Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC2-080 Olive – Reynolds (NIPSCO) 345 kV

July 2017

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) proposes to install PJM Project #AC2-080, a 200.0 MW (26.0 MW Capacity) wind generating facility in Pulaski County, Indiana (see Figure 2). The generating facility will consist of 58 Vestas V136 machines. The primary point of interconnection will be to AEP's Olive – Reynolds (NIPSCO) 345 kV circuit #1 (see Figure 1). The secondary point of interconnection will be to AEP's Reynolds (NIPSCO) – Meadow Lake 345 kV circuit #1 (see Figure 3).

The requested in service date is December 31, 2019.

The objective of this Feasibility Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required maintaining the reliability of the AEP transmission system. Stability analysis is not included as part of this study.

Attachment Facilities

Primary Point of Interconnection (Olive – Reynolds (NIPSCO) 345 kV Circuit #1)

To accommodate the interconnection on the Olive – Reynolds (NIPSCO) 345 kV circuit #1, a new three (3) circuit breaker 345 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

<u>New Line Tap/Switching Station Work and Cost:</u>

- Construct a new three (3) circuit breaker 345 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus. Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required (see Figure 1).
    - **Estimated Station Cost: $8,000,000**

Direct Connection Cost Estimate

The total preliminary cost estimate for Direct Connection work is given in the following tables below.

For AEP building Direct Connection cost estimates:

Description	Total Cost
Olive – Reynolds (NIPSCO) 345 kV T-Line Cut In	**$2,000,000**
Total	**$2,000,000**

Table 1

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following table below:

For AEP building Non-Direct Connection cost estimates:

Description	Estimated Cost
345 kV Revenue Metering	**$250,000**
Upgrade line protection and controls at the Olive 345 kV substation.	**$300,000**
Upgrade line protection and control settings at the Reynolds (NIPSCO) 345 kV substation.	**NIPSCO to provide cost estimate**
Total	**$550,000**

Table 2

Secondary Point of Interconnection (Reynolds (NIPSCO) – Meadow Lake 345 kV Circuit #1)

To accommodate the interconnection on the Reynolds (NIPSCO) – Meadow Lake 345 kV circuit #1, a new three (3) circuit breaker 345 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed (see Figure 3). Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

It is understood that IC is responsible for all costs associated with this interconnection. The cost of IC's generating plant and the costs for the line connecting the generating plant to the point of interconnection are not included in this report; these are assumed to be IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

Interconnection Customer Requirements

Requirement from the PJM Open Access Transmission Tariff:

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.

AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

Option 1

Network Impacts

The Queue Project AC2-080 was evaluated as a 200.0 MW (Capacity 26.0 MW) injection tapping the Olive – Reynolds 345 kV line in the AEP area. Project AC2-080 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-080 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
2978_C2_05DUMONT 765-B_A	CONTINGENCY '2978_C2_05DUMONT 765-B_A' OPEN BRANCH FROM BUS 243206 TO BUS 920251 CKT 1 / 243206 05DUMONT 765 920251 X1-020 TAP 765 1 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTON ; 765 1 END
112-65-BT4-5__	CONTINGENCY '112-65-BT4-5__' TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1 / WILTO; 765 05DUMONT 765 TRIP BRANCH FROM BUS 275233 TO BUS 270644 CKT 1 / WILTO;4M 345 WILTO; 765 TRIP BRANCH FROM BUS 275233 TO BUS 270927 CKT 1 / WILTO;4M 345 WILTO; R 345 TRIP BRANCH FROM BUS 275233 TO BUS 275333 CKT 1 / WILTO;4M 345 WILTO;4C 33 END
112-65-BT3-4__	CONTINGENCY '112-65-BT3-4__' TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1 / WILTO; 765 05DUMONT 765 TRIP BRANCH FROM BUS 275232 TO BUS 270644 CKT 1 / WILTO;3M 345 WILTO; 765 TRIP BRANCH FROM BUS 275232 TO BUS 270926 CKT 1 / WILTO;3M 345 WILTO; B 345 TRIP BRANCH FROM BUS 275232 TO BUS 275332 CKT 1 / WILTO;3M 345 WILTO;3C 33 END
8649_B2_TOR546	CONTINGENCY '8649_B2_TOR546' OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANG R 765 243208 05JEFRSO 765 1 END
695_B2	CONTINGENCY '695_B2' OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTO; 765 1 END

