[redacted] Report to:

Southwest Power Pool

for

[redacted]

Power Flow Study

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Foreword

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1. Introduction

[redacted] is proposing to construct two 200 MW Variable Frequency Transformer (VFT) installations at the existing High Voltage Direct Current (HVDC) facility sites at Blackwater and Eddy County on the Southwestern Public Service (SPS) transmission systems. Each site will consist of two 100 MW VFT's. Per the Southwest Power Pool (SPP) Open Access Transmission Tariff, a feasibility study is required to evaluate the initial impact of the new facilities upon the existing transmission system. General Electric's Power Systems Energy Consulting group (PSEC) has performed this study for SPP.

The objective of this study was to test the performance of the SPS transmission system with the proposed VFT installations on line and determine the impacts caused by area power transfers in the east-west and west-east directions. A relative approach was used for this analysis. First, the thermal and voltage performance of the benchmark system, without the proposed VFT's, was determined in order to establish a baseline. Then system performance with the VFT's was determined and compared to the baseline. This relative approach removes any ambiguities as to the actual impact of the proposed VFT's and associated power transfer since existing criteria violations are identified.

The power flow analysis identified transmission line and transformer loading under both normal and contingency (e.g., single line outage) operating conditions. Voltage violations under normal and contingency conditions were also identified. Reinforcements to correct violations have not been study.

2. Study Approach

2.1 System Conditions

Two cases, representing the 2004 summer peak system conditions with the existing SPS HVdc ties in export and import mode, were provided by SPS. A summary of the SPS area (area 526 in the powerflow data) is provided in Table 2.1 for the two benchmark cases.

Table 2.1 SPS area conditions for benchmark cases

	Export Benchmark Case (export-ep0)	Import Benchmark Case (import-ep0)
Total Generation	5380 MW	4575 MW
Total Load	4982 MW	4982 MW
Imports from ac ties	400 MW	0 MW

Each of these benchmark cases was modified to include the proposed VFT. Two VFT installations were considered. One VFT was connected at the Roosevelt substation, in parallel with the existing Blackwater back-to-back HVdc to Public Service New Mexico (PNM). The second VFT was installed at the Eddy County substation, in parallel with the back-to-back Eddy Co. HVdc tie. For this installation, both 230 kV and 345 kV interconnection alternatives were considered. In summary, the following interconnection options were studied:

- 230kV interconnection at Roosevelt substation
- 230kV interconnection at Eddy County substation
- 345kV interconnection at Eddy County substation

Both East-West and West-East transfers scenarios were considered for each VFT. For all cases, the direction of transfer for the VFT's and HVdc ties was kept the same. The following conditions were studied:

- 200MW West-East Transfer for Blackwater VFT
- 200MW East-West Transfer for Blackwater VFT
- 200MW West-East Transfer for Eddy County VFT
- 200MW East-West Transfer for Eddy County VFT

- 400MW West-East Transfer for Blackwater & Eddy County VFT
- 400MW East-West Transfer for Blackwater & Eddy County VFT

Twelve study cases were developed to represent the different combinations of VFT interconnection and transfer scenarios. These are listed in Table 2.2. The table lists a case name and the transfer of each VFT. The "export" cases all modeled the in-service VFT's and existing HVdc ties exporting power to the WSCC system. The "import" cases all modeled the in-service VFT's and existing HVdc ties importing power from the WSCC system. In order to accommodate the change in imports or exports from the benchmark cases (*export-ep0* and *import-ep0*), generation in the SPP system was uniformly scaled up or down. However, SPS generation (area 526 in the powerflow data) was not modified. For example the SPP generation was scaled up by 400 MW from the dispatch represented in case *export-ep0* to create case *export-ep4*. The SPS generation was not changed. Thus, the incremental exchanges of power (import or export) by the VFT's was received or delivered over the SPS ac ties to the remainder of the SPP system. Incremental losses were provided by the system swing generator.

Table 2.2 Study scenarios

Case Name	Blackwater 230 kV VFT	Eddy Co. 230 kV VFT	Eddy Co. 345 kV VFT
export-ep0	-	-	-
export-ep1	200 MW	-	-
export-ep2	-	200 MW	-
export-ep3	-	-	200 MW
export-ep4	200 MW	200 MW	-
export-ep5	200 MW	-	200 MW
import-ep0	-	-	-
import-ep1	200 MW	-	-
import-ep2	-	200 MW	-
import-ep3	-	-	200 MW
import-ep4	200 MW	200 MW	-
import-ep5	200 MW	-	200 MW

In all cases, the VFT was modeled as a generator with no reactive capability or shunt compensation.

Local and regional contingencies were studied for evaluating the steady-state performance of the SPS system with and without the VFT installations. The following contingencies were studied:

- Zone 264: Clovis/Hereford 69 kV and up
- Zone 267: Pecos Valley 69 kV and up
- Zone 268: Hobbs 115 kV and up
- Area 526: SPS area 345 kV and up

In total, 268 line and transformer outages were evaluated. Contingency cases were solved with all control elements active. For each outage, all bus voltages and line/transformers flow in the SPS area with a voltage level of 69 kV and above were monitored for violations. The following SPS and SPP criteria were applied:

Thermal Criteria: Line and transformer flows to remain within their normal rating (first rating listed in the powerflow data) for normal operating conditions. Flows to remain within their emergency rating (second rating listed in the powerflow data) for post-contingency conditions.

Voltage Criteria: All station voltages to remain between 0.95 pu and 1.05 pu for normal conditions. Voltage to remain between 0.90 and 1.05 for post-contingency conditions. The change in voltage from normal to post-contingency to be less than 0.05 pu, regardless of the absolute voltage.

Voltage and branch flows that did not meet criteria listed above were flagged as violations.

3. Results

This section describes the results of the primary thermal and voltage analysis of the two VFT installations. A full listing of all unsolved cases, thermal violations, and voltage violations is provided in Appendix A. In this section, the results of analysis for each VFT interconnection scenario is described, with relevant tables showing violations.

3.1 Description of Tabular Results

Results of the thermal and voltage analysis are provided in this section. The results are presented in the form of tables showing comparisons of the benchmark and VFT systems.

The thermal violation tables show the overload element, the element type (line or transformer), its rating in MVA, and the per unit loading for the benchmark case and the corresponding Blackwater VFT cases. The listings are grouped buy overloaded element. Only cases where at least one of the cases had an overload and there was at least a 3% (0.03 pu) change in loading between the two cases are shown. Note that while the MVA rating is listed for transmission lines, overloads are calculated based on a current rating (the current at rated MVA, rated voltage) and line current. Note that a value of "0" under per unit loading indicates that the actual loading was less than 80% of rated and was thus not recorded during contingency processing. A value of "9" under per unit loading indicates an unsolved powerflow condition.

The voltage violation tables show violations where there was at least a 0.01 pu change between any the benchmark and VFT cases. The tables list the bus with the voltage violation, the bus voltage (or delta voltage from pre to post-contingency) for the benchmark and VFT cases, and a description of the outage. The listings are grouped buy bus for the absolute voltage violations, and by outage for the delta voltage violations. Note that a value of "0" indicates that the bus voltage was well within criteria for that condition and was not recorded during contingency processing. A value of "9" indicates that the powerflow could not be solved for the particular case and contingency. Note that the absolute voltage violations are listed in the main body of the report, while the delta voltage violations are listed in the appendix.

