Revised Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-074

Jacksonville – Renaker 138kV

October 2017

Revised: November 2020

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

Bluebird Solar LLC, the Interconnection Customer (IC), has proposed a solar generating facility located in Harrison County, Kentucky. The installed facilities will have a total capability of 80 MW with 56 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2019. **This study does not imply a EKPC commitment to this in-service date.**

Point of Interconnection

AC1-074 will interconnect with the EKPC Transmission system along the Jacksonville – Renaker 138kV line.

Cost Summary

The AC1-074 project will be responsible for the following costs:

Description	7	Total Cost
Attachment Facilities	\$	0
Direct Connection Network Upgrades	\$	3,200,000
Non Direct Connection Network Upgrades	\$	100,000
Allocation for New System Upgrades	\$	0
Contribution for Previously Identified Upgrades	\$	0
Total Costs	\$	3,300,000

Attachment Facilities

No Attachment Facilities are required to support this interconnection request.

Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	T	otal Cost
Build 138kv switching station at Jacksonville Tap including	\$	3,200,000
associated transmission line work. Estimated Time: 18		
months. PJM network Upgrade # n5929		
Total Direct Connection Facility Costs	\$	3,200,000

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	To	otal Cost
Adjust remote, relaying, and metering settings at Jacksonville	\$	50,000
138kV Sub. PJM network Upgrade # n5930		
Adjust remote, relaying, and metering settings at Renaker	\$	50,000
138kV Sub. PJM network Upgrade # n5931		
Total Non-Direct Connection Facility Costs	\$	100,000

Interconnection Customer Requirements

- 1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.
- 2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.
- 3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

EKPC Requirements

The Interconnection Customer will be required to comply with all EKPC Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "EKPC Facility Connection Requirements" document located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/ekpc.aspx

Network Impacts

The Queue Project AC1-074 was evaluated as a 80.0 MW (Capacity 56.0 MW) injection into a tap of the Jacksonville Tap – Renaker 138 kV line in the EKPC area. Project AC1-074 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-074 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
	CONTINGENCY '363_B2_TOR1682'
363_B2_TOR1682	OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
	END
	CONTINGENCY '4812_B2_TOR8931'
4812_B2_TOR8931	OPEN BRANCH FROM BUS 242921 TO BUS 242924 CKT 1 / 242921 05CORNU 765 242924 05HANG R 765 1
	END
	CONTINGENCY 'P7-1C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'
P7-1C5 4541MELDAHLSP	OPEN BRANCH FROM BUS 342838 TO BUS 249581 CKT 1
RLCKSTUARTSPU RLOCKDPLEK	OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1
	END

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection) None.

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None.

Short Circuit
(Summary of impacted circuit breakers) None.

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)

	Cor	ntingency	Affected		В	us		Power	Load	ing %	Ra	ting	MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	N-1	363_B2_T OR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	149.4 1	149.7 6	ER	1370	4.9	3
2	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	127.4 8	127.7 5	NR	1134	5.04	
3	N-1	4812_B2_T OR8931	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	114.1 2	114.3 4	ER	1370	5.01	
4	DCTL	P7-1C5 4541MELD AHLSPRL CKSTUAR TSPURLO CKDPLEK	EKPC - LGEE	4SPUR-KENT-R- 4KENTON 138 kV line	342661	324267	1	AC	100.4 8	101.9	ER	281	4.68	4
5	DCTL	P7-1C5 4541MELD AHLSPRL CKSTUAR TSPURLO CKDPLEK	EKPC - EKPC	4SPURLOCK-4SPUR- KENT-R 138 kV line	342664	342661	1	AC	100.4 8	101.8 9	ER	281	4.68	5

Note: Please see 0 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

7

	Cor	ntingency	Affected		В	us		Power	Loadi	ing %	Ra	ting	MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
6	N-1	363_B2_T OR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	156.6 2	157.0 5	ER	1370	7.01	
7	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	122.1 4	122.6 8	NR	1134	7.2	

Note: Please see 0 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None.

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

No network impacts were identified in the Stability Study. See Attachment 3 for details

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)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	1-074 cation
#1, 2, 3	7TRIMBLE- 06CLIFTY 345 kV line	A potential constraint was identified by PJM on the Trimble – Clifty 345 kV line (LG&E/OVEC tie line). An LG&E affected system study is required to determine if the AC1-074 queue project causes any impacts on the LG&E system, including the Trimble-Clifty LG&E-OVEC tie line. The LG&E Affected System Study results conclude that there are no LG&E system impacts due to AC1-074.	N/A	\$ 0	\$ 0
		Note: although there are no required upgrades on the Trimble – Clifty 345 kV line, PJM has identified potential congestion on the line as summarized in the Energy Delivery section above.			
#4, 5	4SPUR-KENT-R- 4KENTON 138 kV line	To relieve the 4SPUR-KENT-R-4KENTON 138 kV line & 4SPURLOCK-4SPUR-KENT-R 138 kV line overloads:	b2827 / N6041	\$ 0	\$ 0
		EKPC:			
		2021 Baseline Upgrade B2827: Upgrade Spurlock-KU Kenton 138kv series reactor			
		from 1200A at 5% impedance to 1600A at 6.5% impedance.			
		New EKPC rating will be 291 MVA SE for both branches.			
		EKPC would charge a \$62,500 acceleration cost to place baseline upgrade B2827 into service one year earlier than required (advancing it from summer 2021 to			
		summer 2020). The AC1-074 customer would need to provide EKPC with enough			
		notice (at least 18 months in advance) to meet a summer 2020 in-service date.			
		LG&E:			
		The LG&E-end SE rating on the 4SPUR-KENT-R-4KENTON 138 kV line is 306			
		MVA and is sufficient. No LG&E end upgrade required.			
			Total New No	etwork Upgrades	\$ 0

