[CE] Quad Cities units No. 1 & 2	**(1,861 MW)**
[AMIL] Clinton unit No. 1	**(1,108 MW)**
[AMIL] Newton unit No. 2	**(650 MW)**
[AMIL] Baldwin units No. 1 & 3	**(1,310 MW)**
Total	**(4,929 MW)**

MTEP16

Illinois Generation Retirement Sensitivity Analysis

STUDY REPORT

November 1, 2016

Public Version

EXECUTIVE SUMMARY

MISO performed a transmission system sensitivity reliability analysis of the potential retirement of all of the aforementioned generating units located in the state of Illinois. The scope, model development, and review results were closely discussed and reviewed with all potentially impacted Transmission Owner (TO) both within and neighboring MISO.

The study results indicated that there are no reliability issues created as a result of all of the identified generators that were studied in this sensitivity analysis. While this sensitivity analysis was conducted during the MTEP16 reliability analysis, further studies may be required to evaluate future impacts due to changes in assumptions of system conditions related to other Attachment Y requests submitted.

This sensitivity analysis is not an Attachment Y study and is for informational purposes only to determine whether there will be any immediate transmission needs in the event that all of these generators follow through with their potential retirement plans. Further study may be required to evaluate the impacts due to changes in assumptions of system conditions related to other Attachment Y requests submitted in future MTEP Reliability assessments.

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1.0 INTRODUCTION

The total capacity of potential generation retiring in the state if Illinois is 4,898 MW with two (2) of the units connected directly to ComEd 345 kV transmission system. The remaining units are located throughout Illinois as shown in *Figure 1.0-1* below.

After MISO initiated this retirement sensitivity analysis for the units in Illinois, the retirement of the Quad Cities Nuclear Generating Plant (Q in *Figure 1.0-1*: Geographic location of Illinois Generation) was announced in the PJM Generation Deactivation process. Hence, MISO decided to also analyze near term impact of the Quad Cities retirement focusing on the Summer 2018 model. This near term retirement case will be noted throughout this report.

