PJM Generator Interconnection Request
Queue #X3-051
Flat Lick (Rolling Hills) 765kV
Impact Study

(Add Stability Analysis Results)

749456
April 2013
Version 2 June 12, 2013

X3-051 Flat Lick (Rolling Hills) 765kV Impact Study

General

Tenaska Inc. proposes to install PJM Project #X3-051, a 610 MW (610 MW capacity) addition at its natural gas generating facility (Rolling Hills) in Vinton County, Ohio (Figure 1). The existing plant consists of five F class gas turbines. Tenaska plans to add two steam turbine generators to create 2-2x1 combined cycle units. One stand alone gas turbine will remain. The existing gas turbines are 170 MW each. The point of interconnection evaluated is the existing Flatlick 765 kV station. One 765 kV breaker will be added to the Flatlick 765 kV ring (Figure 2).

The requested in-service date is March 1, 2016.

The intent of the Impact study is to determine system reinforcements and associated costs and construction time estimates required to facilitate the addition of the new generating plant to the transmission system. The reinforcements include the direct connection of the generator to the system and any network upgrades necessary to maintain the reliability of the transmission system.

Attachment Facilities

The point of interconnection is at the Flatlick 765 kV station via a single 765 kV breaker added to the existing Flatlick 765 kV ring (Figure 2). Protection schemes will need to be modified and 765 kV revenue metering will need to be installed.

The following work is required to connect Project X3-051 to the Flatlick 765 kV Station:

Station Cost:

- A third 765 kV bus will be constructed and a 765 kV breaker will be added to support one of the new generation sources. The second generation source will be added to the existing 765 kV bus #2. Estimated Cost (2012 Dollars): $6,236,200* (Network Upgrade #n3729)

- Total Estimated Interconnection Cost (2012 Dollars): **$6,236,200***

Protection and Relaying Cost:

- Marysville existing line protection will need to be relocated from existing breaker C to new breaker E.

- Cables from existing bus protection CT's will need to be replaced and re-routed to accommodate for the new low impedance bus protection at Flatlick. (Network Upgrade #n3730)

- Total Estimated Protection and Relaying Cost (2013 Dollars): **$308,000**

It is understood that Tenaska Inc. is responsible for all costs associated with this connection.

The standard time required for construction is 18 months after signing an interconnection agreement.

* The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements.

Network Impacts

The Queue Project #X3-051 was studied as a(n) 610.0MW(Capacity610.0MW) injection at Flatlick 765kV station in the AEP area. Project #X3-051 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

No problems were identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

No problems were identified.

Short Circuit

No problems were identified.

Stability Analysis

Generation Interconnection Request X3-051 is for an addition of 2 x 305 MW steam turbines to the existing facilities at Flatlick 765 kV Substation in the American Electric Power (AEP) network.

This report describes a dynamic simulation analysis of X3-051.

Two load flow cases were used for analysis: the RTEP 2015 light load case and RTEP 2015 summer peak case, both with the addition of the X3-051 models at maximum power output and leading power factor at the generator bus.

The initial evaluation was performed on the 2015 light load case. It was found that, although the system was transiently stable, in most cases the post fault voltage damping was insufficient to satisfy the PJM damping criterion. Subsequent tests on two onerous contingencies with X3-051 offline similarly did not meet the damping criterion.

Evaluation of X3-051 was then completed using the 2015 summer peak case.
26 contingencies were studied, each with a 10 second simulation time period. Studied faults included:

a) Steady state operation
b) Three phase faults with normal clearing time
c) Single phase faults with single phase stuck breaker

Single phase faults with delayed clearing were omitted as the AEP clearing times indicate that dual primary communication systems are used at 765 kV.

The fault simulations met the fault recovery criteria in the RTEP 2015 summer peak case:

a) X3-051 rode through the faults (except for faults where protective action tripped X3-051);
b) the system with X3-051 included was found to be transiently stable;
c) a new steady state was reached;
d) voltages at the POI and nearby buses returned to an acceptable range, with system stability being maintained.

No mitigations were found to be required.

Light Load Analysis

Not required for combined cycle plants.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. "Network Impacts", initially caused by the addition of this project generation)

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None

MISO Impacts

PJM will determine if there are any impacts on MISO facilities in the Facilities study

Duke Integration

Evaluation of the impacts of the X3-051 project on the Duke transmission facilities recently integrated into PJM will be completed in the Facilities Study.