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

	Cor	ntingency	Affected		В	us		Power	Load	ing %	Ra	ting	MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
6	N-1	363_B2_T OR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	156.6 2	157.0 5	ER	1370	7.01	
7	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	122.1 4	122.6 8	NR	1134	7.2	

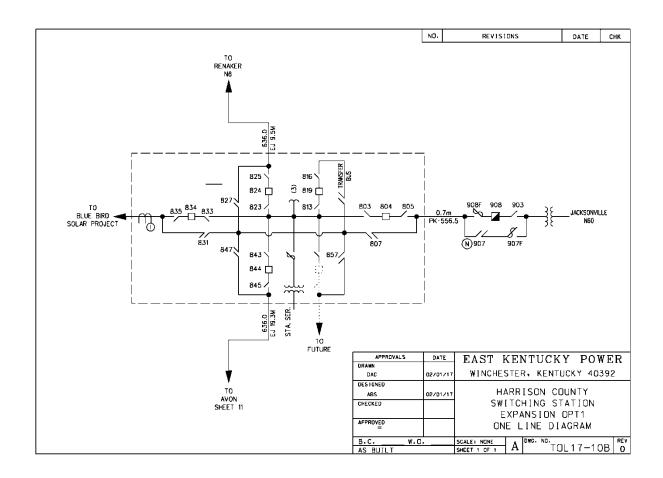
Note: Please see 0 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Affected Systems Analysis

Based on the LG&E KU Affected Systems Study dated 6/12/20:

No Mitigations Required

Attachment 1. Single Line Diagram



Attachment 2. Single Line Diagram

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 3

(LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 149.41% to 149.76% (DC power flow) of its emergency rating (1370 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 4.9 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
247286	05AND G2	0.41
247287	05AND G3	0.85
243442	05RKG1	19.63
243443	05RKG2	19.33
342900	1COOPER1 G	3.29
342903	1COOPER2 G	6.37
342918	1JKCT 1G	2.6
342921	1JKCT 2G	2.6
342924	1JKCT 3G	2.6
342927	1JKCT 4G	1.72
342930	1JKCT 5G	1.72
342933	1JKCT 6G	1.72
342936	1JKCT 7G	1.72
342939	1JKCT 9G	1.77
342942	1JKCT 10G	1.77
342945	1LAUREL 1G	1.86

	Full
Bus Name	Contribution
X3-028 C	112.82
Y2-006	16.65
Y3-038	0.53
Z1-046	19.5
AA1-001	5.68
AA1-004	15.81
AB1-087 C OP	41.37
AB1-088 C	41.37
_	39.8
	4.28
AC1-074 C OP	4.9
AC1-248	48.36
AC1-282	11.37
AC1-283	35.01
AC1-287	11.24
	Y2-006 Y3-038 Z1-046 AA1-001 AA1-004 AB1-087 C OP AB1-088 C OP AC1-040 C AC1-040 C AC1-074 C OP AC1-248 AC1-282 AC1-283

Appendix 4

(EKPC - LGEE) The 4SPUR-KENT-R-4KENTON 138 kV line (from bus 342661 to bus 324267 ckt 1) loads from 100.48% to 101.9% (AC power flow) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5

4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.68 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	10.07
342960	1SPURLK2G	14.67
342963	1SPURLK3G	7.71

Bus Number	Bus Name	Full Contribution
342966	1SPURLK4G	7.71
	AC1-074 C	
926731	OP	3.28
	AC1-074 E	
926732	OP	1.4

Appendix 5

(EKPC - EKPC) The 4SPURLOCK-4SPUR-KENT-R 138 kV line (from bus 342664 to bus 342661 ckt 1) loads from 100.48% to 101.89% (AC power flow) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5

4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.68 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	10.07
342960	1SPURLK2G	14.67
342963	1SPURLK3G	7.71

Bus Number	Bus Name	Full Contribution
342966	1SPURLK4G	7.71
	AC1-074 C	
926731	OP	3.28
	AC1-074 E	
926732	OP	1.4

Attachment 3. Dynamic Simulation Analysis

Executive Summary

PJM Queue project AC1-074 is a request for 80.0 MW Maximum Facility Output (MFO) Solar Generation Plant. The Point of Interconnection is a new three breaker ring station by tapping in/out Renaker – Jacksonville 138 kV circuit in the East Kentucky Power (EKPC) transmission system, Harrison County, Kentucky. AC1-074 project consist 33 TMEIC Solar Ware 2.5 MW Inverters.

The dynamic model for the AC1-074 plant is based on the 'PVGU1' and 'PVEU1' TMEIC standard PSS/E user models provided by the developer in the System Impact Study Data package.

This study is based on the 2020_SP summer peak load case and modified to include applicable queue projects. PJM queue project AC1-074 was dispatched at a maximum power transfer of 80.0 MW and POI voltage of 138.4 kV, consistent with the default generator reference voltage specified in PJM Manual 03 *Transmission Operations* Section 3.3.3 for generator connections to the PJM 138.0 kV system.

AC1-074 was tested for compliance with NERC, PJM and other applicable criteria. 62 contingencies were studied, each with a 15 second simulation time period.

Based on the contingencies tested, AC1-074 meets for all criteria contingencies tested.

