

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AD2-171***

Branchburg-Alburtis 500kV

September 2018

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, 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 impact study is performed.

The Feasibility 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

The Interconnection Customer (IC), has proposed a Natural Gas generating facility located in Hunterdon County, New Jersey. The installed facilities will have a total capability of 700 MW with 700 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2023. **This study does not imply a PSE&G commitment to this in-service date.**

Point of Interconnection

AD2-171 will interconnect with the PJM transmission system along one of the following points of interconnection:

- PSEG: Alburdis- Branchburg 500kV Line
- JCPL: Gilbert 230kV Substation

Cost Summary

The AD2-171 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$ 0
Direct Connection Network Upgrades	\$ 97,191,947
Non Direct Connection Network Upgrades	\$ 310,860
Total Costs	\$ 97,191,947

In addition, the AD2-171 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	\$ **0
Previously Identified Upgrades	\$ 0
Total Costs	\$ **0

** Please see the “New System Reinforcements” section of the Feasibility Study Report for a description of a technical evaluation that will be performed by PPL Electric Utilities during the Impact Study. Additional costs may be identified during the Impact Study once this evaluation is completed.

Cost allocations for these upgrades will be provided in the System Impact Study Report.

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	Total Cost
[PSEG] AD2-171 Interconnection Substation. Install a new 500kV three breaker ring bus substation along the Alburdis- Branchburg 500kV Line	\$ 97,191,947
Total Direct Connection Facility Costs	\$ 97,191,947

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	Total Cost
[PPL Electric Utilities] Alburdis 500kV Substation: <ul style="list-style-type: none"> • Modify the existing Branchburg 500kV circuit breaker protection and control scheme. • Modify the existing Branchburg- Breinigsville tie 500kV circuit breaker protection and control scheme. • Perform system checks and test equipment before placing in service. 	\$ 155,430
[PSEG] Branchburg 500kV Substation: <ul style="list-style-type: none"> • Modify the existing Alburdis 500kV circuit breaker protection and control scheme & tie breaker protection and control scheme. • Perform system checks and test equipment before placing in service. 	\$ 155,430
Total Non-Direct Connection Facility Costs	\$ 310,860

PSEG Scope of Work Assumptions:

- Land acquisition for the 500kV switchyard & associated transmission line tie in is assumed to be the developers responsibility and the cost estimates do not include land acquisition costs.
- This estimate is without identification of any property, extensive research and field review. This estimate may vary depending upon the substation location and its orientation.
- Site location assumed to be in heavily wooded area. Clearing and grubbing is included.
- Grading of site is included and based on minimal elevation changes.
- Allowance for rock excavation included based on assumed location and past project experience.
- Piles are assumed to be not required.
- Water table assumed to be below required excavation depth. Construction dewatering including.
- All excavated materials will be transported off site.
- (2) 60'x90' timber work pads are included.
- Silt fence is included for the length of the OP construction.
- Labor is included to move the mats up to 2x to support construction, and remove them.
- All Material and equipment costs are based on 2018 pricing.
- Steel is priced at \$2.65/lb.
- No escalation is included in the total project cost. Present day dollar value assumed.
- Sales Tax is included (NJ 2018)
- CIAC Tax was NOT included
- Labor rates (2018) are based on a 50 hour work week by all trades.
- Control house priced as prefabricated building with internals preinstalled.
- All equipment will be received when needed and no temporary accommodations will be required.
- Quantity of 500kV bus supports assumed based on past projects. Quantity to be revised with detailed design.
- SSVTs assumed to be gas (SF6) type. No containment pit is required.
- SSVT cable and duct bank routing based on worst case (longest run) location. Lengths to be revised with detailed design.
- Emergency generator assumed to be located next to control house and installed on a concrete slab at grade.
- Outages will be available.
- Permits will be available.
- Resources will be available.
- Engineering/Design is included.
- Project Management is included.
- Construction Management is included.