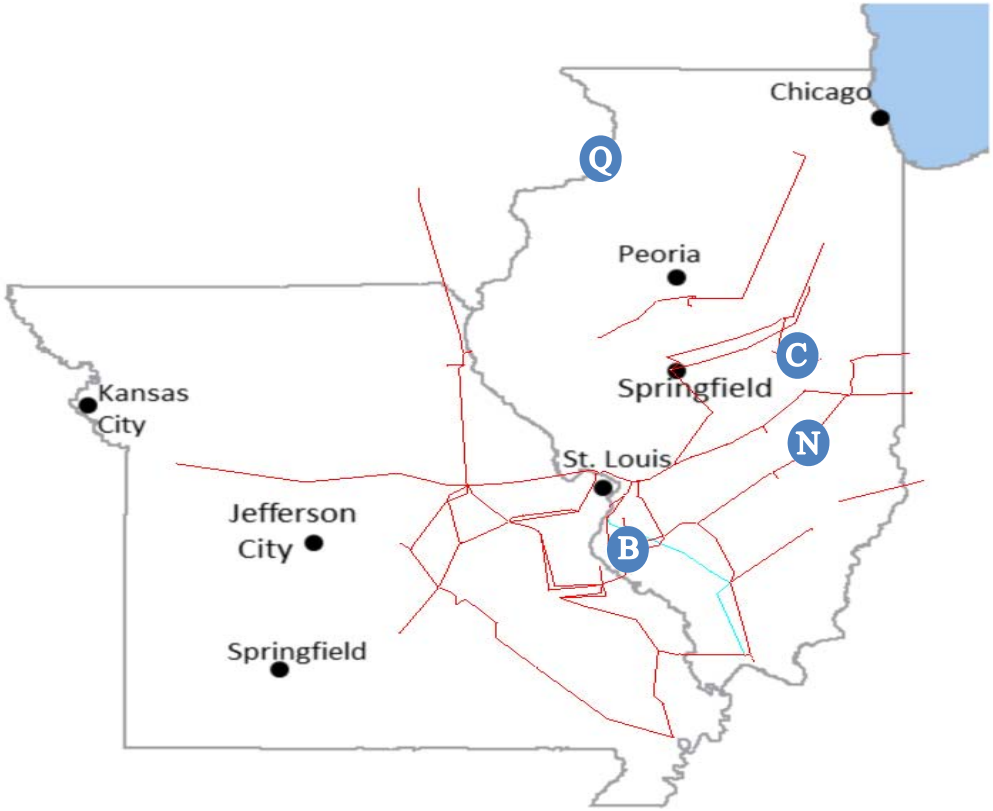

Figure 1.0-1: Geographic location of Illinois Generation

Power Flow Area	Unit Description	kV Network	Capacity (MW/Mvar)	Potential Date of Retirement
ComEd	Quad Cities unit No.1	345	930/331	
ComEd	Quad Cities unit No.2	345	931/341	
AMIL	Clinton unit No. 1	345	1,108/573	
AMIL	Newton unit No. 2	345	650/230	
AMIL	Baldwin unit No. 1	345	668/374	
AMIL	Baldwin unit No. 2	345	642/309	
Total			*4,929/2,158*	

Table 1.0-1: Potential Retirement Units

2.0 STUDY OBJECTIVES

The principal objective of this sensitivity study is to determine any near-term transmission needs if the unit(s), for which a potential change in status, is followed through. The study work included monitoring and identifying the steady state branch/voltage violations on transmission facilities due to the unavailability of these Generation Resources. The potentially impacted Transmission Owner(s) transmission criteria were used for monitoring such violations.

This sensitivity analysis is not an Attachment Y study and is for informational purposes only to determine whether there will be any immediate transmission needs in the event that all of these generators follow through with their potential retirement plans. Further study may be required to evaluate the impacts due to changes in assumptions of system conditions related to other Attachment Y requests submitted in future MTEP Reliability assessments.

2.1 QUAD CITIES RETIREMENT

The near term study for Quad Cities Nuclear Generating Plant retirement was developed due to the formal introduction to the PJM Generation Deactivation process[1] targeting June 1, 2018. Due to this change after the initiation of the Illinois retirement study, MISO decided to analyze near-term impacts of retirement of the plant (units No. 1 and No. 2).

[1] http://www.pjm.com/planning/generation-deactivation.aspx

3.0 MODELS AND ASSUMPTIONS

Corresponding to the anticipated retirement of these units, the following power system analysis models were used for the study:

- MTEP16 2018 Summer Peak (wind at 15%)
  - Additionally a focal case for Section 2.1
- MTEP16 2021 Summer Peak (wind at 15%)
- MTEP16 2021 Shoulder Peak (wind at 40%)

These generation sensitivity study models were created in accordance with the *Section 3.2* of MISO's BPM-020 - Transmission Planning (rev14). These models originated from the MTEP16 base models with both appendix A and MTEP16 target-A projects modeled as in-service along with an LBA centric dispatch for each of the powerflow models in which the units being studied were taken out of service and replaced with local balancing available generation.

3.1 MODEL ASSUMPTIONS

The following changes were applied to models to reflect transmission/generation additions/retirements/suspensions.

3.1.1 GENERATION

3.1.1.1 GREATER ILLINOIS STUDY

The following generation assumptions were considered:

- All units previously approved for suspension or retirement (through MISO's Attachment Y process) were modelled out-of-service.
- No change was made to the dispatch of hydroelectric generation and wind generation.