Table 3

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)

AC2-080 Contribution to Previously Identified Overloads												
Contingency					Bus		Loading		Rating			
#	Type	Name	Affected Area	Facility Description	From	To	Initial	Final	Type	MVA	MW Con.	FG App.
1	LFFB	2978_C2_05DUMONT 765-B_A	AEP - AEP	X2-052 TAP-05DUMONT 345 kV line	247610	243219	115.32	117.35	ER	1409	42.87	
2	LFFB	112-65-BT4-5__	AEP - AEP	X2-052 TAP-05DUMONT 345 kV line	247610	243219	107.7	109.59	ER	1409	41.90	
3	LFFB	112-65-BT3-4__	AEP - AEP	X2-052 TAP-05DUMONT 345 kV line	247610	243219	107.7	109.58	ER	1409	41.90	

Table 4

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

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

Delivery of Energy Portion of Interconnection Request

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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

AC2-080 Delivery of Energy Portion of Interconnection Request												
	Contingency				Bus		Loading		Rating			FG
#	Type	Name	Affected Area	Facility Description	From	To	Initial	Final	Type	MVA	MW Con.	App.
1	N-1	8649_B2_TOR546	AEP - AEP	05SORENS-AC1-225 TAP 765 kV line	246999	927280	101.04	101.06	NR	4249	52.83	
2	N-1	695_B2	AEP - AEP	X2-052 TAP-05DUMONT 345 kV line	247610	243219	107.61	109.5	NR	1409	41.90	
3	N-1	8649_B2_TOR546	AEP - AEP	AC1-225 TAP-05MARYSV 765 kV line	927280	242928	103.56	103.58	NR	4249	52.83	

Table 5

Previous System Reinforcements

#	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
#1	X2-052 TAP-05DUMONT 345 kV line	The following work determined during the sag study will be required to resolve the X2-052 Tap – Dumont 345 kV line overload: Replace tower 20 with a custom steel pole and the removal of swing angle brackets on 2 structures (PJM Network Upgrade N4512). New SE rating to be 1868 MVA. This overload is caused by the AB1 Queue.	The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	**$1.0775 Million**
			Total New Network Upgrades	**$1.0775 Million**

Table 6

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed Backfeed Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this Feasibility Study, the construction of the 200.0 MW (26.0 MW Capacity) wind generating facility of IC(PJM Project #AC2-080) will require the following additional interconnection charges. This plan of service will interconnect the proposed wind generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the IC's generating facility.

Cost Breakdown for Primary Point of Interconnection (Olive – Reynolds (NIPSCO) 345 kV)		
Attachment Cost	New 345 kV Switching Station	**$8,000,000**
Non-Direct Connection Cost Estimate	345 kV Revenue Metering	**$250,000**
	Upgrade line protection and controls at the Olive 345 kV substation.	**$350,000**
	Upgrade line protection and control settings at the Reynolds (NIPSCO) 345 kV substation.	**NIPSCO to provide cost estimate**
	The following work determined during the sag study will be required to resolve the X2-052 Tap – Dumont 345 kV line overload: Replace tower 20 with a custom steel pole and the removal of swing angle brackets on 2 structures (PJM Network Upgrade N4512). New SE rating to be 1868 MVA. This overload is caused by the AB1 Queue.	**$1,077,500**
	Total Estimated Cost for Project AC2-080	**$9,677,500**