PPL Scope of Work Assumptions:

- Prior to this project a single fiber path between Alburdis and Branchburg will be established and the Alburdis – Branchburg 500kV line protection will be fiber based.
- For any operational, governmental, and/or environmental regulatory delays, the use of additional resources, such as overtime, premiums for expedited material, and/or contractor labor, may enable PPL EU to decrease this construction period but no guarantees can be made. It is also assumed that all rights-of-way and easements are secured by the anticipated construction start dates.

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.

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.

Public Service Electric and Gas (PSE&G) Requirements

The Interconnection Customer will be required to comply with all PSE&G Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Information and Requirements for Electric Service" document located at the following links:

http://www.pseg.com/business/builders/new_service/before/
<http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx>

Network Impacts

The Queue Project AD2-171 was evaluated as a 700.0 MW (Capacity 700.0 MW) injection tapping the Branchburg to Alburdis 500 kV line in the PJM500 area. Project AD2-171 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-171 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Generator Deliverability

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

None.

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

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)

None.

Steady-State Voltage Requirements

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

Steady State Voltage Studies to be conducted during later study phases

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

Stability Studies to be conducted during later study phases

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

#	Area	Bus No.	Bus	Breaker	Rating Type	Duty Percent Without AD2-171	Duty Percent With AD2-171	Duty Percent Difference
1	PPL	1	Alburtis 500.kV	BRANCBURG E	s	96.14%	100.09%	3.95%
2	PPL	1	Alburtis 500.kV	CAP BANK 1	s	96.14%	100.09%	3.95%
3	PPL	1	Alburtis 500.kV	CAP BANK 2	s	96.14%	100.09%	3.95%
4	PPL	1	Alburtis 500.kV	HOSENSACK 3E	s	96.14%	100.09%	3.95%
5	PPL	1	Alburtis 500.kV	WESCOS EASTA	s	96.14%	100.09%	3.95%
6	PPL	1	Alburtis 500.kV	WESCOS EASTG	s	96.14%	100.09%	3.95%

Winter Analysis - 2021

Winter Studies to be conducted during later study phases

Light Load Analysis - 2021

Light Load Studies to be conducted during later study phases

Affected System Analysis & Mitigation

NYISO Impacts:

NYISO Impacts to be determined during later study phases (as applicable).

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.

None.

New System Reinforcements

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

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#1, 2, 3, 4, 5, 6	Alburtis 500 kV Circuit Breakers	<p>In order to mitigate the overloads of facilities above, the following reinforcements are required:</p> <ul style="list-style-type: none"> Replace the overdutied Circuit Breakers at Alburtis 500kV Switchyard with 63kA Breakers <p>Although all of the affected circuit breakers at the Alburtis 500kV switchyard have already been replaced with 63 kA breakers, there may be additional upgrades identified at Alburtis to support the higher fault current. The Alburtis 500kV switchyard was initially designed for 40 kA and the ground grid, bus structures, etc. may need to be upgraded to support the higher fault current. PPL will perform an analysis during the Impact Study to determine if upgrades are required. **Although the upgrade cost is identified as \$0 at this time, additional costs may be incurred during the Impact Study if PPL identifies reinforcements through the aforementioned analysis.</p>		\$ **0
Total New Network Upgrades				\$ **0

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.

