

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AD2-133***

Eagle Valley 115kV

August 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.

The conduct of light load analysis as required under the PJM planning process is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of the light load analysis which shall be performed following execution of the System Impact Study agreement.

General

The Interconnection Customer (IC), has proposed an uprate to an existing wind generating facility located in Centre County, Pennsylvania. This projects requests an increase to the install capability of 100.33 MW with 18 MW of this output being recognized by PJM as capacity. The installed facilities of Q36 & AD2-133 will have a total capability of 150.325 MW with 28 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2020. **This study does not imply a Mid-Atlantic Interstate Transmission (MAIT) commitment to this in-service date.**

Point of Interconnection

AD2-133 will interconnect with the MAIT transmission system at the Eagle Valley 115kV substation.

Cost Summary

The AD2-133 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$ 0

Description	Total Cost
Direct Connection Network Upgrades	\$ 0
Non Direct Connection Network Upgrades	\$ 0
Total Costs	\$ 0

In addition, the AD2-133 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	\$ 19,226,200
Previously Identified Upgrades	\$ 35,706,100
Total Costs	\$ 54,932,300

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

General Information

Interconnected

Transmission Owner ("TO"): Mid-Atlantic Interstate Transmission, LLC ("MAIT")

Affected TO(s)
(if applicable):

Mid-Atlantic Interstate Transmission, LLC ("MAIT")
West Penn Power Company ("West Penn")

PJM Zone:

Penelec

FE Operating Company or
Planning Region:

Penelec

Customer Connection Request

Requested Backfeed Date: n/a Requested Commercial Operation Date: 12/31/2020
This study does not imply a FirstEnergy commitment to these dates.

New Facilities

Capacity: 18 MW
 Energy: 100.325 MW
 MFO¹: 150.325 MW
 Fuel: Wind

Existing Facilities

Capacity: 10 MW
 Energy: 50 MW
 MFO: 50 MW
 Prior Queue Position(s): Q36

¹ Maximum Facility Output

Attachment Facilities

No Attachment Facilities are required to support this interconnection request.

Direct Connection Cost Estimate

No Direct Connection Facilities are required to support this interconnection request.

Non-Direct Connection Cost Estimate

No Non-Direct Connection Facilities are required to support this interconnection request.

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.
4. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.
5. The purchase and installation of supervisory control and data acquisition (“SCADA”) equipment to provide information in a compatible format to the FE Transmission System Control Center.
6. Compliance with the FE and PJM generator power factor and voltage control requirements.
7. The execution of a back-up service agreement to serve the customer load supplied from the AD2-133 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

8. The IC shall design its wind-powered Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformers connected to the FE transmission system.

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.

FE Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

<http://www.firstenergycorp.com/feconnect>

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

System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

The IC has requested a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document. This standard requires the GSU transformer to have a grounded wye connection on the high (utility) side and a delta connection on the low (generator) side. However, because AD2-133 is studied as an increase to the output to the existing Q36 project, which was constructed with a non-standard GSU transformer winding configuration, FE will allow a one-time exception to this requirement and permit the IC to install a GSU transformer with grounded wye windings on both the high and low sides.

Network Impacts

The Queue Project AD2-133 was evaluated as a 100.3 MW (Capacity 18.0 MW) injection at the Eagle Valley 115kV substation in the PenElec area. Project AD2-133 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-133 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
AP-P1-2-WP-230-005-B	CONTINGENCY 'AP-P1-2-WP-230-005-B' /* AA1-085 TAP - MILESBERG 230KV DISCONNECT BRANCH FROM BUS 918700 TO BUS 235219 CKT 1 /* AA1-085 TAP 230 01MILESB 230 END
AP-P1-2-WP-345-311T	CONTINGENCY 'AP-P1-2-WP-345-311T' /* ARMSTRONG -HOMERCITY 345KV DISCONNECT BRANCH FROM BUS 235129 TO BUS 200769 CKT 1 /* 01ARMSTRONG 345 26HOMER CY 345 END
AP-P2-2-WP-230-001T	CONTINGENCY 'AP-P2-2-WP-230-001T' /* ELKO #2 230KV BUS DISCONNECT BRANCH FROM BUS 235175 TO BUS 235158 CKT 1 /* 01ELKO 230 01CARB 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 /* 01ELKO 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 200726 CKT 1 /* 01ELKO 230 26SHAWVL 2 230 REDUCE BUS 237007 SHUNT BY 100 PERCENT /* 01ELKO CAP 138 DISCONNECT BUS 237007 /* 01ELKO CAP 138 END

Contingency Name	Description
AP-P2-3-WP-230-443T	CONTINGENCY 'AP-P2-3-WP-230-443T' */ UPDATED CON AJK 3-31-16 DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 DISCONNECT BUS 235158 END
AP-P2-3-WP-230-446T	CONTINGENCY 'AP-P2-3-WP-230-446T' /* ELKO- MOSHANNON STK BKR AT ELKO DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1 /* 26SHAWVL 2 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235158 TO BUS 235175 CKT 1 /* 01CARB 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 /* 01ELKO 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235220 TO BUS 235236 CKT 1 /* 01MOSHAN 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235236 TO BUS 236732 CKT 81 /* 01QUEHAN 230 01QUEHANNA 46 END
AP-P2-3-WP-500-461T	CONTINGENCY 'AP-P2-3-WP-500-461T' /* 468 DISCONNECT BRANCH FROM BUS 200011 TO BUS 235104 CKT 1 /* KEYSTONE 500 01CABOT 500 DISCONNECT BRANCH FROM BUS 235104 TO BUS 235153 CKT 1 /* 01CABOT 500 01CABOT 138 DISCONNECT BRANCH FROM BUS 235104 TO BUS 235153 CKT 3 /* 01CABOT 500 01CABOT 138 END

Contingency Name	Description
AP-P2-3-WP-500-462T	CONTINGENCY 'AP-P2-3-WP-500-462T' /* 469 DISCONNECT BRANCH FROM BUS 200011 TO BUS 235104 CKT 1 /* KEYSTONE 500 01CABOT 500 DISCONNECT BRANCH FROM BUS 235104 TO BUS 235153 CKT 2 /* 01CABOT 500 01CABOT 138 DISCONNECT BRANCH FROM BUS 235104 TO BUS 235153 CKT 4 /* 01CABOT 500 01CABOT 138 END
ATSI-P2-3-CEI-345-004D	CONTINGENCY 'ATSI-P2-3-CEI-345-004D' /* ERIE WEST 345KV BKR 8 DISCONNECT BRANCH FROM BUS 200599 TO BUS 200600 CKT 1 /* 26ERIE W 345 26ERIE SO 345 DISCONNECT BRANCH FROM BUS 200599 TO BUS 238547 CKT 1 /* 26ERIE W 345 02AT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239036 CKT 1 /* 02AT 345 02PERRY 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239082 CKT 1 /* 02AT 345 02S8-ATT 345 DISCONNECT BUS 200600 /* 26ERIE SO 345 DISCONNECT BUS 238547 /* 02AT 345 END
PJM_P1_APS_B_G692	CONTINGENCY 'PJM_P1_APS_B_G692' / 200011 KEYSTONE 500 235104 01CABOT 500 1 OPEN BRANCH FROM BUS 200011 TO BUS 235104 CKT 1 END
PL:P12:001029	CONTINGENCY 'PL:P12:001029' /* LACK-LAEN 230KV LINE DISCONNECT BRANCH FROM BUS 208009 TO BUS 208054 CKT 1 /* LACK-LAEN 230 END

Contingency Name	Description
PL:P13:100352	CONTINGENCY 'PL:P13:100352' /* OXBOW 230/34.5KV T1 DISCONNECT BRANCH FROM BUS 200706 TO BUS 200825 CKT 3 /* /* N.MESHPN-MESH2REA T3 DISCONNECT BUS 200708 /* /* OXBOW DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1 /* /* NMES-LACK 230KV LINE END
PL:P42:001131	CONTINGENCY 'PL:P42:001131' /* AT JUNIATA SUB LEWISTOWN SOUTH CB FAIL DISCONNECT BRANCH FROM BUS 208004 TO BUS 200009 CKT 1 /* DISCONNECT JUNI TR1 DISCONNECT BRANCH FROM BUS 208004 TO BUS 209997 CKT 3 /* DISCONNECT JUNI TR3 DISCONNECT BRANCH FROM BUS 200513 TO BUS 208004 CKT 1 /* DISCONNECT JUNI-LEWIS LINE END
PL:P42:100547	CONTINGENCY 'PL:P42:100547' /* AT JUNIATA SUB LEWISTOWN 230KV CB FAILED DISCONNECT BRANCH FROM BUS 208004 TO BUS 200513 CKT 1 /* DISCONNECT JUNI - LEWISTOWN LINE DISCONNECT BRANCH FROM BUS 208004 TO BUS 209997 CKT 4 /* DISCONNECT T4 DISCONNECT BRANCH FROM BUS 208004 TO BUS 200009 CKT 2 /* DISCONNECT T2 END
PL:P42:100577	CONTINGENCY 'PL:P42:100577' /* AT JUNIATA 500SUB TR1 230KV CB FAILED DISCONNECT BRANCH FROM BUS 200009 TO BUS 200183 CKT 1 /* DISCONNECT BRANCH FROM BUS 200009 TO BUS 208004 CKT 1 /* DISCONNECT BUS 208004 /* END

