Empire District Electric Co. (2) 47 MW Generation Unit Additions
To LaRussell Power Station

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1. Introduction

The Empire District Electric Co. (EDE) of Joplin, Missouri has made two separate requests to evaluate two 48 MW generation additions at the existing LaRussell Power station. A powerflow analysis, a short circuit analysis and a transient stability study was performed at the request of the Southwest Power Pool.

Presently, the LaRussell Power Station has two generation units each having the capabilities to produce approximately 90MW. The proposed generating units, referred to as #3 and #4, are scheduled to be in service (#3) June 2003 and (#4) December 2003. These units will be used to serve the EDE native load.

The powerflow analysis was conducted to look for equipment that overloads on the EDE, SPA, City Utilities of Springfield and two specific tie lines to Associated Electric due to the increased generation.

The short circuit analysis was conducted to evaluate the impact to short circuit capabilities at busses in close electrical proximity to the LaRussell Power Station.

The transient stability study was performed to verify machine performance following a disturbance on the system and to identify system stability issues.

2. Study Methodology

2.1 Power Flow Model

The Southwest Power Pool Load Flow Model 2004 summer peak (04sp.sav) and the 2004 winter peak (04wp.sav) models were used for the power flow analysis. However, the 04sp.sav case had a fictitious generation unit modeled at the LaRussell bus which was generating 150 MW. This generation was shifted to other actual units on the EDE system to develop a new case in which the impact of the new generators could be evaluated. The new generation was then modeled in 50 MW increments.

Evaluation of the 2006 cases, found that the generation modeled at LaRussell exceeded the existing capacity with the addition of both of the new generating units. EDE does not have the capacity of actual generation to re-dispatch from the LaRussell area; therefore, no evaluation of the new generation was done for 2006.

All generation units at the LaRussell Plant were increased to maximum capacity. Generation units at EDE Stateline Plant were reduced such that the total generation on the EDE system was equivalent to the base case generation. An 'n-1' analysis was performed in which all branches for EDE, SPA, and City Utilities of Springfield were outaged individually. Any equipment that had a loading greater than 100% of Rate B and was impacted by the additional generation at LaRussell was evaluated.

2.2 Short Circuit Model

A study was also completed to investigate how the additional generation would impact available short circuit current. The model that was used for the short circuit analysis was the 2005 summer peak (Sc05-1.raw) with the corresponding sequence data (Sc05-1.seq). No information was provided for the GSU for the new generation units so a very low impedance value of 6% for a 70 MVA transformer was modeled.

3. Discussion of Results

3.1 Power Flow Model

The results of the Power Flow study are shown in Table 1. The table contains the summer Rate B loading. The results labeled 'Base Case' were from 'n-1' study of the 04sp.sav case which had a fictitious generator modeled at the LaRussell bus producing 150 MW. The case with generation dispatched to actual units on the EDE system is labeled 'EDE Gen. Adjust'. The cases with the new generators #3 and #4 are labeled 'LaRussell 50 MW' and 'LaRussell 100 MW' respectively.

The results indicate that an AEC line from Carthage to Reads loads to 108%, the two auto-transformers at Carthage load to 109.7% and 110.5 %, the auto-transformer at Joplin 389 loads to 102%, and the 42 MVA auto-transformer at Aurora 124 loads to 102.4%. However, each of these branches are loaded beyond 100% under certain contingencies in both the Base Case study and the EDE Gen. Adjusted Study.

The winter study indicated that the new generation at LaRussell did not cause any branches to exceed the Rate B loadings.

3.2 Short Circuit Study Results

The increase in short circuit currents are shown in Table 2. The criteria for listing a bus in the Table 2 was that the bus was only one bus away from LaRussell or that there was more than a 1% increase in fault current. As can be seen in Table 2, there was little impact to the fault currents except at the LaRussell Power Station

1-2001 SOUTHWEST POWER POOL POWER FLOW MODEL
2004 SUMMER PEAK 04 SP RESULTS

*** ACCC OVERLOAD REPORT: MONITORED ELEMENTS LOADED ABOVE 100.0 % OF RATING SET B ***

DISTRIBUTION FACTOR FILE: E:\Generation 2004\04sp Extended.dfx
SUBSYSTEM DESCRIPTION FILE: E:\Generation 2004\Autocont.sub
MONITORED ELEMENT FILE: E:\Generation 2004\Autocont Extended.mon
CONTINGENCY DESCRIPTION FILE: E:\Generation 2004\04 extended.con