3.2 Blackwater VFT (ep1)

All contingencies for the ep1 cases were able to achieve a valid powerflow solution. Thermal violations for the ep1 export case are listed in Table 3.1. Table 3.2 lists the thermal violations for the ep1 import case.

These results show three lines and two transformers that experience new overloads with the VFT exporting 200 MW to the WSCC system. These are the HEREFD3-FRIONA3 115 kV line, the Roosevelt-Tolk 230 kV lines (circuits 1 and 12), and the DFSMTH 230/115 kV transformers (1 and 2). All violations are post-contingency overloads.

Four lines experience new overloads with the VFT importing 200 MW. These are the PARMRC3-DS-#2300 115 kV line, the DS-#230-CURRY3 115 kV line, and the two Curry Roosevelt 230 kV lines. The two 115 kV lines show base system (n-0) overloads. In addition, an existing 112% post-contingency overload on the CUNNINH3 230/115 kV transformer is increased to 116% with the VFT.

Table 3.1 Overloaded elements for the Blackwater VFT, ep1 export scenario

Overloaded Element	Rated Mva	export -ep0	export -ep1	Outage description
HEREFD3 -FRIONA3 115	90	0.809	1.051	line POTTRC7 to FRIODR7 345 ck 1
HEREFD3 -FRIONA3 115	90	0.809	1.051	tran FRIODR7 345 to FRIODR6 230 ck 1
DFSMTH6 230/115 ck 1 tran	150	0.987	1.023	tran DFSMTH6 230 to DFSMTH3 115 ck 2
DFSMTH6 230/115 ck 2 tran	150	0.987	1.023	tran DFSMTH6 230 to DFSMTH3 115 ck 1
ROOSEVL6-TOLKW6 230 1	451	0.817	1.039	line POTTRC7 to FRIODR7 345 ck 1
ROOSEVL6-TOLKW6 230 1	451	1.019	1.291	line ROOSEVL6 to TOLKE6 230 ck 2
ROOSEVL6-TOLKW6 230 1	451	0.816	1.038	tran FRIODR7 345 to FRIODR6 230 ck 1
ROOSEVL6-TOLKE6 230 2	451	0.807	1.027	line POTTRC7 to FRIODR7 345 ck 1
ROOSEVL6-TOLKE6 230 2	451	1.015	1.287	line ROOSEVL6 to TOLKW6 230 ck 1
ROOSEVL6-TOLKE6 230 2	451	0.806	1.026	tran FRIODR7 345 to FRIODR6 230 ck 1

Table 3.2 Overloaded elements for the Blackwater VFT, ep1 import scenario

Overloaded Element	Rated Mva	import -ep0	import -ep1	Outage description
PARMRC3 -DS-#203 115	69	0.847	1.009	Base system (n-0)
DS-#203 -CURRY3 115	69	1.010	1.173	Base system (n-0)
DS-#203 -CURRY3 115	90	0.899	1.010	line HEREFD3 to DFSMTH3 115 ck 1
DS-#203 -CURRY3 115	90	0.907	1.055	line DFSMTH6 to PLANTX6 230 ck 1
DS-#203 -CURRY3 115	90	0.923	1.122	line POTTRC7 to FRIODR7 345 ck 1
DS-#203 -CURRY3 115	90	0.907	1.070	line ROOSEVL6 to TOLKE6 230 ck 2
DS-#203 -CURRY3 115	90	0.909	1.074	line ROOSEVL6 to TOLKW6 230 ck 1
DS-#203 -CURRY3 115	90	0.880	1.007	line BC-EART3 to PLANTX3 115 ck 1
DS-#203 -CURRY3 115	90	0.923	1.122	tran FRIODR7 345 to FRIODR6 230 ck 1
CURRY3-ROOSEVL3 115 1	146	0.981	1.046	line CURRY3 to ROOSEVL3 115 ck 2
CURRY3-ROOSEVL3 115 2	146	0.981	1.046	line CURRY3 to ROOSEVL3 115 ck 1
CUNNINH3 115/230 tran	168	1.123	1.156	line LEACO6 to CUNNINH6 230 ck 1

There are several new absolute voltage violations in the export case with the VFT. These are listed in Table 3.3. The absolute voltage violations are at the 230 kV buses near the Blackwater VFT and south to Chaves. These are post-contingency violations that result from loss of either circuit of the Roosevelt-Tolk 230 kV line. In addition, there are several new delta voltage violations on the 115 and 230 kV system in this area. The most extensive of these are caused by loss of either Rosevelt-Tolk 230 kV circuit or loss of the Roosevelt 230/115 kV transformer. These are shown in Appendix A.

Note that there are no absolute voltage violations introduced by the VFT case for the import scenario. The CV-CTNW2 to SMITH2 69 kV line outage causes new delta voltage violations at three 69 kV buses in the vicinity of the outage.

Table 3.3 Absolute voltage violations for the Blackwater VFT, ep1 export scenario

Bus	export-ep0	export-ep1	Outage description
51193 CLOVIS S 230	0.000	0.890	line ROOSEVL6 to TOLKE6 230 ck 2
51193 CLOVIS S 230	0.000	0.888	line ROOSEVL6 to TOLKW6 230 ck 1
51195 OASIS6 230	0.000	0.894	line ROOSEVL6 to TOLKE6 230 ck 2
51195 OASIS6 230	0.000	0.893	line ROOSEVL6 to TOLKW6 230 ck 1
51203 ROOSEVL6 230	0.000	0.890	line ROOSEVL6 to TOLKE6 230 ck 2
51203 ROOSEVL6 230	0.000	0.888	line ROOSEVL6 to TOLKW6 230 ck 1
51205 CLOVIS G 230	0.000	0.890	line ROOSEVL6 to TOLKE6 230 ck 2
51205 CLOVIS G 230	0.000	0.888	line ROOSEVL6 to TOLKW6 230 ck 1
52073 CHAVES6 230	0.895	0.881	line TOLK7 to EDDYCO7 345 ck 1
52073 CHAVES6 230	0.879	0.864	line CHAVES6 to EDDYCO6 230 ck 1
52073 CHAVES6 230	0.896	0.882	tran EDDYCO6 230 - EDDYCO7 345 ck 1

3.3 Eddy Co. 230 kV VFT (ep2)

Loss of the Tolk-Eddy Co. 345 kV line and/or the Eddy Co. 345/230 kV transformer could not be solved for the ep2 case in export mode. The unsolved cases are the result of low voltages in the Eddy Co. area when the Eddy Co. VFT is exporting 200 MW. For example, loss of the Tolk-Eddy Co. 345 kV line causes an increase in flow from Oasis to Chaves and down to Eddy Co. With the 200 MW of additional export at Eddy Co, the system collapses at Chaves. A test case run with reactive support at Chaves 230 kV was able to reach a solution.

All thermal violations that were cased or worsened by the Eddy Co. VFT were under importing conditions. They are listed in Table 3.4. Both the Eddy Co. and Cunningham 230/115 kV transformers have existing overloads that are increased with the VFT importing 200 MW. The existing base system overload on the DS #203-Curry 115 kV is increased and two post-contingency overloads are introduced for this line with the VFT.