Contingency Name	Description
PN_P4-500-001A	CONTINGENCY 'PN_P4-500-001A' /* KEYSTONE 500KV BKR 1 DISCONNECT BRANCH FROM BUS 200011 TO BUS 200810 TO BUS 200906 CKT 3/* KEYSTONE 500 26KEYSTONE 230 26KEYSTN#3 20.00 REMOVE MACHINE H FROM BUS 200033 /* KEYS G2 20 REMOVE MACHINE L FROM BUS 200033 /* KEYS G2 20 DISCONNECT BUS 200033 /* KEYS G2 20 END
PN_P4-500-001D	CONTINGENCY 'PN_P4-500-001D' /* KEYSTONE 500KV BKR 4 DISCONNECT BRANCH FROM BUS 200011 TO BUS 200810 TO BUS 200906 CKT 3/* KEYSTONE 500 26KEYSTONE 230 26KEYSTN#3 20.00 REMOVE MACHINE H FROM BUS 200032 /* KEYS G1 20 REMOVE MACHINE L FROM BUS 200032 /* KEYS G1 20 DISCONNECT BUS 200032 /* KEYS G1 20 END
PN_P4-500-001F	CONTINGENCY 'PN_P4-500-001F' /* KEYSTONE 500KV BKR 6 DISCONNECT BRANCH FROM BUS 200011 TO BUS 200005 CKT 1 /* KEYSTONE 500 CONEM-GH 500 DISCONNECT BRANCH FROM BUS 200011 TO BUS 200810 TO BUS 200907 CKT 4/* KEYSTONE 500 26KEYSTONE 230 26KEYSTN#4 20.00 REDUCE BUS 200011 SHUNT BY 100 PERCENT /* KEYSTONE 500 END

Contingency Name	Description
PN_P4-500-001J	CONTINGENCY 'PN_P4-500-001J' /* KEYSTONE 500KV BKR 16 DISCONNECT BRANCH FROM BUS 200011 TO BUS 235104 CKT 1 /* KEYSTONE 500 01CABOT 500 DISCONNECT BRANCH FROM BUS 200011 TO BUS 200810 TO BUS 200907 CKT 4/* KEYSTONE 500 26KEYSTONE 230 26KEYSTN#4 20.00 REDUCE BUS 200011 SHUNT BY 100 PERCENT /* KEYSTONE 500 END
PN_P4-500-002A	CONTINGENCY 'PN_P4-500-002A' /* CONEMAUGH 500KV BKR 1 DISCONNECT BRANCH FROM BUS 200005 TO BUS 200912 CKT 3 /* CONEM-GH 500 26CONEMAGH 230 DISCONNECT BUS 200031 /* CONE G2 22 END
PN_P4-500-002F	CONTINGENCY 'PN_P4-500-002F' /* CONEMAUGH 500KV BKR 6 DISCONNECT BRANCH FROM BUS 200005 TO BUS 200912 CKT 3 /* CONEM-GH 500 26CONEMAGH 230 DISCONNECT BUS 200030 /* CONE G1 22 END
PN-P1-2-PN-230-002	CONTINGENCY 'PN-P1-2-PN-230-002' /* HOMER CITY - KEYSTONE 230KV DISCONNECT BRANCH FROM BUS 200767 TO BUS 200795 CKT 1 /* 26HOMER CT 230 26SHELOCTA 230 DISCONNECT BRANCH FROM BUS 200795 TO BUS 200810 CKT 1 /* 26SHELOCTA 230 26KEYSTONE 230 DISCONNECT BRANCH FROM BUS 200795 TO BUS 200739 CKT 2 /* 26SHELOCTA 230 26SHELOCTA 115 DISCONNECT BUS 200795 /* 26SHELOCTA 230 END

Contingency Name	Description
PN-P1-2-PN-230-100T	CONTINGENCY 'PN-P1-2-PN-230-100T' /* ERIE EAST - SOUTH RIPLEY 230KV DISCONNECT BRANCH FROM BUS 200654 TO BUS 135251 CKT 1 /* 26ERIE E 230 S RIPLEY 230 END
PN-P1-2-PN-230-102T	CONTINGENCY 'PN-P1-2-PN-230-102T' /* NORTH MESHOPPEN - LACKAWANNA 230KV DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1 /* 26N.MESH230 26OXBOW 230 DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1 /* 26OXBOW 230 LACK 230 DISCONNECT BRANCH FROM BUS 200706 TO BUS 200825 CKT 3 /* 26N.MESH230 26MESH2REA 115 DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1 /* 26OXBOW 230 26OXBOW 35 DISCONNECT BRANCH FROM BUS 200825 TO BUS 200677 CKT 3 /* 26MESH2REA 115 26NO MESHO 115 END
PN-P1-2-PN-230-103AT	CONTINGENCY 'PN-P1-2-PN-230-103AT' /* LEWISTOWN - JUNIATA (PPL) 230KV DISCONNECT BRANCH FROM BUS 200513 TO BUS 208004 CKT 1 /* 26LEWISTWN 230 JUNI BU1 230 END

Contingency Name	Description
PN-P2-3-PN-115-46FT	<p>CONTINGENCY 'PN-P2-3-PN-115-46FT' /* 756</p> <p>DISCONNECT BRANCH FROM BUS 200677 TO BUS 200699 CKT 1 /* 26NO MESHO 115 26MEHOP 3 115</p> <p>DISCONNECT BRANCH FROM BUS 200677 TO BUS 200678 CKT 1 /* 26NO MESHO 115 26LENOX 115</p> <p>DISCONNECT BRANCH FROM BUS 200677 TO BUS 200684 CKT 1 /* 26NO MESHO 115 26N MESH 35</p> <p>DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1 /* 26N.MESH PN 230 26OXBOW 230</p> <p>DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1 /* 26OXBOW 230 LACK 230</p> <p>DISCONNECT BRANCH FROM BUS 200825 TO BUS 200706 CKT 3 /* 26MESH2REA 115 26N.MESH PN 230</p> <p>DISCONNECT BRANCH FROM BUS 200677 TO BUS 200825 CKT 3 /* 26NO MESHO 115 26MESH2REA 115</p> <p>DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1 /* 26OXBOW 230 26OXBOW 35</p> <p>REDUCE BUS 200677 SHUNT BY 100 PERCENT /* 26NO MESHO 115</p> <p>END</p>
PN-P2-3-PN-115-60C	<p>CONTINGENCY 'PN-P2-3-PN-115-60C' /* SHELOCTA STUCK 115KV BREAKER B4 (#2 XFMR)</p> <p>DISCONNECT BRANCH FROM BUS 200739 TO BUS 200795 CKT 2 /* 26SHELOCTA 115 26SHELOCTA 230</p> <p>DISCONNECT BRANCH FROM BUS 200731 TO BUS 200739 CKT 1 /* 26SHLOCTA1 23 26SHELOCTA 115</p> <p>DISCONNECT BRANCH FROM BUS 200739 TO BUS 202643 CKT 1 /* 26SHELOCTA 115 26BLAIRVLE+ 115</p> <p>DISCONNECT BRANCH FROM BUS 200739 TO BUS 200764 CKT 1 /* 26SHELOCTA 115 26EDGEWOOD 115</p> <p>DISCONNECT BRANCH FROM BUS 200767 TO BUS 200795 CKT 1 /* 26HOMER CT 230 26SHELOCTA 230</p> <p>DISCONNECT BRANCH FROM BUS 200795 TO BUS 200810 CKT 1 /* 26SHELOCTA 230 26KEYSTONE 230</p> <p>END</p>

Contingency Name	Description
PN-P2-3-PN-230-17T	CONTINGENCY 'PN-P2-3-PN-230-17T' /* 744 DISCONNECT BRANCH FROM BUS 200825 TO BUS 200706 CKT 3 /* 26MESH2REA 115 26N.MESH2PN 230 DISCONNECT BRANCH FROM BUS 200677 TO BUS 200825 CKT 3 /* 26NO MESH0 115 26MESH2REA 115 DISCONNECT BRANCH FROM BUS 200677 TO BUS 200706 CKT 4 /* 26NO MESH0 115 26N.MESH2PN 230 DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1 /* 26N.MESH2PN 230 26OXBOW 230 DISCONNECT BRANCH FROM BUS 200706 TO BUS 200924 CKT 1 /* 26N.MESH2PN 230 26CANYON 230 DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1 /* 26E.TWANDA 230 26CANYON 230 DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1 /* 26OXBOW 230 26OXBOW 35 DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1 /* 26OXBOW 230 LACK 230 END
PN-P2-3-PN-230-9G	CONTINGENCY 'PN-P2-3-PN-230-9G' /* 577 DISCONNECT BRANCH FROM BUS 200767 TO BUS 200768 CKT 1 /* 26HOMER CT 230 26QUEMAHON 230 DISCONNECT BRANCH FROM BUS 200768 TO BUS 200796 CKT 1 /* 26QUEMAHON 230 26HOOVRSVL 230 DISCONNECT BRANCH FROM BUS 200743 TO BUS 200796 CKT 3 /* 26HOOVERSV 115 26HOOVRSVL 230 DISCONNECT BRANCH FROM BUS 200767 TO BUS 200795 CKT 1 /* 26HOMER CT 230 26SHELOCTA 230 DISCONNECT BRANCH FROM BUS 200795 TO BUS 200810 CKT 1 /* 26SHELOCTA 230 26KEYSTONE 230 DISCONNECT BRANCH FROM BUS 200739 TO BUS 200795 CKT 2 /* 26SHELOCTA 115 26SHELOCTA 230 END

Contingency Name	Description
PN-P2-3-PN-230-9H	CONTINGENCY 'PN-P2-3-PN-230-9H' /* 578 DISCONNECT BRANCH FROM BUS 200767 TO BUS 200769 TO BUS 202641 CKT S/* 26HOMER CT 230 26HOMER CY 345 26HOMERCITYS 23.00 DISCONNECT BRANCH FROM BUS 200767 TO BUS 200795 CKT 1 /* 26HOMER CT 230 26SHELOCTA 230 DISCONNECT BRANCH FROM BUS 200795 TO BUS 200810 CKT 1 /* 26SHELOCTA 230 26KEYSTONE 230 DISCONNECT BRANCH FROM BUS 200739 TO BUS 200795 CKT 2 /* 26SHELOCTA 115 26SHELOCTA 230 END