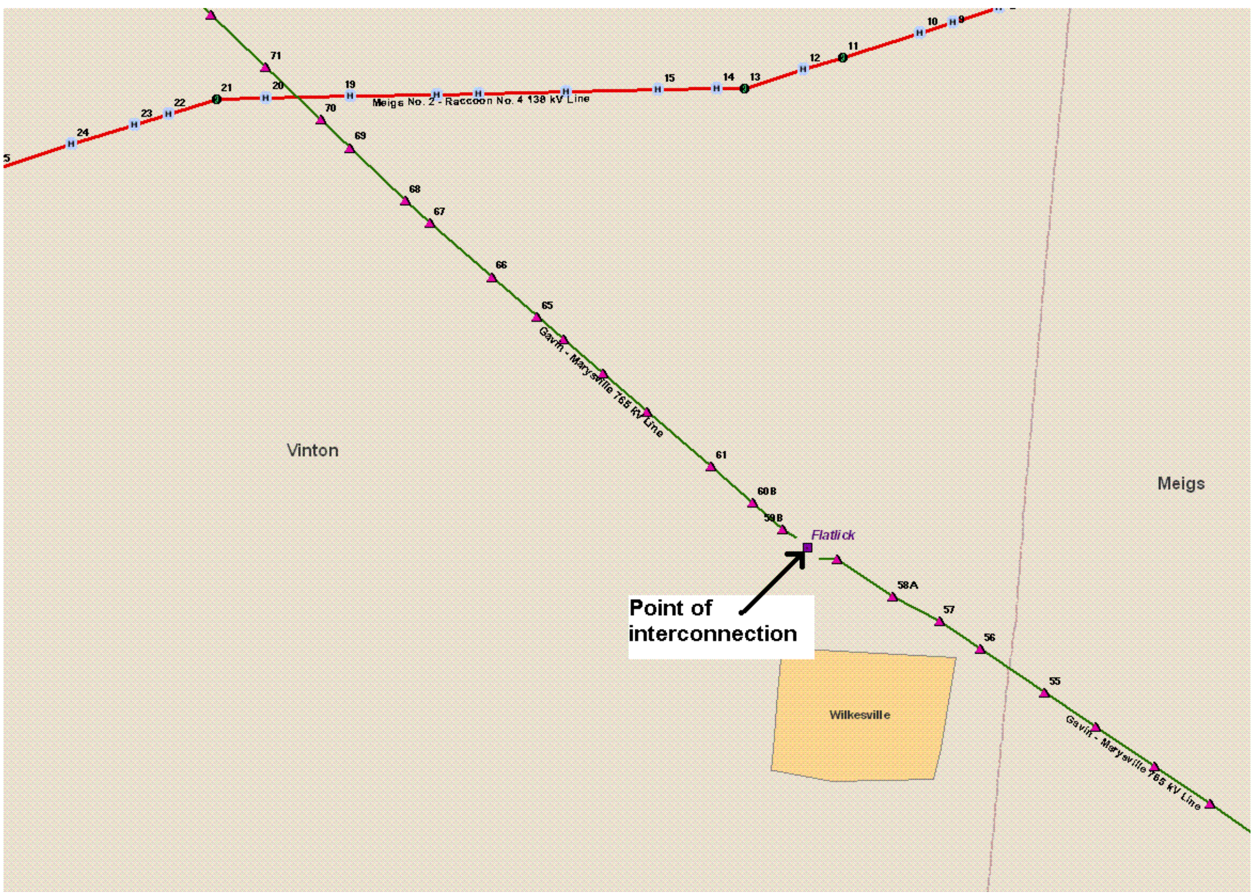


Figure 1: X3-051 Point of Interconnection

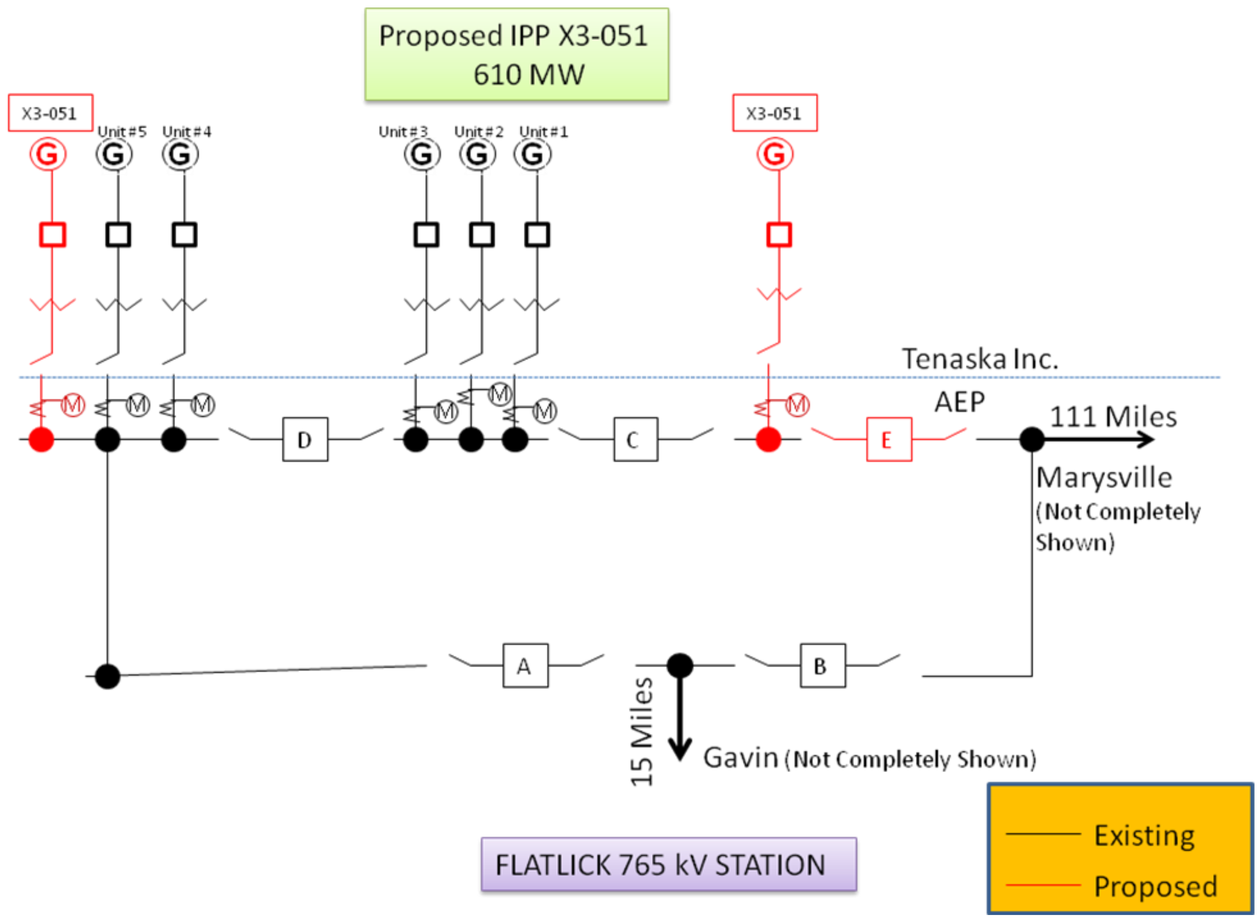
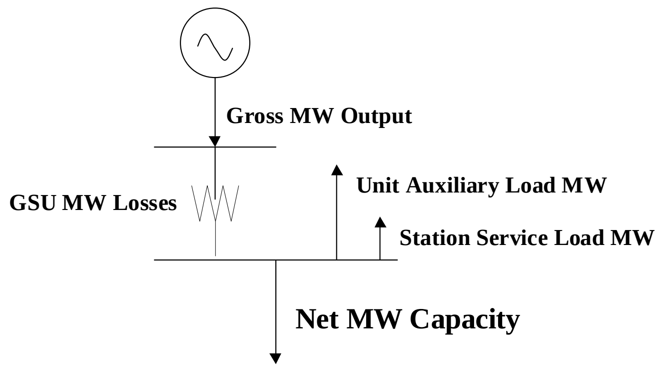


Figure 2: Point of Interconnection at Flatlick 765 kV Station

Attachment #1

Unit Capability Data



Net MW Capacity = (Gross MW Output - GSU MW Losses* – Unit Auxiliary Load MW - Station Service Load MW)

Queue Letter/Position/Unit ID: ______________________________Queue X3-051 (ST1)

Primary Fuel Type: ____ Natural Gas

Maximum Summer (92º F ambient air temp.) Net MW Output**: _________________277

Maximum Summer (92º F ambient air temp.) Gross MW Output: _________________291

Minimum Summer (92º F ambient air temp.) Gross MW Output:__________________102

Maximum Winter (30º F ambient air temp.) Gross MW Output:___________________305

Minimum Winter (30º F ambient air temp.) Gross MW Output: __________________106

Gross Reactive Power Capability at Maximum Gross MW Output – Please include Reactive Capability Curve (Leading and Lagging): _150 MVAR lag, 100 MVAR lead

Individual Unit Auxiliary Load at Maximum Summer MW Output (MW/MVAR): .0001/.0001

Individual Unit Auxiliary Load at Minimum Summer MW Output (MW/MVAR): .0001/.0001

Individual Unit Auxiliary Load at Maximum Winter MW Output (MW/MVAR): .0001/.0001

Individual Unit Auxiliary Load at Minimum Winter MW Output (MW/MVAR): .0001/.0001

Station Service Load (MW/MVAR): ______________________________________ 14/10

* GSU losses are expected to be minimal.