Table 3.4 Overloaded elements for the Eddy Co. 230 kV VFT ep2 import scenario

Overloaded Element	Rated Mva	import -ep0	import -ep2	Outage description
DS-#203 -CURRY3 115	69	1.010	1.083	Base system (n-0)
DS-#203 -CURRY3 115	90	0.923	1.033	line POTTRC7 to FRIODR7 345 ck 1
DS-#203 -CURRY3 115	90	0.923	1.033	tran FRIODR7 345 to FRIODR6 230 ck 1
CHAVES3 115/230 ck 1 tran	150	1.098	1.059	tran CHAVES3 115 to CHAVES6 230 ck 2
CHAVES3 115/230 ck 2 tran	150	1.098	1.059	tran CHAVES3 115 to CHAVES6 230 ck 1
EDDYCO3 115/230 ck 1 tran	168	1.131	1.276	line EDDYCO6 to 7RIVER6 230 ck 1
EDDYCO3 115/230 ck 1 tran	168	0.978	1.063	tran 7RIVER3 115 to 7RIVER6 230 ck 1
CUNNINH3 115/230 tran	168	1.123	1.355	line LEACO6 to CUNNINH6 230 ck 1
CUNNINH3 115/230 tran	168	0.935	1.003	line CUNNINH6 to POTJCT6 230 ck 1
CUNNINH3 115/230 tran	168	0.994	1.075	tran LEACO3 115 to LEACO6 230 ck 1
CUNNINH3 115/230 tran	168	0.927	1.031	tran POTJCT3 115 to POTJCT6 230 ck 1

Table 3.5 and 3.6 list the absolute and delta voltage violations introduced in the ep2 export case, respectively. There were no new absolute voltage violations for the import case. The delta voltage violations for the import case are listed in Table 3.7

With the VFT exporting 200 MW, the Tuco 345 kV and 230 kV buses experience slight voltage violations. Existing violations at LP-MLWK 230 kV, Carlisl 230 kV, and Chaves 230 kV are exacerbated. Delta voltage violations are seen on several buses at 69 kV through 345 kV near Blackwater. In particular, loss of the Roosevelt 230/115 kV transformer causes ten new 115 kV delta voltage violations.

Table 3.5 Absolute voltage violations for the Eddy Co. 230 kV VFT ep2 export scenario

Bus	export-ep0	export-ep2	Outage description
50507 LP-MLWK6 230	0.942	0.930	Base system (n-0)
51533 TUCO6 230	0.961	0.948	Base system (n-0)
51534 TUCO7 345	0.968	0.949	Base system (n-0)
51647 CARLISL6 230	0.942	0.931	Base system (n-0)
52073 CHAVES6 230	0.964	0.938	Base system (n-0)
52073 CHAVES6 230	0.000	0.889	line OASIS6 to CHAVES6 230 ck 1
52073 CHAVES6 230	0.895	9.000	line TOLK7 to EDDYCO7 345 ck 1
52073 CHAVES6 230	0.879	0.861	line CHAVES6 to EDDYCO6 230 ck 1
52073 CHAVES6 230	0.896	9.000	tran EDDYCO6 230/345 ck 1

Table 3.6 Delta voltage violations for the Eddy Co. 230 kV VFT ep2 export scenario

Bus	export-ep0	export-ep2	Outage description
52072 CHAVES3 115	-0.061	-0.071	line CHAVES6 to EDDYCO6 230 ck 1
52073 CHAVES6 230	-0.086	-0.077	line CHAVES6 to EDDYCO6 230 ck 1
52078 URTON3 115	-0.059	-0.068	line CHAVES6 to EDDYCO6 230 ck 1
52084 ROSWLC3 115	-0.058	-0.066	line CHAVES6 to EDDYCO6 230 ck 1
52088 SAMSON3 115	-0.057	-0.065	line CHAVES6 to EDDYCO6 230 ck 1
52094 ROSWIN3 115	-0.056	-0.063	line CHAVES6 to EDDYCO6 230 ck 1
52098 BRASHER3 115	-0.056	-0.063	line CHAVES6 to EDDYCO6 230 ck 1
52104 TWEEDY3 115	-0.054	-0.060	line CHAVES6 to EDDYCO6 230 ck 1
52253 POTJCT6 230	0.000	-0.052	line CUNNINH6 to POTJCT6 230 ck 1
51180 FE-CLVS3 115	-0.052	-0.050	line CURRY3 to FE-CLVS3 115 ck 1
52171 CV-ARTE2 69	0.000	-0.054	line NAVAJ33 to NAVAJ43 115 ck 1
52141 CV-CTNW2 69	0.000	-0.051	line NAVAJ43 to EDDYCO3 115 ck 1
52143 COTTON2 69	0.000	-0.051	line NAVAJ43 to EDDYCO3 115 ck 1
52171 CV-ARTE2 69	0.000	-0.057	line NAVAJ43 to EDDYCO3 115 ck 1
52186 EDDYCO7 345	0.000	-0.053	line OASIS6 to CHAVES6 230 ck 1
52101 CV-ORH2 69	0.000	-0.054	line RIACLN2 to CV-ORH2 69 ck 1
52101 CV-ORH2 69	0.000	-0.053	line ROSWIN2 to RIACLN2 69 ck 1
52073 CHAVES6 230	-0.070	9.000	line TOLK7 to EDDYCO7 345 ck 1
52073 CHAVES6 230	-0.069	9.000	tran EDDYCO6 230 /345 ck 1
52186 EDDYCO7 345	0.071	9.000	tran EDDYCO6 230/345 ck 1
51076 FE-TUCU3 115	0.000	-0.065	tran ROOSEVL3 115// 230 ck 1
51070 TUCUMCA3 115	0.000	-0.065	tran ROOSEVL3 115/230 ck 1
51126 DS-#203 115	0.000	-0.054	tran ROOSEVL3 115/230 ck 1
51156 NORRST3 115	0.000	-0.061	tran ROOSEVL3 115/230 ck 1
51168 NORRIS3 115	0.000	-0.061	tran ROOSEVL3 115/230 ck 1
51170 FE-CLVS3 115	0.000	-0.055	tran ROOSEVL3 115/230 ck 1
51176 CURRY3 115	0.000	-0.061	tran ROOSEVL3 115/230 ck 1
51180 FE-CLVS3 115	0.000	-0.061	tran ROOSEVL3 115/230 ck 1
51202 ROOSEVL3 115	0.000	-0.073	tran ROOSEVL3 115/230 ck 1
51208 PORTALE3 115	0.000	-0.053	tran ROOSEVL3 115/230 ck 1

Table 3.7 Delta voltage violations for the Eddy Co. 230 kV VFT ep2 import scenario

Bus	import-ep0	import-ep2	Outage description
52139 CV-LKAR2 69	0.000	-0.055	line CV-CTNW2 to SMITH2 69 ck 1
52141 CV-CTNW2 69	-0.047	-0.064	line CV-CTNW2 to SMITH2 69 ck 1
52143 COTTON2 69	-0.047	-0.064	line CV-CTNW2 to SMITH2 69 ck 1

3.4 Eddy Co. 345 kV VFT (ep3)

The Tolk-Eddy Co. 345 kv line outage could not be solved for the ep3 case in export mode. As noted in section 3.3, this is cased by the excessive power transfer through the Chaves station with the addition exports at Eddy Co. This will likely require some compensation in the Chaves area. For the 345 kV VFT interconnection, loss of the Eddy Co. 345/230 kV transformer does not cause any solution problems.