CONTINGENCY EVENTS	OVERLOADED LINES	MVA(MW)FLOW			
MULTI-SECTION LINE GROUPINGS	FROM NAME TO NAME CKT	PRE-CNT	POST-CNT	RATING	PERCENT
OPEN LINE FROM BUS 59468 [AUR124 5161.00] TO BUS 59480 [MON383 5161.00] CKT 1					CONTINGENCY SINGLE 54
BASE CASE	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.3	37.0	36.0	100.3
EDE GEN ADJUST	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.6	37.2	36.0	101.1
LARUSSELL 50 MW	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.4	37.3	36.0	100.9
LARUSSELL 100 MW	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.4	37.4	36.0	101.4
OPEN LINE FROM BUS 59479 [LAR382 5161.00] TO BUS 59480 [MON383 5161.00] CKT 1					CONTINGENCY SINGLE 83
LARUSSELL 50 MW	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.4	37.0	36.0	100.3
LARUSSELL 100 MW	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.4	37.6	36.0	101.9
OPEN LINE FROM BUS 59483 [JOP389 5161.00] TO BUS 59607 [JOP422 5161.00] CKT 1					CONTINGENCY SINGLE 92
BASE CASE	59483*JOP389 5 161 59592 JOP389 269.0 1	57.7	76.7	75.0	102.3
EDE GEN ADJUST	59483*JOP389 5 161 59592 JOP389 269.0 1	56.4	75.3	75.0	100.4
LARUSSELL 50 MW	59483*JOP389 5 161 59592 JOP389 269.0 1	57.5	76.5	75.0	102.0
OPEN LINE FROM BUS 52688 [CARTHAG5161.00] TO BUS 52690 [CARTHG 269.000] CKT 1					CONTINGENCY SINGLE 277
BASE CASE	52688*CARTHAG5 161 52690 CARTHG 269.0 2	52.4	91.5	84.0	108.9
EDE GEN ADJUST	52688*CARTHAG5 161 52690 CARTHG 269.0 2	52.4	92.5	84.0	110.1
LARUSSELL 50 MW	52688*CARTHAG5 161 52690 CARTHG 269.0 2	52.6	91.8	84.0	109.3
LARUSSELL 100 MW	52688*CARTHAG5 161 52690 CARTHG 269.0 2	52.9	92.2	84.0	109.7
OPEN LINE FROM BUS 52688 [CARTHAG5161.00] TO BUS 52690 [CARTHG 269.000] CKT 2					CONTINGENCY SINGLE 278
BASE CASE	52688*CARTHAG5 161 52690 CARTHG 269.0 1	53.4	92.0	84.0	109.6
EDE GEN ADJUST	52688*CARTHAG5 161 52690 CARTHG 269.0 1	53.4	92.1	84.0	109.6
LARUSSELL 50 MW	52688*CARTHAG5 161 52690 CARTHG 269.0 1	53.6	92.4	84.0	110.0
LARUSSELL 100 MW	52688*CARTHAG5 161 52690 CARTHG 269.0 1	53.9	92.9	84.0	110.5
OPEN LINE FROM BUS 52690 [CARTHG 269.000] TO BUS 96649 [2JASPER 69.000] CKT 1					CONTINGENCY SINGLE 442
BASE CASE	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.3	39.6	36.0	107.4
EDE GEN ADJUST	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.6	40.0	36.0	108.6
LARUSSELL 50 MW	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.4	39.8	36.0	108.0
LARUSSELL 100 MW	52690*CARTHG 269.0 96751 2REEDS 69.0 1	30.4	39.8	36.0	108.0
OPEN LINE FROM BUS 59480 [MON383 5161.00] TO BUS 59591 [MON383 269.000] CKT 1					CONTINGENCY SINGLE 87
BASE CASE	59468*AUR124 5 161 59537 AUR124 269.0 3	23.0	42.4	42.0	101.1
LARUSSELL 50 MW	59468*AUR124 5 161 59537 AUR124 269.0 3	23.0	42.5	42.0	101.3
LARUSSELL 100 MW	59468*AUR124 5 161 59537 AUR124 269.0 3	23.2	43.0	42.0	102.4

TABLE 1

Change in Fault Current with 100 MW increase in Generation at LaRussell						
Description			Fault Current		Results	
Bus #	Bus	KV	Initial	With 100 MW	Difference	% Change
52692	Springfield	161	26771	26931	160	0.6%
52688	Carthage	161	15731	16381	650	4.1%
59479	LaRussell 382	161	13672	15810	2138	15.6%
59480	Monett 383	161	10678	11102	424	4.0%
59468	Aurora 124	161	9156	9321	165	1.8%
59472	Tipton 292	161	14475	14658	183	1.3%
59591	Monett 383	69	11559	11718	159	1.4%
59476	Asbury 349	161	13463	13631	168	1.2%
59466	Atlas 109	161	14461	14757	296	2.0%
52686	Neosho SPA	161	13457	13610	153	1.1%
52690	Carthage	69	13814	13980	166	1.2%

TABLE 2

4. Transient Stability Study[1]

The transient stability analysis was performed to verify machine performance following a disturbance on the system and to identify system stability issues. The study includes an analysis of the 2002 summer peak Southwest Power Pool Transient Stability Model modified with the Empire generation units as well as certain other prospective merchant plants that are ahead of Empire in the Southwest Power Pool interconnection study queue. Machine dynamic data was included from the current stability dynamics database from SPP with additions and adjustments included for the later year generation additions. Simulation of bus fault conditions with subsequent clearing by protection systems was performed, and the machine parameters were monitored in the period during and immediately after the fault.

The study models were subjected to four fault conditions to test various levels of system disturbances. The events simulate the more probable as well as extreme cases of fault conditions as specified by NERC planning criteria.

A. Three phase fault on the LaRussell 161kV bus with subsequent clearing of the LaRussell-Monet 161kV line in 5 cycles.

B. Three phase fault on the LaRussell 161kV bus with subsequent clearing of the LaRussell-Springfield 161kV line in 5 cycles.

C. Three phase fault on the LaRussell 161kV bus with subsequent clearing of the LaRussell-Carthage 161kV line in 5 cycles.

Analysis of the machine dynamics indicates that the system remains stable following the disturbances for all contingencies tested for both LaRussell #3 and LaRussell #4 additions.

[1] The Transient Stability information is from the Southwest Power Pool (SPP) Report "Transient Stability Study Empire District Electric Co. (2) 47 MW Generation Unit Additions to LaRussell Power Station". The SPP performed the Transient Stability Study.