



SPP *Southwest Power Pool*



Norborne Transmission Study

**SPP ENGINEERING DEPARTMENT,
PLANNING**

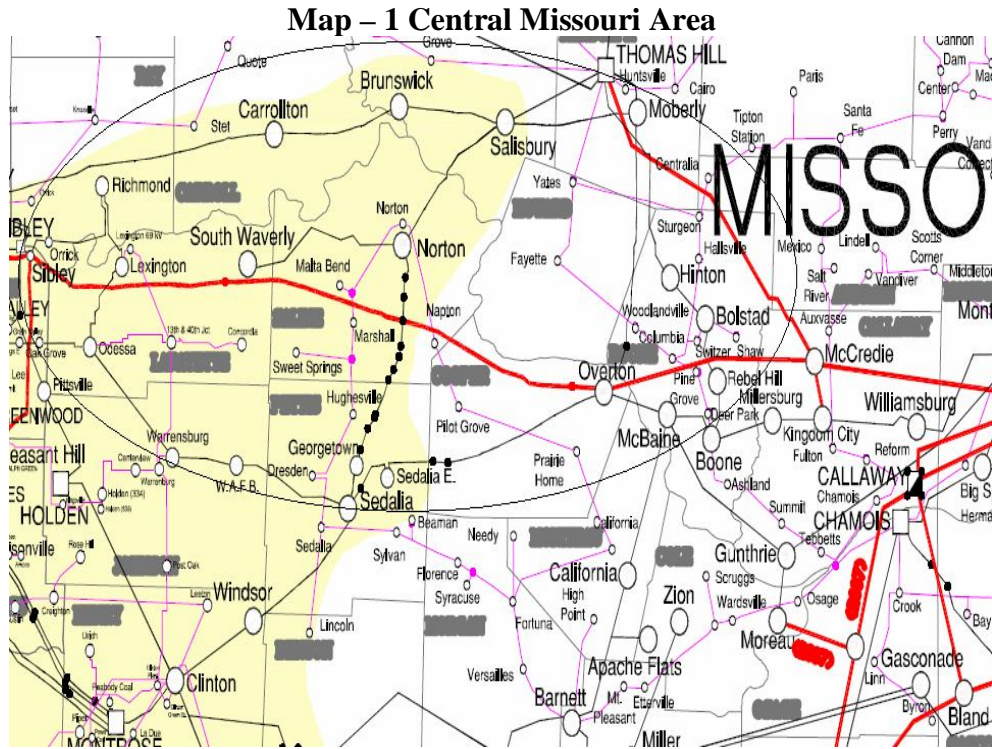
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1. EXECUTIVE SUMMARY

The objective of the Norborne Transmission Study is to develop a transmission expansion plan for Central Missouri and surrounding areas in response to a proposed 660 MW generation addition at Norborne in 2013.



The study was conducted as per an Arkansas Electric Cooperative Co (AECC) request. The scope for the analysis was developed in collaboration with AECC staff. SPP staff conducted the study after incorporating suggested topology modifications into the analysis around the Central Missouri area by both AECC staff and Associated Electric Cooperative Inc (AECI) staff. The topology changes were made after AECI staff provided feedback regarding the study assumptions used for the analysis. The regional solution identified in the study is to construct a 345 kV line from the Norborne plant tapping into the Sibley to Overton 345 kV line. This solution resolves the overload issue in the region with the exception of Overton transformer.

2. INTRODUCTION

A. Background

A meeting consisting of AECC staff and SPP staff was held in August 2007 to discuss transmission expansion alternatives in the Central Missouri area. At this meeting, the scope of the study was discussed and finalized.

B. Scope

This study used the 2007 SPP Transmission Expansion Plan (STEP) Rerun 4 load flow models, which included 100kV and above STEP upgrades that were identified at the time this study was being prepared. The 2017 summer peak base case scenario 0 and transaction scenario models 1 through 5 were used in the study analysis. A few model corrections have been incorporated (example: rating changes). In addition to these corrections the following topology changes were made:

- Addition of the Jasper - Chouteau – GRDA 345 kV line
- Removal of the East Centerton - Osage creek 345 kV line
- Addition of a 260 MW transaction from AECI to AEPW.
- Removal of a 75 MW transaction from EES to AEPW.

To accommodate the above transactions, EES generation was adjusted by 75 MW. AEPW generation was also adjusted by 185 MW. The SPP Tariff studies generation dispatch information for 2017 summer peak was used.

Two n-1 contingency analyses were performed, one on the modified base cases and the other with the addition of a new 345 kV line from Norborne to tap the Sibley – Overton 345 kV line. The difference in the two sets of results determined the effectiveness of the 345 kV line tap from Sibley – Overton to Norborne. The modified base cases include Norborne-Thomas Hill 345 kV line, Norborne-Dresden 345 kV line, a 345/161 kV transformer at Dresden and the Dresden-Mt Hulda 161 kV line.