Generator Deliverability

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

#	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To			Initial	Final	Type	MVA		
1	N-1	PJM_P1_AP S_B_G692	PENELEC - AP	26BLAIRSVL-01SOCIAL 138 kV line	200763	235253	1	DC	99.79	100.17	ER	287	1.08	

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		Circuit	Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To			Initial	Final	Type	MVA		
2	LFFB	PN_P4- 500-001D	PENEL EC	26KEYSTONE 230/1 kV transformer	200810	999438	4	DC	97.86	100.0 9	ER	635	13.96	1
3	LFFB	PN_P4- 500-001A	PENEL EC	26KEYSTONE 230/1 kV transformer	200810	999438	4	DC	97.78	100.0 1	ER	635	13.96	

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		
4	LFFB	PN-P2-3-PN-115-46FT	PENELEC - PL	26LEWISTWN-JUNI BU1 230 kV line	200513	208004	1	DC	102.27	104.46	ER	624	17.65	2
5	LFFB	PN-P2-3-PN-230-17T	PENELEC - PL	26LEWISTWN-JUNI BU1 230 kV line	200513	208004	1	DC	101.76	103.95	ER	624	17.64	
6	LFFB	PL:P42:100577	PENELEC	26SHADE GP-26ROXBURY 115 kV line	200522	200520	1	DC	103.07	104.74	ER	160	5.94	3
7	LFFB	PL:P42:001131	PENELEC	26SHADE GP-26ROXBURY 115 kV line	200522	200520	1	DC	100.46	102.13	ER	160	5.93	
8	LFFB	PL:P42:100547	PENELEC	26SHADE GP-26ROXBURY 115 kV line	200522	200520	1	DC	100.46	102.13	ER	160	5.93	
9	LFFB	PN_P4-500-001J	PENELEC	26BLAIRSVL 138/115 kV transformer	200740	200763	1	DC	103.39	104.36	ER	300	6.47	4
10	LFFB	AP-P2-3-WP-500-461T	PENELEC	26BLAIRSVL 138/115 kV transformer	200740	200763	1	DC	101.36	102.25	ER	300	5.97	
11	LFFB	AP-P2-3-WP-500-462T	PENELEC	26BLAIRSVL 138/115 kV transformer	200740	200763	1	DC	101.35	102.24	ER	300	5.97	
12	LFFB	PN-P2-3-PN-115-60C	PENELEC	26SEWARD-26FLORENCE 115 kV line	200741	200766	1	DC	137.75	139.32	ER	190	6.6	5
13	LFFB	PN-P2-3-PN-230-9G	PENELEC	26SEWARD-26FLORENCE 115 kV line	200741	200766	1	DC	128.52	129.82	ER	190	5.5	
14	LFFB	PN-P2-3-PN-230-9H	PENELEC	26SEWARD-26FLORENCE 115 kV line	200741	200766	1	DC	127.54	128.82	ER	190	5.41	

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
15	LFFB	PN_P4-500-001J	PENELEC - AP	26BLAIRSVL-01SOCIAL 138 kV line	200763	235253	1	DC	107.83	108.84	ER	287	6.47	6
16	LFFB	AP-P2-3-WP-500-461T	PENELEC - AP	26BLAIRSVL-01SOCIAL 138 kV line	200763	235253	1	DC	105.7	106.64	ER	287	5.97	
17	LFFB	AP-P2-3-WP-500-462T	PENELEC - AP	26BLAIRSVL-01SOCIAL 138 kV line	200763	235253	1	DC	105.69	106.63	ER	287	5.97	
18	LFFB	PN_P4-500-002A	PENELEC	26SHELOCTA- 26KEYSTONE 230 kV line	200795	200810	1	DC	122.91	125.76	ER	917	26.02	7
19	LFFB	PN_P4-500-002F	PENELEC	26SHELOCTA- 26KEYSTONE 230 kV line	200795	200810	1	DC	122.84	125.7	ER	917	26.02	
20	LFFB	PN_P4-500-001F	PENELEC	26KEYSTONE 230/1 kV transformer	200810	999437	3	DC	119.51	121.99	ER	612	15.07	8
21	LFFB	PN_P4-500-001J	PENELEC	26BLAIRVLE+-26BLRSVL E 115 kV line	202643	200740	1	DC	108.44	109.39	ER	300	6.36	9
22	LFFB	AP-P2-3-WP-500-461T	PENELEC	26BLAIRVLE+-26BLRSVL E 115 kV line	202643	200740	1	DC	106.99	107.87	ER	300	5.86	
23	LFFB	AP-P2-3-WP-500-462T	PENELEC	26BLAIRVLE+-26BLRSVL E 115 kV line	202643	200740	1	DC	106.99	107.87	ER	300	5.86	
24	LFFB	PN-P2-3-PN-115-46FT	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	112.24	113.49	ER	554	15.39	10
25	LFFB	AP-P2-3-WP-230-446T	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	110.36	113.07	ER	554	20.17	

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
26	LFFB	AP-P2-3-WP-230-443T	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	110.2	112.91	ER	554	20.17	
27	BUS	AP-P2-2-WP-230-001T	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	110.18	112.89	ER	554	20.17	
28	LFFB	AP-P2-2-WP-230-001T	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	110.18	112.89	ER	554	20.17	
29	LFFB	PN_P4-500-001F	PJM500 - PJM500	KEYSTONE 500/1 kV transformer	999437	200011	3	DC	113.75	116.22	ER	612	15.07	11
30	LFFB	ATSI-P2-3-CEI-345-004D	AP - AP	01KISSNG-01KARNSC 138 kV line	235203	235197	1	DC	116.55	117.47	ER	268	5.42	12

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

Affected System Analysis & Mitigation

NYISO Impacts:

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

Light Load Analysis - 2021

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Winter Analysis - 2021

Winter Studies to be conducted during later study phases

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

FE Summer Peak Transmission <100 kV Analysis

#	Contingency Description	Overloaded Element	Rating (MVA)	% Loading After AD2-133	Final % Loading	AD2-133 MW Contrib.	FE Comments/Reinforcements
31	Eagle Valley - Philipsburg 115 kV Line & Greenwood - Westfall 46 kV Line	Eldorado - Hydracon Tap 46 kV Line	44	103.10	103.10	19.32	Upgrade terminal equipment at Eldorado.
32	Eldorado - Summit 46 kV Line & Bear Rock - Johnstown 230 kV Line	Eldorado - Hydracon Tap 46 kV Line	44	105.99	105.99	6.13	Upgrade terminal equipment at Eldorado.
33	Greenwood - Westfall 46 kV Line & Bear Rock - Johnstown 230 kV Line	Eldorado - Hydracon Tap 46 kV Line	44	117.43	117.43	9.09	Upgrade terminal equipment at Eldorado.
34	Greenwood - Westfall 46 kV Line & Johnstown #2 230/115 kV XFMR Fault	Eldorado - Hydracon Tap 46 kV Line	44	110.59	110.59	9.17	Upgrade terminal equipment at Eldorado.
35	Greenwood - Westfall 46 kV Line & Bear Rock - Johnstown 230 kV Line	Westfall - Hydracon Tap 46 kV Line	55	100.16	100.16	9.09	Upgrade terminal equipment at Westfall.
36	Philipsburg #1 XFMR Fault & Summit #1 115/46 kV XFMR Fault	Eldorado - Hydracon Tap 46 kV Line	44	123.38	123.38	37.65	Upgrade terminal equipment at Eldorado.
37	Philipsburg #1 XFMR Fault & Greenwood - Westfall 46 kV Line	Eldorado - Hydracon Tap 46 kV Line	44	103.03	103.03	19.32	Upgrade terminal equipment at Eldorado.
38	Philipsburg #1 XFMR Fault & Summit #1 115/46 kV XFMR Fault	Westfall - Hydracon Tap 46 kV Line	55	112.38	112.38	37.65	Upgrade terminal equipment at Westfall.

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.

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
39	Non	Non	PENELEC - PL	26LEWISTWN-JUNI BU1 230 kV line	200513	208004	1	DC	107.08	110.5	NR	493	16.83	
40	N-1	PL:P13:1003 52	PENELEC - PL	26LEWISTWN-JUNI BU1 230 kV line	200513	208004	1	DC	101.57	103.76	ER	624	17.63	
41	N-1	PN-P1-2- PN-230- 103AT	PENELEC	26SHADE GP- 26ROXBURY 115 kV line	200522	200520	1	DC	99.34	101.01	ER	160	5.92	
42	N-1	PN-P1-2- PN-230- 100T	PENELEC	26GLADE-26WARREN 230 kV line	200593	200811	1	DC	119.56	120.11	ER	621	7.47	
43	Non	Non	PENELEC	26E.TWANDA-26CANYON 230 kV line	200675	200924	1	DC	145.02	145.59	NR	515	6.42	
44	N-1	PL:P12:0010 29	PENELEC	26E.TWANDA-26CANYON 230 kV line	200675	200924	1	DC	138.33	138.81	ER	615	6.35	
45	N-1	AP-P1-2- WP-230- 005-B	PENELEC - AP	26SHAWVL 2-01SHINGL 230 kV line	200726	235248	1	DC	100.28	101.31	ER	554	12.63	
46	N-1	PJM_P1_AP S_B_G692	PENELEC	26BLAIRSVL 138/115 kV transformer	200740	200763	1	DC	101.21	102.11	ER	300	6.01	