Thermal overloads for the ep2 import scenarios are listed in Table 3.8. There were no new thermal violations introduced in the VFT export case. The thermal overloads for the ep3 cases are similar to those found in the ep2 cases.

Voltage violations are listed in Tables 3.9 through 3.11. The violations are similar to those for the Eddy Co. 230 kV interconnection case (ep2), with a slight improvement for some post-contingency voltages.

Table 3.8 Overloaded elements for the Eddy Co. 345 kV VFT ep3 import scenario

Overloaded Element	Rated Mva	import -ep0	import -ep3	Outage description
DS-#203 -CURRY3 115	69	1.010	1.079	Base system (n-0)
DS-#203 -CURRY3 115	90	0.923	1.029	line POTTRC7 to FRIODR7 345 ck 1
DS-#203 -CURRY3 115	90	0.923	1.029	tran FRIODR7 345 to FRIODR6 230 ck 1
EDDYCO3 115/230 ck 1 tran	168	1.131	1.253	line EDDYCO6 to 7RIVER6 230 ck 1
EDDYCO3 115/230 ck 1 tran	168	0.978	1.052	tran 7RIVER3 115 to 7RIVER6 230 ck 1
CUNNINH3 115/230 tran	168	1.123	1.318	line LEACO6 to CUNNINH6 230 ck 1
CUNNINH3 115/230 tran	168	0.994	1.062	tran LEACO3 115 to LEACO6 230 ck 1
CUNNINH3 115/230 tran	168	0.927	1.014	tran POTJCT3 115 to POTJCT6 230 ck 1

Table 3.9 Absolute voltage violations for the Eddy Co. 345 kV VFT ep3 export scenario

Bus	export-ep0	export-ep3	Outage description
50507 LP-MLWK6 230	0.942	0.931	Base system (n-0)
51533 TUCO6 230	0.961	0.949	Base system (n-0)
51534 TUCO7 345	0.968	0.950	Base system (n-0)
51647 CARLISL6 230	0.942	0.932	Base system (n-0)
52073 CHAVES6 230	0.964	0.946	Base system (n-0)
52073 CHAVES6 230	0.895	9.000	line TOLK7 to EDDYCO7 345 ck 1
52073 CHAVES6 230	0.879	0.867	line CHAVES6 to EDDYCO6 230 ck 1
52186 EDDYCO7 345	1.067	1.036	tran EDDYCO6 230/345 ck 1

Table 3.10 Delta voltage violations for the Eddy Co. 345 kV VFT ep3 export scenario

Bus	export-ep0	export-ep3	Outage description
52073 CHAVES6 230	-0.086	-0.080	line CHAVES6 to EDDYCO6 230 ck 1
51180 FE-CLVS3 115	-0.052	-0.050	line CURRY3 to FE-CLVS3 115 ck 1
51126 DS-#203 115	0.000	-0.051	line DS-#203 to CURRY3 115 ck 1
52171 CV-ARTE2 69	0.000	-0.056	line NAVAJ33 to NAVAJ43 115 ck 1
52141 CV-CTNW2 69	0.000	-0.053	line NAVAJ43 to EDDYCO3 115 ck 1
52143 COTTON2 69	0.000	-0.053	line NAVAJ43 to EDDYCO3 115 ck 1
52171 CV-ARTE2 69	0.000	-0.060	line NAVAJ43 to EDDYCO3 115 ck 1
52173 ARTW2 69	0.000	-0.052	line NAVAJ43 to EDDYCO3 115 ck 1
52101 CV-ORH2 69	0.000	-0.052	line RIACLN2 to CV-ORH2 69 ck 1
52101 CV-ORH2 69	0.000	-0.051	line ROSWIN2 to RIACLN2 69 ck 1
52073 CHAVES6 230	-0.070	9.000	line TOLK7 to EDDYCO7 345 ck 1
52186 EDDYCO7 345	0.071	0.057	tran EDDYCO6 230/345 ck 1
51070 TUCUMCA3 115	0.000	-0.064	tran ROOSEVL3 115/ 230 ck 1
51180 FE-CLVS3 115	0.000	-0.060	tran ROOSEVL3 115/ 230 ck 1
51202 ROOSEVL3 115	0.000	-0.072	tran ROOSEVL3 115/ 230 ck 1
51076 FE-TUCU3 115	0.000	-0.064	tran ROOSEVL3 115/230 ck 1
51126 DS-#203 115	0.000	-0.053	tran ROOSEVL3 115/230 ck 1
51156 NORRST3 115	0.000	-0.060	tran ROOSEVL3 115/230 ck 1
51168 NORRIS3 115	0.000	-0.060	tran ROOSEVL3 115/230 ck 1
51170 FE-CLVS3 115	0.000	-0.054	tran ROOSEVL3 115/230 ck 1
51176 CURRY3 115	0.000	-0.060	tran ROOSEVL3 115/230 ck 1
51208 PORTALE3 115	0.000	-0.052	tran ROOSEVL3 115/230 ck 1

Table 3.11 Delta voltage violations for the Eddy Co. 345 kV VFT ep3 import scenario

Bus	import-ep0	import-ep3	Outage description
52139 CV-LKAR2 69	0.000	-0.052	line CV-CTNW2 to SMITH2 69 ck 1
52141 CV-CTNW2 69	-0.047	-0.062	line CV-CTNW2 to SMITH2 69 ck 1
52143 COTTON2 69	-0.047	-0.062	line CV-CTNW2 to SMITH2 69 ck 1
52153 ARTESIA2 69	-0.051	0.000	line NAVAJ33 to NAVAJ43 115 ck 1
52163 NAVAJ22 69	-0.051	0.000	line NAVAJ33 to NAVAJ43 115 ck 1
52165 NAVAJR2 69	-0.051	0.000	line NAVAJ33 to NAVAJ43 115 ck 1
52169 ARTTOW2 69	-0.051	0.000	line NAVAJ33 to NAVAJ43 115 ck 1

3.5 Blackwater and Eddy Co. 230 kV VFT's (ep4)

Three line outages could not be solved for the ep4 export case. An noted above, the Tolk-Eddy Co. 345 kV line outage (and the Eddy Co. 345/230 kV transformer outage) could not solve due to extreme low voltages in the Eddy Co. area when the exporting to WSCC.

Loss of the Potter Co.-Finney-Holcombb 345 kV line line results in a voltage collapse along the Oklaunion-Tuco 345 kV line. Similarly, outage of the Oklaunion-Tuco 345 kV line could not be solved for this case. These contingencies did not present any solution or voltage problems with only one VFT exporting 200 MW, only for cases ep4 and ep5 with 400 MW of export.

These unsolved cases indicate that there may be a transfer limit on importing power into SPS. The power exported by the VFT's was supplied by generation outside of SPS. For the ep4 case, this results in 458 MW (400 MW transfer plus 58 MW of additional losses) of additional imports on the ac ties into SPS, on top of the 400 MW in the benchmark case. Supplying some portion of the added 400 MW of exports by units near Blackwater and/or Eddy Co. could eliminate some of the voltage and thermal problems found in this case.