Description

This study evaluates the stability, low voltage ride-through (LVRT) and dynamics for PJM queue project AC1-074 which is 80.0 MW MFO Solar Farm. The proposed POI is a three breaker ring bus which taps in/out existing Renaker – Jacksonville 138 kV circuit in EKPC area. The AC1-074 project is a Solar Farm made up of 33 TMEIC 2.5 MW Solar Ware Inverters. The solar inverters facility is modeled at 82.5 MW gross output of which 2.5 MW is consumed as auxiliaries. For this stability study, the AC1-074 project was studied for a total net injection of 80.0 MW into the 138.0 kV Transmission System.

The dynamic model for the AC1-074 plant is based on the 'PVGU1' and 'PVEU1' TMEIC standard PSS/E user models provided by the developer in the System Impact Study Data package.

Criteria

The stability study for AC1-074 was performed on a <u>RTEP SP_2020 Summer Peak load</u> case for normal operating conditions, and modified to include applicable queue projects. The range of contingencies evaluated was limited to those necessary to assess compliance with NERC, PJM and other applicable criteria. Simulation time was 15 seconds for all faults.

Simulated NERC Standard TPL-001 faults include:

- 1. Three-phase (3ph) fault with normal clearing (Category P1)
- 2. Single-line-to-ground on bus (slg) with normal clearing (Category P2)
- 3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
- 4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5) not performed for this study
- 5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P2, P3 and P6 faults will be studied on an as needed basis.

Other applicable criteria tested include:

- 1. TO specific criteria
- 2. Other criteria

The system was tested for an all lines in service condition and the faults listed above. Specific fault descriptions and breaker clearing times used for this study are provided in Appendix A.

All generators were monitored to assess transient stability and satisfactory post-contingency conditions.

Case Setup

Generators within 5 to 8 buses from the generator(s) under study are dispatched at their

maximum power output and set at unity power factor at the high side of the generator step up transformer. Alternatively, generators can be adjusted to hold scheduled voltages.

Specific dispatch conditions at the generator terminals for the AC1-074 generator, as obtained in the power flow solution, are illustrated below:

	33 TMEIC Solar War 2.5 MW Inverters
Gross power output (MW)	82.5
Reactive power output (MVARS)	-0.2
Auxiliary Load (MW/MVARS)	2.5, 0.0
Station Service Load (MW/MVARS)	
Net real power injection (MW)	80.0
Voltage at the POI (P.U.)	1.00

Results

Simulation Initialization

The case was initialized successfully. No errors were reported.

20 second no fault test (Steady State evaluation)

The system successfully met the 20 second run test without any significant deviations in system states.

Simulation Results

Dynamics and stability was tested using Siemens/PTI PSS/E Version 33.0, the 2020 case with a Summer Peak Load condition and the data supplied by the developer.

<u>Transient Stability</u>: For all contingencies studied, transient stability is maintained, with all oscillations stabilized in less than 15 seconds. Also, the voltage levels returned to acceptable levels for all contingencies following the fault clearance. Hence, no transient stability issues were identified for contingencies tested.

<u>LVRT:</u> For the cases studied, the queue project rides through the faults shown in Appendix A thus meeting the LVRT test specified in FERC order 661 and 661A.

Small Signal (if applicable):

SPS:

Maintenance outage: No maintenance outage conditions were evaluated.

Conclusion

Transient stability is maintained for all contingencies tested.

Mitigations:

None

Recommendations:

None

Appendix A: Fault Table

No.	Contingency ID	Type of Fault		ng time cles)	Results					
	g	31	Normal	Delayed						
Criteria = TPL 001-4_P1										
01	AC1-074-TAP-P1-01	3ph fault on AC1-074 Tap – Renaker 138 kV	6.0	N/A	OK					
02	AC1-074-TAP-P1-01	3ph fault on AC1-074 Tap – Jacksonville – Avon 138 kV	6.0	N/A	OK					
03	AC1-074-RENA-P1-01	3ph fault on Renaker – Spurlock 138 kV	6.0	N/A	OK					
04	AC1-074-RENA-P1-02	3ph fault on Renaker – Bavarian / Boone 138 kV	6.0	N/A	OK					
05	AC1-074-RENA-P1-03	3ph fault on Renaker 138/69 kV TF	6.0	N/A	OK					
06	AC1-074-RENA-P1-04	3ph fault on Renaker – Colemansville– Bracken Co 69 kV	8.0	N/A	OK					
07	AC1-074-RENA-P1-05	3ph fault on Renaker – KU Cynthiana – KU Millersburg 69 kV	8.0	N/A	OK					
08	AC1-074-RENA-P1-06	3ph fault on Renaker – Three M - Headquarters69 kV	8.0	N/A	OK					
09	AC1-074-RENA-P1-07	3ph fault on Renaker – Williamstown 69 kV	8.0	N/A	OK					
10	AC1-074-RENA-P1-08	3ph fault on Renaker – Lees Lick – KU Scott 69 kV	8.0	N/A	OK					
11	AC1-074-SPUR-P1-01	3ph fault on Spurlock – Stanley Parker 138 kV (N Bus)	6.0	N/A	OK					
12	AC1-074-SPUR-P1-02	3ph fault on Spurlock – Renaker 138 kV (S Bus)	6.0	N/A	OK					
13	AC1-074-SPUR-P1-03	3ph fault on Spurlock – Maysville – Plumville 138 kV (N Bus)	6.0	N/A	OK					
14	AC1-074-SPUR-P1-04	3ph fault on Spurlock – Flemingsburg / Goddard 138 kV (S Bus)	6.0	N/A	OK					
15	AC1-074-SPUR-P1-05	3ph fault on Spurlock – Kenton 138 kV (N Bus)	6.0	N/A	OK					
16	AC1-074-SPUR-P1-06	3ph fault on Spurlock – Inland 138 kV (S Bus)	6.0	N/A	OK					
17	AC1-074-SPUR-P1-07	3ph fault on Spurlock G1	6.0	N/A	OK					
18	AC1-074-SPUR-P1-08	3ph fault on Spurlock 138/345 kV TF 9	6.0	N/A	OK					
19	AC1-074-SPUR-P1-09	3ph fault on Spurlock 138/345 kV TF 10	6.0	N/A	OK					
20	AC1-074-SPUR-P1-10	3ph fault on Spurlock 138/345 kV TF 12	6.0	N/A	OK					
21	AC1-074-AVON-P1-01	3ph fault on Avon – Jacksonville – AC1-074 Tap 138 kV	6.0	N/A	OK					
22	AC1-074-AVON-P1-02	3ph fault on Avon – Fayette 138 kV	6.0	N/A	OK					
23	AC1-074-AVON-P1-03	3ph fault on Avon – Beck – Boonesboro N – Dale 138 kV	6.0	N/A	OK					
24	AC1-074-AVON-P1-04	3ph fault on Avon 138/345 kV TF	6.0	N/A	OK					
25	AC1-074-AVON-P1-04	3ph fault on Avon – KU Loudon 138kV	6.0	N/A	OK					
		Criteria = TPL 001-4_P2								