Table 7

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

Option 2

Network Impacts

The Queue Project AC2-080 was evaluated as a 200.0 MW (Capacity 26.0 MW) injection tapping the Olive – Meadow 345 kV line in the AEP area. Project AC2-080 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-080 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
2978_C2_05DUMONT 765-B_A	CONTINGENCY '2978_C2_05DUMONT 765-B_A' OPEN BRANCH FROM BUS 243206 TO BUS 920251 CKT 1 / 243206 05DUMONT 765 920251 X1-020 TAP 765 1 OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTON ; 765 1 END
8648_C2_05JEFRSO 765-B1	CONTINGENCY '8648_C2_05JEFRSO 765-B1' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 OPEN BRANCH FROM BUS 243208 TO BUS 242865 CKT 2 / 243208 05JEFRSO 765 242865 05JEFRSO 345 2 OPEN BRANCH FROM BUS 242865 TO BUS 248000 CKT Z1 / 242865 05JEFRSO 345 248000 06CLIFTY 345 Z1 END
112-65-BT4-5__	CONTINGENCY '112-65-BT4-5__' TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1 / WILTO; 765 05DUMONT 765 TRIP BRANCH FROM BUS 275233 TO BUS 270644 CKT 1 / WILTO;4M 345 WILTO; 765 TRIP BRANCH FROM BUS 275233 TO BUS 270927 CKT 1 / WILTO;4M 345 WILTO; R 345 TRIP BRANCH FROM BUS 275233 TO BUS 275333 CKT 1 / WILTO;4M 345 WILTO;4C 33 END
112-65-BT3-4__	CONTINGENCY '112-65-BT3-4__' TRIP BRANCH FROM BUS 270644 TO BUS 243206 CKT 1 / WILTO; 765 05DUMONT 765 TRIP BRANCH FROM BUS 275232 TO BUS 270644 CKT 1 / WILTO;3M 345 WILTO; 765 TRIP BRANCH FROM BUS 275232 TO BUS 270926 CKT 1 / WILTO;3M 345 WILTO; B 345 TRIP BRANCH FROM BUS 275232 TO BUS 275332 CKT 1 / WILTO;3M 345 WILTO;3C 33 END
8649_B2_TOR546	CONTINGENCY '8649_B2_TOR546' OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANG R 765 243208 05JEFRSO 765 1 END

Contingency Name	Description
695_B2	CONTINGENCY '695_B2' OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTO; 765 1 END
8807_B2	CONTINGENCY '8807_B2' OPEN BRANCH FROM BUS 243878 TO BUS 255205 CKT 1 / 243878 05MEADOW 345 255205 17REYNOLDS 345 1 END
363_B2_TOR1682	CONTINGENCY '363_B2_TOR1682' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 END

Table 8

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)

AC2-080 Contribution to Previously Identified Overloads												
	Contingency				Bus		Loading		Rating			FG
#	Type	Name	Affected Area	Facility Description	From	To	Initial	Final	Type	MVA	MW Con.	App.
1	LFFB	8648_C2_05JEFRSO 765-B1	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	101.52	103.56	ER	2938	60.01	
2	LFFB	2978_C2_05DUMONT 765-B_A	AEP - AEP	X2-052 TAP-05DUMONT 345 kV line	247610	243219	115.34	117.41	ER	1409	43.49	
3	LFFB	112-65-BT4-5__	AEP - AEP	X2-052 TAP-05DUMONT 345 kV line	247610	243219	107.71	109.68	ER	1409	42.92	
4	LFFB	112-65-BT3-4__	AEP - AEP	X2-052 TAP-05DUMONT 345 kV line	247610	243219	107.71	109.67	ER	1409	42.92	

Table 9

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

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Delivery of Energy Portion of Interconnection Request

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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