Table 3.12 lists the thermal violations for the ep4 export case, and Table 3.13 lists the thermal violations for the ep4 import case. In general, loss of the 230 kV and 345 kV infeeds into the study region cause overloads during export conditions. In addition, the Roosevelt-Tolk 230 kV line is jut at its thermal rating for the base system. For the import scenario, several lines are overloaded under base system conditions. These include the Tolk-Tuco 230 kV line and several 115 kV lines.

Table 3.14 lists the absolute voltage violations for the ep4 export case. There are extensive voltage violations for this case, both for base system and post-contingency conditions. Eighteen 230 kV and 345 kV buses have base system voltage violations. The Potter Co.-Friodr 345 kV line outage and Roosevelt-Tolk 230 kV line outages result in voltages below 0.90 pu on several 230 and 345 kV buses.

Under import conditions, the ep4 case resulted in only one new voltage violations, as seen in Table 3.15. The Tuco 230 kV bus voltage is 0.94 pu for the base system conditions.

Table 3.12 Overloaded elements for the Blackwater and Eddy Co. 230 kV VFT ep4 export scenario

Overloaded Element	Rated Mva	export -ep0	export -ep4	Outage description
HEREFD3 -FRIONA3 115	69	0.000	1.003	Base system (n-0)
HEREFD3 -FRIONA3 115	90	0.809	1.206	line POTTRC7 to FRIODR7 345 ck 1
HEREFD3 -FRIONA3 115	90	0.000	1.099	line ROOSEVL6 to TOLKE6 230 ck 2
HEREFD3 -FRIONA3 115	90	0.000	1.107	line ROOSEVL6 to TOLKW6 230 ck 1
HEREFD3 -FRIONA3 115	90	0.809	1.207	tran FRIODR7 345 to FRIODR6 230 ck 1
HEREFD3 -FRIONA3 115	90	0.000	1.009	tran ROOSEVL3 115/ 230 ck 1
DFSMTH6 230/115 ck 1 tran	150	0.987	1.051	tran DFSMTH6 230 to DFSMTH3 115 ck 2
DFSMTH6 230/115 ck 2 tran	150	0.987	1.051	tran DFSMTH6 230 to DFSMTH3 115 ck 1
CARGIL3 -FRIONA3 115	90	0.000	1.037	line POTTRC7 to FRIODR7 345 ck 1
CARGIL3 -FRIONA3 115	90	0.000	1.038	tran FRIODR7 345 to FRIODR6 230 ck 1
ROOSEVL6-TOLKW6 230 1	347	0.801	1.002	Base system (n-0)
ROOSEVL6-TOLKW6 230 1	451	0.817	1.104	line POTTRC7 to FRIODR7 345 ck 1
ROOSEVL6-TOLKW6 230 1	451	1.019	1.329	line ROOSEVL6 to TOLKE6 230 ck 2
ROOSEVL6-TOLKW6 230 1	451	0.816	1.103	tran FRIODR7 345 to FRIODR6 230 ck 1
ROOSEVL6-TOLKE6 230 2	451	0.807	1.091	line POTTRC7 to FRIODR7 345 ck 1
ROOSEVL6-TOLKE6 230 2	451	1.015	1.326	line ROOSEVL6 to TOLKW6 230 ck 1
ROOSEVL6-TOLKE6 230 2	451	0.806	1.090	tran FRIODR7 345 to FRIODR6 230 ck 1
ARTESIA2 69/115 ck 2 tran	40	1.097	1.061	tran ARTESIA2 69 to ARTESIA3 115 ck 1

Table 3.13 Overloaded elements for the Blackwater and Eddy Co. 230 kV VFT ep4 import scenario

Overloaded Element	Rated Mva	import -ep0	import -ep4	Outage description
CARGIL3 -PARMRC3 115	69	0.000	1.035	Base system (n-0)
CARGIL3 -PARMRC3 115	90	0.000	1.068	line POTTRC7 to FRIODR7 345 ck 1
CARGIL3 -PARMRC3 115	90	0.000	1.068	tran FRIODR7 345 to FRIODR6 230 ck 1
PARMRC3 -DS-#203 115	69	0.847	1.083	Base system (n-0)
PARMRC3 -DS-#203 115	90	0.000	1.018	line DFSMTH6 to PLANTX6 230 ck 1
PARMRC3 -DS-#203 115	90	0.000	1.105	line POTTRC7 to FRIODR7 345 ck 1
PARMRC3 -DS-#203 115	90	0.000	1.002	line ROOSEVL6 to TOLKW6 230 ck 1
PARMRC3 -DS-#203 115	90	0.000	1.106	tran FRIODR7 345 to FRIODR6 230 ck 1
DS-#203 -CURRY3 115	69	1.010	1.247	Base system (n-0)
DS-#203 -CURRY3 115	90	0.899	1.073	line HEREFD3 to DFSMTH3 115 ck 1
DS-#203 -CURRY3 115	90	0.907	1.148	line DFSMTH6 to PLANTX6 230 ck 1
DS-#203 -CURRY3 115	90	0.923	1.233	line POTTRC7 to FRIODR7 345 ck 1
DS-#203 -CURRY3 115	90	0.825	1.017	line CASTRC3 to BC-EART3 115 ck 1
DS-#203 -CURRY3 115	90	0.859	1.025	line OASIS6 to CHAVES6 230 ck 1
DS-#203 -CURRY3 115	90	0.907	1.125	line ROOSEVL6 to TOLKE6 230 ck 2
DS-#203 -CURRY3 115	90	0.909	1.129	line ROOSEVL6 to TOLKW6 230 ck 1
DS-#203 -CURRY3 115	90	0.880	1.070	line BC-EART3 to PLANTX3 115 ck 1
DS-#203 -CURRY3 115	90	0.833	1.010	tran DFSMTH6 230 to DFSMTH3 115 ck 1
DS-#203 -CURRY3 115	90	0.833	1.010	tran DFSMTH6 230 to DFSMTH3 115 ck 2
DS-#203 -CURRY3 115	90	0.923	1.233	tran FRIODR7 345 to FRIODR6 230 ck 1
CURRY3-ROOSEVL3 115 1	146	0.981	1.064	line CURRY3 to ROOSEVL3 115 ck 2
CURRY3-ROOSEVL3 115 2	146	0.981	1.064	line CURRY3 to ROOSEVL3 115 ck 1
TOLKE6 -TUCO6 230	347	0.884	1.091	Base system (n-0)
DOUD3 -WOLFRTH3 115	112	0.823	1.033	Base system (n-0)
EDDYCO3 115/230 ck 1 tran	168	1.131	1.284	line EDDYCO6 to 7RIVER6 230 ck 1
EDDYCO3 115/230 ck 1 tran	168	0.978	1.066	tran 7RIVER3 115 to 7RIVER6 230 ck 1
CUNNINH3 115/230 tran	168	1.123	1.391	line LEACO6 to CUNNINH6 230 ck 1
CUNNINH3 115/230 tran	168	0.935	1.013	line CUNNINH6 to POTJCT6 230 ck 1
CUNNINH3 115/230 tran	168	0.994	1.088	tran LEACO3 115 to LEACO6 230 ck 1
CUNNINH3 115/230 tran	168	0.927	1.047	tran POTJCT3 115 to POTJCT6 230 ck 1

