



SOUTHWESTERN PUBLIC SERVICE
VOLTAGE CONSTRAINED
IMPORT LIMITS
2001 FALL-2010 SUMMER
STUDY

FINAL

SOUTHWEST POWER POOL

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1. **OBJECTIVE**

The objective for this project is to determine the Voltage Stability Total Transfer Capability (TTC) and the Available Transfer Capability (ATC) for Southwestern Public Service Company (SPS) from 2001 Fall through 2010 Summer.

2. **SCOPE**

- A. This study determines the TTC for SPS from 2001 Fall through 2010 Summer using selected Steady State Power Flow models published by the Southwest Power Pool (SPP) Model Development Working Group (MDWG) January 26th, 2001.
- B. The study outage is the loss of a SPS Tolk unit (540 MW).
- C. This study is restricted to determining the TTC in mega-watts (MW) as defined by the following voltage criteria:
 - 1) The SPS TUCO 230 kV bus voltage must remain above 92.5%.
 - 2) The American Electric Power (AEPW) Oklaunion 345 kV bus voltage must remain above 90%. The Oklaunion EHV substation is in Texas.
 - 3) The SPS MOORE6 230 kV bus voltage must remain above 90.0%.
 - 4) The SPS POTTRC6 230 kV bus and POTTRC7 345 kV bus voltage 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) SUNF
 - 4) Westplains Energy (WEPL)
 - 5) Western Resources
 - 6) Western Farmers Electric Cooperative
 - 7) OKGE

- E. Transactions which effect WR exports and SPS imports were added to the base models. The added transactions come before OASIS request 242232.
- F. The following conditions were added to the original base models:
- 1) The Electric Reliability Council of Texas (ERCOT) North HVDC (NDC) is a load of 200 MW, 100 Mvar with three 30 Mvar of switched capacitors and one 50 Mvar switched reactor available on the Oklaunion 345 kV bus. Power is flowing from AEP Calpine generation to ERCOT in all models.
 - 2) Blackwater HVDC is a load of 200 MW, 100 Mvar with four 30 Mvar and one 54 Mvar of switched capacitors available. Power is flowing from SPP to WSCC in all models.
 - 3) The Eddy County HVDC is a load of 200 MW, 100 Mvar with four 30 Mvar of switched capacitors available. Power is flowing from SPP to WSCC in all models.
 - 4) The Lamar HVDC has 210 MW of the real power flowing from WSCC to SPS in the 2004 Winter through 2010 Summer Peak models. The reactive power flow is 105 Mvar to the HVDC tie. There are four 30 Mvar of switched capacitors available at Lamar HVDC.
 - 5) The West Plains (WEPL) Texas County Phase Shifter is set to 0 MW in all models.
 - 6) The Tolk unit 2 was turned OFF. The Tolk unit 1 real power dispatched is 540 MW. The Tolk unit 1 reactive power capability is 280 Mvar. SPS import was increased by 540 MW. The EQ-EAST generation was scaled up 540 MW.
- G. The SPS TTC for EQ-EAST to SPS was determined.
- H. The results of the study will be documented.

3. STUDY APPROACH

The 2001 Fall through 2010 Summer models were modified to include the effects of the NDC, Lamar HVDC, Eddy County HVDC, Blackwater HVDC, and the Texas County Phase Shifter. Appropriate transactions were added to the base models. The modified models were screened by the Powertech Labs Incorporated "Voltage Security Assessment Tool" (VSAT) to determine when the TUCO, Oklaunion, Moore, or Potter bus voltage reaches the low voltage limit for SPS imports. The imports were adjusted in 10 MW steps. The SPP to SPS tie flow was recorded. The SPS import limit is reached for the transfer that causes a bus voltage above the limit voltage to within 1 MW. The exporting area(s) generation was scaled up and the SPS generation was scaled down for each transfer. WR was the exception since Wolf Creek generation was kept constant.

4. ASSUMPTIONS

A. Models

The SPP 2001 series power flow models from 2001 Fall to 2010 Summer were used to analyze the SPS TTC. These models include MDWG update 4 changes. The steady state models are:

<u>Model</u>	<u>Year</u>	<u>Season</u>	<u>Load</u>
B01FA3	2000	Fall	Peak
B01WP3	2001/02	Winter	Peak
B02AP3	2002	April	Minimum
B02G3	2002	Spring	Peak
B02SP3	2002	Summer	Peak
B02FA3	2002	Fall	Peak
B02WP3	2002/03	Winter	Peak
B03G3	2003	Spring	Peak
B04SP3	2004	Summer	Peak
B04WP3	2004/05	Winter	Peak
B06SP3	2006	Summer	Peak
B06WP3	2006/07	Winter	Peak
B10SP3	2010	Summer	Peak

B. Loads

1). Steady State Voltage Stability

The load is modeled as 100% constant real and reactive power. This load model assumes autotransformer regulation is complete and distribution load tap changing (LTC) transformers have recovered load to an acceptable voltage.