AC2-080 Delivery of Energy Portion of Interconnection Request

	Contingency				Bus		Loading		Rating			
#	Type	Name	Affected Area	Facility Description	From	To	Initial	Final	Type	MVA	MW Con.	FG App.
1	N-1	363_B2_TOR1682	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	134.36	137.24	NR	2114	60.92	
2	N-1	363_B2_TOR1682'	AEP - AEP	05SORENS-AC1-225 TAP 765 kV line	246999	927280	101.05	101.07	NR	4249	52.38	

AC2-080 Delivery of Energy Portion of Interconnection Request												
	Contingency		Affected Area	Facility Description	Bus		Loading		Rating		MW Con.	FG App.
#	Type	Name			From	To	Initial	Final	Type	MVA		
3	N-1	695_B2	AEP - AEP	X2-052 TAP-05DUMONT 345 kV line	247610	243219	107.62	109.59	NR	1409	42.92	
4	N-1	8649_B2_TOR546	AEP - AEP	AC1-225 TAP-05MARYSV 765 kV line	927280	242928	103.31	116.09	NR	4249	52.38	
5	N-1	8807_B2	AEP - AEP	AC2-080 TAP-05OLIVE 345 kV line	931600	243229	103.31	116.09	NR	971	124.07	

Table 10

Figure 1: Primary Point of Interconnection (Olive – Reynolds (NIPSCO) 345 kV Circuit #1)