3.1.1.2 QUAD CITITIES RETIREMENT

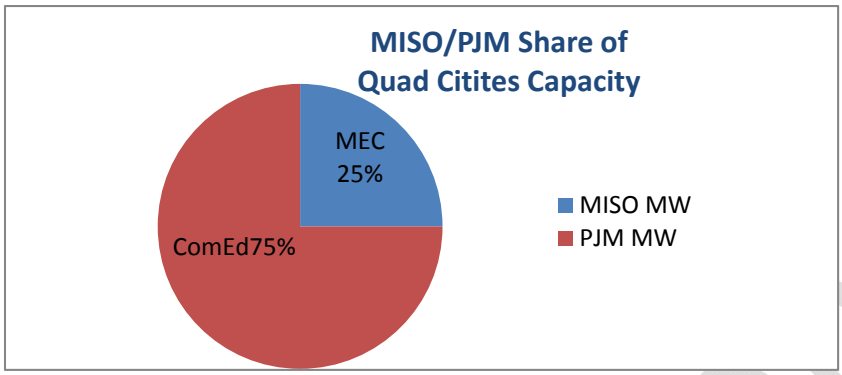

Figure 3.1.1.2-1: Quad Cities Generation Capacity split

PJM generation was re-dispatched within ComEd for the capacity of Exelon's 75% ownership share of Quad Cities generation station. Within the MTEP16 Summer Peak 2018 model, a small amount of generation was in-service and available, about 16 MW, for redispatch in the ComEd area. Substantially more offline generation capacity (~5,800 MW) was available in ComEd. These offline units were brought online to cover PJM's portion, about 1,368 MW of Quad Cities retirement, less ~18 MW in loss savings within the ComEd area. Listed in *Table 3.1.1.2-1:* PJM Redispatch for Quad **Cities** along with the details of the specific generation changes made to the case for PJM generation.

Matching MTEP reliability studies, generation in MISO was re-dispatched for the capacity of MEC's 25% ownership share of Quad Cities generation station following an LBA centric merit order. MISO redispatch was first focused on local MEC units and then expanded to adjacent LBA's merit order dispatch. Listed in *Table 3.1.1.2-2*: MISO LBA Centric Merit Order **Dispatch** details for MISO's portion of Quad Cities (456 MW) capacity less ~15 MW in loss savings. To dispatch enough capacity, the following LBAs received increases in generation: ALTE, ALTW, AMMO, DPC, MEC and MPW.

All units previously approved for suspension or retirement (through MISO's Attachment Y process) were modelled out-of-service.

Bus No.	Bus Name	ID	Change MW	New Pgen
274715	[CE] Nelson EC	C1	174	174
274717	[CE] Nelson EC	C2	174	174
274716	[CE] Nelson EC	S1	126	126
274718	[CE] Nelson EC	S2	106	126
274723	[CE] River EC	2	162	162
274823	[CE] Rockford	21	154	154
274822	[CE] Rockford	11	152	152
274824	[CE] Rockford	12	150	150
274734	[CE] Elwood EC	8	76	76
274735	[CE] Elwood EC	4	75	75
	Loss Savings		18	

Table 3.1.1.2-1: PJM Redispatch for Quad Cities

Bus No.	Bus Name	ID	Change MW	New Pgen
635213	[MEC] Neal	3	10	540
629069	[ITCM] Emery Steam	1	19	256
629072	[ITCM] Lansing	4	13	277
629066	[ITCM] Prairie Creek	4	14	163
629046	[ITCM] Fox Lake	3	96	96
630787	[ITCM] Prairie Creek	3	51	51
629070	[ITCM] Beaver Channel	2	2	241
629051	[ITCM] Fox Lake	1	13	13
633009	[MPW] MPW	9	7	165
681542	[DPC] JP Madgett	6	12	422
629055	[ITCM] Roquette	1	42	42
699552	[ALTE] Neenah	2	11	150
630385	[CIPC] South Summit Lake	1	40	40
630385	[CIPC] South Summit Lake	2	39	39
699552	[ALTE] Neenah	1	14	154
346002	[AMMO] Goose Creek	5	60	60
	Loss Savings		15	

Table 3.1.1.2-2: MISO LBA Centric Merit Order Dispatch

3.1.2 TRANSMISSION

All approved appendix A and MTEP16 target-A projects were modelled in-service.