No.	Contingency ID	Type of Fault		ng time cles)	Results	
			Normal	Delayed		
26	AC1-074-TAP-P2-01	SLG fault on AC1-074 Tap, Loss of AC1-074 Tap 138 kV Bus	6.0	N/A	OK	
27	AC1-074-RENA-P2-01	SLG fault on Renaker 138 kV Bus, Loss of Renaker 138 kV Bus	6.0	N/A	OK	
28	AC1-074-RENA-P2-02	SLG fault on Renaker 69 kV Bus, Loss of Renaker 69 kV Bus	8.0	N/A	OK	
29	AC1-074-SPUR-P2-01	SLG fault on Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus (11,13,15,17 and 18)	8.0	N/A	OK	
30	AC1-074-SPUR-P2-02	SLG fault on Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus (12,14,16 and 19,20)	8.0	N/A	OK	
		Avon is Ring Bus. Bus fault will impact one element / circuit at a time				
	<u>'</u>	Criteria = TPL 001-4 P4				
31	AC1-074-TAP-P4-01	SLG fault on AC1-074 Tap – Renaker 138 kV, SB '824' at AC1-074, Loss of AC1-074 138 kV Bus	6.0	14.0	OK	
32	AC1-074-TAP-P4-02	SLG fault on AC1-074 Tap – Jacksonville – Avon 138 kV, SB '844' at AC1-074, Loss of AC1-074 138 kV Bus	6.0	14.0	ОК	
33	AC1-074-TAP-P4-03	SLG fault on AC1-074 Tap – unit 138 kV, SB '834' at AC1-074, Loss of AC1-074 138 kV Bus	6.0	14.0	ОК	
34	AC1-074-RENA-P4-01	SLG fault on Renaker – Spurlock 138 kV, SB '844' at Renaker 138 kV, Loss of Renaker 138 kV Bus	6.0	15.0	OK	
35	AC1-074-RENA-P4-02	SLG fault on Renaker – Bavarian / Boone 138 kV, SB '824' at Renaker 138 kV, Loss of Renaker 138 kV Bus	6.0	15.0	OK	
36	AC1-074-RENA-P4-03	SLG fault on Renaker 138/69 kV TF, SB '808' at Renaker 138 kV, Loss of Renaker 138 kV Bus	6.0	15.0	ОК	
37	AC1-074-RENA-P4-04	SLG fault on Renaker – AC1-074 Tap 138 kV, SB '814' at Renaker 138 kV, Loss of Renaker 138 kV Bus	6.0	15.0	ОК	
38	AC1-074-RENA-P4-05	SLG fault on Renaker 69/138 kV TF, SB '648' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	OK	
39	AC1-074-RENA-P4-06	SLG fault on Renaker – Colemansville –Bracken Co69 kV, SB '624' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	OK	
40	AC1-074-RENA-P4-07	SLG fault on Renaker – KU Cynthiana 69 kV, SB '664' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	ОК	
41	AC1-074-RENA-P4-08	SLG fault on Renaker – Three M - Headquarters69 kV, SB '604' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	OK	
42	AC1-074-RENA-P4-09	SLG fault on Renaker-Williamstown 69kV, SB '634' at Renaker 69kV, Loss of Renaker 69kV Bus	8.0	19.0	ОК	
43	AC1-074-RENA-P4-10	SLG fault on Renaker – Lees Lick – KU Scott 69 kV, SB '614' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	OK	
44	AC1-074-SPUR-P4-01	SLG fault on Spurlock – Stanley Parker 138 kV (N Bus), SB '814' at Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus	6.0	14.0	OK	
46	AC1-074-SPUR-P4-02	SLG fault on Spurlock – Maysville – Plumville 138 kV (N Bus), SB '834' at Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus	6.0	14.0	OK	
47	AC1-074-SPUR-P4-03	SLG fault on Spurlock – Kenton 138 kV (N Bus), SB '854' at Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus	6.0	14.0	OK	
48	AC1-074-SPUR-P4-04	SLG fault on Spurlock G1, SB '18G' at Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus	6.0	14.0	OK	
49	AC1-074-SPUR-P4-05	SLG fault on Spurlock 138/345 kV TF 9, SB '878' at Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus	6.0	14.0	ОК	
50	AC1-074-SPUR-P4-05	SLG fault on Spurlock – Renaker 138 kV (S Bus), SB '824' at Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus	6.0	15.0	ОК	
50	AC1-074-SPUR-P4-05	SLG fault on Spurlock – Flemingsburg / Godard 138 kV (S Bus), SB '844' at Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus	6.0	15.0	OK	