Single-Line Diagram

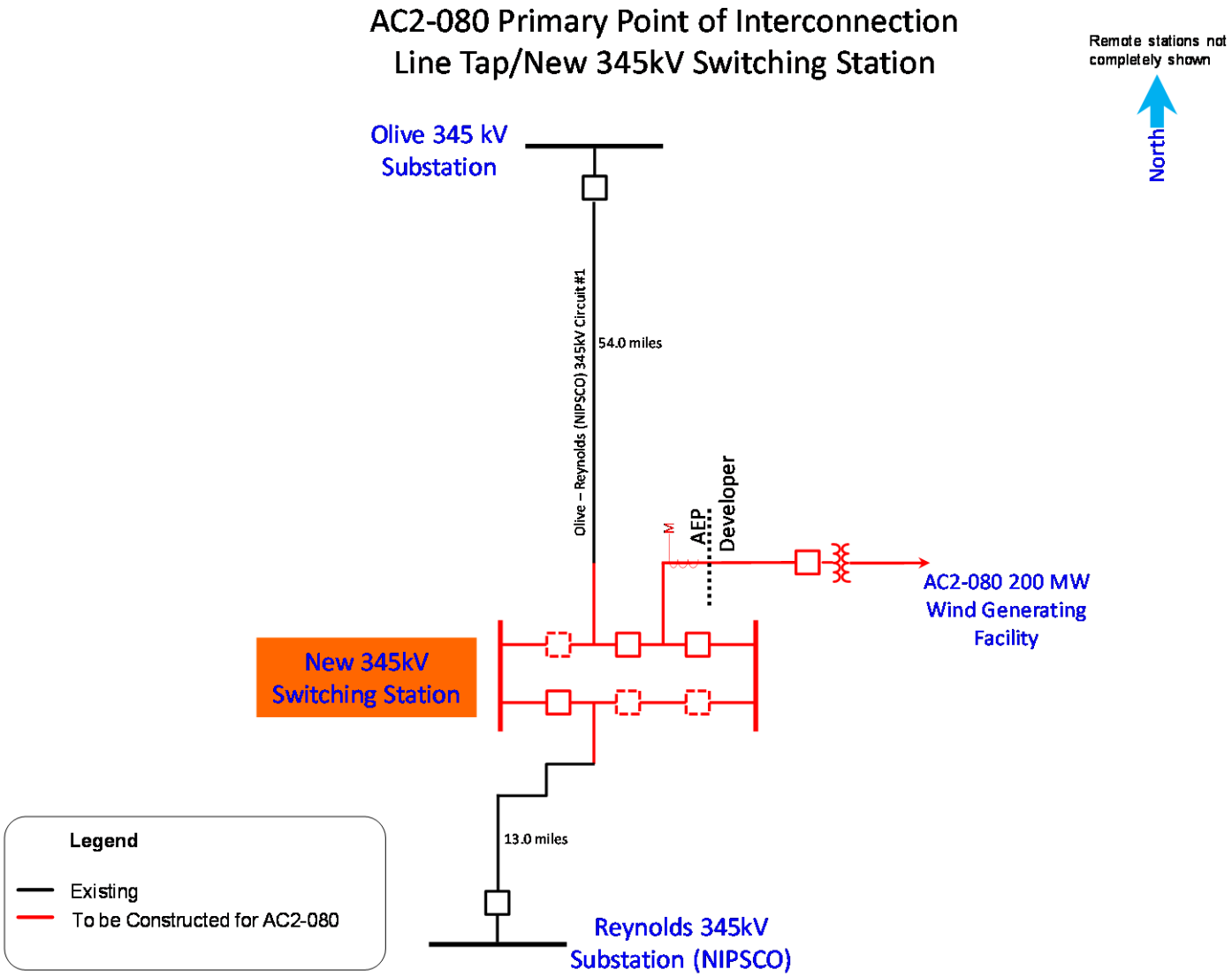
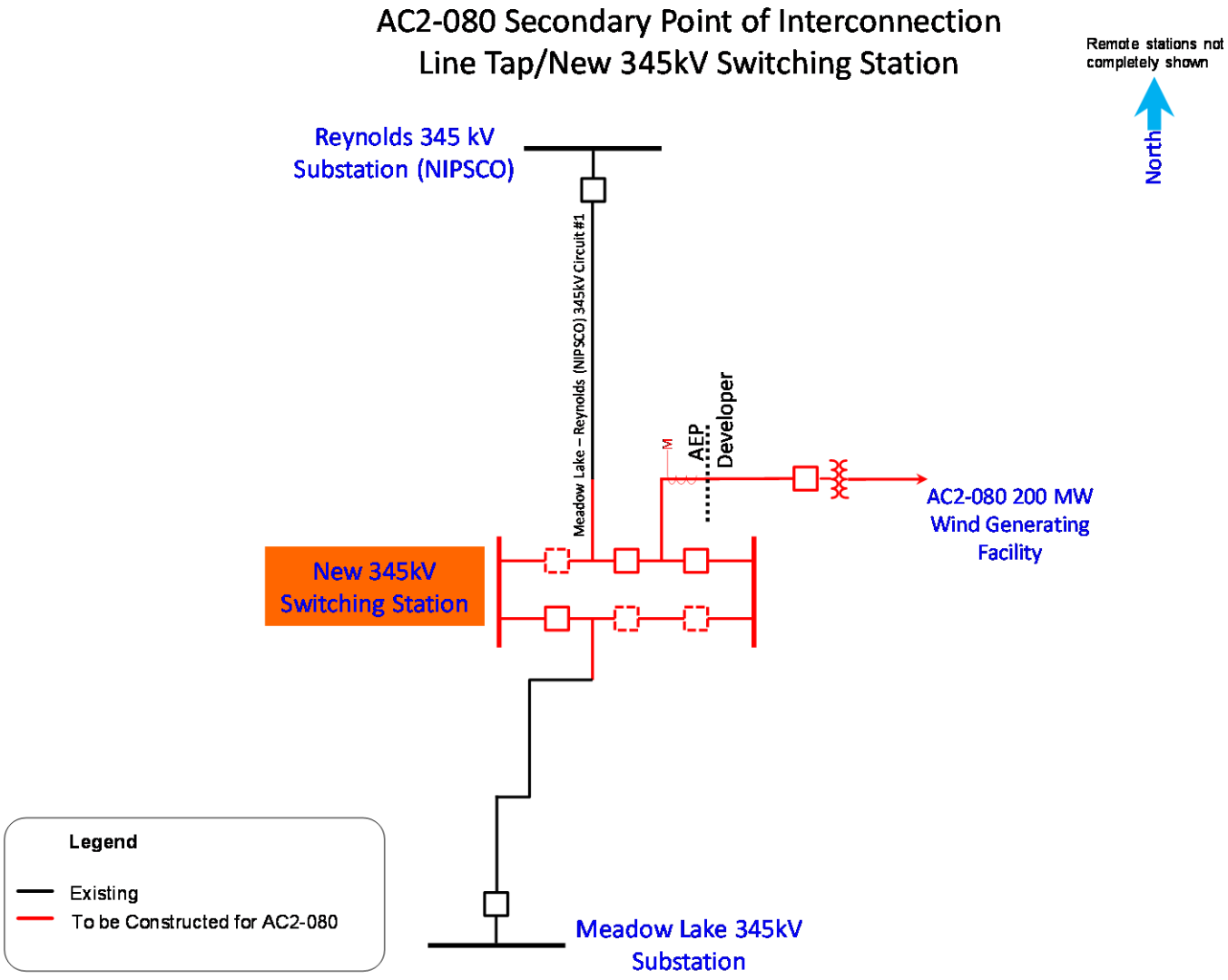