3.2 MODELS

MTEP16 Model Name	Loads	Illinois Generation	Dispatch
MISO16_2018_SUM__TA.sav (wind at 14%)	50/50 probabilistic load	Off	LBA
MISO16_2021_SUM__TA.sav (wind at 14%)	50/50 probabilistic load	Off	LBA
MISO16_2021_SH40_TA.sav (wind at 40%)	50/50 probabilistic load	Off	LBA

Table 3.2-1: Power Flow Models

3.3 MONITORING AND CONTINGENCIES

Listed in *Table 3.3-1,* below, the following power flow areas that were monitored both within and around the state of Illinois as shown in *Figure 3.3-1* below.

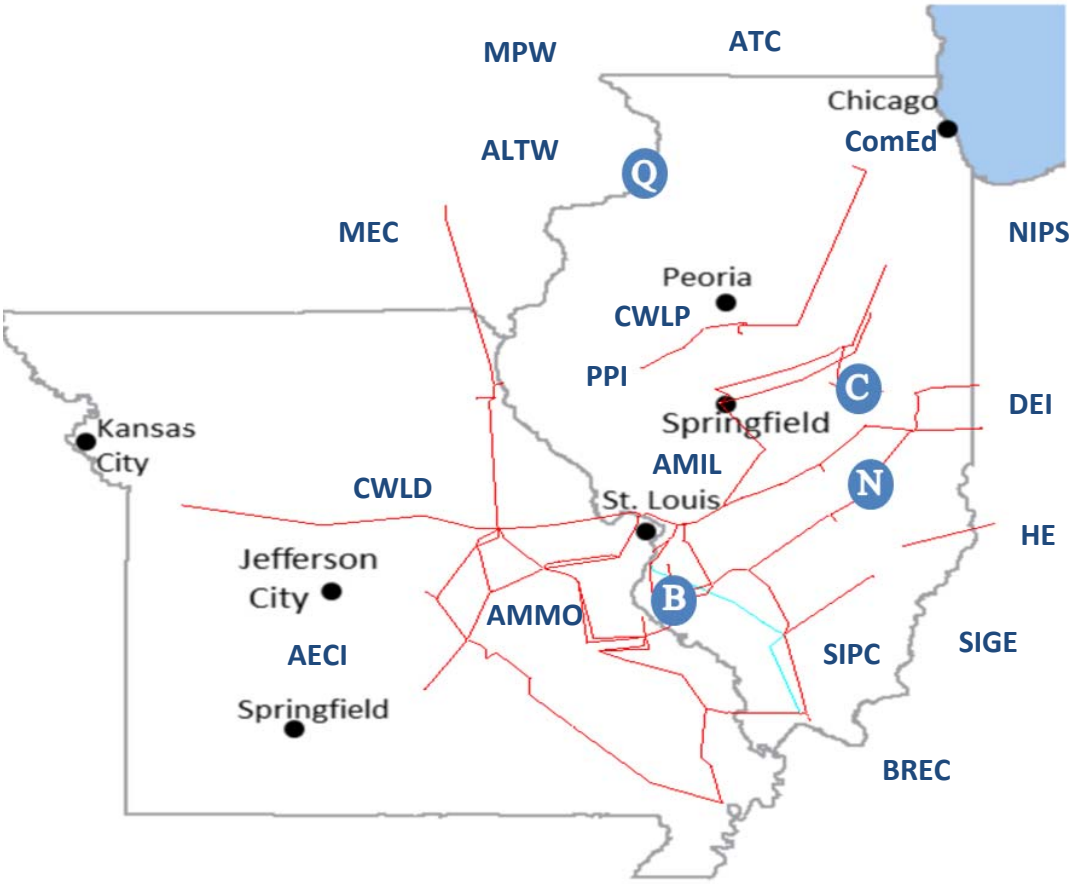

Figure 3.3-1: Geographic of the Potential Impacted Control Areas

Control Area	CA No.	State	kV Level
AECI	330	MO	BES
ALTE	694	WI	BES
ALTW	627	IA	BES
AMIL	357	IL	BES
AMMO	356	MO	BES
BREC	314	KY	BES
ComEd	222	IL	BES
CWLP	360	IL	BES
DEI	208	IN	BES
HE	207	IN	BES
MEC	635	IA	BES
MGE	697	WI	BES
MPW	633	IA	BES
NIPS	217	IN	BES
PPI	in 357	IL	BES
SIGE	210	IN	BES
SIPC	361	IL	BES
WEC	295	WI	BES
WPS	696	WI	BES

