B-A 345 kV line	HERNANDZ-NORTON_2 115 kV line	PNM	126.8
	HERNANDZ-OJO 115 kV line	PNM	124.6
FC-WESTMESA 345 kV line	HERNANDZ-NORTON_2 115 kV line	PNM	112.2
	HERNANDZ-OJO 115 kV line	PNM	109.0
LUNA-AFTON 345 kV line	LUNA-MIMBRES 115 kV line	PNM	101.8
NEWMAN-AFTON 345 kV line	LUNA-MIMBRES 115 kV line	PNM	116.7

For a detailed listing of all criteria violations in the 2003 HS AFTON ONLY Variation #2 case, please refer to the “2003 HS AFTON ONLY Case” Table in **Appendix 6**.

4.4 2003 LW AFTON ONLY Case (Variation #2)

The 2003 LW AFTON ONLY case was developed and base case and contingency powerflow analyses were performed. The EPE system was represented with 2003 LW loads and with 135 MW of Afton generation on-line and sending the 135 MW output from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. This case simulated the EPE system, as it will exist in the winter of 2003 with the Afton generator on-line and all other proposed generation off-line. In this case, there were no EPE facilities with overload criteria violations with all lines in service. However, the maximum angle on the Arroyo PST tap of +34° is exceeded. The angle on the PST tap is +35.82° when trying to hold a 135 MW northern flow through the PST and the EP line. Therefore this is a criteria violation and a new PST will be required in order to provide 135 MW of firm transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation. Please refer to the “Arroyo PST Sensitivity Analysis” section of the report for more information on the recommended solution of this criteria violation.

There were also some overload criteria violations in the Tri-State area that were noted but not corrected. The table below shows the overload criteria violations with all lines in service for the 2003 LW AFTON ONLY case. Please note that the % loading is a percentage of the normal rating for the table shown below.

**Overload Criteria Violations for 2003 LW AFTON ONLY Case
With All Lines In Service**

LINE	OWNER	RATING (MVA)	FLOW (MVA)	% LOADING
ALAMOGPG 115/25 kV XFMR	Tri-State	5.0	6.8	135.6
WILLARD 115/35 kV XFMR	Tri-State	9.4	10.1	107.8

There were also criteria violations in the EPE and PNM areas during a contingency of the Newman-Afton 345 kV line. The table below shows the overload criteria violations for the 2003 LW AFTON ONLY case during a contingency of the Newman-Afton 345 kV line. Please note that the % loading is a percentage of the emergency rating for the table shown below.

**Overload Criteria Violations for 2003 LW AFTON ONLY Case
During Contingency Conditions**

CONTINGENCY	OVERLOADED LINE / TRANSFORMER	OWNER	% LOADING
NEWMAN-AFTON 345 kV line	DIABLO 345/115 kV XFMR #1	EPE	103.3
	DIABLO 345/115 kV XFMR #2	EPE	103.2
	LUNA-MIMBRES 115 kV line	PNM	101.2

The Diablo autotransformer overloads were corrected after a proposed third 345/115 kV autotransformer at Diablo was modeled. For a detailed listing of all the criteria violations in the 2003 LW AFTON ONLY Variation #2 case, please refer to the “2003 LW AFTON ONLY Case” Table in **Appendix 6**.

4.5 2003 HS AFTONLUNA Case (Variation #3)

The 2003 HS “AFTONLUNA” case was developed and base case and contingency powerflow analyses were performed. The EPE system was represented with 2003 HS loads, 613.9 MW of LUNA generation at Luna 345 kV Substation on-line and Afton generation on-line and sending the 135 MW output from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. This case simulated the EPE system, as it will exist in the summer of 2003 with both the Afton and LUNA generation on-line.

All interconnection modifications required from the previous LUNA Generation Interconnection Study performed by EPE, PNM, and TNMP were incorporated in the Variation #3 base cases (HS and LW). Therefore, all additional modifications required in this Variation are due to the requested Firm Transmission Service.

The Afton generation output was delivered to the WestMesa 345 kV Substation through the EP line and the LUNA generation output was distributed evenly throughout the WSCC. There were no EPE facilities with criteria violations with all lines in service in this case. There were some criteria violations in the Tri-State and PNM areas that were noted but not corrected. The table below shows the overload criteria violations with all lines in service for the 2003 HS AFTONLUNA case. Please note that the % loading is a percentage of the normal rating for the table shown below.

