SOUTHWESTERN PUBLIC SERVICE VOLTAGE CONSTRAINED IMPORT LIMITS 2004 SUMMER – 2010 WINTER STUDY

SOUTHWEST POWER POOL

8/6/2004

1. Objective

A. The first objective of this study is to determine the Voltage Stability Total Transfer Capability (TTC) and the Available Transfer Capability (ATC) for Xcel Energy/Southwestern Public Service Company (SPS) for the period from 2004 Summer to 2010 Winter.

B. The second objective of this study is to determine the Voltage Stability TTC and the ATC for Xcel Energy/SPS for the period from 2005 Summer to 2010 Winter with upgrades proposed for a 150MW SECI to GSEC transfer.

C. The third objective of this study is to determine the Voltage Stability TTC and the ATC for Xcel Energy/SPS for the period from 2007 Summer to 2010 Winter with upgrades proposed for a 300MW SECI to GSEC transfer.

2. Scope

A. This study will determine the TTC for SPS from 2004 Summer through 2010 Winter using selected steady state power flow models published by the Southwest Power Pool (SPP) Model Development Working Group (MDWG) February 2004.

B. The study outage is the loss of a SPS Tolk unit (540MW). This represents the single largest hazard on the SPS system.

C. This study is restricted to determining the TTC in mega-watts (MW) as defined by the following voltage criteria:

1) The SPS Tuco 230kV bus voltage must remain above 92.5%.
2) The American Electric Power (AEPW) Oklaunion 345kV bus voltage must remain above 90.0%. The Oklaunion EHV substation is at the Electric Reliability Council of Texas (ERCOT) North DC tie (NDC).
3) The SPS Moore County Interchange 230kV bus voltage must remain above 90.0%.
4) The SPS Potter County Interchange 230kV and 345kV bus voltages must remain above 90.0%.

D. Bus Voltages in the following areas were monitored to determine if voltages were close to decay for the transfer levels studied:

1) SPS
2) AEPW
3) SUNC
4) WEPL
5) WERE
6) WFEC
7) OKGE

E. Transactions which effect SPS imports were added to the base models. Also, SPS imports and exports to the three connected HVDC ties to WECC were left intact.

F. The following conditions were added to the original base models:

1) The ERCOT North HVDC (NDC) is a load of 220MW, 110MVAR with three 30MVAR switched capacitors and one 50MVAR switched reactor available on the Oklaunion 345kV bus. Power is flowing from AEP Calpine Generation to ERCOT in all models. ATC was also calculated with the NDC flowing into SPP from ERCOT 220MW, and a load of 110MVAR.
2) Tolk Unit 2 was turned OFF to simulate the outage condition. The Tolk unit 1 real power dispatched is 540MW. The Tolk unit 1 reactive power capability is 280MVAR. SPS import was increased by 540MW with a transfer from EQ_EAST.

3) In the 2005 April Minimum model, Tolk unit 2 was already turned off. To simulate the loss of the largest unit, Tolk unit 1 was turned OFF. SPS import was increased by 540MW with a transfer from EQ_EAST.
4) Prior to any proposed upgrades, in the 2007 Summer Peak and the 2010 Summer Peak, 540MW of import capability was not available to make up for the loss of the Tolk unit. Interruptible load was represented by turning on the fictitious Tolk unit 3. This results in the negative ATC values reported in the BASECASE table.

G. The SPS TTC for EQ_EAST to SPS was determined.

H. The results of the study were documented.

3. Study Approach

The 2004 Summer through 2010 Winter models were modified to simulate the effects of the loss of the largest unit on the SPS system. This largest unit is either one of the two 540MW Tolk units. Import was increased from EQ_EAST to make up for the generation deficiency in the SPS control area. This created the base case for each season that was used to determine the import ATC after the loss of this unit.

The modified models were screened using the PowerWorld Voltage Stability PV Curve assessment tool. PowerWorld determines the SPS import limit when the Tuco, Oklaunion, Moore, or Potter bus voltages reach the specified low voltage limit. The imports were adjusted in 1MW increments until one of the above mentioned bus voltage limits is violated. The EQ_EAST area generation was scaled up using participation factors based on unit size while the SPS area generation was adjusted down based on an operational dispatch priority supplied by SPS. The output from PowerWorld represents the ATC available after import of 540MW to replace the generation from the loss of the Tolk unit.