** Your project's declared MW, as first submitted in Attachment N, and later confirmed or modified by the Impact Study Agreement, should be based on either the 92º F Ambient Air Temperature rating of the unit(s) or, if less, the declared Capacity rating of your project.

Queue Letter/Position/Unit ID: ________________________________ Queue X3-051

MVA Base (upon which all reactances, resistance and inertia are calculated): ______370

Nominal Power Factor: ____ 0.85

Terminal Voltage (kV): ____21

Unsaturated Reactances (on MVA Base)

Direct Axis Synchronous Reactance, $X_{d(i)}$: _________________________ 2.22

Direct Axis Transient Reactance, X'd(i): __________________________ 0.286

Direct Axis Sub-transient Reactance, X"d(i): _______________________ 0.238

Quadrature Axis Synchronous Reactance, Xq(i): _____________________ 2.17

Quadrature Axis Transient Reactance, X'q(i): ______________________ 0.476

Quadrature Axis Sub-transient Reactance, X"q(i): ___________________ 0.238

Stator Leakage Reactance, Xl: ___________________________________ 0.211

Negative Sequence Reactance, X2(i): ____________________________ 0.238

Zero Sequence Reactance, X0: __________________________________ 0.123

Saturated Sub-transient Reactance, X"d(v) (on MVA Base): _________________ 0.203

Armature Resistance, Ra (on MVA Base): ______________________ 0.001 ohms/phase

Time Constants (seconds)

Direct Axis Transient Open Circuit, T'_{do}: ____________________________ 8.5

Direct Axis Sub-transient Open Circuit, T''_{do}:_ ______________________ 0.024

Quadrature Axis Transient Open Circuit, T'_{qo}:_ ________________________ 1.8

Quadrature Axis Sub-transient Open Circuit, T''_{qo}: ____________________ 0.04

Inertia, H (kW-sec/kVA, on KVA Base): _________________ 2.845 kw-sec/kva

Speed Damping, D: ____

Saturation Values at Per-Unit Voltage [S(1.0), S(1.2)]: _________________ 0.164,0.578

Units utilize a GENROU Generator model

Unit GSU Data

Queue Letter/Position/Unit ID:________________________________Queue X3-051

Generator Step-up Transformer MVA Base: ______________________________380

Generator Step-up Transformer Impedance (R+jX, or %, on transformer MVA Base):0.0001+j.09

Generator Step-up Transformer Reactance-to-Resistance Ration (X/R):______________

Generator Step-up Transformer Rating (MVA): _________________ OA/FA/FA 380

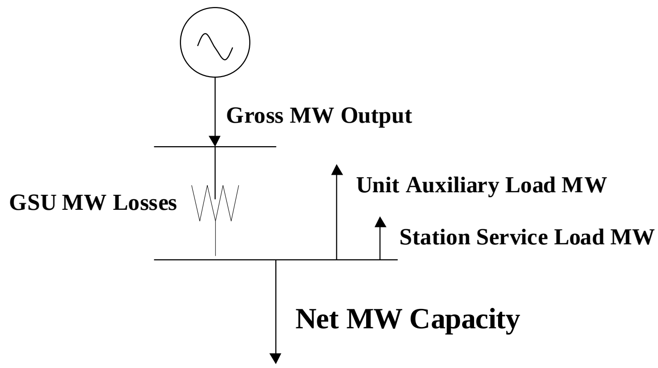
Generator Step-up Transformer Low-side Voltage (kV):_______________________21

Generator Step-up Transformer High-side Voltage (kV): ____________________765

Generator Step-up Transformer Off-nominal Turns Ratio: _______________________

Generator Step-up Transformer Number of Taps and Step Size:+/-5% in 2.5% steps on HS

Unit Capability Data



Net MW Capacity = (Gross MW Output - GSU MW Losses* – Unit Auxiliary Load MW - Station Service Load MW)

Queue Letter/Position/Unit ID: ______________________________Queue X3-051 (ST2)