Table 3.14 Absolute voltage violations for the Blackwater and Eddy Co. 230 kV VFT ep4 export scenario

Bus	export-ep0	export-ep4	Outage description
50507 LP-MLWK6 230	0.942	0.912	Base system (n-0)
50507 LP-MLWK6 230	0.000	0.880	line POTTRC7 to FRIODR7 345 ck 1
50507 LP-MLWK6 230	0.000	0.881	tran FRIODR7 345/230 ck 1
50527 LP-ETAP2 230	0.000	0.948	Base system (n-0)
50858 FINNEY7 345	1.068	9.000	line FINNEY7 to HOLCOMB7 345 ck 1
51193 CLOVIS S 230	0.000	0.934	Base system (n-0)
51193 CLOVIS S 230	0.000	0.890	line POTTRC7 to FRIODR7 345 ck 1
51193 CLOVIS S 230	0.000	0.861	line ROOSEVL6 to TOLKE6 230 ck 2
51193 CLOVIS S 230	0.000	0.859	line ROOSEVL6 to TOLKW6 230 ck 1
51193 CLOVIS S 230	0.000	0.890	tran FRIODR7 345/230 ck 1
51195 OASIS6 230	0.000	0.932	Base system (n-0)
51195 OASIS6 230	0.000	0.888	line POTTRC7 to FRIODR7 345 ck 1
51195 OASIS6 230	0.000	0.864	line ROOSEVL6 to TOLKE6 230 ck 2
51195 OASIS6 230	0.000	0.862	line ROOSEVL6 to TOLKW6 230 ck 1
51195 OASIS6 230	0.000	0.889	tran FRIODR7 345/230 ck 1
51199 FRIODR6 230	0.000	0.943	Base system (n-0)
51199 FRIODR6 230	0.000	0.891	line POTTRC7 to FRIODR7 345 ck 1
51199 FRIODR6 230	0.000	0.877	line ROOSEVL6 to TOLKE6 230 ck 2
51199 FRIODR6 230	0.000	0.875	line ROOSEVL6 to TOLKW6 230 ck 1
51199 FRIODR6 230	0.000	0.891	tran FRIODR7 345/230 ck 1
51200 FRIODR7 345	0.000	0.947	Base system (n-0)
51200 FRIODR7 345	0.944	0.891	line POTTRC7 to FRIODR7 345 ck 1
51200 FRIODR7 345	0.000	0.886	line ROOSEVL6 to TOLKE6 230 ck 2
51200 FRIODR7 345	0.000	0.884	line ROOSEVL6 to TOLKW6 230 ck 1
51200 FRIODR7 345	1.052	1.028	tran FRIODR7 345/230 ck 1
51203 ROOSEVL6 230	0.000	0.934	Base system (n-0)
51203 ROOSEVL6 230	0.000	0.890	line POTTRC7 to FRIODR7 345 ck 1
51203 ROOSEVL6 230	0.000	0.861	line ROOSEVL6 to TOLKE6 230 ck 2
51203 ROOSEVL6 230	0.000	0.859	line ROOSEVL6 to TOLKW6 230 ck 1
51203 ROOSEVL6 230	0.000	0.890	tran FRIODR7 345/230 ck 1
51205 CLOVIS G 230	0.000	0.934	Base system (n-0)
51205 CLOVIS G 230	0.000	0.890	line POTTRC7 to FRIODR7 345 ck 1
51205 CLOVIS G 230	0.000	0.861	line ROOSEVL6 to TOLKE6 230 ck 2
51205 CLOVIS G 230	0.000	0.859	line ROOSEVL6 to TOLKW6 230 ck 1
51205 CLOVIS G 230	0.000	0.890	tran FRIODR7 345/230 ck 1
51321 SWISHER6 230	0.942	0.921	Base system (n-0)
51321 SWISHER6 230	0.000	0.893	line POTTRC7 to FRIODR7 345 ck 1
51321 SWISHER6 230	0.000	0.894	tran FRIODR7 345/230 ck 1
51403 HALECO6 230	0.944	0.919	Base system (n-0)
51403 HALECO6 230	0.000	0.888	line POTTRC7 to FRIODR7 345 ck 1
51403 HALECO6 230	0.000	0.888	tran FRIODR7 345/230 ck 1
51533 TUCO6 230	0.961	0.929	Base system (n-0)
51533 TUCO6 230	0.000	0.895	line POTTRC7 to FRIODR7 345 ck 1
51533 TUCO6 230	0.000	0.896	tran FRIODR7 345/230 ck 1
51534 TUCO7 345	0.968	0.920	Base system (n-0)
51534 TUCO7 345	0.000	0.878	line POTTRC7 to FRIODR7 345 ck 1
51534 TUCO7 345	0.000	0.880	tran FRIODR7 345/230 ck 1

Table 3.14 Absolute voltage violations for the Blackwater and Eddy Co. 230 kV VFT ep4 export scenario, continued.

Bus	export-ep0	export-ep4	Outage description
51647 CARLISL6 230	0.942	0.912	Base system (n-0)
51647 CARLISL6 230	0.000	0.881	line POTTRC7 to FRIODR7 345 ck 1
51647 CARLISL6 230	0.000	0.881	tran FRIODR7 345/230 ck 1
51689 LUBE6 230	0.000	0.948	Base system (n-0)
51763 WOLFRTH6 230	0.000	0.949	Base system (n-0)
51811 GRASSLN6 230	0.000	0.950	Base system (n-0)
51861 BORDEN6 230	0.000	0.948	Base system (n-0)
52073 CHAVES6 230	0.964	0.928	Base system (n-0)
52073 CHAVES6 230	0.000	0.893	line EDDYCO6 to CUNNINH6 230 ck 1
52073 CHAVES6 230	0.000	0.896	line CUNNINH6 to POTJCT6 230 ck 1
52073 CHAVES6 230	0.000	0.888	line OASIS6 to CHAVES6 230 ck 1
52073 CHAVES6 230	0.895	9.000	line TOLK7 to EDDYCO7 345 ck 1
52073 CHAVES6 230	0.879	0.845	line CHAVES6 to EDDYCO6 230 ck 1
52073 CHAVES6 230	0.896	9.000	tran EDDYCO6 230/345 ck 1
52186 EDDYCO7 345	1.067	9.000	tran EDDYCO6 230/345 ck 1

Table 3.15 Absolute voltage violations for the Blackwater and Eddy Co. 230 kV VFT ep4 import scenario

Bus	import-ep0	import-ep4	Outage description
50808 KNGSML3 115	1.052	1.038	line FINNEY7 to POTTRC7 345 ck 1
50808 KNGSML3 115	1.052	1.038	line FINNEY7 to HOLCOMB7 345 ck 1
50808 KNGSML3 115	1.053	1.035	line TUCO7 to O.K.U.-7 345 ck 1
51533 TUCO6 230	0.951	0.941	Base system (n-0)

3.6 Blackwater 230 kVand Eddy Co. 345 kV VFT's (ep5)

The results for the ep5 cases are similar to those for ep4. The unsolved cases, thermal overloads and voltage violations are all nearly identical. There were some minor improvements in bus voltages associated with the 345 kV Eddy Co. interconnection. The added power transfers into the SPP area cause thermal overloads on several infeeds, and low voltage violations on several 230 kV and 345 kV buses. Thermal and voltage violations are listed in Tables 3.16 through 3.19.