No.	Contingency ID	Type of Fault	Cleari (cy	Results	
		1	Normal	Delayed	
51	AC1-074-SPUR-P4-05	SLG fault on Spurlock – Inland 138 kV (S Bus), SB '864' at Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus	6.0	15.0	ОК
52	AC1-074-SPUR-P4-05	SLG fault on Spurlock 138/345 kV TF 10, SB '888' at Spurlock 138 kV S Bus, Loss of Spurlock 138 kV South Bus	6.0	15.0	ОК
53	AC1-074-AVON-P4-01	SLG fault on Avon – Jacksonville – AC1-074 Tap 138 kV, SB '844' at Avon 138 kV, Loss of Avon-KU Loudon 138kV line	6.0	15.0	ОК
54	AC1-074-AVON-P4-02	SLG fault on Avon – Jacksonville – AC1-074 Tap 138 kV, SB '834' at Avon 138 kV, Loss of Avon 138/345 kV TF	6.0	15.0	ОК
55	AC1-074-AVON-P4-03	SLG fault on Avon 138/345 kV TF, SB '834' at Avon 138 kV, Loss of Avon – Jacksonville – AC1-074 Tap 138 kV	6.0	15.0	OK
56	AC1-074-AVON-P4-04	SLG fault on Avon 138/345 kV TF, SB '814' at Avon 138 kV, Loss of Avon – Becknerville – Boonesboro – Dale 138 kV	6.0	15.0	ОК
57	AC1-074-AVON-P4-05	SLG fault on Avon – Becknerville – Boonesboro – Dale 138 kV, SB '814' at Avon 138 kV, Loss of Avon 138/345 kV TF	6.0	15.0	ОК
58	AC1-074-AVON-P4-06	SLG fault on Avon – Becknerville – Boonesboro – Dale 138 kV, SB '824' at Avon 138 kV, Loss of Avon – Fayette 138 kV	6.0	15.0	ОК
59	AC1-074-AVON-P4-07	SLG fault on Avon – Fayette 138 kV, SB '824' at Avon 138 kV, Loss of Avon – Becknerville – Boonesboro – Dale 138 kV	6.0	15.0	ОК
60	AC1-074-AVON-P4-08	SLG fault on Avon-Fayette 138kV, SB '864' at Avon 138kV, Loss of Avon – KU Loudon 138kV	6.0	15.0	ОК
		Criteria = TPL 001-4_P5			
		Not required – Communication redundancy			
		Criteria = TPL 001-4_P7			
61	AC1-074-SPUR-P7-01	SLG fault on Spurlock – Stanley Parker 138 kV (N Bus) + Spurlock – Renaker 138 kV (S Bus)	6.0	N/A	OK
62	AC1-074-SPUR-P7-02	SLG fault on Spurlock – Maysville – Plumville 138 kV (N Bus) + Spurlock – Flemingsburg / Goddard 138 kV (S Bus)	6.0	N/A	OK