4. Assumptions

A. Models

The SPP 2004 series power flow models from 2004 Summer to 2010 Winter were used to analyze the SPS TTC. These models include MDWG update 2 changes. The steady state models used were:

Year	Season	Load
2004	Summer	Shoulder
2004	Summer	Peak
2004	Fall	Peak
2004/05	Winter	Peak
2005	April	Minimum
2005	Spring	Peak
2005	Summer	Shoulder
2005	Summer	Peak
2005	Fall	Peak
2005/06	Winter	Peak
2007	Summer	Peak
2007/08	Winter	Peak
2010	Summer	Peak
2010/11	Winter	Peak

B. Generation

1) Reactive Reserve

Currently, there are no SPP criteria specifying reactive reserve requirements. No reactive reserve was implemented in the models.

2) Real Power Dispatch

PowerWorld was set to scale generation up in the source area, EQ_EAST, based on participation factors of the units. These participation factors were based on the unit's maximum power capability. Generation in the sink area, SPS, was set to adjust based on the dispatch priority provided to SPP by SPS. This dispatch priority was implemented in PowerWorld by adjusting the participation factor of units for AGC control in SPS.

In the 2005 April Minimum, the generation dispatch priority provided by SPS was altered to eliminate a known operating constraint on the SPS system. This involved shifting generation from Harrington in the North to Mustang and Cunningham in the South to reduce the North to South flow on the SPS system.

3) Exciter Limiters

The model does not reflect constraints due to over excitation relays.

C. Shunts

Automatic switching of capacitors and reactors were modeled.

D. Transformers

1) Power Transformers
   Transformers were allowed to regulate voltage according to their modeled characteristics.

2) Phase Shifters
   Operation of phase shifting transformers was enabled according to their modeled characteristics.

E. High Voltage Direct Current Converter Stations

1) ERCOT North (Oklaunion)
   Analyzed flowing in both directions (into SPP, and out of SPP). Set as a load of 220MW, 110MVAR (out of SPP) and as a load of –220MW, 110MVAR (into SPP). Represents flow from SPS to ERCOT. Modeled as a constant real and reactive power load.

2) Blackwater
   Set as a load of 200MW, 0MVAR with a 50MVAR switched capacitor in-service. Represents flow from SPS to WECC. Modeled as a constant real and reactive power load.

3) Eddy County
   Set as a load of 200MW, 100MVAR with a switched capacitor of 120MVAR until 2004 Winter when it becomes a load of 165MW, 82.5MVAR with a switched capacitor of 90MVAR. Represents flow from SPS to WECC. Modeled as a constant real and reactive power load.

4) Lamar
   Set as a load of –210MW, 0MVAR with a switched reactor of 50MVAR. Represents flow from WECC to SPS. Modeled as a constant real and reactive power load.

F. Transactions

The SPP 2004 series base model transfers constitute the starting point for this study. The transfers to and from each HVDC tie were left intact. However, the ERCOT North DC tie was adjusted in each case such that it was flowing into or from SPP to ERCOT. The generation at AEPW Calpine was increased/decreased to make the transfer.

G. Model Overloads

Overloads in the models are ignored for the voltage stability SPS Import limit analysis.

H. Contingency Selection

The SPS Import limiting outage for this study is the loss of a Tolk unit.

I. Voltage Collapse Margin
Transfer limit is reached when the Tuco 230kV bus reaches 92.5%, or the Oklaunion 345kV, Moore 230kV, Potter 230kV, or Potter 345kV bus voltages reach 90.0% for SPS Imports with loss of the Tolk unit.