Table 3.16 Overloaded elements for the Blackwater 230 kV and Eddy Co. 345 kV VFT ep5 export scenario

Overloaded Element	Rated Mva	export -ep0	export -ep5	Outage description
HEREFD3 -FRIONA3 115	90	0.809	1.197	line POTTRC7 to FRIODR7 345 ck 1
HEREFD3 -FRIONA3 115	90	0.000	1.086	line ROOSEVL6 to TOLKE6 230 ck 2
HEREFD3 -FRIONA3 115	90	0.000	1.093	line ROOSEVL6 to TOLKW6 230 ck 1
HEREFD3 -FRIONA3 115	90	0.809	1.197	tran FRIODR7 345 to FRIODR6 230 ck 1
HEREFD3 -FRIONA3 115	90	0.000	1.000	tran ROOSEVL3 115/230 ck 1
DFSMTH6 230/115 ck 1 tran	150	0.987	1.048	tran DFSMTH6 230 to DFSMTH3 115 ck 2
DFSMTH6 230/115 ck 2 tran	150	0.987	1.048	tran DFSMTH6 230 to DFSMTH3 115 ck 1
CARGIL3 -FRIONA3 115	90	0.000	1.029	line POTTRC7 to FRIODR7 345 ck 1
CARGIL3 -FRIONA3 115	90	0.000	1.029	tran FRIODR7 345 to FRIODR6 230 ck 1
ROOSEVL6-TOLKW6 230 1	451	0.817	1.091	line POTTRC7 to FRIODR7 345 ck 1
ROOSEVL6-TOLKW6 230 1	451	1.019	1.310	line ROOSEVL6 to TOLKE6 230 ck 2
ROOSEVL6-TOLKW6 230 1	451	0.816	1.090	tran FRIODR7 345 to FRIODR6 230 ck 1
ROOSEVL6-TOLKE6 230 2	451	0.807	1.079	line POTTRC7 to FRIODR7 345 ck 1
ROOSEVL6-TOLKE6 230 2	451	1.015	1.307	line ROOSEVL6 to TOLKW6 230 ck 1
ROOSEVL6-TOLKE6 230 2	451	0.806	1.077	tran FRIODR7 345 to FRIODR6 230 ck 1
ARTESIA2 69/115 ck 1 tran	40	1.092	1.042	tran ARTESIA2 69 to ARTESIA3 115 ck 2
ARTESIA2 69/115 ck 2 tran	40	1.097	1.040	tran ARTESIA2 69 to ARTESIA3 115 ck 1

Table 3.17 Overloaded elements for the Blackwater 230 kV and Eddy Co. 345 kV VFT ep5 import scenario

Overloaded Element	Rated Mva	import -ep0	import -ep5	Outage description
CARGIL3 -PARMRC3 115	69	0.000	1.031	Base system (n-0)
CARGIL3 -PARMRC3 115	90	0.000	1.064	line POTTRC7 to FRIODR7 345 ck 1
CARGIL3 -PARMRC3 115	90	0.000	1.065	tran FRIODR7 345 to FRIODR6 230 ck 1
PARMRC3 -DS-#203 115	69	0.847	1.079	Base system (n-0)
PARMRC3 -DS-#203 115	90	0.000	1.016	line DFSMTH6 to PLANTX6 230 ck 1
PARMRC3 -DS-#203 115	90	0.000	1.102	line POTTRC7 to FRIODR7 345 ck 1
PARMRC3 -DS-#203 115	90	0.000	1.102	tran FRIODR7 345 to FRIODR6 230 ck 1
DS-#203 -CURRY3 115	69	1.010	1.243	Base system (n-0)
DS-#203 -CURRY3 115	90	0.899	1.071	line HEREFD3 to DFSMTH3 115 ck 1
DS-#203 -CURRY3 115	90	0.907	1.146	line DFSMTH6 to PLANTX6 230 ck 1
DS-#203 -CURRY3 115	90	0.923	1.230	line POTTRC7 to FRIODR7 345 ck 1
DS-#203 -CURRY3 115	90	0.825	1.014	line CASTRC3 to BC-EART3 115 ck 1
DS-#203 -CURRY3 115	90	0.859	1.026	line OASIS6 to CHAVES6 230 ck 1
DS-#203 -CURRY3 115	90	0.907	1.120	line ROOSEVL6 to TOLKE6 230 ck 2
DS-#203 -CURRY3 115	90	0.909	1.124	line ROOSEVL6 to TOLKW6 230 ck 1
DS-#203 -CURRY3 115	90	0.880	1.068	line BC-EART3 to PLANTX3 115 ck 1
DS-#203 -CURRY3 115	90	0.833	1.007	tran DFSMTH6 230 to DFSMTH3 115 ck 1
DS-#203 -CURRY3 115	90	0.833	1.007	tran DFSMTH6 230 to DFSMTH3 115 ck 2
DS-#203 -CURRY3 115	90	0.923	1.230	tran FRIODR7 345 to FRIODR6 230 ck 1
CURRY3-ROOSEVL3 115 1	146	0.981	1.065	line CURRY3 to ROOSEVL3 115 ck 2
CURRY3-ROOSEVL3 115 2	146	0.981	1.065	line CURRY3 to ROOSEVL3 115 ck 1
TOLKE6 -TUCO6 230	347	0.884	1.098	Base system (n-0)
DOUD3 -WOLFRTH3 115	112	0.823	1.024	Base system (n-0)
EDDYCO3 115/230 ck 1 tran	168	1.131	1.262	line EDDYCO6 to 7RIVER6 230 ck 1
EDDYCO3 115/230 ck 1 tran	168	0.978	1.053	tran 7RIVER3 115 to 7RIVER6 230 ck 1
CUNNINH3 115/230 tran	168	1.123	1.354	line LEACO6 to CUNNINH6 230 ck 1
CUNNINH3 115/230 tran	168	0.935	1.001	line CUNNINH6 to POTJCT6 230 ck 1
CUNNINH3 115/230 tran	168	0.994	1.076	tran LEACO3 115 to LEACO6 230 ck 1
CUNNINH3 115/230 tran	168	0.927	1.031	tran POTJCT3 115 to POTJCT6 230 ck 1

Table 3.18 Voltage violations for the Blackwater 230 kV and Eddy Co. 345 kV VFT ep5 export scenario