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
47	N-1	PN-P1-2- PN-230-002	PENELEC	26SEWARD- 26FLORENCE 115 kV line	200741	200766	1	DC	127.55	128.8	ER	190	5.28	
48	Non	Non	PENELEC	26SEWARD- 26FLORENCE 115 kV line	200741	200766	1	DC	106.98	108.41	NR	164	5.2	
49	N-1	PJM_P1_AP S_B_G692	PENELEC - AP	26BLAIRSVL-01SOCIAL 138 kV line	200763	235253	1	DC	105.55	106.49	ER	287	6.01	
50	Non	Non	PENELEC - AP	26BLAIRSVL-01SOCIAL 138 kV line	200763	235253	1	DC	102.93	104.07	NR	225	5.7	
51	N-1	AP-P1-2- WP-345- 311T	PENELEC	26HOMER CT- 26SHELOCTA 230 kV line	200767	200795	1	DC	139.7	140.57	ER	917	17.13	
52	Non	Non	PENELEC	26HOMER CT- 26SHELOCTA 230 kV line	200767	200795	1	DC	132.31	135.72	NR	731	15.75	
53	N-1	AP-P1-2- WP-345- 311T	PENELEC	26SHELOCTA- 26KEYSTONE 230 kV line	200795	200810	1	DC	124.3	125.32	ER	917	20.06	
54	Non	Non	PENELEC	26SHELOCTA- 26KEYSTONE 230 kV line	200795	200810	1	DC	116.88	119.5	NR	731	18.87	
55	Non	Non	PENELEC	26CANYON-26N.MESHPN 230 kV line	200924	200706	1	DC	133.58	134.12	NR	546	6.42	
56	N-1	PJM_P1_AP S_B_G692	PENELEC	26BLAIRVLE+-26BLRSVL E 115 kV line	202643	200740	1	DC	106.88	107.76	ER	300	5.91	
57	Non	Non	PENELEC	26BLAIRVLE+-26BLRSVL E 115 kV line	202643	200740	1	DC	100.43	101.44	NR	249	5.6	
58	N-1	PN-P1-2- PN-230- 102T	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	110.98	112.23	ER	554	15.36	

#	Contingency		Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To	Circuit		Initial	Final	Type	MVA		
59	Non	Non	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	105.11	106.43	NR	489	14.56	
60	N-1	PL:P13:1003 52	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	110.98	112.23	ER	554	15.36	

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 15, 16, 17	26BLAIRSVL- 01SOCIAL 138 kV line	<p>In order to mitigate the overloads of facilities above, the following reinforcements are required:</p> <ul style="list-style-type: none"> PENELEC: Reconductor the Blairsville East to Social Hall 138 kV line and upgrade terminal equipment - PENELEC portion. 4.8 miles total. The new conductor will be 636 ACSS replacing the existing 636 ACSR conductor. At Blairsville East, the wave trap and breaker disconnects will be replaced. (PJM Upgrade Id: b3007.2) The scheduled in-service date is 06/01/2021. APS: Reconductor the Blairsville East to Social Hall 138 kV line and upgrade terminal equipment - AP portion. 4.8 miles total. The new conductor will be 636 ACSS replacing the existing 636 ACSR conductor. At Social Hall, meters, relays, bus conductor, a wavetrap, circuit breaker and disconnects will be replaced. (PJM Upgrade Id: b3007.1) The scheduled in-service date is 06/01/2021. <p>This reinforcement was identified as a baseline project; Therefore the AD2-133 project does not have cost responsibility for this upgrade, however it may be responsible for acceleration costs. AD2-133 would be subject to interim deliverability till this project this project is completed.</p>	b3007.1 b3007.2	\$ 0
#2, 3 18, 19, 20, 29	26KEYSTONE 230/1 kV transformer	<p>In order to mitigate the overloads of facilities above, the following reinforcements are required:</p> <ul style="list-style-type: none"> PENELEC: Replace the #3 500/230kV transformer bank and associated equipment. @ Keystone. The estimated cost is \$18,341,200. The estimated time to complete is 21 months. 		\$ 18,341,200

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
31, 32, 33, 34, 35, 36, 37, 38	Eldorado - Hydracon Tap 46 kV Line	In order to mitigate the overloads of facilities above, the following reinforcements are required: <ul style="list-style-type: none"> PENELEC: Upgrade Westfall terminal equipment. @ Eldorado. The estimated time to complete is 13 months. PENELEC: Upgrade Eldorado terminal equipment. @ Westfall. The estimated time to complete is 13 months. 		\$ 885,000
Total New Network Upgrades				\$ 19,226,200

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
#4, 5	26LEWISTWN-JUNI BU1 230 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: <ul style="list-style-type: none"> PENELEC: Convert North Meshoppen to a 4 BKR ring bus by installing 2 230kV breakers and modifying bus work. @ North Meshoppen. Estimated Cost: \$2,822,600. Estimated Time to Complete: 14 months. PPL: Since FE is alleviating the Lewistown – Juniata 230kV line overload by reconfiguring their North Meshoppen substation bus, then the overload at the PPL EU end no longer exists. No PPL reinforcement is required. 		\$ 2,822,600
#6, 7, 8	26SHADE GP-26ROXBURY 115 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: <ul style="list-style-type: none"> PENELEC: Reconductor the Roxbury-Shade Gap 115kV line with 336.4 kcmil ACSS. @ Roxbury-Shade Gap 115kV Line. The estimated cost excluding tax is \$19,049,100. The estimated time to complete is 21 months. 		\$ 19,049,100

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#9, 10, 11 21, 22, 23	26BLAIRSVL 138/115 kV transformer	<p>In order to mitigate the overloads of facilities above, the following reinforcements are required:</p> <ul style="list-style-type: none"> PENELEC: Upgrade Blairsville East 115 kV terminal equipment. Replace 115 kV circuit breaker and disconnects. (PJM Upgrade Id: b3009) The scheduled in-service date is 06/01/2021. <p>This reinforcement was identified as a baseline project; Therefore the AD2-133 project does not have cost responsibility for this upgrade, however it may be responsible for acceleration costs. AD2-133 would be subject to interim deliverability till this project this project is completed.</p>	b3009	\$ 0
#12, 13, 14	26SEWARD-26FLORENCE 115 kV line	<p>In order to mitigate the overloads of facilities above, the following reinforcements are required:</p> <ul style="list-style-type: none"> PENELEC: Upgrade Florence 115kV line terminal equipment at Seward SS (PJM Upgrade Id: b2951.1). The estimated in-service date is 10/15/2018 and required in-service date is 06/01/2022. PENELEC: Replace Blairsville East/Seward 115kV line tuner, coax, line relaying and carrier set at Shelocta SS (PJM Upgrade Id: b2951.2). The estimated in-service date is 10/15/2018 and required in-service date is 06/01/2022. PENELEC: Replace Seward/Shelocta 115kV line CVT, tuner, coax, and line relaying at Blairsville East SS (PJM Upgrade Id: b2951.3). The estimated in-service date is 10/15/2018 and required in-service date is 06/01/2022. <p>This reinforcement was identified as a baseline project; Therefore the AD2-133 project does not have cost responsibility for this upgrade, however it may be responsible for acceleration costs. AD2-133 would be subject to interim deliverability till this project this project is completed.</p>	b2951.1 b2951.2 b2951.3	\$ 0
#24, 25, 26, 27, 28	01SHINGL-26LEWISTWN 230 kV line	<p>In order to mitigate the overloads of facilities above, the following reinforcements are required:</p> <ul style="list-style-type: none"> PENELEC / APS: Upgrade terminal equipment on Lewistown line exit @ Shingletown SS. The estimated cost excluding tax is \$445,200. The estimated time to complete is 12 months. 		\$ 445,200
#30	01KISSNG-01KARNSC 138 kV line	<p>In order to mitigate the overloads of facilities above, the following reinforcements are required:</p> <ul style="list-style-type: none"> APS: Reconductor line with 954 kcmil ACSR. @ Karns City-Kissinger Jct 138kV Line. The estimated cost excluding tax is \$13,389,200. The estimated time to complete is 16 months. 		\$ 13,389,200
Total New Network Upgrades				\$ 35,706,100

Attachment 1. Flowgate Details

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

(PENELEC - PENELEC) The 26KEYSTONE 230/1 kV transformer (from bus 200810 to bus 999438 ckt 4) loads from 97.86% to 100.09% (**DC power flow**) of its emergency rating (635 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-001D'. This project contributes approximately 13.96 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
236828	01GRAYMONT	0.35
200886	26ARWF_N39	0.5
200890	26BF_G21_K23	5.49
200503	26C.SLOPE	4.48
200915	26CHSTN_FL	0.31
200805	26COLVER13	19.25
202158	26CON.GEN1	0.13
202160	26CON.GEN2	0.09
200945	26CT_V3-030	0.17
200846	26FORWARD	4.17
200888	26HIGHLAND	0.43
200837	26HOMER C1	29.1
200838	26HOMER C2	24.08
200839	26HOMER C3	25.5
200636	26IUP CO-G	0.54
200894	26K02	6.76
200823	26MHP_X3-003	3.43
203034	26NA_O38_P22	0.44
200905	26Q36	0.26

Bus Number	Bus Name	Full Contribution
200864	K-013 E	0.23
292340	K-022	0.05
292542	L-013 1	4.18
LTF	MORGAN	1.04
293301	N-039 E	10.56
LTF	NEWTON	0.72
LTF	NYISO	41.36
293603	O-018 E	9.09
293802	O-038 E	6.6
293902	O-048 E	3.76
294515	P-022 E	2.64
294573	P-028 E	9.34
203999	P-047 E	9.89
294903	P-060 E	6.9
LTF	PRAIRIE	1.41
290086	Q-036 E	5.57
200883	Q-053 E	7.75
296332	R-032 E	10.49
293432	R-040 E	0.24