**Overload Criteria Violations for 2003 HS AFTONLUNA Case
With All Lines In Service**

LINE	OWNER	RATING (MVA)	FLOW (MVA)	% LOADING
ALAMO GPG 115/25 kV XFMR	Tri-State	5.0	7.8	155.9
WILLARD 115/35 kV XFMR	Tri-State	9.4	11.7	125.0
MEJIA_T-NORTON_1 115 kV line	PNM	115.5	125.4	105.8
SOCORROP 115/25 kV XFMR	Tri-State	10.0	10.4	104.4
SUNSHIN# 115/14 kV	PNM	12.5	12.6	100.5

There were also criteria violations during contingency conditions in the EPE and PNM areas. The table below shows the overload criteria violations for the 2003 HS AFTONLUNA case during contingency conditions. Please note that the % loading is a percentage of the emergency rating for the table shown below.

**Overload Criteria Violations for 2003 HS AFTONLUNA Case
During Contingency Conditions**

CONTINGENCY	OVERLOADED LINE / TRANSFORMER	OWNER	% LOADING
SAN JUAN-B-A 345 kV line	HERNANDZ-OJO 115 kV line	PNM	123.8
	HERNANDZ-NORTON_2 115 kV line	PNM	123.1
FC-WESTMESA 345 kV line	HERNANDZ-OJO 115 kV line	PNM	110.7
	HERNANDZ-NORTON_2 115 kV line	PNM	104.3
LUNA-AFTON 345 kV line	LUNA-MIMBRES 115 kV line	PNM	113.0
NEWMAN-AFTON 345 kV line	LUNA-MIMBRES 115 kV line	PNM	127.6
	DIABLO 345/115 kV XFMR #1	EPE	100.9
	DIABLO 345/115 kV XFMR #2	EPE	100.9
NEWMAN-ARROYO 345 kV line	LUNA-MIMBRES 115 kV line	PNM	105.8
LUNA-DIABLO 345 kV line	LUNA-MIMBRES 115 kV line	PNM	104.7
ARROYO 345/115 kV XFMR	LUNA-MIMBRES 115 kV line	PNM	100.2

The Diablo autotransformer overloads were corrected after a proposed third 345/115 kV autotransformer at Diablo was modeled. For a detailed listing of all criteria violations in the 2003 HS AFTONLUNA Variation #3 case, please refer to the “2003 HS AFTONLUNA CASE” Table in **Appendix 6**.

4.6 2003 LW AFTONLUNA Case (Variation #3)

The 2003 LW “AFTONLUNA” case was developed and base case and contingency powerflow analyses were performed. The EPE system was represented with 2003 LW loads, 613.9 MW of LUNA generation on-line and 135 MW of Afton generation on-line and sending the 135 MW output from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. This case simulated the EPE system, as it will exist in the winter of 2003 with both the Afton and LUNA generation on-line. The Afton generation output was delivered to the WestMesa 345 kV Substation through the EP line and the LUNA generation output was distributed evenly throughout the WSCC. There were no EPE facilities with criteria violations with all lines in service in this case. There were two criteria violations in the Tri-State area that were noted but not corrected. The table below shows the overload criteria violations with all lines in service for the 2003 LW AFTONLUNA case. Please note that the % loading is a percentage of the normal rating for the table shown below.

**Overload Criteria Violations for 2003 LW AFTONLUNA Case
With All Lines In Service**

LINE	OWNER	RATING (MVA)	FLOW (MVA)	% LOADING
ALAMOGPG 115/25 kV XFMR	Tri-State	5.0	6.8	136.2
WILLARD 115/35 kV XFMR	Tri-State	9.4	10.2	108.3

There were also criteria violations in the EPE and PNM areas during a contingency of the Newman-Afton 345 kV line. The table below shows the overload criteria

violations for the 2003 HS AFTONLUNA case during the Newman-Afton 345 kV line contingency. Please note that the % loading is a percentage of the emergency rating for the table shown below.

**Overload Criteria Violations for 2003 LW AFTONLUNA Case
During Contingency Conditions**

CONTINGENCY	OVERLOADED LINE / TRANSFORMER	OWNER	% LOADING
NEWMAN-AFTON 345 kV line	LUNA-MIMBRES 115 kV line	PNM	110.0
	DIABLO 345/115 kV XFMR #1	EPE	106.2
	DIABLO 345/115 kV XFMR #2	EPE	106.2

The Diablo autotransformer overloads were corrected after a proposed third 345/115 kV autotransformer at Diablo was modeled. For a detailed listing of all criteria violations in the 2003 LW AFTONLUNA Variation #3 case, please refer to the “2003 LW AFTONLUNA CASE” Table in **Appendix 6**.