Appendix B: Project Model

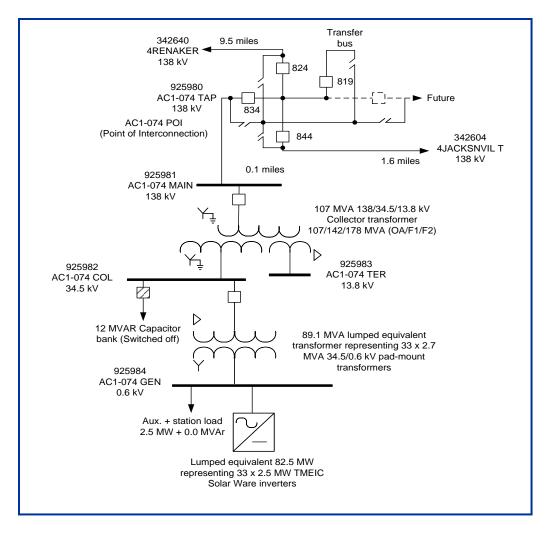


Figure B-1: PJM AC1-074 modeling details

Table 1: AC1-074 Plant Model

	Impact Study Data	Model
Solar inverters	33 x 2.5 MW TMEIC Solar Ware inverters	Lumped equivalent representing 33 x 2.5 MW
		TMEIC Solar Ware inverters
	MVA base = 2.7 MVA	
	Vt = 0.6 kV	Pgen 82.5 MW
		Pmax 82.5 MW
	Unsaturated sub-transient reactance = N/A	Pmin 0 MW
		Qgen 5.224 MVAr
		Qmax 33.65 MVAr
		Qmin -33.65 MVAr
		Mbase 89.1 MVA
G 1	22 24 7/2 51 77	Zsorce j999999.0 pu @ Mbase
Solar inverter	33 x 34.5/0.6 kV two winding transformers	Lumped equivalent representing 33 x 34.5/0.6
GSU	D : 271011	kV two winding transformers
transformers	Rating = 2.7 MVA	D .: 00.13474
	T 6 1 27 M/A	Rating = 89.1 MVA
	Transformer base = 2.7 MVA	T C 1 00 1 MV/A
	Y 1 0 0045 10 057	Transformer base = 89.1 MVA
	Impedance = $0.0045 + j0.057$ pu	1 0 0045 10 055
	@ MVA base	Impedance = $0.0045 + j0.057$ pu
	NY 1 C. NYA	@ MVA base
	Number of taps = NA	N 1 C. 7
	Tap step size = NA	Number of taps = 5
C 11	1 120/24 5/12 01 W days 2 2 1 2 2	Tap step size = 2.5 %
Collector step-up	1 x 138/34.5/13.8 kV three winding	1 x 138/34.5/13.8 kV three winding transformer
transformer	transformer	Datin = 107/142/179 MV/A (OA/E1/E2)
	Beting = 107/142/179 MVA (OA/E1/E2)	Rating = 107/142/178 MVA (OA/F1/F2)
	Rating = 107/142/178 MVA (OA/F1/F2)	Transformer base = 107 MVA
	Transformer base = 107 MVA	Transformer base = 107 WIVA
	Transformer base = 107 WVA	Impedances:
	Impedances:	High to low = $0.0019 + j0.09$ pu
	High to low = $0.0019 + j0.09$ pu	High to low $= 0.0019 + j0.09$ pu High to tertiary $= 0.0046 + j0.1278$ pu
	High to tertiary = $0.0046 + j0.1278$ pu	Low to tertiary = $0.0040 + j0.1278$ pu
	Low to tertiary = $0.0040 + j0.1278$ pu	All impedances @ MVA base
	All impedances @ MVA base	7411 Impedances & 141 v 71 base
	1 impedances & 11111 base	Number of taps $= 5$
	Number of taps $= 5$	Tap step size = 2.5%
	Tap step size $= 2.5\%$	14p 36ep 3126 210 /0
Capacitor banks	34.5 kV level two 6 MVAR cap banks	12 MVAR capacitor bank (Switched off)
-	-	•
Auxiliary and	2.5 MW + 0.00 MVAr	2.5 MW + 0.00 MVAr at low voltage side of
station load		GSU
Transmission line	138kV 0.1 Miles	Positive sequence impedance =
	Positive sequence impedance =	0.00031+0.00293j pu
	0.00031+0.00293j pu	Charging susceptance = 0.0001 pu @ 100 MVA
	Charging susceptance = 0.0001 pu @ 100	base
	MVA base	

Appendix C: Power Flow and Dynamic Models

C.1) Power Flow Model Data

```
VERSION 33
BAT_PURGBRN, 342640, 342604, '1'
RDCH
1
925980, 'AC1-074 TAP ', 138.0000,1, 320, 1.9962,1.10000,0.90000,1.10000,0.90000
                                                   6, 340, 1.01087,
925981, 'AC1-074 MAIN', 138.0000,1, 320, 2.1276,1.10000,0.90000,1.10000,0.90000
                                                         1,1.01100,
925982, 'AC1-074 COL', 34.5000,1, 320, 5.8853,1.10000,0.90000,1.10000,0.90000
                                                         1,1.01126,
925983, 'AC1-074 TER', 13.8000,1, 320, 23.8517,1.10000,0.90000,1.10000,0.90000
                                                         1,1.01116, -
925984, 'AC1-074 GEN ', 0.6000,2, 320, 21.2779,1.10000,0.90000,1.10000,0.90000
                                                         1,1.01728, -
                                                   1,
0 / END OF BUS DATA, BEGIN LOAD DATA
925984,'1',1, 320, 1,
                                   2.500,
                                                 0.000,
                                                              0.000,
                                                                           0.000,
                                                                                         0.000,
                                                                                                       0.000,
0 / END OF LOAD DATA, BEGIN FIXED SHUNT DATA
0 / END OF FIXED SHUNT DATA, BEGIN GENERATOR DATA
-33.650,1.01087,925980, 89.100, 0.00000E+0,
                     0,
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
342604,925980,'1', 1.35500E-3, 6.40200E-3, 0.0010 0.00000, 0.00000, 0.00000, 1,2, 1.57, 340,1.0000
                                                       0.00167, 167.00, 179.00, 179.00, 0.00000,
342640,925980,'1', 8.04500E-3, 3.79980E-2, 0.0099
0.00000, 0.00000, 0.00000,1,1, 9.33, 340,1.0000
                                                       0.00993, 167.00, 179.00, 179.00, 0.00000,
925980,925981,'1', 3.10000E-4, 2.93000E-3, 0.0000 0.00000, 0.00000, 0.00000,1,1, 0.00, 340,1.0000
                                                                    0.00,
                                                     0.00010,
                                                                                  0.00,
                                                                                             0.00, 0.00000,
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
925981,925982,925983,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,' 0,1.0000, 0,1.0000, 'YNOyn0d1 '
                                                                                       ',1,
                                                                                               1,1.0000,
 1.90000E-3, 9.00000E-2,
                                 107.00, 3.20000E-3, 2.52000E-2, 107.00, 4.60000E-3, 1.27800E-1,
107.00,1.01116, 6.1483
1.00000, 138.000, 0.000, 107.00, 14
0.95000, 5, 0, 0.00000, 0.00000, 0.000
                                               142.00, 178.00, 0,
                                                                               0, 1.05000, 0.95000, 1.05000,
1.00000, 34.500, 0.000, 107.00, 14
0.95000, 5, 0, 0.00000, 0.00000, 0.000
                                                                               0, 1.05000, 0.95000, 1.05000,
                                               142.00, 178.00, 0,
```