Bus Number	Bus Name	Full Contribution
200925	26R32	0.5
202225	26SCI_S29B	0.17
200833	26SEWRDB34	17.54
200809	26SITHE	1.69
200889	26STNY CRK	0.33
200834	26SW_E13_K22	0.3
932001	AC2-004 C	0.86
932002	AC2-004 E	5.77
932571	AC2-077	2.75
932981	AC2-122 C	2.48
932982	AC2-122 E	4.05
934801	AD1-108	0.15
934811	AD1-109	0.11
934821	AD1-110	0.12
934951	AD1-127	40.43
935061	AD1-142	0.12
935191	AD1-154	2.74
936421	AD2-055	3.45
936941	AD2-119 C	2.75
936942	AD2-119 E	3.79
936991	AD2-133 C	2.5
936992	AD2-133 E	11.45
LTF	AMIL	0.16
LTF	BAYOU	0.61
LTF	BIG_CAJUN1	0.94
LTF	BIG_CAJUN2	1.9
LTF	BLUEG	0.96
LTF	CALDERWOOD	0.33
LTF	CANNELTON	0.17
LTF	CATAWBA	0.23
LTF	CBM-N	2.76
LTF	CELEVELAND	0.66
LTF	CHEOAH	0.31
LTF	CHILHOWEE	0.11
LTF	CHOCTAW	0.63
LTF	CLIFTY	4.12
LTF	COTTONWOOD	2.41
LTF	DEARBORN	0.19
LTF	EDWARDS	0.27
LTF	ELMERSMITH	0.48
LTF	FARMERCITY	0.19
LTF	G-007	0.01
LTF	GIBSON	0.32
LTF	HAMLET	0.76

Bus Number	Bus Name	Full Contribution
LTF	ROWAN	0.46
291409	S-029B E	0.17
LTF	SANTEETLA	0.09
LTF	SMITHLAND	0.12
LTF	TATANKA	0.33
LTF	TILTON	0.33
LTF	TRIMBLE	0.18
LTF	TVA	0.46
LTF	UNIONPOWER	0.48
297050	V2-019 E	0.06
293393	V3-030E	4.75
LTF	VFT	0.17
903643	W3-099 C OP1	1.18
903644	W3-099 E OP1	7.89
907462	X1-109 E	7.81
910522	X3-003 E	1.56
913142	Y1-033 E OP1	4
914041	Y2-042	0.04
914101	Y2-055	3.11
916051	Z1-038	1.51
916202	Z1-069 E	7.63
916351	Z1-091	1.92
917631	Z2-104	0.09
918331	AA1-046 C	1.68
918332	AA1-046 E	11.21
918682	AA1-082 E	5.28
918701	AA1-085 C	1
918702	AA1-085 E	6.65
918871	AA1-106	2.06
919201	AA1-144 OP	15.02
919491	AA2-000	45.59
920341	AA2-132	2.1
920351	AA2-133	1.7
LTF	AA2-300	19.01
930411	AB1-082	2.76
930511	AB1-092	1.67
931091	AB1-160 C	0.52
931092	AB1-160 E	2.23
925512	AC1-025 E	0.13
926991	AC1-186 C	3.17
926992	AC1-186 E	21.29
927001	AC1-187 C	2.08
927002	AC1-187 E	14.12

Appendix 2

(PENELEC - PL) The 26LEWISTWN-JUNI BU1 230 kV line (from bus 200513 to bus 208004 ckt 1) loads from 102.27% to 104.46% (**DC power flow**) of its emergency rating (624 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-46FT'. This project contributes approximately 17.65 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
236828	01GRAYMONT	1.34
200812	26ALY HYDR	1.41
200805	26COLVER13	10.62
200846	26FORWARD	2.04
200894	26K02	12.19
200823	26MHP_X3-003	4.32
200905	26Q36	0.33
200913	26SHAW-D	0.24
200715	26SHAWVL 1	1.19
200722	26SHAWVL 2	1.22
200665	26SHAWVL 3	1.83
200666	26SHAWVL 4	1.83
200852	26WARR RDG	0.4
932571	AC2-077	2.07
934801	AD1-108	0.18
934811	AD1-109	0.13
934821	AD1-110	0.15
934951	AD1-127	25.89
935061	AD1-142	0.11
935191	AD1-154	1.76
936421	AD2-055	7.32
936471	AD2-062 C O1	4.96
936472	AD2-062 E O1	2.48
936941	AD2-119 C	10.76
936942	AD2-119 E	14.86
936991	AD2-133 C	3.17
936992	AD2-133 E	14.49
LTF	CBM-N	1.97
LTF	CBM-S1	3.98
LTF	CBM-S2	2.54
LTF	CBM-W1	17.81
LTF	CBM-W2	24.7

Bus Number	Bus Name	Full Contribution
LTF	O-066	26.83
294515	P-022 E	2.79
294573	P-028 E	11.79
203999	P-047 E	7.82
294903	P-060 E	3.75
290086	Q-036 E	7.04
200883	Q-053 E	6.54
296332	R-032 E	6.2
291409	S-029B E	0.08
297050	V2-019 E	0.05
293393	V3-030E	3.2
901241	W1-045C OP1	0.87
901242	W1-045E OP1	1.42
903643	W3-099 C OP1	0.99
903644	W3-099 E OP1	6.61
LTF	WEC	1.01
907462	X1-109 E	8.83
910522	X3-003 E	1.96
914041	Y2-042	0.06
914101	Y2-055	3.28
916051	Z1-038	1.88
916202	Z1-069 E	5.81
917631	Z2-104	0.14
918331	AA1-046 C	0.87
918332	AA1-046 E	5.82
918682	AA1-082 E	5.97
918701	AA1-085 C	3.16
918702	AA1-085 E	21.05
918871	AA1-106	2.4
919201	AA1-144 OP	17.32
919491	AA2-000	96.85
920341	AA2-132	1.49

Bus Number	Bus Name	Full Contribution
LTF	CIN	3.68
LTF	CPL	0.54
LTF	G-007	4.14
LTF	IPL	2.37
LTF	LGEE	0.76
LTF	MEC	6.79
LTF	MECS	6.21
293301	N-039 E	11.15
LTF	NYISO	29.59
293603	O-018 E	5.37
293802	O-038 E	6.97

Bus Number	Bus Name	Full Contribution
920351	AA2-133	1.95
930411	AB1-082	2.21
930511	AB1-092	3.56
931091	AB1-160 C	0.4
931092	AB1-160 E	1.7
925512	AC1-025 E	0.52
926991	AC1-186 C	1.63
926992	AC1-186 E	10.97
927001	AC1-187 C	1.63
927002	AC1-187 E	11.06

Appendix 3

(PENELEC - PENELEC) The 26SHADE GP-26ROXBURY 115 kV line (from bus 200522 to bus 200520 ckt 1) loads from 103.07% to 104.74% (**DC power flow**) of its emergency rating (160 MVA) for the line fault with failed breaker contingency outage of 'PL:P42:100577'. This project contributes approximately 5.94 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
236828	01GRAYMONT	0.45
200812	26ALY HYDR	0.49
200894	26K02	3.72
200852	26WARR RDG	0.14
936223	AD2-028 C2	0.53
936224	AD2-028 E2	2.66
936421	AD2-055	2.36
936941	AD2-119 C	3.65
936942	AD2-119 E	5.04
936991	AD2-133 C	1.07
936992	AD2-133 E	4.87
LTF	CATAWBA	0.03
LTF	CBM-N	0.56
LTF	CBM-S1	0.21
LTF	CBM-W1	2.18
LTF	CBM-W2	1.75
LTF	CELEVELAND	0.09
LTF	CIN	0.39
LTF	G-007	0.36

Bus Number	Bus Name	Full Contribution
LTF	HAMLET	0.17
LTF	IPL	0.25
LTF	LGEE	0.07
LTF	MEC	0.65
LTF	MECS	0.98
293301	N-039 E	3.82
LTF	NYISO	8.44
293802	O-038 E	2.39
LTF	O-066	2.11
294515	P-022 E	0.95
290086	Q-036 E	2.37
LTF	ROWAN	0.08
LTF	UNIONPOWER	0.02
LTF	WEC	0.11
918701	AA1-085 C	1.06
918702	AA1-085 E	7.09
919491	AA2-000	31.16
930511	AB1-092	1.14
925512	AC1-025 E	0.18

Appendix 4

(PENELEC - PENELEC) The 26BLAIRSVL 138/115 kV transformer (from bus 200740 to bus 200763 ckt 1) loads from 103.39% to 104.36% (**DC power flow**) of its emergency rating (300 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-001J'. This project contributes approximately 6.47 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200890	26BF_G21_K23	2.55
200805	26COLVER13	11.61
202158	26CON.GEN1	0.09
202160	26CON.GEN2	0.18
200846	26FORWARD	2.02
200636	26IUP CO-G	0.36
932001	AC2-004 C	0.4
932002	AC2-004 E	2.68
932561	AC2-076	-2.02
932981	AC2-122 C	1.15
932982	AC2-122 E	1.88
934951	AD1-127	21.79
935191	AD1-154	1.2
936991	AD2-133 C	1.16
936992	AD2-133 E	5.31
LTF	AMIL	0.27
LTF	BAYOU	0.9
LTF	BIG_CAJUN1	1.38
LTF	BIG_CAJUN2	2.79
LTF	BLUEG	1.68
LTF	CALDERWOOD	0.45
LTF	CANNELTON	0.29
LTF	CATAWBA	0.25
LTF	CBM-N	0.72
LTF	CELEVELAND	0.72
LTF	CHEOAH	0.41
LTF	CHILHOWEE	0.15
LTF	CHOCTAW	0.92
LTF	CLIFTY	7.04
LTF	COTTONWOOD	3.6
LTF	DEARBORN	0.88
LTF	EDWARDS	0.5
LTF	ELMERSMITH	0.82
LTF	FARMERCITY	0.33