4.7 2003 HS AFTONLUNANEW Case (Variation #4)

The 2003 HS AFTONLUNANEW case was developed and base case and contingency powerflow analyses were performed. The EPE system was represented with 2003 HS loads. It included 613.9 MW of LUNA generation at Luna 345 kV Substation, 500 MW of NEW generation at Newman 115 kV Substation and Afton generation on-line and sending the 135 MW output from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. This case simulated the EPE system, as it will exist in the summer of 2003 with the Afton, LUNA, and NEW generation on-line.

All interconnection modifications required from the previous LUNA Generation Interconnection Study performed by EPE, PNM, and TNMP, and the interconnection modifications required from the previous NEW Generation Interconnection Study performed by EPE were incorporated in the Variation #4 base cases (HS and LW). Therefore, all additional modifications required in this Variation are due to the requested Firm Transmission Service.

The Afton generation output was delivered to the WestMesa 345 kV Substation through the EP line and the LUNA and NEW generation outputs were distributed evenly throughout the WSCC. There were no EPE facilities with criteria violations with all lines in service in this case. There were some criteria violations in the Tri-State and PNM areas that were noted but not corrected. The table below shows the overload criteria violations with all lines in service for the 2003 HS AFTONLUNANEW case. Please note that the % loading is a percentage of the normal rating for the table shown below.

**Overload Criteria Violations for 2003 HS AFTONLUNANEW Case
With All Lines In Service**

LINE	OWNER	RATING (MVA)	FLOW (MVA)	% LOADING
ALAMOGPG 115/25 kV XFMR	Tri-State	5.0	7.9	157.1
WILLARD 115/35 kV XFMR	Tri-State	9.4	11.9	126.4
MEJIA_T-NORTON_1 115 kV line	PNM	115.5	132.1	112.0
SOCORROP 115/25 kV XFMR	Tri-State	10.0	10.5	104.8
SUNSHIN# 115/14 kV	PNM	12.5	12.6	100.8

There were also criteria violations during contingency conditions in the PNM area. The table below shows the overload criteria violations for the 2003 HS AFTONLUNANEW case during contingency conditions. Please note that the % loading is a percentage of the emergency rating for the table shown below.

**Overload Criteria Violations for 2003 HS AFTONLUNANEW Case
During Contingency Conditions**

CONTINGENCY	OVERLOADED LINE / TRANSFORMER	OWNER	% LOADING
SAN JUAN-B-A 345 kV line	HERNANDZ-OJO 115 kV line	PNM	123.5
	HERNANDZ-NORTON_2 115 kV line	PNM	120.1
FC-WESTMESA 345 kV line	HERNANDZ-OJO 115 kV line	PNM	109.8
	HERNANDZ-NORTON_2 115 kV line	PNM	100.7

For a detailed listing of all criteria violations in the 2003 HS AFTONLUNANEW Variation #4 case, please refer to the 2003 HS AFTONLUNANEW CASE Table in **Appendix 6**.

4.8 2003 LW AFTONLUNANEW Case (Variation #4)

The 2003 LW AFTONLUNANEW case was developed and a base case and contingency powerflow analysis was performed. The EPE system was represented with 2003 LW loads, 613.9 MW of LUNA generation, 500 MW of NEW generation on-line and Afton generation on-line and sending the 135 MW output from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. This case simulated the EPE system, as it will exist in the winter of 2003 with the Afton, LUNA, and NEW generation on-line. The Afton generation output was delivered to the WestMesa 345 kV Substation through the EP line and the LUNA and NEW generation outputs were distributed evenly throughout the WSCC. There were no EPE facilities with criteria violations with all lines in service in this case. There were two criteria violations in the Tri-State area that were noted but not corrected. The table below shows the overload criteria violations with all lines in service for the 2003 LW AFTONLUNANEW case. Please note that the % loading is a percentage of the normal rating for the table shown below.

**Overload Criteria Violations for 2003 LW AFTONLUNANEW Case
With All Lines In Service**

LINE	OWNER	RATING (MVA)	FLOW (MVA)	% LOADING
ALAMOGPG 115/25 kV XFMR	Tri-State	5.0	7.9	136.6
WILLARD 115/35 kV XFMR	Tri-State	9.4	11.9	108.8

There were also criteria violations during contingency conditions in the PNM area. The table below shows the overload criteria violations for the 2003 LW AFTONLUNANEW case during contingency conditions. Please note that the % loading is a percentage of the emergency rating for the table shown below.