J. System Improvements

1. GS150—These improvements were proposed to alleviate constraints that would limit import capability for an import of 150MW from SECI to serve GSEC.
    a. Addition of a 14.4MVAR capacitor bank at Dallam 115kV (2005).
    b. Addition of a 28.8MVAR capacitor bank at Kress 115kV (2007).
    c. Addition of a 28.8MVAR capacitor bank at Bushland 115kV (2007).
    d. Addition of a 100.0MVAR capacitor bank at Oklaunion 345kV (2007).
    e. Addition of a 50.0MVAR capacitor bank at Swisher 230kV (2007).
    f. Addition of a 14.4MVAR capacitor bank at Hale Co. 69kV (2007).
    g. Addition of a 28.8MVAR capacitor bank at Chaves 115kV (2007).
    h. Addition of a 115kV circuit between Amarillo South and Rockwell (2007).
    i. Addition of a second 230/345kV autotransformer at Potter Co. (2007).
    j. Addition of a 115/345kV autotransformer at Tuco Interchange (2007).

2. XEM300—These improvements were proposed to alleviate constraints that would limit import capability for an import of an additional 300MW from SECI. The XEM300 cases also include the GS150 upgrades.
    a. Addition of a 260 mile, 345kV circuit from Tuco Interchange to Mooreland, OK.
    b. Addition of a 120 mile, 345kV circuit from Spearville, KS to Mooreland, OK.
    c. Addition of a 138/345kV autotransformer at Mooreland, OK.

5. Study Results

The SPS TTC and ATC for each seasonal model studied are listed in Attachment A.

The most limiting ATC in the 2004 Summer to 2005 Summer Peak time period is **0 MW** (in the **2005 April Minimum** and **2005 Summer Peak**.

6. Contacts

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Import Limits

2004 Summer through 2010 Winter

BASECASE

July 19, 2004

YEAR	**2004**	**2004**	**2004**	**2004**	**2005**	**2005**	**2005**	**2005**	**2005**	**2005**	**2007**	**2007**	**2010**	**2010**
SEASON	**SUMMER**	**SUMMER**	**FALL**	**WINTER**	**APRIL**	**SPRING**	**SUMMER**	**SUMMER**	**FALL**	**WINTER**	**SUMMER**	**WINTER**	**SUMMER**	**WINTER**
LOAD LEVEL	**SHOULDER**	**PEAK**	**PEAK**	**PEAK**	**MINIMUM**	**PEAK**	**SHOULDER**	**PEAK**	**PEAK**	**PEAK**	**PEAK**	**PEAK**	**PEAK**	**PEAK**
MODEL	**04SH**	**04SP**	**04FA**	**04WP**	**05AP**	**05G**	**05SH**	**05SP**	**05FA**	**05WP**	**07SP**	**07WP**	**10SP**	**10WP**
Synchronous Import Transactions in Models														
LAMAR to SPS	0	0	0	210	210	210	210	210	210	210	210	210	210	210
AMRN to SPS	100	100	100	200	200	200	200	200	200	200	200	200	200	200
AEPW to SPS	41	40	43	-9	-10	-4	-9	-10	-7	-9	-10	-9	-11	-9
OKGE to SPS	100	100	0	0	0	0	0	0	0	0	0	0	0	0
KACP to SPS	50	50	50	0	0	0	0	0	0	0	0	0	0	0
Total Syn. Import Modeled	291	290	193	401	400	406	401	400	403	401	400	401	399	401
WECC Transactions in Models														
SPS TO BLACKWATER	200	200	200	200	200	200	200	200	200	200	200	200	200	200
SPS TO EDDY	200	200	200	200	200	200	200	200	200	200	200	200	200	200
Total WECC Export	400	400	400	400	400	400	400	400	400	400	400	400	400	400
SPP-ERCOT Flow	220	220	220	220	220	220	220	220	220	220	220	220	220	220
EASTERN IMPORT ATC	**143**	**73**	**283**	**66**	**0**	**571**	**71**	**0**	**0**	**66**	**-75**	**63**	**-68**	**54**
Limiting Criteria	Oklaunion	Oklaunion	Oklaunion	Moore 230kV	Oklaunion	Potter 345kV	Potter 345kV	Tuco 230kV	Potter 345kV	Potter 345kV	Oklaunion	Moore 230kV	Oklaunion	Moore 230kV
Critical Contingency = Loss of Tolk Unit (540MW)														
Eastern TTC Calculation														
ATC	**143**	**73**	**283**	**66**	**0**	**571**	**71**	**0**	**0**	**66**	**-75**	**63**	**-68**	**54**
TRM Reserved (critical Con)	540	540	540	540	540	540	540	540	540	540	540	540	540	540
Syn Import Modeled	291	290	193	401	400	406	401	400	403	401	400	401	399	401
Total TTC	**974**	**903**	**1016**	**1007**	**940**	**1517**	**1012**	**940**	**943**	**1007**	**865**	**1004**	**871**	**995**