Primary Fuel Type: ____ Natural Gas

Maximum Summer (92º F ambient air temp.) Net MW Output**: _________________277

Maximum Summer (92º F ambient air temp.) Gross MW Output: _________________291

Minimum Summer (92º F ambient air temp.) Gross MW Output:__________________102

Maximum Winter (30º F ambient air temp.) Gross MW Output:___________________305

Minimum Winter (30º F ambient air temp.) Gross MW Output: __________________106

Gross Reactive Power Capability at Maximum Gross MW Output – Please include Reactive Capability Curve (Leading and Lagging): _150 MVAR lag, 100 MVAR lead

Individual Unit Auxiliary Load at Maximum Summer MW Output (MW/MVAR): .0001/.0001

Individual Unit Auxiliary Load at Minimum Summer MW Output (MW/MVAR): .0001/.0001

Individual Unit Auxiliary Load at Maximum Winter MW Output (MW/MVAR): .0001/.0001

Individual Unit Auxiliary Load at Minimum Winter MW Output (MW/MVAR): .0001/.0001

Station Service Load (MW/MVAR): ______________________________________ 14/10

* GSU losses are expected to be minimal.

** Your project's declared MW, as first submitted in Attachment N, and later confirmed or modified by the Impact Study Agreement, should be based on either the 92º F Ambient Air Temperature rating of the unit(s) or, if less, the declared Capacity rating of your project.

Queue Letter/Position/Unit ID: Queue X3-051

MVA Base (upon which all reactances, resistance and inertia are calculated): 370

Nominal Power Factor: 0.85

Terminal Voltage (kV): 21

Unsaturated Reactances (on MVA Base)

- Direct Axis Synchronous Reactance, $X_{d(i)}$: 2.22
- Direct Axis Transient Reactance, X'd(i): 0.286
- Direct Axis Sub-transient Reactance, X"d(i): 0.238
- Quadrature Axis Synchronous Reactance, Xq(i): 2.17
- Quadrature Axis Transient Reactance, X'q(i): 0.476
- Quadrature Axis Sub-transient Reactance, X"q(i): 0.238
- Stator Leakage Reactance, Xl: 0.211
- Negative Sequence Reactance, X2(i): 0.238
- Zero Sequence Reactance, X0: 0.123

Saturated Sub-transient Reactance, X"d(v) (on MVA Base): 0.203

Armature Resistance, Ra (on MVA Base): 0.001 ohms/phase

Time Constants (seconds)

- Direct Axis Transient Open Circuit, T'_{do}: 8.5
- Direct Axis Sub-transient Open Circuit, T''_{do}: 0.024
- Quadrature Axis Transient Open Circuit, T'_{qo}: 1.8
- Quadrature Axis Sub-transient Open Circuit, T''_{qo}: 0.04
- Inertia, H (kW-sec/kVA, on KVA Base): 2.845 kw-sec/kva

Speed Damping, D: ______

Saturation Values at Per-Unit Voltage [S(1.0), S(1.2)]: 0.164,0.578

Units utilize a GENROU Generator model

Unit GSU Data

Queue Letter/Position/Unit ID:____________________________________Queue X3-051

Generator Step-up Transformer MVA Base: __________________________________380

Generator Step-up Transformer Impedance (R+jX, or %, on transformer MVA Base):0.00001+j.09

Generator Step-up Transformer Reactance-to-Resistance Ration (X/R):________________

Generator Step-up Transformer Rating (MVA): ________________________ OA/FA/380

Generator Step-up Transformer Low-side Voltage (kV):__________________________21

Generator Step-up Transformer High-side Voltage (kV): ________________________765

Generator Step-up Transformer Off-nominal Turns Ratio: __________________________

Generator Step-up Transformer Number of Taps and Step Size:______________________

Appendix 2

1. Description of the Project

The proposed X3-051 project is specified in the Impact Study data provided in Attachment 1. Attachment 2 shows the one line diagram of the AEP network in the vicinity of X3-051.
X3-051 is connected to the AEP system via the existing Flatlick 765 kV Substation. The existing Flatlick 765 kV Substation will be expanded to accommodate the connection of X3-051.
Figure 1 shows how X3-051 has been modeled in this study. Table 1 lists the parameters given in the impact study data and the corresponding parameters of the X3-051 loadflow model. Attachment 3 provides a diagram of the PSS/E model in the vicinity of X3-051; Attachment 4 gives the X3-051 PSS/E loadflow model.
The dynamic model for the X3-051 plant is based on standard PSS/E models and is included in Attachment 5.