Network Impacts

The Queue Project AD2-171 was evaluated as a 700.0 MW (Capacity 700.0 MW) injection at the Gilbert 230kV substation in the JCPL area. Project AD2-171 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-171 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
JC-P1-2-JCN-230-004	CONTINGENCY 'JC-P1-2-JCN-230-004' /* GILBERT - GLEN GARDNER (V1036) 230 KV DISCONNECT BRANCH FROM BUS 206236 TO BUS 206233 CKT 1 /* 28GILBERT 230 28G GARDNR 230 END
JC-P1-2-JCN-230-060T	CONTINGENCY 'JC-P1-2-JCN-230-060T' /* GILBERT - SPRINGFIELD (A1015) 230 KV LINE DISCONNECT BRANCH FROM BUS 206236 TO BUS 208091 CKT 1 /* 28GILBERT 230 SFLD 230 END
JC-P7-1-JCN-230-2	CONTINGENCY 'JC-P7-1-JCN-230-2' /* GILBERT-GLEN GARDNER & GILBERT-MORRISTOWN 230 KV DISCONNECT BRANCH FROM BUS 206236 TO BUS 206233 CKT 1 /* 28GILBERT 230 28G GARDNR 230 DISCONNECT BRANCH FROM BUS 206236 TO BUS 206375 CKT 1 /* 28GILBERT 230 28TEWKSBR Y 230 DISCONNECT BRANCH FROM BUS 206375 TO BUS 206243 CKT 1 /* 28TEWKSBR Y 230 28MO-TOWN 230 DISCONNECT BRANCH FROM BUS 206243 TO BUS 206204 CKT 5 /* 28MO-TOWN 230 28MORRISTO 35 SET BUS 206204 SHUNT TO 11 MVAR /* 28MORRISTO 35 REMOVE LOAD 1 FROM BUS 206204 /* 28MORRISTO 35 END

Contingency Name	Description
JC-P7-1-JCN-230-2LT	CONTINGENCY 'JC-P7-1-JCN-230-2LT' /* GILBERT-GLEN GARDNER & GILBERT-MORRISTOWN 230 KV DISCONNECT BRANCH FROM BUS 206236 TO BUS 206233 CKT 1 /* 28GILBERT 230 28G GARDNR 230 DISCONNECT BRANCH FROM BUS 206236 TO BUS 206375 CKT 1 /* 28GILBERT 230 28TEWKSBRY 230 DISCONNECT BRANCH FROM BUS 206375 TO BUS 206243 CKT 1 /* 28TEWKSBRY 230 28MO-TOWN 230 DISCONNECT BRANCH FROM BUS 206243 TO BUS 206204 CKT 5 /* 28MO-TOWN 230 28MORRISTO 35 SET BUS 206204 SHUNT TO 11 MVAR /* 28MORRISTO 35 END
ME-P1-2-ME-230-212T	CONTINGENCY 'ME-P1-2-ME-230-212T' /* PORTLAND - MARTINS CREEK 230 KV DISCONNECT BRANCH FROM BUS 204510 TO BUS 208024 CKT 1 /* 27PORTLAND 230 MACR 230 END
PJM_P1_28A	CONTINGENCY 'PJM_P1_28A' DISCONNECT BRANCH FROM BUS 200008 TO BUS 200043 CKT 1 /* HOSENSAK STEEL 500 500 END
PL:P12:101211	CONTINGENCY 'PL:P12:101211' /* LAUS T3 500/230KV DISCONNECT BRANCH FROM BUS 200099 TO BUS 208045 CKT 3 /* END

Generator Deliverability

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

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
1	N-1	ME-P1-2-ME-230-212T	JCPL - JCPL	28GILBERT-28G GARDNR 230 kV line	206236	206233	1	DC	89.45	100.77	ER	923	104.52	1
2	N-1	JC-P1-2-JCN-230-060T	JCPL - JCPL	28GILBERT-28G GARDNR 230 kV line	206236	206233	1	DC	85.22	100.38	ER	923	139.89	
3	Non	Non	JCPL - PL	28GILBERT-SFLD 230 kV line	206236	208091	1	DC	93.57	127.06	NR	653	219.05	
4	N-1	PJM_P1_2_8A	PL - METED	SFLD-27HOSNSACK 230 kV line	208091	204686	1	DC	81.48	108.18	ER	783	209.09	2
5	N-1	JC-P1-2-JCN-230-004	PL - METED	SFLD-27HOSNSACK 230 kV line	208091	204686	1	DC	78.04	105.95	ER	783	218.53	
6	N-1	PL:P12:10 1211	METED - METED	AA2-115 TAP-27S.RDG 230 kV line	920200	204512	1	DC	99.91	107.43	ER	531	39.94	3
7	Non	Non	METED - METED	AA2-115 TAP-27S.RDG 230 kV line	920200	204512	1	DC	97.12	106.5	NR	445	41.73	