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Import Limits

2004 Summer through 2010 Winter

WITH GS150 IMPROVEMENTS

July 19, 2004

YEAR SEASON LOAD LEVEL MODEL	2005 SUMMER SHOULDER 05SH	2005 SUMMER PEAK 05SP	2005 FALL PEAK 05FA	2005 WINTER PEAK 05WP	2007 SUMMER PEAK 07SP	2007 WINTER PEAK 07WP	2010 SUMMER PEAK 10SP	2010 WINTER PEAK 10WP
Synchronous Import Transactions in Models								
LAMAR to SPS	210	210	210	210	210	210	210	210
AMRN to SPS	200	200	200	200	200	200	200	200
AEPW to SPS	-9	-10	-7	-9	-10	-9	-11	-9
OKGE to SPS	0	0	0	0	0	0	0	0
KACP to SPS	0	0	0	0	0	0	0	0
Total Syn. Import Modeled	401	400	403	401	400	401	399	401

WECC Transactions in Models								
SPS TO BLACKWATER	200	200	200	200	200	200	200	200
SPS TO EDDY	200	200	200	200	200	200	200	200
Total WECC Export	400	400	400	400	400	400	400	400

SPP-ERCOT Flow	220	220	220	220	220	220	220	220

EASTERN IMPORT ATC	**141**	**73**	**0**	**131**	**213**	**260**	**150**	**262**
Limiting Criteria	Potter 345kV	Tuco 230kV	Potter 345kV	Potter 345kV	Oklaunion	Moore 230kV	Oklaunion	Moore 230kV
Critical Contingency = Loss of Tolk Unit (540MW)								

Eastern TTC Calculation								
ATC	**141**	**73**	**0**	**131**	**213**	**260**	**150**	**262**
TRM Reserved (critical Con)	540	540	540	540	540	540	540	540
Syn Import Modeled	401	400	403	401	400	401	399	401
Total TTC	**1082**	**1013**	**943**	**1072**	**1153**	**1201**	**1089**	**1203**

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Import Limits

2004 Summer through 2010 Winter

WITH XEM300 IMPROVEMENTS

July 19, 2004

YEAR	2007	2007	2010	2010
SEASON	SUMMER	WINTER	SUMMER	WINTER
LOAD LEVEL	PEAK	PEAK	PEAK	PEAK
MODEL	07SP	07WP	10SP	10WP
Synchronous Import Transactions in Models				
LAMAR to SPS	210	210	210	210
AMRN to SPS	200	200	200	200
AEPW to SPS	-10	-9	-11	-9
OKGE to SPS	0	0	0	0
KACP to SPS	0	0	0	0
Total Syn. Import Modeled	400	401	399	401

WECC Transactions in Models				
SPS TO BLACKWATER	200	200	200	200
SPS TO EDDY	200	200	200	200
Total WECC Export	400	400	400	400

SPP-ERCOT Flow	220	220	220	220

EASTERN IMPORT ATC	**530**	**607**	**462**	**635**
Limiting Criteria	Tuco 230kV	Oklaunion	Oklaunion	Oklaunion
Critical Contingency = Loss of Tolk Unit (540MW)				

Eastern TTC Calculation				
ATC	**530**	**607**	**462**	**635**
TRM Reserved (critical Con)	540	540	540	540
Syn Import Modeled	400	401	399	401
Total TTC	**1470**	**1548**	**1401**	**1576**