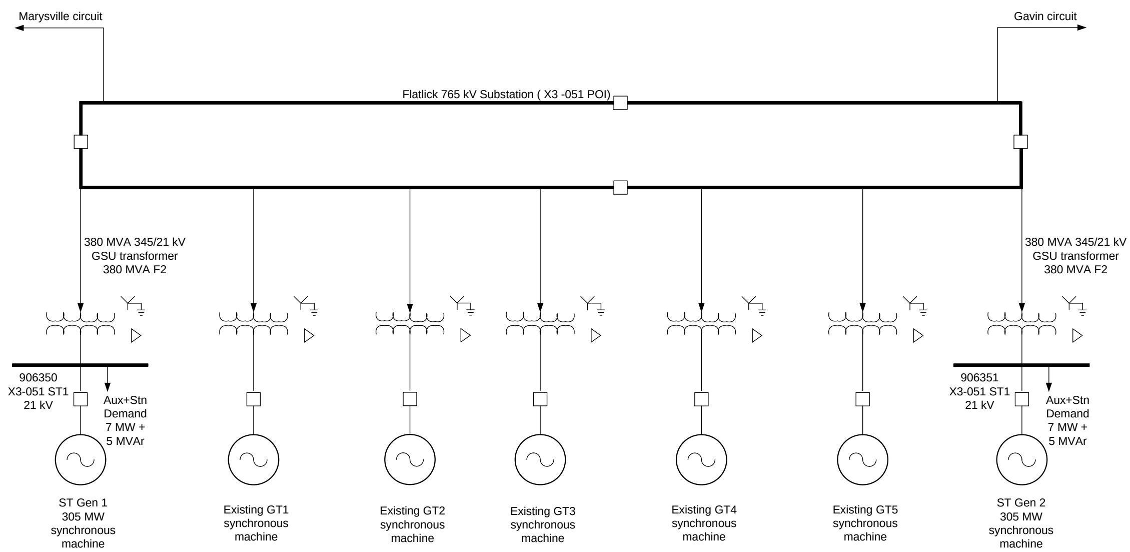


Figure 1: X3-051 Model

Table 1: X3-051 Plant Model

	Impact Study Data	Model
Steam turbines		
Generator	2 x 305 MW ST +150 / -100 MVAr. Vt = 21 kV Unsaturated reactance, pu @ 370 MVA: X''d(i) = 0.238 X''q(i) = 0.238	2 x 305 MW ST MBASE 370 MVA PMAX 305 MW PMIN 0 MW QMAX 150 MVAr QMIN -100 MVAr XSORCE 0.238 pu
GSU transformer	2 x 380 MVA F2 765 / 21 kV Ynd 0.00001 % + j 9.00 % @ 380 MVA	2 x 380 MVA 765 / 21 kV Ynd 0.00001 % + j 9.00% @ 380 MVA
Auxiliary demand	N/A	Not modeled
Combined Station Demand	14 MW + 10 MVAr	14 MW + 10 MVAr
Transmission line	N/A	Not modelled

2. Loadflow and Dynamics Case Setup

The dynamics simulation analysis was carried out using PSS/E Version 30.3.1.
The load flow scenario and fault cases for this study are based on PJM's Region Transmission Planning Process[1] and discussions with PJM.
This study is focused on the ability of the plant to ride through faults. The selected load flow scenarios are the RTEP 2015 light load case and RTEP 2015 summer peak case, both provided by PJM, with the following modifications:

- Modeling of X3-051 at the Point of Interconnection, Flatlick 765 kV Substation
- Removal of withdrawn and subsequent queue projects in the vicinity of X3-051
- Connection and disconnection of some distant generation units in the PJM system in order to maintain slack units within limits
- Deactivation of bus 243462 (an AEP 242 kV bus connected only to a transformer and solving at > 1.4 pu voltage) to improve loadflow convergence

In the load flow the X3-051 generators are set to maximum power output (total 610 MW), leading power factor, and approximately 0.95 pu voltage at the generator bus. Generation within the PJM500 system (area 225 in the PSS/E case) and within a 4 bus radius of X3-051 has been dispatched online at maximum output, with the exception of the units shown in Table 2 for both light load and summer peak cases.

[1] Manual 14B: PJM Region Transmission Planning Process, Rev 19, September 15 2011, Attachment G : PJM Stability, Short Circuit, and Special RTEP Practices and Procedures.

Table 2: Generation at reduced output within 5-bus radius of X3-051

Bus	Name	Unit	PGEN (MW)	PMAX (MW)	Reason
243187	05GVG2 26.000	2H	657.2	667	Conflict with governor model, PMAX not achievable
243187	05GVG2 26.000	2R	650	653	
246759	05SOLIDA 138.00	1	173	185	Conflict with governor model, PMAX not achievable
270000	20FOOTHL 345.00	1	171	191	Conflict with governor model, PMAX not achievable
270000	20FOOTHL 345.00	2	171	191	
270001	20ZELDA 345.00	1	171	191	
270001	20ZELDA 345.00	2	171	191	
270001	20ZELDA 345.00	3	171	191	

A number of 765 kV shunt reactors were switched out of service (listed in Table 3) to achieve an acceptable voltage profile across the 765 kV network.