**Overload Criteria Violations for 2003 LW AFTONLUNANEW Case
During Contingency Conditions**

CONTINGENCY	OVERLOADED LINE / TRANSFORMER	OWNER	% LOADING
SAN JUAN-B-A 345 kV line	HERNANDZ-OJO 115 kV line	PNM	123.5
	HERNANDZ-NORTON_2 115 kV line	PNM	120.1
FC-WESTMESA 345 kV line	HERNANDZ-OJO 115 kV line	PNM	109.8
	HERNANDZ-NORTON_2 115 kV line	PNM	100.7

For a detailed listing of all criteria violations in the 2003 LW AFTONLUNANEW Variation #4 case, please refer to the 2003 LW AFTONLUNANEW CASE Table in **Appendix 6**.

4.9 Sensitivity Analysis of Arroyo PST Tap Range

In addition to the powerflow analyses performed on the cases listed above, a sensitivity analysis on the Arroyo PST tap range was performed. This sensitivity analysis was performed on the 2003 HS AFTON ONLY (Variation #2) case. This analysis was performed to determine all violations of the tap limits on the Arroyo Phase Shifting Transformer (PST). The Arroyo PST was designed with an angle range of $\pm 34^\circ$. The natural flow of power on the Arroyo-WestMesa (EP) line from north to south. When power is sent in the opposite direction (south to north), this operation forces the PST to increase its angle in order to hold the desired flow. This analysis was performed to determine if the maximum existing angle was reached. If the maximum existing angle is reached, a new PST with an increased angle range will be required to provide the desired transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. This sensitivity analyzed various operating scenarios that will occur due to maintenance and/or contingency conditions. The table below shows the results of the sensitivity analysis. The first sensitivity (2003 HS case without requested Transmission Service) is shown to provide a comparison of the impact on the PST angle when 135 MW of Afton generation is sent north through the EP line.

**SENSITIVITY ANALYSIS ON 2003 HS AFTON ONLY CASE
TO DETERMINE ANGLE LIMIT VIOLATIONS ON ARROYO PST**

	SENSITIVITY	PST FLOW (MW)	PST ANGLE (DEGREES)
1	2003 HS case without requested Transmission Service	+185.3	0.11
2	2003 HS case with requested Transmission Service (all lines in service)	-135.0	29.61
3	2003 HS case with requested Transmission Service and 25% series compensation on WestMesa-Arroyo 345 kV line	-135.4	27.90
4	2003 HS case with requested Transmission Service and 50% series compensation on WestMesa-Arroyo 345 kV line	-134.5	26.01
5	Springerville Generation off (2 units)	-134.9	34.30
6	Springerville-Luna (SL) Series Compensation off	-135.4	46.72
7	Springerville-Greenlee (SG) Series Compensation off	-134.6	35.29
8	San Juan- McKinley (SJMK) Series Compensation off	-135.1	37.10
9	Springerville-Vail (SV) Series Compensation off	-135.0	29.71
10	SG & SJMK Series Compensation off	-135.0	41.25
11	SG, SJMK, & SV Series Compensation off	-135.0	42.10
12	SL & SJMK Series Compensation off	-135.3	52.90
13	SL, SJMK, & SV Series Compensation off	-134.9	54.00
14	SL & SG Series Compensation off	-135.4	79.90

As can be seen in the table above, all sensitivities except Sensitivities #2-#4 and #9 exceed the existing +34° angle limit of the PST. In addition, the Arroyo PST angle was +35.8° in the 2003 LW AFTON ONLY case, also exceeding the designed angle limit of the PST. A comparison between the case without Afton generation and without the requested Transmission Service (Sensitivity #1) and the case with Afton generation on-line and with the requested Transmission Service (Sensitivity #2) shows the impact of the firm Transmission Service request on the PST angle. In Sensitivity #1, the PST angle is at +0.11°. Once the requested transmission service is provided from Afton 345 kV Substation to WestMesa 345 kV Substation (Sensitivity #2), the PST angle increases to +29.61°, almost reaching its maximum limit.