Dynamic Data

```
/*******************
********
          AC1-074 - 80 MW MFO
             Renaker - Jacksonville Tap 138 kV (EKPC)
             Solar
             33 x 2.5 MW TMEIC inverters
/*** PSSE Version:
            33
/*******************
*******
/Generator/ Converter (Inverter)
0.02
     0.02 0.0 0.1 2.0
      1.0 2.0 0.02 /
/Electrical Control Model for the PV converter
925984 'USRMDL' '1' 'PVEU1' 102 0 4 24 10 4
      1 0
0
 0
             2
0.1
      13
                       0
      0.08
          0.415 - 0.415
                                 0.926
                           0.05
0.02
          1
                -1
                                     0.1
```

C.2) PSS/E Single Line Diagram

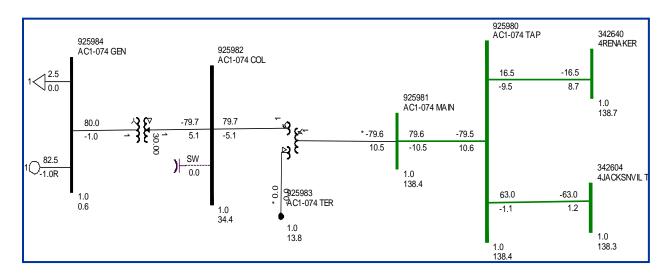


Figure C-1: Single-line diagram for AC1-074 2020-SP case (Breaker information not shown)

C.3) Area Generation

C.4)

Bus Number	Bus Name	Id	VSched (pu)	Remote Bus Number	In Service	PGen (MW)	PMax (MW)	PMin (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	Mbase (MVA)
248005	06KYGER 345.00	1	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	100.0
248005	06KYGER 345.00	2	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	95.0
248005	06KYGER 345.00	3	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	95.0
248005	06KYGER 345.00	4	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	95.0
248005	06KYGER 345.00	5	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	95.0
248005	06KYGER 345.00	6	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	117.7
248005	06KYGER 345.00	7	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	123.4
248005	06KYGER 345.00	8	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	123.4
248005	06KYGER 345.00	9	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	123.4
248005	06KYGER 345.00	A	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	123.4
251968	08ZIMRHP 26.000	1	1.0261	249577	1	870.0	872.0	420.0	205.0	205.0	-86.6	975.0
251969	08ZIMRLP 22.000	1	1.0261	249577	1	476.0	478.0	230.0	102.1	102.1	-43.1	780.0
253038	09KILLEN 345.00	2	1.0377	0	1	610.0	612.0	230.0	199.0	199.0	-63.0	734.0
253038	09KILLEN 345.00	3	1.0377	0	1	16.9	18.0	15.7	18.0	18.0	-10.2	33.7
253077	09STUART 345.00	1	1.0145	0	1	580.0	580.6	300.0	5.6	280.0	-17.0	678.0
253077	09STUART 345.00	2	1.0145	0	1	580.0	580.0	300.0	5.6	280.0	-30.0	678.0
253077	09STUART 345.00	3	1.0145	0	1	580.0	580.4	300.0	8.0	280.0	8.0	678.0
253077	09STUART 345.00	4	1.0145	0	1	577.0	577.0	300.0	5.6	280.0	-30.0	678.0
253077	09STUART 345.00	5	1.0145	0	1	7.7	9.2	0.0	0.1	8.8	-5.2	13.0
253110	09ADKINS 345.00	1	1.0022	0	1	82.0	82.0	38.0	24.0	24.0	-15.0	108.0

Bus Number	Bus Name	Id	VSched (pu)	Remote Bus Number	In Service	PGen (MW)	PMax (MW)	PMin (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	Mbase (MVA)
253110	09ADKINS 345.00	2	1.0022	0	1	82.0	82.0	38.0	22.0	22.0	-16.0	108.0
253110	09ADKINS 345.00	3	1.0022	0	1	81.0	81.0	38.0	22.0	22.0	-13.0	108.0
253110	09ADKINS 345.00	4	1.0022	0	1	80.0	80.0	38.0	22.0	22.0	-14.0	108.0
253110	09ADKINS 345.00	5	1.0022	0	1	82.0	82.0	38.0	27.0	27.0	-13.0	108.0
253110	09ADKINS 345.00	6	1.0022	0	1	79.0	79.0	38.0	25.0	25.0	-14.0	108.0
324017	1GHNT 1 18.000	1	1.018	324253	1	519.0	519.0	180.0	115.4	226.0	-156.0	640.0
342018	1GHNT 2 22.000	2	1.0203	324105	1	528.0	528.0	168.0	96.5	255.0	-68.0	618.2
342019	1GHNT 3 22.000	3	1.0203	324105	1	528.0	528.0	168.0	96.5	255.0	-68.0	618.2
342020	1GHNT 24 22.000	4	1.0203	324105	1	512.0	512.0	181.0	96.5	268	-43.0	618.0
342918	1JKCT 1G 13.800	1	1	0	1	110.0	110.0	0.0	-2.3	78.0	-60.3	140.0
342921	1JKCT 2G 13.800	1	1	0	1	110.0	110.0	0.0	-2.4	78.0	-60.3	140.0
342924	1JKCT 3G 13.800	1	1	0	1	110.0	110.0	0.0	-2.4	78.0	-60.3	140.0
342927	1JKCT 4G 13.800	1	1	0	1	73.0	73.0	0.0	18.5	40.0	-34.5	103.0
342930	1JKCT 5G 13.800	1	1	0	1	73.0	73.0	0.0	18.5	40.0	-34.5	103.0
342933	1JKCT 6G 13.800	1	1	0	1	73.0	73.0	0.0	17.7	72.5	-42.7	103.0
342936	1JKCT 7G 13.800	1	1	0	1	73.0	73.0	0.0	17.7	72.5	-42.7	103.0
342939	1JKCT 9G 13.800	1	1	0	1	73.0	76.0	0.0	38.8	41.8	-76.0	127.3
342942	1JKCT 10G 13.800	1	1	0	1	76.0	76.0	0.0	39.3	41.8	-76.0	127.3
342957	1SPURLK1G 22.000	1	1	0	1	344.0	344.0	100.0	127.4	175.0	-142.0	360.0
342960	1SPURLK2G 22.000	1	1	0	1	554.0	555.0	210.0	208.0	290.0	-227.0	636.6
342963	1SPURLK3G 18.000	1	1	0	1	304.0	306.0	80.0	128.6	268.0	-138.2	387.5
342966	1SPURLK4G 18.000	1	1	0	1	304.0	306.0	80.0	128.6	268.0	-138.2	387.5
894753	V3-045 G1 13.800	1	1.0109	250154	1	37.3	37.3	0.0	1.4	16.0	-16.0	40.3
894754	V3-045 G2 13.800	1	1.0109	250154	1	37.3	37.3	0.0	1.4	16.0	-16.0	40.3
894755	V3-045 G3 13.800	1	1.0109	250154	1	37.3	37.3	0.0	1.4	16.0	-16.0	40.3
925984	AC1-074 GEN 0.6000	1	1	0	1	82.5	82.5	0.0	-1.0	33.7	-33.7	89.1
931183	AB1-169 CT1 25.000	1	1.0145	253077	1	341.0	341.0	0.0	99.7	165.6	-112.4	380.0
931184	AB1-169 ST1 25.000	1	1.0145	253077	1	243.6	243.6	0.0	99.7	300.0	-177.0	437.0
931185	AB1-169 CT2 25.000	1	1.0145	253077	1	341.0	341.0	0.0	99.7	165.6	-112.4	380.0
931186	AB1-169 ST2 25.000	1	1.0145	253077	1	243.6	243.6	0.0	99.7	300.0	-177.0	437.0