Table 3.3-1: List of Potential Impacted Control Areas

All NERC Category P1, P2, P3, P4, P5, P6 and P7 contingencies that were simulated in the MTEP16 reliability assessment were also used for Quad Cities retirement transmission sensitivity analysis. The Category P3 and P6 contingencies were selected from the MTEP16 stock steady state results. Only those P3 and P6 events that POM could not find a system adjustment solution for were selected for all control areas shown above in *Table 3.3-1*, below.

3.3.1 QUAD CITIES RETIREMENT

MISO simulated P1-P7 contingencies to determine any transmission impacts of the Quad Cities generation units No. 1 and No. 2 retiring. All impacted TOs listed in *Table 3.3.1-1*, below, provided contingencies that were simulated along with PJM supplied contingencies. Additional requested contingencies from American Transmission Company, and Muscatine Power and Water were also included through feedback.

Control Area	
AECI	HE
AMRN	IPL
ATC	ITCM
CWLD	MEC
CWLP	MPW
DEI	NIPS
DPC	SIGE

Table 3.3.1-1: TO Provided Contingencies

In addition to predefined contingencies, MISO has combined all P1 contingencies to construct an extensive set of P3 and P6 contingencies within five (5) buses of the Quad Cities 345 kV (bus 270864).

4.0 STUDY CRITERIA AND METHODOLOGY

4.1 GREATER ILLINOIS RETIREMENT STUDY

PTI – PSS®E version 33 and PowerGEM – TARA version 820 were used to perform AC contingency analysis and SCED. The powerflow cases were solved with automatic control of LTCs, phase shifters, DC taps, switched shunts enabled (regulating), and area interchange enabled.

4.2 QUAD CITIES RETIREMENT

MISO utilized PSS®E's (v33.8) AC contingency calculation program to analyze P1-P7 contingencies. For the simulation the following options were utilized:

- Facility loading
  - MVA loading for transformers
  - Current loading for transmission lines
  - FDNS solution
  - Tap adjustments enabled
  - Area Interchange disabled
  - Phase Shifters enabled
  - DC taps enabled
  - Switched Shunts enabled all

For outages that did not solve due to iteration limits being exceeded or the case "blowing up[2]", an additional simulation was conducted with utilizing FNSL solutions and locking phase shifting transformers.

4.3 STEADY STATE THERMAL CRITERIA

The transmission planning criteria applied for the thermal analysis was the same criteria used in the MTEP16 steady-state analysis.

4.4 STEADY STATE VOLTAGE CRITERIA

The transmission planning criteria applied for the thermal analysis was the same criteria used in the MTEP16 steady-state analysis.

4.5 VOLTAGE STABILITY CRITERIA

No concerns were raised by MISO or the potentially impacted TO's that required a voltage (PV) stability assessment.

4.6 DYNAMIC STABILITY CRITERIA

No concerns were raised by MISO or the potentially impacted TO's that required a dynamic (transient) stability assessment.

5.0 STUDY RESULTS

There were no new thermal or voltage issues identified in any of the three powerflow cases that were studied. Any issues identified are consistent with the MTEP16 reliability analysis results.

5.1 2018 SUMMER PEAK ANALYSIS

The analysis of the 2018 summer peak case identified the following:

5.1.1 Thermal Violations

Zero (0) NERC category P1 (single event: loss of transmission circuit or transformer) violations identified.

Zero (0) NERC category P2 (single event: Bus Section or internal breaker failure event) violations identified.

[2] Power flow simulation does not converge and numerical solution mismatch becomes large

Zero (0) NERC category P3 (multiple events: loss of P1.1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P4 (multiple events: loss of P2.2 fault + loss of P2.4 breaker failure event) violations identified.

Zero (0) NERC category P5 (multiple events: loss of P2.2 single event + loss of P2.4 relay failure event) violations identified.