Bus Number	Bus Name	Full Contribution
LTF	G-007A	3.07
LTF	GIBSON	0.57
LTF	HAMLET	0.75
292542	L-013 1	1.94
LTF	MORGAN	1.49
293301	N-039 E	4.25
LTF	NEWTON	1.26
LTF	NYISO	10.72
293603	O-018 E	4.65
293802	O-038 E	2.65
293902	O-048 E	1.75
294515	P-022 E	1.06
294903	P-060 E	3.35
LTF	PRAIRIE	2.39
290086	Q-036 E	2.58
200883	Q-053 E	3.93
296332	R-032 E	5.36
293432	R-040 E	0.11
LTF	ROWAN	0.48
291409	S-029B E	0.08
LTF	SANTEETLA	0.12
LTF	SMITHLAND	0.19
LTF	TATANKA	0.59
LTF	TILTON	0.6
LTF	TRIMBLE	0.32
LTF	TVA	0.67
LTF	UNIONPOWER	0.6
293393	V3-030E	2.7
LTF	VFT	8.35
913142	Y1-033 E OP1	1.83
918331	AA1-046 C	0.81
918332	AA1-046 E	5.39
926991	AC1-186 C	1.54
926992	AC1-186 E	10.36

Appendix 5

(PENELEC - PENELEC) The 26SEWARD-26FLORENCE 115 kV line (from bus 200741 to bus 200766 ckt 1) loads from 137.75% to 139.32% (**DC power flow**) of its emergency rating (190 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-60C'. This project contributes approximately 6.6 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200890	26BF_G21_K23	2.87
200503	26C.SLOPE	2.64
200805	26COLVER13	8.38
200846	26FORWARD	2.23
932001	AC2-004 C	0.45
932002	AC2-004 E	3.01
932561	AC2-076	-1.46
932981	AC2-122 C	1.3
932982	AC2-122 E	2.12
934951	AD1-127	23.84
936991	AD2-133 C	1.18
936992	AD2-133 E	5.41
LTF	AMIL	0.16
LTF	BAYOU	0.55
LTF	BIG_CAJUN1	0.84
LTF	BIG_CAJUN2	1.69
LTF	BLUEG	0.98
LTF	CALDERWOOD	0.28
LTF	CANNELTON	0.17
LTF	CATAWBA	0.16
LTF	CBM-N	0.72
LTF	CELEVELAND	0.47
LTF	CHEOAH	0.25
LTF	CHILHOWEE	0.09
LTF	CHOCTAW	0.56
LTF	CLIFTY	4.12
LTF	COTTONWOOD	2.17
LTF	DEARBORN	0.46
LTF	EDWARDS	0.29
LTF	ELMERSMITH	0.48
LTF	FARMERCITY	0.19
LTF	G-007A	1.61
LTF	GIBSON	0.33

Bus Number	Bus Name	Full Contribution
LTF	HAMLET	0.51
292542	L-013 1	2.18
LTF	MORGAN	0.91
293301	N-039 E	4.43
LTF	NEWTON	0.74
LTF	NYISO	10.8
293603	O-018 E	5.11
293802	O-038 E	2.77
293902	O-048 E	1.97
294515	P-022 E	1.11
294903	P-060 E	3.7
LTF	PRAIRIE	1.4
290086	Q-036 E	2.63
200883	Q-053 E	4.22
296332	R-032 E	5.9
293432	R-040 E	0.12
LTF	ROWAN	0.32
291409	S-029B E	0.09
LTF	SANTEETLA	0.07
LTF	SMITHLAND	0.11
LTF	TATANKA	0.34
LTF	TILTON	0.35
LTF	TRIMBLE	0.19
LTF	TVA	0.4
LTF	UNIONPOWER	0.38
293393	V3-030E	2.41
LTF	VFT	4.41
913142	Y1-033 E OP1	2.07
918331	AA1-046 C	0.89
918332	AA1-046 E	5.98
926991	AC1-186 C	1.71
926992	AC1-186 E	11.44

Appendix 6

(PENELEC - AP) The 26BLAIRSVL-01SOCIAL 138 kV line (from bus 200763 to bus 235253 ckt 1) loads from 107.83% to 108.84% (**DC power flow**) of its emergency rating (287 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-001J'. This project contributes approximately 6.47 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200890	26BF_G21_K23	2.55
200805	26COLVER13	11.61
202158	26CON.GEN1	0.09
202160	26CON.GEN2	0.18
200846	26FORWARD	2.02
200636	26IUP CO-G	0.36
932001	AC2-004 C	0.4
932002	AC2-004 E	2.68
932561	AC2-076	-2.02
932981	AC2-122 C	1.15
932982	AC2-122 E	1.88
934951	AD1-127	21.79
935191	AD1-154	1.2
936991	AD2-133 C	1.16
936992	AD2-133 E	5.31
LTF	AMIL	0.27
LTF	BAYOU	0.9
LTF	BIG_CAJUN1	1.38
LTF	BIG_CAJUN2	2.79
LTF	BLUEG	1.68
LTF	CALDERWOOD	0.45
LTF	CANNELTON	0.29
LTF	CATAWBA	0.25
LTF	CBM-N	0.72
LTF	CELEVELAND	0.72
LTF	CHEOAH	0.41
LTF	CHILHOWEE	0.15
LTF	CHOCTAW	0.92
LTF	CLIFTY	7.04
LTF	COTTONWOOD	3.6
LTF	DEARBORN	0.88
LTF	EDWARDS	0.5
LTF	ELMERSMITH	0.82
LTF	FARMERCITY	0.33

Bus Number	Bus Name	Full Contribution
LTF	G-007A	3.07
LTF	GIBSON	0.57
LTF	HAMLET	0.75
292542	L-013 1	1.94
LTF	MORGAN	1.49
293301	N-039 E	4.25
LTF	NEWTON	1.26
LTF	NYISO	10.72
293603	O-018 E	4.65
293802	O-038 E	2.65
293902	O-048 E	1.75
294515	P-022 E	1.06
294903	P-060 E	3.35
LTF	PRAIRIE	2.39
290086	Q-036 E	2.58
200883	Q-053 E	3.93
296332	R-032 E	5.36
293432	R-040 E	0.11
LTF	ROWAN	0.48
291409	S-029B E	0.08
LTF	SANTEETLA	0.12
LTF	SMITHLAND	0.19
LTF	TATANKA	0.59
LTF	TILTON	0.6
LTF	TRIMBLE	0.32
LTF	TVA	0.67
LTF	UNIONPOWER	0.6
293393	V3-030E	2.7
LTF	VFT	8.35
913142	Y1-033 E OP1	1.83
918331	AA1-046 C	0.81
918332	AA1-046 E	5.39
926991	AC1-186 C	1.54
926992	AC1-186 E	10.36

Appendix 7

(PENELEC - PENELEC) The 26SHELOCTA-26KEYSTONE 230 kV line (from bus 200795 to bus 200810 ckt 1) loads from 122.91% to 125.76% (**DC power flow**) of its emergency rating (917 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-002A'. This project contributes approximately 26.02 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
236828	01GRAYMONT	0.63
200886	26ARWF_N39	0.97
200890	26BF_G21_K23	10.33
200503	26C.SLOPE	8.69
200915	26CHSTN_FL	0.58
200805	26COLVER13	34.27
202158	26CON.GEN1	0.2
202160	26CON.GEN2	0.15
200891	26CSLMN_L13	0.37
200945	26CT_V3-030	0.31
200835	26DSGENWIN	0.48
200846	26FORWARD	7.79
200888	26HIGHLAND	0.82
200837	26HOMER C1	49.04
200838	26HOMER C2	40.72
200839	26HOMER C3	43.11
200636	26IUP CO-G	0.9
200894	26K02	11.7
200892	26LOOKOUT	0.35
200823	26MHP_X3-003	5.73
203034	26NA_O38_P22	0.85
200905	26Q36	0.49
200925	26R32	0.95
202225	26SCI_S29B	0.32
200833	26SEWRDB34	37.28
200809	26SITHE	2.85
200889	26STNY CRK	0.61
200834	26SW_E13_K22	0.56
932001	AC2-004 C	1.62
932002	AC2-004 E	10.86
932571	AC2-077	4.68
932981	AC2-122 C	4.67
932982	AC2-122 E	7.63
934801	AD1-108	0.26
934811	AD1-109	0.19
934821	AD1-110	0.2

Bus Number	Bus Name	Full Contribution
LTF	GIBSON	0.32
LTF	HAMLET	1.05
200864	K-013 E	0.43
292340	K-022	0.1
292350	K-023	0.28
292542	L-013 1	7.87
LTF	MORGAN	1.2
293301	N-039 E	20.61
LTF	NEWTON	0.72
LTF	NYISO	70.21
293603	O-018 E	17.44
293802	O-038 E	12.88
293902	O-048 E	7.09
LTF	O-066	3.4
294515	P-022 E	5.15
294573	P-028 E	15.62
203999	P-047 E	16.74
294903	P-060 E	12.99
LTF	PRAIRIE	1.46
290086	Q-036 E	10.38
200883	Q-053 E	14.83
296332	R-032 E	20.12
293432	R-040 E	0.44
LTF	ROWAN	0.61
291409	S-029B E	0.31
LTF	SANTEETLA	0.11
LTF	SMITHLAND	0.13
LTF	TATANKA	0.33
LTF	TILTON	0.32
LTF	TRIMBLE	0.19
LTF	TVA	0.53
LTF	UNIONPOWER	0.6
297050	V2-019 E	0.1
293393	V3-030E	8.79
903643	W3-099 C OP1	2.04
903644	W3-099 E OP1	13.67