C. Generation

1) Reactive Reserve

Currently, SPP criteria do not specify generation reactive reserve requirements. On a provisional basis, the SPP staff is limiting the total reactive capability per system to 90% of its maximum capability. The Transmission Assessment Working Group will be requested to develop SPP criteria.

2) Real Power Dispatch

The analysis scales generation up in the Source and scale generation down in the Sink for the transfers. The unit participation will be based on the current generation dispatch in the model.

3) Exciter Limiters

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

D. Shunts

Automatic switching of capacitors and reactors were modeled.

E. Transformers

1) Power Transformers

Transformers modeled with voltage regulation and tap changers were allowed to regulate voltage.

2) Phase Shifters

Operation of phase shifting transformers was enabled.

F. High Voltage Direct Current Converters Stations

1) ERCOT North (Oklaunion)

(See section 2.F.1)

2) Blackwater

(See section 2.F.2)

3) Eddy County

(See section 2.F.3)

4) Lamar

(See section 2.F.4)

5) Steady state model

The Lamar, Blackwater, Eddy County, and Oklaunion HVDC ties area modeled as constant real and reactive power loads.

G. SPS EHV Transmission Plan

- 1) The Potter (Western Systems Coordinating Council (WSCC)) to Holcomb Sunflower Electric Power Corp. (SUNC) 345 kV is in service by fall 2001.
- 2) The Lamar to Holcomb (SUNC) 345 kV is in service winter 2004.
- 3) The Potter to Northwest, Oklahoma Gas and Electric (OKGE), 345 kV is in service 2006 summer.

H. Transactions

The SPP 2001 series base model transfers constitute the starting point for this study. The transfers to and from the Lamar, Eddy County, and NDC were added to each base model. OASIS transaction before OASIS request (242232) that limit WR exports or SPS import and are not modeled in the 2001 series base models were also added to the models. The AMRN to SPS 200 MW transaction is included in the 2001 winter through 2010 Summer peak models.

I. Model Overloads

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

J. Contingency Selection

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

K. Voltage Collapse Margin

Transfer limit is reached when the TUCO 230 kV bus reaches 92.5%, the Oklaunion 345 kV, Moore 230 kV, Potter 230 kV, or Potter 345 kV bus reaches 90% for SPS Imports with one Tolk unit off.

5. TASKS

Task 1 Model Preparation

The SPP base models were modified by making the North HVDC, Lamar HVDC, Eddy County HVDC, and the Blackwater HVDC loads. The Texas County phase shifter was set to 0 MW. The Tolk unit 2 was turned OFF and unit 1 was dispatched to 540 MW. SPS imports 540 MW from EQ-EAST. Appropriate transactions were added to the models. The WSCC Lamar HVDC transaction to SPS was -210 MW in the 2004 summer peak model, this transaction was changed to 210 MW.

Task 2 Analyze SPS Import limits with voltage constraints

Perform SPS imports from EQ-EAST.

Task 3 Report Results of the SPS Import

Summarize results of the SPS Imports by model and transaction path.

Task 4 Report SPS TTC and ATC for Import

Report results of the SPS TTC and ATC limit for the model year and seasons studied.

6. PROJECT DELIVERABLES

A. Report SPS transactions added to the base models.

The SPS transactions added to the base models are in **Attachment A**. The NET TO SPP interchange includes SPS to SPP tie flow real power (MW). A negative interchange means the net schedule is into SPS. This flow does not include WSCC HVDC tie flow.

B. Report the SPS TTC and ATC for each model studied and each scenario.

The SPS TTC and ATC for each model studied is in **Attachment B**. The TTC and ATC is the most limiting transfer from all sources included in the study. The ATC for the **2006** and **2010 summer models** is **0 MW**. The model is unstable for any additional SPS imports for the 2006 and 2010 summer models.

The most limiting ATC from 2001 fall through **2002** summer is **159 MW** (in the 2002 summer peak model).

7. **CONTACTS**

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ATTACHMENT A: SPS Transactions added to the base models.