The ac contingency (n-1) analysis on all study models observed the following standards:

- All SPP and NERC reliability standards.
- A 3% thermal transfer distribution cutoff factor
- A 2% change cutoff for voltage violations

These practices are in concert with the current SPP tariff studies process.

3. STUDY METHODOLOGY

A. Models

The study models for the Norborne Transmission Study were derived from the 2007 STEP 2017 Summer Peak Rerun 4 models (Scenarios 0-5) which included 100 kV and above STEP upgrades that were identified at the time of the study. The scope section of this report describes the topology changes that were made to the load flow model.

B. Reliability Analysis

The n-1 contingency analysis of select multi-terminal outages and all of the single-element outages 69 kV and above were performed using PTI's PSS/E program. This analysis was performed on the base case models described in section 1.A above. The following subsystems were monitored for violations on lines 69 kV and above:

- Areas: AECE, EDE, GRDA, MIPU, SPA, SPRM and AMRN.

The 345 kV Sibley – Overton tap to Norborne line was proposed by AECC and AECE staff. When comparing the modified base case to the case with 345 kV Sibley – Overton tap to Norborne line, all of the identified overloads were corrected with the exception of Overton transformer.

C. Economic Screening

SPP staff estimated the cost of the proposed transmission upgrade. The cost estimate for the upgrade is \$12.75 million for an approximated 17 mile line from Norborne to the tap on the Sibley – Overton 345 kV. A total of five 345 kV circuit breakers (cost estimated at \$3.75 million) would be required for the project. Total cost estimate for this proposed line upgrade is \$16.5 million.

In addition, this study recommends the Overton transformer be upgraded to 450/450 since it was observed that the proposed transmission upgrade caused the existing 345/161 kV 300 MVA Overton transformer to overload. Recently, Ameren Services Company staff confirmed the cost to upgrade the transformer at \$4.6 million.

Hence, the grand total cost estimate for the proposed transmission upgrade and Overton transformer upgrade is \$21.1 million.

4. FINDINGS

The reliability analysis was conducted in two ACCC runs, one without the 345 kV upgrade from Sibley - Overton tap point to Norborne and the other that includes the recommended upgrade.

The reliability analysis conducted without the 345 kV upgrade produced a few overloads in the study area. The overloads are shown in Table 1 below.

Table – 1 Overloaded Elements in the modified base case

Slot No.	Overloaded Element
1	GEORGETOWN - GEORGETOWN TAP 2 69KV CKT
2	DRESDEN 345/161 KV TRANSFORMER CKT 1
3	THOMAS HILL (THOMAS H) 345/161/13.8KV TRANSFORMER CKT 1

The overloads can be resolved with the new and existing operating directives listed below.

For the Georgetown–Georgetown Tap 2 69 kV overload, AECI would open Georgetown tap 2-Dresden 69 kV (96530, 96528) and close Georgetown tap 1-Dresden 69 kV (96529-96528). This would be a new operating directive.

The Dresden 345/161 kV transformer overload is the new violation found in this study. It is reasonable to assume that the transactions as described in the scope of this study can be the cause.

The overload of the Thomas Hill 345/161 kV transformer can be mitigated by modifying the existing Thomas Hill operating guide. The existing Thomas Hill operating guide needs to be expanded in order to include the Norborne – Dresden 345 kV contingency.

For voltage violations, a 2% change cut off SPP criteria was applied. The topology changes provided by AECI staff mitigates any voltage violations. Hence, in the study no voltage violations were found in the Central Missouri area.

The reliability analysis conducted with the proposed upgrade in the model resolves the overloads found in the reliability analysis without this upgrade. The 345 kV Sibley - Overton tap point to Norborne provides an acceptable regional solution. The Overton transformer is the only new overload caused by proposed upgrade for the contingency of Kingdom City transformer. This has been confirmed to be valid by Ameren Services Company staff.

5. RESULTS OF ANALYSIS

Table 2 shown below is a listing of overloaded elements and the contingency causing the violation that were found in the modified base case which did not include the 345 kV Sibley – Overton (tap) line to Norborne. The (n-1) contingency analysis was completed using the PSS/E version 30.

Table – 2 Without Sibley Overton Tap from Norborne. The new tap at Corder 345 kV Bus# 96052 has been removed.