Table 3: 765 kV Line shunt reactors switched out

From Bus Number	From Bus Name	To Bus Number	To Bus Name	Id	Line B From (pu on 100 MVA) Removed	Line B To (pu on 100 MVA) Removed
242510	05BAKER 765.00	242511	05BROADF 765.00	1	-3	-3
242924	05HANG R 765.00	243208	05JEFRSO 765.00	1	-3	-3*
243207	05GRNTWN 765.00	243208	05JEFRSO 765.00	1	-3	-3
242509	05AXTON 765.00	242514	05J.FERR 765.00	1	-3	0
242512	05CLOVRD 765.00	242514	05J.FERR 765.00	1	-3	0
242512	05CLOVRD 765.00	242515	05JOSHUA 765.00	1	-3	0
243208	05JEFRSO 765.00	243209	05ROCKPT 765.00	1	-1.5	-1.5
243209	05ROCKPT 765.00	243210	05SULLVA 765.00	1	-1.5	-1.5
242511	05BROADF 765.00	242514	05J.FERR 765.00	1	-1.5	0
242513	05CULLOD 765.00	242517	05WYOMIN 765.00	1	0	-3
242928	05MARYSV 765.00	243206	05DUMONT 765.00	1	-3*	-3
242508	05AMOS 765.00	242929	05NPROCT 765.00	1	-1.5*	0
242922	05FLTLCK 765.00	242923	05GAVIN 765.00	1	0	-3*
242922	05FLTLCK 765.00	242928	05MARYSV 765.00	1	0	-3*
242926	05MALIS 765.00	242928	05MARYSV 765.00	1	0	-3*

* Denotes line shunt reactors which have been switched out of the light load case only.

In addition to the changes to P_{GEN} in the loadflow case, changes were made to the dynamics case to resolve initialization issues:

- Several distant generation units were switched off or netted.

- For bus 270000 existing units 1, 2 & 3 and bus 270001 existing units 1 & 2, the saturation factors S(1.0) and S(1.2) were much higher than expected; it was assumed they are % rather than per unit values. These values were thus divided by 100 to set more realistic values.
- For bus 248000 machine C (+ machine 6), the governor model was switched off to avoid initializing out of limits.

3. Fault Cases

Table 4 toTable 6 list the contingencies that were studied, with representative worst case total clearing times provided by PJM. Each contingency was studied over a 10 second simulation time interval. Faults were applied to transmission circuits and transformers connected to the Point of Interconnection or one bus removed[2].

The studied faults included:

a) Steady state operation

b) Three phase faults with normal clearing time

c) Single phase faults with single phase stuck breaker

Single phase faults with delayed clearing were omitted as the AEP clearing times indicated that dual primary communication systems are used at 765 kV.

The one line diagram of the AEP network in Attachment 2 shows where faults were applied.

The positive sequence fault impedances for single line to ground faults were derived from a separate short circuit case provided by PJM, modified by PSC to ensure that connected generators in the vicinity of X3-051 have not withdrawn from the PJM queue, and are not greater than the queue position under study.

4. Fault Recovery Criteria

The fault recovery criteria applicable to this study are as per PJM's Region Transmission Planning Process:

a) Post-contingency voltages should remain within +/- 0.05 pu of the pre-contingency voltages at transmission level buses.

b) Post-contingency oscillations should be positively damped with a damping margin of at least 3%.

c) The X3-051 generators should maintain their pre-contingent power output following the fault.

5. Summary of Results

An evaluation was performed on the 2015 light load case, with results in Attachment 6A. It was found that the system was transiently stable, however in most cases the post fault

[2] One bus removed from the POI refers to buses with transmission circuit breakers, not tee-offs or buses with only supply circuit breakers.

voltage damping was insufficient to satisfy the PJM damping criterion. Subsequent tests on two onerous contingencies with X3-051 offline (Attachment 6B) similarly did not meet the damping criterion, indicating the issue it is not caused by X3-051.