SOUTHWEST POWER POOL					(July 24, 2001)															
SPP MODEL DEVELOPMENT WORKING GROUP																				
INTERCHANGE DATA FOR 2001 SERIES UPDATE 4 MODELS																				
SPS Transactions for Import Limit Study					NERC MODEL=	2001F	2001W	2001L	2002G	2002S	2002F	2002W	2002F	2002S	2002W	2005S	2005W	2010S		
REGION	AREA	FROM	AREA	TO	TRANS. NO.	COMMENTS	FIRM	01FA	01/02WP	02AP	02G	02SP	02FA	02/03WP	03G	04SP	04/05WP	06SP	06/07WP	10SP
2001 Models with Update 3:																				
SPP	526	SPS	956	WSCC	1	PNM-BLACKWATER	X	150	150	150	150	150	150	150	150	150	150	150	150	150
	526	SPS	956	WSCC	2	EPE-EDDY COUNTY	X	50	50	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	956	WSCC	3	TNP-EDDY COUNTY	X	35	35	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	956	WSCC	4	LAS CRUCES-EDDY COUNTY	X	0	0	0	0	0	0	0	0	0	0	0	0	0
						SUBTOTAL		85	85	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	957	WSCC	5	PSCO-Lamar	X	0	0	0	0	0	0	0	0	0	0	210	-210	-210
	526	SPS	520	AEPW	1		X	0	0	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	520	AEPW	2		X	0	0	0	0	0	0	0	0	0	0	0	0	0
						SUBTOTAL		0	0	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	524	OKGE	1		X	0	0	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	544	EMDE	1		X	0	0	0	0	0	0	0	0	0	0	0	0	0
						NET SCHEDULE (pre-trans)		235	235	150	150	150	150	150	150	150	150	360	-60	-60
						NET TO SPP (pre-trans)		0	0	0	0	0	0	0	0	0	0	0	0	0
3B-XXXX4.SAV: 2001 Models with Update 3 and HVDC at 200MW load and transactions:																				
SPP	526	SPS	955	WSCC	1	PNM-BLACKWATER	X	150	150	150	150	150	150	150	150	150	150	150	150	150
	526	SPS	955	WSCC	1	NEW	X	50	50	50	50	50	50	50	50	50	50	50	50	50
						SUBTOTAL		200	200	200	200	200	200	200	200	200	200	200	200	200
	526	SPS	956	WSCC	2	EPE-EDDY COUNTY	X	50	50	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	956	WSCC	3	TNP-EDDY COUNTY	X	35	35	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	956	WSCC	4	LAS CRUCES-EDDY COUNTY	X	0	0	0	0	0	0	0	0	0	0	0	0	0
					5	NEW		115	115	200	200	200	200	200	200	200	200	200	200	200
						SUBTOTAL		200	200	200	200	200	200	200	200	200	200	200	200	200
	526	SPS	957	WSCC	5	PSCO-Lamar	X	0	0	0	0	0	0	0	0	0	0	210	-210	-210
	526	SPS	957	WSCC	6	210 TO SWPS TOTAL	X	0	0	0	0	0	0	0	0	0	0	-420	0	0
						SUBTOTAL		0	0	0	0	0	0	0	0	0	0	-210	-210	-210
	526	SPS	520	AEPW	1		X	0	0	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	520	AEPW	2		X	0	0	0	0	0	0	0	0	0	0	0	0	0
						SUBTOTAL		0	0	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	524	OKGE	1		X	0	0	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	544	EMDE	1		X	0	0	0	0	0	0	0	0	0	0	0	0	0
	526	SPS	88	NPCC (EQ-	1	TOLK 2 Unit OFF import gen.		-540	-540	-540	-540	-540	-540	-540	-540	-540	-540	-540	-540	-540
	526	SPS	356	AMRN	1			0	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
	526	SPS	356	AMRN	2			0	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
	526	SPS	356	AMRN	3			0	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
	526	SPS	356	AMRN	4			0	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50	-50
						SUBTOTAL		0	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200
						NET SCHEDULE (post-trans)		-140	-340	-340	-340	-340	-340	-340	-340	-340	-340	-550	-550	-550
						NET TO SPP (post-trans)		-540	-740	-740	-740	-740	-740	-740	-740	-740	-740	-950	-950	-950

ATTACHMENT B: SPS TTC and ATC.

SOUTHWEST POWER POOL

Southwestern Public Service

Import Limits w/ 10% Generation Reactive Reserve

2001 Fall through 2010 Summer

August 01, 2001

Year	2001	2001	2002	2002	2002	2002	2002	2002	2003	2004	2004	2006	2006	2010
Season	Fall	Winter	April	Spring	Summer	Fall	Winter	Spring	Summer	Winter	Summer	Winter	Summer	
Load Level	Peak	Peak	Minimum	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	Peak	
Model	(01FA)	(01WP)	(02AP)	(02G)	(02SP)	(02FA)	(02WP)	(03G)	(04SP)	(04WP)	(06SP)	(06WP)	(10SP)	
TTC	1031	993	1186	985	899	1009	929	1090	845	1253	950	1528	950	
Reserve - TRM	540	540	540	540	540	540	540	540	540	540	540	540	540	
AMRN to SWPS		200	200	200	200	200	200	200	200	200	200	200	200	
Lamar HVDC to SWPS										210	210	210	210	
ATC	491	253	446	245	159	269	189	350	105	303	0	578	0	