Note: Please see Attachment 3 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
8	DCTL	JC-P7-1-JCN-230-2	PL - METED	SFLD-27HOSNSACK 230 kV line	208091	204686	1	DC	89.83	104.1 6	ER	783	248.74	
9	DCTL	JC-P7-1-JCN-230-2LT	PL - METED	SFLD-27HOSNSACK 230 kV line	208091	204686	1	DC	89.69	104.0 2	ER	783	248.74	

Note: Please see Attachment 3 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

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)

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
10	N-1	PJM_P1_2 8A	JCPL - PL	28GILBERT-SFLD 230 kV line	206236	208091	1	DC	105.2	135.2 9	ER	783	235.58	4
11	N-1	JC-P1-2-JCN-230-004	JCPL - PL	28GILBERT-SFLD 230 kV line	206236	208091	1	DC	100.9 1	132.3 3	ER	783	246.03	
12	DCTL	JC-P7-1-JCN-230-2	JCPL - PL	28GILBERT-SFLD 230 kV line	206236	208091	1	DC	114.3 7	130.5 2	ER	783	280.29	

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
13	DCTL	JC-P7-1- JCN-230- 2LT	JCPL - PL	28GILBERT-SFLD 230 kV line	206236	208091	1	DC	114.2 3	130.3 8	ER	783	280.29	

Note: Please see Attachment 3 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Short Circuit

(Summary of impacted circuit breakers)

None

Steady-State Voltage Requirements

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

Steady State Voltage Studies to be conducted during later study phases

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

Stability Studies to be conducted during later study phases

Winter Analysis - 2021

Winter Studies to be conducted during later study phases

Light Load Analysis - 2021

Light Load Studies to be conducted during later study phases

Affected System Analysis & Mitigation

NYISO Impacts:

NYISO Impacts to be determined during later study phases (as applicable).

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.

None

Attachment 1. Flowgate Details – Option 2

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 1

(JCPL - JCPL) The 28GILBERT-28G GARDNR 230 kV line (from bus 206236 to bus 206233 ckt 1) loads from 89.45% to 100.77% (**DC power flow**) of its emergency rating (923 MVA) for the single line contingency outage of 'ME-P1-2-ME-230-212T'. This project contributes approximately 104.52 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
206340	28GIL 4&5	2.72
206342	28GIL 6&7	2.78
206341	28GIL 8	2.5
206330	28GILCT9	4.22
206346	28MILF GEN	0.32
934091	AD1-037	4.82
936551	AD2-070 C	0.19
937301	AD2-171 O2	104.52
LTF	CBM-N	0.02
LTF	CBM-S1	0.5
LTF	CBM-S2	0.42
LTF	CBM-W1	1.9
LTF	CBM-W2	2.97
LTF	CIN	0.41
LTF	CPL	0.1

Bus Number	Bus Name	Full Contribution
LTF	IPL	0.27
LTF	LGEE	0.09
208905	LMBE CT1	2.31
208906	LMBE CT2	2.31
208908	LMBE ST1	2.77
208946	MACR CT	0.57
208909	MACR G3	10.76
208910	MACR G4	10.76
LTF	MEC	0.78
LTF	MECS	0.6
LTF	NYISO	0.28
905761	W4-097 C	0.01
LTF	WEC	0.11
931051	AB1-154 C	153.49