A subsequent evaluation was carried out on the 2015 summer peak case. The results are summarized in Table 4 toTable 6 with the detailed in Attachment 6C with The results indicate that the fault simulations met the fault recovery criteria for the 2015 summer peak case:

a) the system with X3-051 included was found to be transiently stable,

b) a new steady state was reached,

c) voltages at the POI and nearby buses returned to an acceptable range,

With X3-051 riding through the fault (except for faults where protective action tripped X3-051) and system stability being maintained. No mitigations were found to be required.

Table 4: Steady State Operation

Fault ID	Duration	X3-051 No Mitigation
SS.01	Steady state 20 sec	Stable

Table 5: Three-phase Faults with Normal Clearing

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	X3-051 No Mitigation
3N.01	Fault at X3-051 765 kV on STG601 21/765 kV GSU.	3.5 / 3.5	Stable
3N.02	Fault at X3-051 765 kV on STG701 21/765 kV GSU.	3.5 / 3.5	Stable
3N.03	Fault at Flatlick 765 kV on Marysville circuit.	3.5 / 3.5	Stable
3N.04	Fault at Flatlick 765 kV on Gavin circuit.	3.5 / 3.5	Stable
3N.05	Fault at Marysville 765 kV on Flatlick circuit	3.5 / 3.5	Stable
3N.06	Fault at Marysville 765 kV on 765/345 kV Transformer T-1.	3.5 / 3.5	Stable
3N.07	Fault at Marysville 765 kV on Maliszewski circuit.	3.5 / 3.5	Stable
3N.08	Fault at Marysville 765 kV on Dumont circuit.	3.5 / 3.5	Stable
3N.09	Fault at Gavin 765 kV on Flatlick circuit.	3.5 / 3.5	Stable
3N.10	Fault at Gavin 765 kV on Mountaineer circuit.	3.5 / 3.5	Stable
3N.11	Fault at Gavin 765 kV on Culloden circuit.	3.5 / 3.5	Stable
3N.12	Fault at Gavin 765 kV on Gavin Unit 1.	3.5 / 3.5	Stable
3N.13	Fault at Gavin 765 kV on Gavin Unit 2.	3.5 / 3.5	Stable

Table 6: Single-phase Faults with Stuck Breaker

Fault ID	Fault description	Clearing Time Normal / Stuck Breaker (Cycles)	X3-051 No Mitigation
1B.01	Fault at Flatlick 765 kV on Marysville circuit. Breaker stuck to Gavin circuit. Fault cleared with loss of Gavin circuit and Flatlick generation.	3.5 / 9.5	Stable (Trips X3-051)
1B.02	Fault at Flatlick 765 kV on Gavin circuit. Breaker stuck to Marysville circuit. Fault cleared with loss of Marysville circuit and Flatlick generation.	3.5 / 9.5	Stable (Trips X3-051)
1B.03	Fault at Marysville 765 kV on Flatlick circuit. Breaker stuck to Dumont circuit. Fault cleared with loss of Dumont circuit.	3.5 / 9.5	Stable
1B.04	Fault at Marysville 765 kV on 765/345 kV Transformer T-1. Breaker stuck to Flatlick circuit. Fault cleared with loss of Flatlick circuit.	3.5 / 9.5	Stable
1B.05	Fault at Marysville 765 kV on Maliszewski circuit. Breaker stuck to Dumont cicruit. Fault cleared with loss of Dumont circuit.	3.5 / 9.5	Stable
1B.06	Fault at Marysville 765 kV on Dumont circuit. Breaker stuck to Flatlick circuit. Fault cleared with loss of Flatlick circuit.	3.5 / 9.5	Stable
1B.07	Fault at Marysville 345 kV on 765/345 kV Transformer T-1. Breaker stuck to U2-027. Fault cleared with loss of U2-027 circuit.	3.5 / 12.5	Stable
1B.08	Fault at Gavin 765 kV on Flatlick circuit. Breaker stuck. Fault cleared with no additional losses.	3.5 / 9.5	Stable
1B.09	Fault at Gavin 765 kV on Mountaineer circuit. Breaker stuck to Gavin Unit 1. Fault cleared with loss Gavin Unit 1.	3.5 / 9.5	Stable
1B.10	Fault at Gavin 765 kV on Culloden circuit. Breaker stuck to Gavin Unit 2. Fault cleared with loss of Gavin Unit 2.	3.5 / 9.5	Stable
1B.11	Fault at Gavin 765 kV on Gavin Unit 1. Breaker stuck to Mountaineer. Fault cleared with loss of Mountaineer circuit.	3.5 / 9.5	Stable
1B.12	Fault at Gavin 765 kV on Gavin Unit 2. Breaker stuck to Culloden circuit. Fault cleared with loss of Culloden circuit.	3.5 / 9.5	Stable