Zero (0) NERC category P6 (multiple events: loss of P1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P7 (single event: loss of common tower structure) violations identified.

5.1.2 Voltage Violations

Zero (0) NERC category P1 (single event: loss of transmission circuit or transformer) violations identified.

Zero (0) NERC category P2 (single event: Bus Section or internal breaker failure event) violations identified.

Zero (0) NERC category P3 (multiple events: loss of P1.1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P4 (multiple events: loss of P2.2 fault + loss of P2.4 breaker failure event) violations identified.

Zero (0) NERC category P5 (multiple events: loss of P2.2 single event + loss of P2.4 relay failure event) violations identified.

Zero (0) NERC category P6 (multiple events: loss of P1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P7 (single event: loss of common tower structure) violations identified.

5.2 2021 SUMMER PEAK ANALYSIS

Analysis of the 2017 shoulder case identified the following:

5.2.1 Thermal Violations

Zero (0) NERC category P1 (single event: loss of transmission circuit or transformer) violations identified.

Zero (0) NERC category P2 (single event: Bus Section or internal breaker failure event) violations identified.

Zero (0) NERC category P3 (multiple events: loss of P1.1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P4 (multiple events: loss of P2.2 fault + loss of P2.4 breaker failure event) violations identified.

Zero (0) NERC category P5 (multiple events: loss of P2.2 single event + loss of P2.4 relay failure event) violations identified.

Zero (0) NERC category P6 (multiple events: loss of P1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P7 (single event: loss of common tower structure) violations identified.

5.2.2 Voltage Violations

Zero (0) NERC category P1 (single event: loss of transmission circuit or transformer) violations identified.

Zero (0) NERC category P2 (single event: Bus Section or internal breaker failure event) violations identified.

Zero (0) NERC category P3 (multiple events: loss of P1.1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P4 (multiple events: loss of P2.2 fault + loss of P2.4 breaker failure event) violations identified.

Zero (0) NERC category P5 (multiple events: loss of P2.2 single event + loss of P2.4 relay failure event) violations identified.

Zero (0) NERC category P6 (multiple events: loss of P1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P7 (single event: loss of common tower structure) violations identified.

5.3 2021 SHOULDER PEAK ANALYSIS

Analysis of the 2021 summer peak case identified the following:

5.3.1 Thermal Violations

Zero (0) NERC category P1 (single event: loss of transmission circuit or transformer) violations identified.

Zero (0) NERC category P2 (single event: Bus Section or internal breaker failure event) violations identified.

Zero (0) NERC category P3 (multiple events: loss of P1.1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P4 (multiple events: loss of P2.2 fault + loss of P2.4 breaker failure event) violations identified.

Zero (0) NERC category P5 (multiple events: loss of P2.2 single event + loss of P2.4 relay failure event) violations identified.

Zero (0) NERC category P6 (multiple events: loss of P1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P7 (single event: loss of common tower structure) violations identified.

5.3.2 Voltage Violations

Zero (0) NERC category P1 (single event: loss of transmission circuit or transformer) violations identified.

Zero (0) NERC category P2 (single event: Bus Section or internal breaker failure event) violations identified.

Zero (0) NERC category P3 (multiple events: loss of P1.1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P4 (multiple events: loss of P2.2 fault + loss of P2.4 breaker failure event) violations identified.

Zero (0) NERC category P5 (multiple events: loss of P2.2 single event + loss of P2.4 relay failure event) violations identified.

Zero (0) NERC category P6 (multiple events: loss of P1 single event + loss of P1 single event) violations identified.

Zero (0) NERC category P7 (single event: loss of common tower structure) violations identified.

6.0 ALTERNATIVES ANALYSIS

The study results indicated that there are no alternatives to consider for this study.

7.0 CONCLUSION

The study results indicated that there are no new reliability issues created as a result of all of the identified Illinois generators that were studied in this transmission sensitivity analysis. While this sensitivity analysis was conducted during the MTEP16 reliability analysis, further studies may be required to evaluate future impacts due to changes in assumptions of system conditions related to other Attachment Y requests submitted.