Sensitivities #3 and #4 were performed to determine if adding series compensation on the EP line would reduce the angle on the PST. Series compensation sensitivities of 25% and 50% were analyzed. Comparing Sensitivities #3 and #4 against Sensitivity #2 in the table above shows that the 25% series compensation sensitivity reduced the PST angle by 1.71° and the 50% series compensation sensitivity reduced the PST angle by 3.60°. This angle reduction is not enough to eliminate the need for a new Arroyo PST with a wider-angle range. Additionally, at this time EPE does not recommend series compensation on the EP line. If such compensation is recommended at a future date, additional studies such as SSR studies will be required.

It should also be noted that of the sensitivities analyzed above, only the SL line series compensation is controlled by EPE. Therefore, all other sensitivities not showing the SL series compensation off are out of EPE's control. Since this sensitivity analysis shows the Arroyo PST angle limit is exceeded in many different operating conditions, a new PST with a ± 75°-angle range is required to replace the existing Arroyo PST if the Transmission Request is accepted. This is needed to ensure a firm transmission path of 135 MW from Afton 345 kV Substation to WestMesa 345 kV Substation.

4.10 Conclusions of Powerflow Analyses

In conclusion, results of the powerflow and sensitivity analyses show that impacts to the EPE transmission system occur and are required to be corrected in order to provide an additional 105 MW (135 MW total) of firm transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation. A summary of the estimated costs to correct the impacts to the EPE system is listed below:

**ESTIMATED SYSTEM MODIFICATION COSTS TO PROVIDE
135 MW OF FIRM TRANSMISSION SERVICE FROM AFTON
345 KV SUBSTATION TO WESTMESA 345 KV SUBSTATION**

SYSTEM MODIFICATION	ESTIMATED COST
Third 345/115 kV XFMR (200 MVA) at Diablo Substation	\$3,620,000
Replace Arroyo PST with new PST with a $\pm 75^\circ$ -angle range	\$10,000,000
TOTAL COST:	\$ 13,620,000

In addition to EPE’s recommended system modifications, PNM’s Luna-Mimbres 115 kV line exceeds its emergency operating rating of 133 MW in the Variation #2 and Variation #3 cases (both HS and LW). Therefore, this line will also need to be upgraded. However, since EPE neither owns nor operates this transmission line, no cost evaluation of upgrading the line was made. The line owners, PNM and TNMP must be contacted for this upgrade.

It should also be noted that transferring the 135 MW output of the Afton Generating Station over the requested transmission path from Afton 345 kV Substation to WestMesa 345 kV Substation through the PST has an effect on the Northern New Mexico Import (NNMI) level. In the base case with the Afton Generating Station off-line, the NNMI level in the base case powerflow was 1217.4 MW. The table below shows the calculation of NNMI capability for the “Base Case” without the firm transmission service requested:

**CALCULATION OF NNMI FOR BASE CASE
(WITHOUT FIRM TRANSMISSION SERVICE ON EP LINE)**

NORTHERN NM IMPORTS (+)	FLOW (MW)
Four Corners-WestMesa 345kV	+563.2
San Juan-BA 345 kV	+523.5
San Juan-Ojo 345 kV	+191.2
Bisti-Ambrosia 230 kV	+ 83.4
McKinley-Yahtahey 345 kV	+83.3
WestMesa-Arroyo PST 345 kV	-185.4
Belen-Bernardo 115 kV	-41.8
NNMI FLOW:	1217.4 MW

Once the Afton generation is brought on-line and delivered to the WestMesa 345 kV Substation through the PST, calculated the NNMI level in the powerflow case

increased to 1364.2 MW. The table below shows the calculation of the NNMI capability for the “Afton Only Case” with the firm transmission service requested:

**CALCULATION OF NNMI FOR AFTON ONLY CASE
(WITH FIRM TRANSMISSION SERVICE ON EP LINE)**

NORTHERN NM IMPORTS (+)	FLOW (MW)
Four Corners-WestMesa 345kV	+477.6
San Juan-BA 345 kV	+465.5
San Juan-Ojo 345 kV	+184.9
Bisti-Ambrosia 230 kV	+ 72.4
McKinley-Yahtahey 345 kV	+75.1
WestMesa-Arroyo PST 345 kV	+135.0
Belen-Bernardo 115 kV	-46.3
NNMI FLOW:	1364.2 MW

As can be seen in the tables above, the calculated overall NNMI level increases when the 135 MW generation output from the Afton Generating Station is transferred to the WestMesa 345 kV Substation through the requested transmission path. Although the NNMI level increases with the 135 MW transmission service through the EP line, flows on all northern New Mexico lines (except the EP line) actually decrease. Therefore, the NNMI capability will need to be recalculated in order to account for the change in direction of flow on the EP line. This new calculation will determine a new NNMI limit if the transmission service request is granted.