Appendix 2

(PL - METED) The SFLD-27HOSNSACK 230 kV line (from bus 208091 to bus 204686 ckt 1) loads from 81.48% to 108.18% (**DC power flow**) of its emergency rating (783 MVA) for the single line contingency outage of 'PJM_P1_28A'. This project contributes approximately 209.09 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
206747	28DSM_X3-029	1.64
206741	28FR_U2-059	0.03
206743	28GAR_V4-001	0.03
206340	28GIL 4&5	5.44
206342	28GIL 6&7	5.55
206341	28GIL 8	5
206330	28GILCT9	8.44
206346	28MILF GEN	1.02
206345	28N27_Y2-018	0.32
206744	28PIT_W1-132	0.16
934091	AD1-037	11.61
935071	AD1-143 C1	0.48
935081	AD1-143 C2	0.02
935091	AD1-143 C3	0.48
935101	AD1-143 C4	0.02
936201	AD2-026 C	0.33
936551	AD2-070 C	0.65
937301	AD2-171 O2	209.09
LTF	AMIL	0.27
LTF	BAYOU	0.98
208980	BEPO IPP	5.73
200047	BETH CC4	5.71
200050	BETH CT7	3.72
LTF	BIG_CAJUN1	1.51
LTF	BIG_CAJUN2	3.03
LTF	BLUEG	1.6
LTF	CALDERWOOD	0.51
LTF	CANNELTON	0.28
LTF	CATAWBA	0.34
LTF	CBM-N	0.05
LTF	CELEVELAND	0.97
LTF	CHEOAH	0.47
LTF	CHILHOWEE	0.17
LTF	CHOCTAW	1
LTF	CLIFTY	6.57

Bus Number	Bus Name	Full Contribution
LTF	FARMERCITY	0.32
LTF	G-007A	10.04
LTF	GIBSON	0.54
LTF	HAMLET	1.12
208905	LMBE CT1	5.56
208906	LMBE CT2	5.56
208908	LMBE ST1	6.68
208946	MACR CT	1.37
208909	MACR G3	25.91
208910	MACR G4	25.91
LTF	MORGAN	1.63
209028	N31 IPP	0.15
LTF	NEWTON	1.22
LTF	NYISO	0.73
LTF	PRAIRIE	2.37
LTF	ROWAN	0.67
LTF	SANTEETLA	0.14
LTF	SMITHLAND	0.19
LTF	TATANKA	0.58
LTF	TILTON	0.57
LTF	TRIMBLE	0.31
LTF	TVA	0.72
LTF	UNIONPOWER	0.74
LTF	VFT	34.04
902061	W1-127C	0.04
903481	W3-029C	0.52
903631	W3-044C OP1	1.24
903961	W3-077C	1.04
905441	W4-046 C	0.12
905601	W4-073 C	0.24
905761	W4-097 C	0.04
919531	AA2-017 C1	0.97
919541	AA2-017 C2	0.97
931051	AB1-154 C	307.06
923781	AB2-012	1.57

Bus Number	Bus Name	Full Contribution
LTF	COTTONWOOD	3.87
LTF	DEARBORN	0.78
LTF	EDWARDS	0.48
LTF	ELMERSMITH	0.8

Bus Number	Bus Name	Full Contribution
924141	AB2-058 C	0.12
925461	AC1-018 C	0.1
926081	AC1-087 C	0.32

Appendix 3

(METED - METED) The AA2-115 TAP-27S.RDG 230 kV line (from bus 920200 to bus 204512 ckt 1) loads from 99.91% to 107.43% (**DC power flow**) of its emergency rating (531 MVA) for the single line contingency outage of 'PL:P12:101211'. This project contributes approximately 39.94 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
204689	27PLF_V3-044	0.05
206340	28GIL 4&5	1.04
206342	28GIL 6&7	1.06
206341	28GIL 8	0.95
206330	28GILCT9	1.61
206346	28MILF GEN	0.25
936551	AD2-070 C	0.16
937301	AD2-171 O2	39.94
208940	ALLE CT	0.33
LTF	AMIL	0.21
LTF	BAYOU	0.78
LTF	BIG_CAJUN1	1.21
LTF	BIG_CAJUN2	2.43
LTF	BLUEG	1.25
LTF	CALDERWOOD	0.41
LTF	CANNELTON	0.22
LTF	CATAWBA	0.28
LTF	CBM-N	0.04
LTF	CELEVELAND	0.8
LTF	CHEOAH	0.38
LTF	CHILHOWEE	0.14
LTF	CHOCTAW	0.81
LTF	CLIFTY	5.13
LTF	COTTONWOOD	3.1
LTF	DEARBORN	0.59