Bus	export-ep0	export-ep5	Outage description
50507 LP-MLWK6 230	0.942	0.913	Base system (n-0)
50507 LP-MLWK6 230	0.000	0.883	line POTTRC7 to FRIODR7 345 ck 1
50507 LP-MLWK6 230	0.000	0.884	tran FRIODR7 345/230 ck 1
50507 LP-MLWK6 230	0.000	0.891	tran EDDYCO6 230 /345 ck 1
50527 LP-ETAP2 230	0.000	0.949	Base system (n-0)
50858 FINNEY7 345	1.068	9.000	line FINNEY7 to HOLCOMB7 345 ck 1
51193 CLOVIS S 230	0.000	0.936	Base system (n-0)
51193 CLOVIS S 230	0.000	0.893	line POTTRC7 to FRIODR7 345 ck 1
51193 CLOVIS S 230	0.000	0.866	line ROOSEVL6 to TOLKE6 230 ck 2
51193 CLOVIS S 230	0.000	0.864	line ROOSEVL6 to TOLKW6 230 ck 1
51193 CLOVIS S 230	0.000	0.894	tran FRIODR7 345/230 ck 1
51195 OASIS6 230	0.000	0.935	Base system (n-0)
51195 OASIS6 230	0.000	0.892	line POTTRC7 to FRIODR7 345 ck 1
51195 OASIS6 230	0.000	0.869	line ROOSEVL6 to TOLKE6 230 ck 2
51195 OASIS6 230	0.000	0.867	line ROOSEVL6 to TOLKW6 230 ck 1
51195 OASIS6 230	0.000	0.893	tran FRIODR7 345/230 ck 1
51195 OASIS6 230	0.000	0.900	tran EDDYCO6 230/345 ck 1
51199 FRIODR6 230	0.000	0.945	Base system (n-0)
51199 FRIODR6 230	0.000	0.894	line POTTRC7 to FRIODR7 345 ck 1
51199 FRIODR6 230	0.000	0.881	line ROOSEVL6 to TOLKE6 230 ck 2
51199 FRIODR6 230	0.000	0.879	line ROOSEVL6 to TOLKW6 230 ck 1
51199 FRIODR6 230	0.000	0.895	tran FRIODR7 345/230 ck 1
51200 FRIODR7 345	0.000	0.949	Base system (n-0)
51200 FRIODR7 345	0.944	0.894	line POTTRC7 to FRIODR7 345 ck 1
51200 FRIODR7 345	0.000	0.890	line ROOSEVL6 to TOLKE6 230 ck 2
51200 FRIODR7 345	0.000	0.888	line ROOSEVL6 to TOLKW6 230 ck 1
51200 FRIODR7 345	1.052	1.028	tran FRIODR7 345/230 ck 1
51203 ROOSEVL6 230	0.000	0.936	Base system (n-0)
51203 ROOSEVL6 230	0.000	0.893	line POTTRC7 to FRIODR7 345 ck 1
51203 ROOSEVL6 230	0.000	0.866	line ROOSEVL6 to TOLKE6 230 ck 2
51203 ROOSEVL6 230	0.000	0.864	line ROOSEVL6 to TOLKW6 230 ck 1
51203 ROOSEVL6 230	0.000	0.894	tran FRIODR7 345/230 ck 1
51205 CLOVIS G 230	0.000	0.936	Base system (n-0)
51205 CLOVIS G 230	0.000	0.893	line POTTRC7 to FRIODR7 345 ck 1
51205 CLOVIS G 230	0.000	0.866	line ROOSEVL6 to TOLKE6 230 ck 2
51205 CLOVIS G 230	0.000	0.864	line ROOSEVL6 to TOLKW6 230 ck 1
51205 CLOVIS G 230	0.000	0.894	tran FRIODR7 345/230 ck 1
51321 SWISHER6 230	0.942	0.922	Base system (n-0)
51321 SWISHER6 230	0.000	0.894	line POTTRC7 to FRIODR7 345 ck 1
51321 SWISHER6 230	0.000	0.896	tran FRIODR7 345/230 ck 1
51403 HALECO6 230	0.944	0.920	Base system (n-0)
51403 HALECO6 230	0.000	0.889	line POTTRC7 to FRIODR7 345 ck 1
51403 HALECO6 230	0.000	0.892	tran FRIODR7 345/230 ck 1
51533 TUCO6 230	0.961	0.930	Base system (n-0)
51533 TUCO6 230	0.000	0.897	line POTTRC7 to FRIODR7 345 ck 1
51533 TUCO6 230	0.000	0.899	tran FRIODR7 345/230 ck 1
51534 TUCO7 345	0.968	0.921	Base system (n-0)
51534 TUCO7 345	0.000	0.880	line POTTRC7 to FRIODR7 345 ck 1
51534 TUCO7 345	0.000	0.883	tran FRIODR7 345/230 ck 1

51534 TUCO7 345	0.000	0.897	tran EDDYCO6 230/345 ck 1
51647 CARLISL6 230	0.942	0.913	Base system (n-0)
51647 CARLISL6 230	0.000	0.883	line POTTRC7 to FRIODR7 345 ck 1
51647 CARLISL6 230	0.000	0.884	tran FRIODR7 345/230 ck 1
51647 CARLISL6 230	0.000	0.891	tran EDDYCO6 230/345 ck 1
51689 LUBE6 230	0.000	0.949	Base system (n-0)
51763 WOLFRTH6 230	0.000	0.950	Base system (n-0)
51861 BORDEN6 230	0.000	0.950	Base system (n-0)
52073 CHAVES6 230	0.964	0.936	Base system (n-0)
52073 CHAVES6 230	0.895	9.000	line TOLK7 to EDDYCO7 345 ck 1
52073 CHAVES6 230	0.879	0.848	line CHAVES6 to EDDYCO6 230 ck 1
52073 CHAVES6 230	0.896	0.876	tran EDDYCO6 230/345 ck 1
52186 EDDYCO7 345	1.067	1.034	tran EDDYCO6 230/ 345 ck 1

Table 3.19 Voltage violations for the Blackwater 230 kV and Eddy Co. 345 kV VFT ep5 import scenario

Bus	**import-ep0**	**import-ep5**	**Outage description**
50808 KNGSML3 115	1.052	1.038	line FINNEY7 to POTTRC7 345 ck 1
50808 KNGSML3 115	1.052	1.038	line FINNEY7 to HOLCOMB7 345 ck 1
50808 KNGSML3 115	1.053	1.035	line TUCO7 to O.K.U.-7 345 ck 1
51533 TUCO6 230	0.951	0.940	Base system (n-0)

4. Summary of Thermal and Voltage Analysis

The results of the thermal and voltage analysis show the following:

- To support a 200 MW VFT installation at Blackwater 230 kV under peak load export conditions, voltage support will likely be needed on the local 230 kV system. Several 115 and 230 kV line and transformer overloads will also have to be addressed for both import and export conditions.
- To support a 200 MW VFT installation at Eddy Co. 230 kV under peak load export conditions, voltage support will be required on the 230 kV system from Roosevelt down to Chaves and to Eddy Co. Post-contingency thermal overloads on the Eddy Co. and Cunningham 230/115 kV transformers will also have to be addressed.
- Installing the Eddy Co. VFT on the 345 kV bus does not have a significant impact on the thermal and voltage problems caused by the export or import of power at the site.
- To support two 200 MW VFT installations (at Blackwater and Eddy Co.), more extensive thermal upgrades and voltage support will be required, particularly under export conditions. The primary limitation appears to be in the ability to wheel power through SPS to the VFT sites. It may be possible to limit the extent of the upgrades by increasing SPS generation, and thereby reducing the imports into SPS over the ac ties.