5.0 Q-V ANALYSIS RESULTS

Q-V reactive margin analyses were conducted to verify that providing an additional 105 MW (135 MW total) of firm transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line complies with the WSCC Voltage Stability Criteria. Q-V analysis provides a way to investigate the potential for voltage collapse during the post-transient period within 3 minutes after the disturbance. Q-V analyses were performed on all variations of the 2003 HS case.

The procedure developed by WSCC was used to determine the reactive power margin. As outlined in this procedure, load is increased in the EPE area by 5% and the worst contingency was analyzed to determine the reactive margin on the system. The margin is determined by identifying the critical (weakest) bus on the system during the worst contingency. The critical bus is the most reactive deficient bus. Q-V curves are developed and the minimum point on the curve is defined as the critical point. If the minimum point of the Q-V curve is positive, i.e., above the x-axis, the system is reactive power deficient. If it is negative, i.e., below the x-axis, then the system has some reactive power margin and meets the WSCC criteria.

From experience, it has been established that the worst contingencies impacting reactive power margin on the EPE system are the Springerville-Luna (SL), Luna-Diablo (LD), and Greenlee-Hidalgo (GH) 345 kV lines. During this analysis, it was determined that the worst contingency for voltage stability on the EPE system is the LD 345 kV line. This contingency, therefore, was used in the final analysis to verify that EPE reactive power margins are in compliance with the WSCC criteria. In addition, the Newman-Afton and Luna-Afton 345 kV line contingencies were analyzed to ensure there were no negative impacts to the system reactive margin as a result of the interconnection of Afton generation on the Luna-Newman 345 kV line. Q-V analyses were conducted for the 2003 Heavy Summer system configuration. EPE 345 kV buses monitored included Arroyo, Caliente, Newman, Diablo, Luna, and Hidalgo. Resulting plots and reactive power margins of the analyses can be found in *Appendix 5*.

Please note that the reactive power Q-V margins determined in this analysis for the 135 MW firm transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation are dependent upon the Afton Generating Station being on-line and generating the power, real and reactive, utilized by the transmission service. If this transmission service is utilized for any other purpose than for power generated by Afton Generating Station, the reactive power margins for the transmission service (readjustment of PST flow) must be re-evaluated and a dynamic reactive source on the southwest New Mexico 345 kV system may be required.

Following are the results of the Q-V analysis. The tables that follow show the reactive power margins available for each bus analyzed in each Variation. Please note that a negative number indicates that there is sufficient reactive power to meet WSCC criteria and a positive number indicates that the system is deficient in reactive power and does not meet the criteria.

5.1 2003 HS Base Case (Variation #1)

The Variation #1 case simulated the EPE system without any new generation on-line. Analysis on this case was performed to determine the reactive margin on the EPE system before any new generation comes on-line and ensure that the margin stays the same or higher as new generation comes on-line. The tables below show the results of the analyses for the Luna-Diablo (LD) 345 kV line outage, the Greenlee Hidalgo (GH) 345 kV line outage and the Springerville-Luna (SL) 345 kV line outage:

**2003 HS Base Case – Available Reactive Power Margin
Luna-Diablo 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-114.4
Newman 345 kV	-113.4
Caliente 345 kV	-101.0
Diablo 345 kV	-107.0
Luna 345 kV	-167.0
Hidalgo 345 kV	-236.8

**2003 HS Base Case – Available Reactive Power Margin
Greenlee-Hidalgo 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-123.8
Newman 345 kV	-123.8
Caliente 345 kV	-113.6
Diablo 345 kV	-130.3
Luna 345 kV	-125.6
Hidalgo 345 kV	-115.5

**2003 HS Base Case – Available Reactive Power Margin
Springerville-Luna 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-125.4
Newman 345 kV	-123.8
Caliente 345 kV	-114.3
Diablo 345 kV	-137.3
Luna 345 kV	-137.3
Hidalgo 345 kV	-167.4

As can be seen in the tables above, there were no reactive power margin deficiencies in this case. Of all the buses monitored, the Caliente 345 kV bus had the least MVAR margin. It had a -101.0 MVAR reactive margin during the LD contingency in the 2003 HS case. This margin indicates that there is sufficient reactive power to meet WSCC criteria. The Q-V analysis plots and reactive power margins for the 2003 HS Base Case can be found on pages 1-1 through 1-4 of *Appendix 5*.