Bus Number	Bus Name	Full Contribution
LTF	EDWARDS	0.37
LTF	ELMERSMITH	0.63
LTF	FARMERCITY	0.25
LTF	G-007A	6.38
LTF	GIBSON	0.42
LTF	HAMLET	0.94
LTF	MORGAN	1.31
LTF	NEWTON	0.96
LTF	NYISO	0.52
LTF	PRAIRIE	1.87
LTF	ROWAN	0.56
LTF	SANTEETLA	0.11
LTF	SMITHLAND	0.15
LTF	TATANKA	0.45
LTF	TILTON	0.45
LTF	TRIMBLE	0.24
LTF	TVA	0.58
LTF	UNIONPOWER	0.6
LTF	VFT	18.26
905761	W4-097 C	0.01
920201	AA2-115	49.05
931051	AB1-154 C	58.66
924601	AB2-112	20.52
925601	AC1-035	-2.36

Appendix 4

(JCPL - PL) The 28GILBERT-SFLD 230 kV line (from bus 206236 to bus 208091 ckt 1) loads from 105.2% to 135.29% (**DC power flow**) of its emergency rating (783 MVA) for the single line contingency outage of 'PJM_P1_28A'. This project contributes approximately 235.58 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
206747	28DSM_X3-029	1.86
206741	28FR_U2-059	0.03
206743	28GAR_V4-001	0.03
206340	28GIL 4&5	6.13
206342	28GIL 6&7	6.26
206341	28GIL 8	5.63
206330	28GILCT9	9.51
206346	28MILF GEN	1.16
206345	28N27_Y2-018	0.36
206744	28PIT_W1-132	0.18
934091	AD1-037	13.21
935071	AD1-143 C1	0.57
935081	AD1-143 C2	0.02
935091	AD1-143 C3	0.57
935101	AD1-143 C4	0.02
936201	AD2-026 C	0.36
936551	AD2-070 C	0.74
937301	AD2-171 O2	235.59
LTF	AMIL	0.28
LTF	BAYOU	1.04
208980	BEPO IPP	6.55
200047	BETH CC4	6.52
200050	BETH CT7	4.25
LTF	BIG_CAJUN1	1.61
LTF	BIG_CAJUN2	3.24
LTF	BLUEG	1.7
LTF	CALDERWOOD	0.55
LTF	CANNELTON	0.3
LTF	CATAWBA	0.36
LTF	CBM-N	0.08
LTF	CELEVELAND	1.04
LTF	CHEOAH	0.5
LTF	CHILHOWEE	0.18
LTF	CHOCTAW	1.07
LTF	CLIFTY	6.98
LTF	COTTONWOOD	4.13
LTF	DEARBORN	0.82
LTF	EDWARDS	0.51
LTF	ELMERSMITH	0.85

Bus Number	Bus Name	Full Contribution
LTF	FARMERCITY	0.34
LTF	G-007A	10.5
LTF	GIBSON	0.57
LTF	HAMLET	1.2
208905	LMBE CT1	6.33
208906	LMBE CT2	6.33
208908	LMBE ST1	7.6
208946	MACR CT	1.56
208909	MACR G3	29.49
208910	MACR G4	29.49
LTF	MORGAN	1.74
209028	N31 IPP	0.17
LTF	NEWTON	1.3
LTF	NYISO	1.11
LTF	PRAIRIE	2.53
LTF	ROWAN	0.72
LTF	SANTEETLA	0.15
LTF	SMITHLAND	0.2
LTF	TATANKA	0.61
LTF	TILTON	0.61
LTF	TRIMBLE	0.33
LTF	TVA	0.77
LTF	UNIONPOWER	0.79
LTF	VFT	36.47
902061	W1-127C	0.05
903481	W3-029C	0.57
903631	W3-044C OP1	1.4
903961	W3-077C	1.17
905441	W4-046 C	0.13
905601	W4-073 C	0.27
905761	W4-097 C	0.05
919531	AA2-017 C1	1.14
919541	AA2-017 C2	1.14
931051	AB1-154 C	345.97
923781	AB2-012	1.8
924141	AB2-058 C	0.14
925461	AC1-018 C	0.11
926081	AC1-087 C	0.38