Bus Number	Bus Name	Full Contribution
934951	AD1-127	78.37
935061	AD1-142	0.21
935191	AD1-154	4.85
936421	AD2-055	6.03
936941	AD2-119 C	4.91
936942	AD2-119 E	6.78
936991	AD2-133 C	4.67
936992	AD2-133 E	21.35
LTF	AMIL	0.16
LTF	BAYOU	0.69
LTF	BIG_CAJUN1	1.08
LTF	BIG_CAJUN2	2.18
LTF	BLUEG	0.98
LTF	CALDERWOOD	0.4
LTF	CANNELTON	0.17
LTF	CATAWBA	0.3
LTF	CBM-N	4.69
LTF	CELEVELAND	0.86
LTF	CHEOAH	0.37
LTF	CHILHOWEE	0.13
LTF	CHOCTAW	0.73
LTF	CLIFTY	4.23
LTF	COTTONWOOD	2.73
LTF	EDWARDS	0.26
LTF	ELMERSMITH	0.5
LTF	FARMERCITY	0.19
LTF	G-007	0.65

Bus Number	Bus Name	Full Contribution
907462	X1-109 E	13.17
910522	X3-003 E	2.6
913142	Y1-033 E OP1	7.55
914101	Y2-055	5.39
916051	Z1-038	2.52
916202	Z1-069 E	12.99
916351	Z1-091	3.24
918331	AA1-046 C	3.15
918332	AA1-046 E	21.06
918682	AA1-082 E	8.91
918701	AA1-085 C	1.77
918702	AA1-085 E	11.82
918871	AA1-106	3.5
919201	AA1-144 OP	25.34
919491	AA2-000	79.8
920341	AA2-132	3.55
920351	AA2-133	2.85
LTF	AA2-300	31.8
930411	AB1-082	4.72
930511	AB1-092	2.93
931091	AB1-160 C	0.89
931092	AB1-160 E	3.8
925512	AC1-025 E	0.23
926991	AC1-186 C	5.95
926992	AC1-186 E	39.94
927001	AC1-187 C	3.54
927002	AC1-187 E	24.09

Appendix 8

(PENELEC - PENELEC) The 26KEYSTONE 230/1 kV transformer (from bus 200810 to bus 999437 ckt 3) loads from 119.51% to 121.99% (**DC power flow**) of its emergency rating (612 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-001F'. This project contributes approximately 15.07 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
236828	01GRAYMONT	0.39
200886	26ARWF_N39	0.55
200890	26BF_G21_K23	5.74
200503	26C.SLOPE	4.88
200915	26CHSTN_FL	0.33

Bus Number	Bus Name	Full Contribution
200864	K-013 E	0.25
292340	K-022	0.06
292542	L-013 1	4.37
LTF	MORGAN	2.79
293301	N-039 E	11.7

Bus Number	Bus Name	Full Contribution
200805	26COLVER13	20.03
202158	26CON.GEN1	0.13
202160	26CON.GEN2	0.09
200945	26CT_V3-030	0.18
200846	26FORWARD	4.45
200888	26HIGHLAND	0.46
200837	26HOMER C1	30.19
200838	26HOMER C2	24.85
200839	26HOMER C3	26.3
200636	26IUP CO-G	0.55
200894	26K02	7.39
200823	26MHP_X3-003	3.93
203034	26NA_O38_P22	0.48
200905	26Q36	0.28
200925	26R32	0.54
202225	26SCI_S29B	0.18
200833	26SEWRDB34	19.87
200809	26SITHE	1.75
200889	26STNY CRK	0.35
200834	26SW_E13_K22	0.32
932001	AC2-004 C	0.9
932002	AC2-004 E	6.03
932571	AC2-077	2.88
932981	AC2-122 C	2.6
932982	AC2-122 E	4.23
934801	AD1-108	0.17
934811	AD1-109	0.12
934821	AD1-110	0.13
934951	AD1-127	44.02
935061	AD1-142	0.13
935191	AD1-154	2.76
936421	AD2-055	3.73
936941	AD2-119 C	3.08
936942	AD2-119 E	4.25
936991	AD2-133 C	2.71
936992	AD2-133 E	12.37
LTF	AMIL	0.49
LTF	BAYOU	1.69
LTF	BIG_CAJUN1	2.59
LTF	BIG_CAJUN2	5.21
LTF	BLUEG	3.03
LTF	CALDERWOOD	0.86
LTF	CANNELTON	0.52
LTF	CATAWBA	0.5
LTF	CBM-N	2.9

Bus Number	Bus Name	Full Contribution
LTF	NEWTON	2.26
LTF	NYISO	43.35
293603	O-018 E	9.85
293802	O-038 E	7.31
293902	O-048 E	3.93
294515	P-022 E	2.93
294573	P-028 E	10.73
203999	P-047 E	10.57
294903	P-060 E	7.36
LTF	PRAIRIE	4.32
290086	Q-036 E	6.01
200883	Q-053 E	8.42
296332	R-032 E	11.36
293432	R-040 E	0.25
LTF	ROWAN	0.99
291409	S-029B E	0.18
LTF	SANTEETLA	0.23
LTF	SMITHLAND	0.34
LTF	TATANKA	1.06
LTF	TILTON	1.07
LTF	TRIMBLE	0.58
LTF	TVA	1.25
LTF	UNIONPOWER	1.17
297050	V2-019 E	0.07
293393	V3-030E	5.05
LTF	VFT	11.98
903643	W3-099 C OP1	1.14
903644	W3-099 E OP1	7.65
907462	X1-109 E	8.69
910522	X3-003 E	1.79
913142	Y1-033 E OP1	4.15
914041	Y2-042	0.05
914101	Y2-055	3.13
916051	Z1-038	1.74
916202	Z1-069 E	7.97
916351	Z1-091	2.12
917631	Z2-104	0.11
918331	AA1-046 C	1.78
918332	AA1-046 E	11.92
918682	AA1-082 E	5.88
918701	AA1-085 C	1.1
918702	AA1-085 E	7.3
918871	AA1-106	2.24
919201	AA1-144 OP	16.68
919491	AA2-000	49.41

Bus Number	Bus Name	Full Contribution
LTF	CELEVELAND	1.45
LTF	CHEOAH	0.78
LTF	CHILHOWEE	0.28
LTF	CHOCTAW	1.72
LTF	CLIFTY	12.76
LTF	COTTONWOOD	6.7
LTF	DEARBORN	1.34
LTF	EDWARDS	0.89
LTF	ELMERSMITH	1.49
LTF	FARMERCITY	0.58
LTF	G-007A	4.37
LTF	GIBSON	1.01
LTF	HAMLET	1.56

Bus Number	Bus Name	Full Contribution
920341	AA2-132	2.28
920351	AA2-133	1.92
LTF	AA2-300	19.62
930411	AB1-082	2.87
930511	AB1-092	1.81
931091	AB1-160 C	0.55
931092	AB1-160 E	2.34
925512	AC1-025 E	0.15
926991	AC1-186 C	3.4
926992	AC1-186 E	22.79
927001	AC1-187 C	2.16
927002	AC1-187 E	14.71

Appendix 9

(PENELEC - PENELEC) The 26BLAIRVLE+-26BLRSVL E 115 kV line (from bus 202643 to bus 200740 ckt 1) loads from 108.44% to 109.39% (**DC power flow**) of its emergency rating (300 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-001J'. This project contributes approximately 6.36 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200890	26BF_G21_K23	2.54
200805	26COLVER13	10.8
202158	26CON.GEN1	0.08
200846	26FORWARD	2.01
200636	26IUP CO-G	0.32
932001	AC2-004 C	0.4
932002	AC2-004 E	2.67
932561	AC2-076	-1.99
932981	AC2-122 C	1.15
932982	AC2-122 E	1.88
934951	AD1-127	21.67
935191	AD1-154	1.11
936991	AD2-133 C	1.14
936992	AD2-133 E	5.21
LTF	AMIL	0.27
LTF	BAYOU	0.89
LTF	BIG_CAJUN1	1.36
LTF	BIG_CAJUN2	2.75
LTF	BLUEG	1.66
LTF	CALDERWOOD	0.44

Bus Number	Bus Name	Full Contribution
LTF	GIBSON	0.56
LTF	HAMLET	0.74
292542	L-013 1	1.94
LTF	MORGAN	1.46
293301	N-039 E	4.22
LTF	NEWTON	1.25
LTF	NYISO	10.55
293603	O-018 E	4.63
293802	O-038 E	2.64
293902	O-048 E	1.74
294515	P-022 E	1.05
294903	P-060 E	3.34
LTF	PRAIRIE	2.36
290086	Q-036 E	2.53
200883	Q-053 E	3.9
296332	R-032 E	5.34
293432	R-040 E	0.11
LTF	ROWAN	0.48
291409	S-029B E	0.08
LTF	SANTEETLA	0.12

Bus Number	Bus Name	Full Contribution
LTF	CANNELTON	0.28
LTF	CATAWBA	0.24
LTF	CBM-N	0.71
LTF	CELEVELAND	0.71
LTF	CHEOAH	0.4
LTF	CHILHOWEE	0.14
LTF	CHOCTAW	0.9
LTF	CLIFTY	6.94
LTF	COTTONWOOD	3.55
LTF	DEARBORN	0.87
LTF	EDWARDS	0.5
LTF	ELMERSMITH	0.81
LTF	FARMERCITY	0.32
LTF	G-007A	3.04

Bus Number	Bus Name	Full Contribution
LTF	SMITHLAND	0.18
LTF	TATANKA	0.59
LTF	TILTON	0.6
LTF	TRIMBLE	0.32
LTF	TVA	0.66
LTF	UNIONPOWER	0.59
293393	V3-030E	2.59
LTF	VFT	8.27
913142	Y1-033 E OP1	1.82
918331	AA1-046 C	0.8
918332	AA1-046 E	5.37
926991	AC1-186 C	1.54
926992	AC1-186 E	10.32