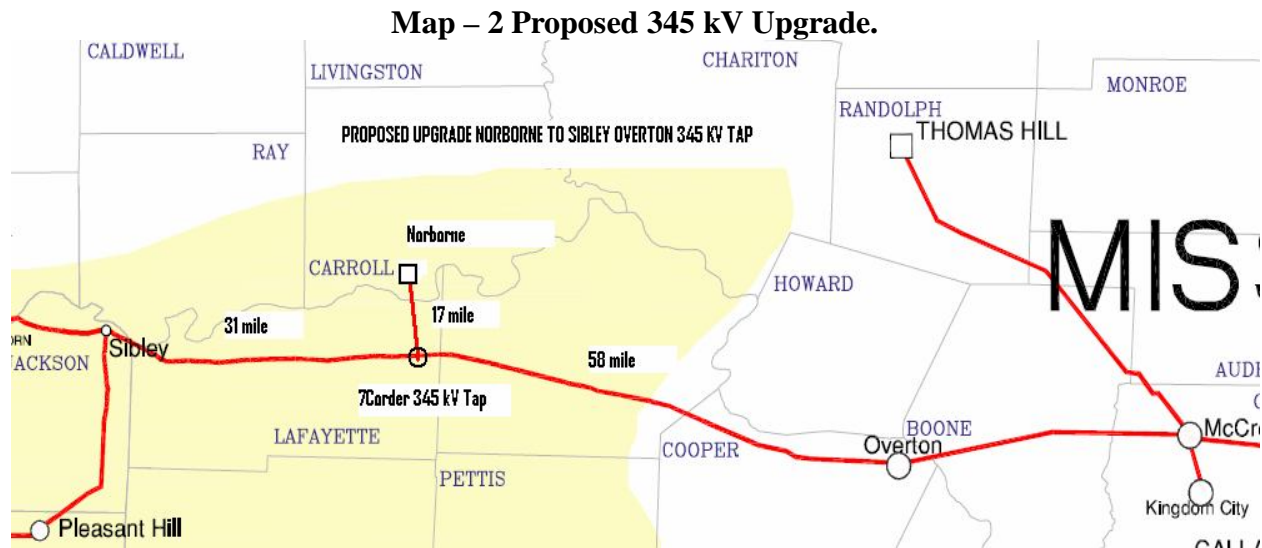
17SP Case	Overloaded element	Contingency Name	Percent Overload
1	'GEORGETOWN - GEORGETOWN TAP 2 69KV CKT 1'	'THOMAS HILL - NORBORNE 345 KV CKT 1	102.35%
2	'GEORGETOWN - GEORGETOWN TAP 2 69KV CKT 1'	'5DRES DN 161.00 - SEDALIA 161KV CKT 1'	113.30%
3	DRESDEN 345/161 KV TRANSFORMER CKT 1	'AI21'	100.45%
3	DRESDEN 345/161 KV TRANSFORMER CKT 1	'MCCREDIE - THOMAS HILL 345KV CKT 1'	101.10%
3	DRESDEN 345/161 KV TRANSFORMER CKT 1	'THOMAS HILL - NORBORNE 345 KV CKT 1	104.07%
1	'THOMAS HILL (THOMAS H) 345/161/13.8KV TRANSFORMER CKT 1'	'AI21'	112.27%
0	'THOMAS HILL (THOMAS H) 345/161/13.8KV TRANSFORMER CKT 1'	DRESDEN 345/161 KV TRANSFORMER CKT 1	101.34%
1	'THOMAS HILL (THOMAS H) 345/161/13.8KV TRANSFORMER CKT 1'	'MCCREDIE - THOMAS HILL 345KV CKT 1'	111.48%
0	'THOMAS HILL (THOMAS H) 345/161/13.8KV TRANSFORMER CKT 1'	'NORBORNE - DRESEDEN 345 KV CKT 1	101.34%

Table – 3 Add new tap from Sibley Overton 345kV line to Norborne. The new tap is at Corder 345 kV Bus# 96052.

17SP Case	Overloaded element	Contingency Name	Percent Overload
4	'OVERTON 345/161/13.8KV TRANSFORMER CKT 1'	'KINGDOM CITY 345/161KV TRANSFORMER CKT 1'	100.98%

The following map illustrates the proposed upgrade. The proposed 345 kV upgrade taps the Sibley - Overton 345 kV line at Corder 345 kV.

The proposed line length is approximately 17 miles and has a Rate A/Rate B of 1195/1195 MVA. The Corder 345 kV Tap is about 31 miles from Sibley and 58 miles from Overton.



6. CONCLUSIONS

The 345 kV Sibley – Overton tap to Norborne line provides an acceptable regional transmission solution for Central Missouri and surrounding areas in response to a proposed 660 MW generation addition at Norborne. The investment for this line is estimated to be \$16.5 million for an approximate length of 17.0 miles and five 345 kV circuit breakers at the substations. Also, an upgrade to the Overton transformer is recommended in this study.

Acronym	Acronym - Expansion
ACCC	Alternate Current Contingency Calculation
AECC	Arkansas Electric Co-operative Co
AECI	Associated Electric Co-operative Inc
AMRN	Ameren Services Company
AEPW	American Electric Power West
BA	Balancing Authority
EDE	Empire District Electric Company
EES	Entergy Energy Service
GRDA	Grand River Dam Authority
kV	kilo Volt
NERC	North American Electric Reliability Corporation
MIPU	Missouri Public Service (Aquila)
MVA	Mega Volt Ampere
MW	Mega Watt
PSS/E	Power System Simulator for Engineering
PTI	Power Technologies International
Rate A	Rating under normal conditions
Rate B	Rating under emergency conditions
SPA	Southwestern Power Administration
SPP	Southwest Power Pool
SPRM	City Utilities of Springfield, Missouri
STEP	SPP Transmission Expansion Plan