5.2 2003 HS AFTON ONLY Case (Variation #2)

The Variation #2 case simulated the EPE system with Afton generation on-line and sending the output from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line. Analysis on this case was performed to determine the reactive margin on the EPE system when Afton generation is on-line and utilizing the requested transmission path and other proposed generators are off-line. This analysis was done to ensure the reactive margin in this case is the same or higher than that shown in Variation #1. The tables below show the results of the analyses for the LD 345 kV line outage, the GH 345 kV line outage, and the SL 345 kV line outage:

**2003 HS AFTON ONLY Case – Available Reactive Power Margin
Luna-Diablo 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-215.7
Newman 345 kV	-211.8
Caliente 345 kV	-186.1
Diablo 345 kV	-147.8
Luna 345 kV	-351.3
Hidalgo 345 kV	-518.6

**2003 HS AFTON ONLY – Available Reactive Power Margin
Greenlee-Hidalgo 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-306.0
Newman 345 kV	-296.8
Caliente 345 kV	-267.3
Diablo 345 kV	-284.6
Luna 345 kV	-327.0
Hidalgo 345 kV	-283.3

**2003 HS AFTON ONLY – Available Reactive Power Margin
Springerville-Luna 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-291.5
Newman 345 kV	-281.8
Caliente 345 kV	-253.7
Diablo 345 kV	-271.6
Luna 345 kV	-318.7
Hidalgo 345 kV	-395.2

As can be seen in the above tables, there were no reactive power margin deficiencies in this case. The Diablo 345 kV was determined to be the critical bus. It showed a -147.8 MVAR reactive margin during the LD contingency. This margin is well within the WSCC criteria and is also higher than that shown in Variation #1. The Q-V analysis plots and reactive power margins for the 2003 HS AFTON ONLY Case can be found on pages 2-1 through 2-6 of *Appendix 5*.

5.3 2003 HS AFTONLUNA Case (Variation #3)

The Variation #3 case simulated the EPE system with Afton and LUNA generation on-line and 135 MW being transferred on the requested transmission path from Afton 345 kV Substation to WestMesa 345 kV Substation. Analysis on this case was performed to determine the reactive margin on the EPE system when Afton and LUNA generation are both on-line and the requested transmission service is being utilized. This analysis was also performed to ensure the reactive margin in this case is the same or higher than that shown in Variation #1. The tables below show the results of the analysis for the LD, Newman-Afton, and Luna-Afton 345 kV line outages:

**2003 HS AFTONLUNA Case – Available Reactive Power Margin
Luna-Diablo 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-277.4
Newman 345 kV	-232.9
Caliente 345 kV	-235.2
Diablo 345 kV	-170.7
Luna 345 kV	-541.4

**2003 HS AFTONLUNA Case – Available Reactive Power Margin
Newman-Afton 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-202.1
Newman 345 kV	-188.9
Caliente 345 kV	-175.7
Diablo 345 kV	-291.0
Luna 345 kV	-595.5

**2003 HS AFTONLUNA – Available Reactive Power Margin
Luna-Afton 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-333.7
Newman 345 kV	-291.5
Caliente 345 kV	-297.0
Diablo 345 kV	-456.0
Luna 345 kV	-912.6

As can be seen in the tables above, there were no reactive power margin deficiencies in this case. For this case, the Diablo 345 kV bus was again determined to be the critical bus. It showed a –170.7 MVAR reactive margin during the LD contingency. This margin is well within the WSCC criteria and is also higher than that shown in Variation #1. The Q-V analysis plots and reactive power margins for the 2003 HS AFTONLUNA Case can be found on pages 3-1 through 3-3 of *Appendix 5*.

5.4 2003 HS AFTONLUNANEW Case (Variation #4)

The Variation #4 case simulated the EPE system with Afton, LUNA, and NEW generation all on-line and 135 MW being transferred on the requested transmission path from Afton 345 kV Substation to WestMesa 345 kV Substation. Analysis on this case was performed to determine the reactive margin on the EPE system when all new generators are on-line and the requested transmission service is being utilized. This analysis was also performed to ensure the reactive margin in this case is the same or higher than that shown in Variation #1. The tables below show the results of the analysis for the LD, Newman-Afton, and Luna-Afton 345 kV line outages:

**2003 HS AFTONLUNANEW Case – Available Reactive Power Margin
Luna-Diablo 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-673.9
Newman 345 kV	-703.2
Caliente 345 kV	-583.8
Diablo 345 kV	-283.2
Luna 345 kV	-1131.5