C.5) Area Plants

Bus Number	Bus Name	Code	PGen (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	VSched (pu)	Remote Bus Number	Remote Bus Name	Voltage (pu)	RMPCT
248005	06KYGER 345.00	2	975	160	274	-306	1.02	0		1.02	100
									08ZIMER		
251968	08ZIMRHP 26.000	-2	870	205	205	-86.6	1.0261	249577	345.00	1.0166	58
									08ZIMER		
251969	08ZIMRLP 22.000	-2	476	102.1	102.1	-43.1	1.0261	249577	345.00	1.0166	42
253038	09KILLEN 345.00	-2	626.9	217	217	-73.2	1.0377	0		1.025	100

Bus Number	Bus Name	Code	PGen (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	VSched (pu)	Remote Bus Number	Remote Bus Name	Voltage (pu)	RMPCT
253077	09STUART 345.00	2	2324.7	24.9	1128.8	-74.2	1.0145	0		1.0145	25
253110	09ADKINS 345.00	-2	486	142	142	-85	1.0022	0		0.9981	100
324017	1GHNT 1 18.000	2	519	115.4	226	-156	1.018	324253	4GHENT 138.00	1.018	100
342918	1JKCT 1G 13.800	2	110	-2.3	78	-60.3	1	0		1	100
342921	1JKCT 2G 13.800	2	110	-2.4	78	-60.3	1	0		1	100
342924	1JKCT 3G 13.800	2	110	-2.4	78	-60.3	1	0		1	100
342927	1JKCT 4G 13.800	2	73	18.5	40	-34.5	1	0		1	100
342930	1JKCT 5G 13.800	2	73	18.5	40	-34.5	1	0		1	100
342933	1JKCT 6G 13.800	2	73	17.7	72.5	-42.7	1	0		1	100
342936	1JKCT 7G 13.800	2	73	17.7	72.5	-42.7	1	0		1	100
342939	1JKCT 9G 13.800	2	73	38.8	41.8	-76	1	0		1	10
342942	1JKCT 10G 13.800	2	76	39.3	41.8	-76	1	0		1	10
342957	1SPURLK1G 22.000	2	344	127.4	175	-142	1	0		1	100
342960	1SPURLK2G 22.000	2	554	208	290	-227	1	0		1	100
342963	1SPURLK3G 18.000	2	304	128.6	268	-138.2	1	0		1	100
342966	1SPURLK4G 18.000	2	304	128.6	268	-138.2	1	0		1	100
894753	V3-045 G1 13.800	2	37.3	1.4	16	-16	1.0109	250154	08MELDLS 138.00	1.0109	100
894754	V3-045 G2 13.800	2	37.3	1.4	16	-16	1.0109	250154	08MELDLS 138.00	1.0109	100
894755	V3-045 G3 13.800	2	37.3	1.4	16	-16	1.0109	250154	08MELDLS 138.00	1.0109	100
925984	AC1-074 GEN 0.6000	2	82.5	-1	33.6	-33.6	1	0		1	100
931183	AB1-169 CT1 25.000	2	341	99.7	165.6	-112.4	1.0145	253077	09STUART 345.00	1.0145	100
931184	AB1-169 ST1 25.000	2	243.6	99.7	300	-177	1.0145	253077	09STUART 345.00	1.0145	100
931185	AB1-169 CT2 25.000	2	341	99.7	165.6	-112.4	1.0145	253077	09STUART 345.00	1.0145	100
931186	AB1-169 ST2 25.000	2	243.6	99.7	300	-177	1.0145	253077	09STUART 345.00	1.0145	100

C.6) Switching Diagrams