Appendix 10

(AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 112.24% to 113.49% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-46FT'. This project contributes approximately 15.39 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
236828	01GRAYMONT	1.99
200805	26COLVER13	7.57
200894	26K02	16.13
200823	26MHP_X3-003	4.99
200913	26SHAW-D	0.3
200715	26SHAWVL 1	1.59
200722	26SHAWVL 2	1.63
200665	26SHAWVL 3	2.54
200666	26SHAWVL 4	2.54
932571	AC2-077	2.1
934801	AD1-108	0.21
934811	AD1-109	0.16
934821	AD1-110	0.17
935061	AD1-142	0.11
935191	AD1-154	1.42
936421	AD2-055	10
936941	AD2-119 C	16.04

Bus Number	Bus Name	Full Contribution
LTF	O-066	14.39
294573	P-028 E	13.6
203999	P-047 E	8.05
290086	Q-036 E	6.14
297050	V2-019 E	0.05
293393	V3-030E	1.88
903643	W3-099 C OP1	0.96
903644	W3-099 E OP1	6.42
LTF	WEC	0.52
907462	X1-109 E	10.18
910522	X3-003 E	2.27
914041	Y2-042	0.07
914101	Y2-055	3.72
916051	Z1-038	2.16
916202	Z1-069 E	5.94
916351	Z1-091	1.38
917631	Z2-104	0.16

Bus Number	Bus Name	Full Contribution
936942	AD2-119 E	22.15
936991	AD2-133 C	2.76
936992	AD2-133 E	12.63
LTF	CBM-N	1.93
LTF	CBM-S1	1.81
LTF	CBM-S2	0.79
LTF	CBM-W1	9.35
LTF	CBM-W2	11.65
LTF	CIN	1.84
LTF	CPLE	0.12
LTF	G-007	2.25
LTF	IPL	1.19
LTF	LGEE	0.37
LTF	MEC	3.36
LTF	MECS	3.53
LTF	NYISO	28.96

Bus Number	Bus Name	Full Contribution
918682	AA1-082 E	6.88
918701	AA1-085 C	4.59
918702	AA1-085 E	30.61
918871	AA1-106	2.85
919201	AA1-144 OP	20.12
919491	AA2-000	132.3
920341	AA2-132	1.5
920351	AA2-133	2.22
930411	AB1-082	2.32
930511	AB1-092	4.86
931091	AB1-160 C	0.41
931092	AB1-160 E	1.74
925512	AC1-025 E	0.77
927001	AC1-187 C	1.69
927002	AC1-187 E	11.49

Appendix 11

(PJM500 - PJM500) The KEYSTONE 500/1 kV transformer (from bus 999437 to bus 200011 ckt 3) loads from 113.75% to 116.22% (**DC power flow**) of its emergency rating (612 MVA) for the line fault with failed breaker contingency outage of 'PN_P4-500-001F'. This project contributes approximately 15.07 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200886	26ARWF_N39	0.55
200890	26BF_G21_K23	5.74
200503	26C.SLOPE	4.88
200915	26CHSTN_FL	0.33
200805	26COLVER13	20.03
202158	26CON.GEN1	0.13
202160	26CON.GEN2	0.09
200945	26CT_V3-030	0.18
200846	26FORWARD	4.45
200888	26HIGHLAND	0.46
200837	26HOMER C1	30.19
200838	26HOMER C2	24.85
200839	26HOMER C3	26.3
200636	26IUP CO-G	0.55
200894	26K02	7.39

Bus Number	Bus Name	Full Contribution
LTF	GIBSON	1.01
LTF	HAMLET	1.56
200864	K-013 E	0.25
292340	K-022	0.06
292542	L-013 1	4.37
LTF	MORGAN	2.79
293301	N-039 E	11.7
LTF	NEWTON	2.26
LTF	NYISO	43.35
293603	O-018 E	9.85
293802	O-038 E	7.31
293902	O-048 E	3.93
294515	P-022 E	2.93
203999	P-047 E	10.57
294903	P-060 E	7.36

Bus Number	Bus Name	Full Contribution
203034	26NA_O38_P22	0.48
200905	26Q36	0.28
200925	26R32	0.54
202225	26SCI_S29B	0.18
200833	26SEWRDB34	19.87
200809	26SITHE	1.75
200889	26STNY CRK	0.35
200834	26SW_E13_K22	0.32
932001	AC2-004 C	0.9
932002	AC2-004 E	6.03
932571	AC2-077	2.88
932981	AC2-122 C	2.6
932982	AC2-122 E	4.23
934801	AD1-108	0.17
934811	AD1-109	0.12
934951	AD1-127	44.02
935061	AD1-142	0.13
935191	AD1-154	2.76
936421	AD2-055	3.73
936991	AD2-133 C	2.71
936992	AD2-133 E	12.37
LTF	AMIL	0.49
LTF	BAYOU	1.69
LTF	BIG_CAJUN1	2.59
LTF	BIG_CAJUN2	5.21
LTF	BLUEG	3.03
LTF	CALDERWOOD	0.86
LTF	CANNELTON	0.52
LTF	CATAWBA	0.5
LTF	CBM-N	2.9
LTF	CELEVELAND	1.45
LTF	CHEOAH	0.78
LTF	CHILHOWEE	0.28
LTF	CHOCTAW	1.72
LTF	CLIFTY	12.76
LTF	COTTONWOOD	6.7
LTF	DEARBORN	1.34
LTF	EDWARDS	0.89
LTF	ELMERSMITH	1.49
LTF	FARMERCITY	0.58
LTF	G-007A	4.37

Bus Number	Bus Name	Full Contribution
LTF	PRAIRIE	4.32
290086	Q-036 E	6.01
200883	Q-053 E	8.42
296332	R-032 E	11.36
293432	R-040 E	0.25
LTF	ROWAN	0.99
291409	S-029B E	0.18
LTF	SANTEETLA	0.23
LTF	SMITHLAND	0.34
LTF	TATANKA	1.06
LTF	TILTON	1.07
LTF	TRIMBLE	0.58
LTF	TVA	1.25
LTF	UNIONPOWER	1.17
297050	V2-019 E	0.07
293393	V3-030E	5.05
LTF	VFT	11.98
907462	X1-109 E	8.69
913142	Y1-033 E OP1	4.15
914101	Y2-055	3.13
916202	Z1-069 E	7.97
916351	Z1-091	2.12
918331	AA1-046 C	1.78
918332	AA1-046 E	11.92
918682	AA1-082 E	5.88
918701	AA1-085 C	1.1
918702	AA1-085 E	7.3
918871	AA1-106	2.24
919201	AA1-144 OP	16.68
919491	AA2-000	49.41
920341	AA2-132	2.28
LTF	AA2-300	19.62
930411	AB1-082	2.87
930511	AB1-092	1.81
931091	AB1-160 C	0.55
931092	AB1-160 E	2.34
926991	AC1-186 C	3.4
926992	AC1-186 E	22.79
927001	AC1-187 C	2.16
927002	AC1-187 E	14.71

Appendix 12

(AP - AP) The 01KISSNG-01KARNSC 138 kV line (from bus 235203 to bus 235197 ckt 1) loads from 116.55% to 117.47% (**DC power flow**) of its emergency rating (268 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-CEI-345-004D'. This project contributes approximately 5.42 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
236828	01GRAYMONT	0.22
200805	26COLVER13	7.86
200828	26HNSMLK 1	1.07
200829	26HNSMLK 2	1.07
200830	26HNSMLK 3	1.07
200831	26HNSMLK 4	1.07
200832	26HNSMLK 5	1.07
200894	26K02	3.87
200608	26PINEY #1	1.03
200662	26SCRUB GR	2.2
932571	AC2-077	1.17
935191	AD1-154	2.54
936421	AD2-055	2.14
936941	AD2-119 C	1.68
936942	AD2-119 E	2.32
936991	AD2-133 C	0.97
936992	AD2-133 E	4.44
LTF	AMIL	0.21
LTF	BAYOU	0.67
LTF	BIG_CAJUN1	1.03
LTF	BIG_CAJUN2	2.07
LTF	BLUEG	1.26
LTF	CALDERWOOD	0.33
LTF	CANNELTON	0.22
LTF	CATAWBA	0.18
LTF	CBM-N	1.23
LTF	CELEVELAND	0.53
LTF	CHEOAH	0.3
LTF	CHILHOWEE	0.11
LTF	CHOCTAW	0.68
LTF	CLIFTY	5.21
LTF	COTTONWOOD	2.67
LTF	DEARBORN	0.73
LTF	EDWARDS	0.38
LTF	ELMERSMITH	0.62
LTF	FARMERCITY	0.25

Bus Number	Bus Name	Full Contribution
LTF	G-007A	1.91
LTF	GIBSON	0.42
LTF	HAMLET	0.54
LTF	MORGAN	1.1
LTF	NEWTON	0.95
LTF	NYISO	18.58
203999	P-047 E	4.04
LTF	PRAIRIE	1.79
290086	Q-036 E	2.16
LTF	ROWAN	0.35
LTF	SANTEETLA	0.09
LTF	SMITHLAND	0.14
LTF	TATANKA	0.45
LTF	TILTON	0.46
LTF	TRIMBLE	0.24
LTF	TVA	0.49
LTF	UNIONPOWER	0.44
297050	V2-019 E	0.03
293393	V3-030E	1.62
LTF	VFT	5.26
903643	W3-099 C OP1	0.98
903644	W3-099 E OP1	6.54
914101	Y2-055	2.18
915951	Y3-092 FTIR	101.88
916202	Z1-069 E	3.29
918701	AA1-085 C	0.64
918702	AA1-085 E	4.24
919491	AA2-000	28.34
930411	AB1-082	1.26
930511	AB1-092	1.04
931091	AB1-160 C	0.23
931092	AB1-160 E	0.96
925512	AC1-025 E	0.08
927001	AC1-187 C	0.93
927002	AC1-187 E	6.3