**2003 HS AFTONLUNANEW Case – Available Reactive Power Margin
Newman-Afton 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-484.9
Newman 345 kV	-466.4
Caliente 345 kV	-424.6
Diablo 345 kV	-719.7
Luna 345 kV	-1081.4

**2003 HS AFTONLUNANEW – Available Reactive Power Margin
Luna-Afton 345 kV Line Outage**

Bus Name	Reactive Margin (MVAR)
Arroyo 345 kV	-568.2
Newman 345 kV	-557.6
Caliente 345 kV	-503.9
Diablo 345 kV	-742.7
Luna 345 kV	-1037.1

As can be seen in the tables above, there were no reactive power margin deficiencies in this case. For this case, the Diablo 345 kV bus was again determined to be the critical bus. It showed a –283.2 MVAR reactive margin during the LD contingency. This margin is well within the WSCC criteria and is also higher than that shown in Variation #1. The Q-V analysis plots and reactive power margins for the 2003 HS AFTONLUNANEW Case can be found on pages 4-1 through 4-3 of *Appendix 5*.

In conclusion, the Q-V analyses indicate that there is sufficient MVAR margin to meet the WSCC criteria in all Variations analyzed. The analysis shows that providing an additional 105 MW (135 MW total) of firm transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation through the EP line does not adversely impact the EPE system reactive margin. However, reactive power Q-V margins determined in this analysis are dependent upon the Afton Generating Station being on-line and generating the

power, real and reactive, utilized by the transmission service. If this transmission service is utilized for any other purpose than for power generated by Afton Generating Station, the reactive power margins for the transmission service (readjustment of PST flow) must be re-evaluated and a dynamic reactive source on the southwest New Mexico 345 kV system may be required.

6.0 TIME FRAME FOR EPE SYSTEM MODIFICATIONS

The following table shows the estimated time needed to construct/upgrade facilities required on the EPE system as a result of providing an additional 105 MW (135 MW total) of firm point-to-point transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation. Times shown are in months.

PROJECT	Order Materials	Engineering & Design	Construction	Total
Add third 345/115 kV transformer at Diablo Sub	6-8	3-6	3-6	12-20
Replace Arroyo 345 kV PST with new PST	9-11	3-5	6-8	18-24

As can be seen from the table above, the addition of a third 345/115 kV transformer at Diablo Substation can take from 12-20 months to complete. The time frame is dependent on the number of orders ahead of EPE's order in the manufacturer's ordering queue. It is also dependent on the number of projects the EPE Substation Department has scheduled ahead of this project.

The replacement of the Arroyo Phase Shifting Transformer can take from 18-24 months, also depending on the number of orders ahead of EPE's order in the manufacturer's ordering queue and on the number of projects the EPE Substation Department has scheduled ahead of the project. If the infrastructure installed at Arroyo is utilized, the line will not need to be taken out of service to complete construction. However, during the removal of the old PST and the installation of the new PST, there will be no flow control on the WestMesa-Arroyo (EP) 345 kV line. At this time, EPE's Substation cannot give a good estimate of the time it will take to restore the power flow control to the EP line. During this time it is necessary that arrangements be made with PNM to maintain EPE's transmission capability into southern New Mexico.

7.0 DISCLAIMER

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. Additionally, contracts and agreements between EPE and PNM govern the setting of the phase shifting transformer that is integral to the requested transmission path. Therefore, notwithstanding the physical transmission transfer capacities determined in this Study, any changes in or use of the transfer capacities above those contractual limits, including changing the PST settings, will require agreement of the contractual parties or re-negotiation of the applicable contracts.

8.0 CERTIFICATION

El Paso Electric Company (EPE) has performed this *Transmission Service Request Study* for XXXXXXXXXXXXXXXXXXXXXXXXXXXX (XXX) pursuant to XXX's Request for firm Transmission Service received by EPE on October 24, 2001 and the *Agreement for a Transmission Service Facilities Study* signed December 12, 2001. The Study analyzes the impacts on the EPE system in providing an additional 105 MW (135 MW total) of firm transmission service from Afton 345 kV Substation to WestMesa 345 kV Substation. It also provides cost estimates for facilities required to correct the impacts on EPE's transmission system. In addition, the Study notes impacts to other systems caused by the requested transmission service. EPE performed powerflow and QV reactive margin analyses.

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