Figure 3: Secondary Point of Interconnection (Reynolds (NIPSCO) – Meadow Lake 345 kV Circuit #1)

Single-Line Diagram



Appendices – Option 1

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

(AEP - AEP) The X2-052 TAP-05DUMONT 345 kV line (from bus 247610 to bus 243219 ckt 2) loads from 115.32% to 117.35% (**DC power flow**) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of '2978_C2_05DUMONT 765-B_A'. This project contributes approximately 42.87 MW to the thermal violation.

CONTINGENCY '2978_C2_05DUMONT 765-B_A'
OPEN BRANCH FROM BUS 243206 TO BUS 920251 CKT 1 / 243206 05DUMONT 765 920251 X1-020 TAP 765 1
OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTON ; 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
247900	*05FR-11G E*	*6.99*
247901	*05FR-12G E*	*6.88*
247902	*05FR-21G E*	*7.35*
247903	*05FR-22G E*	*7.04*
247904	*05FR-3G E*	*14.26*
247905	*05FR-4G E*	*10.72*
246909	*05MDL-1G C*	*0.71*
247906	*05MDL-1G E*	*16.04*
246910	*05MDL-2G C*	*0.35*
247907	*05MDL-2G E*	*7.96*
246976	*05MDL-3G C*	*0.35*
247912	*05MDL-3G E*	*8.32*
246979	*05MDL-4G C*	*0.71*
247913	*05MDL-4G E*	*7.94*
931011	*AC2-007 C*	*0.49*
931012	*AC2-007 E*	*0.92*
931601	*AC2-080 C OP*	*5.57*
931602	*AC2-080 E OP*	*37.3*
290051	*GSG-6; E*	*6.12*
275149	*KEMPTON ;1E*	*10.51*
290108	*LEEDK;1U E*	*14.15*
274850	*MENDOTA H;RU*	*3.52*
275148	*MILKS GRV;1E*	*10.51*
293061	*N-015 E*	*9.04*
293644	*O22 E1*	*5.88*
293645	*O22 E2*	*11.42*
290021	*O50 E*	*11.38*
294392	*P-010 E*	*11.48*
274830	*PWR VTREC;1U*	*3.56*
274831	*PWR VTREC;2U*	*3.56*
274722	*S-055 E*	*6.51*

884780	*S-058 C*	*28.93*
884781	*S-058 E*	*86.78*
295111	*SUBLETTE E*	*1.59*
247556	*T-127 C*	*2.04*
247943	*T-127 E*	*8.14*
291984	*U4-033*	*0.72*
274814	*UNIV PK N;0U*	*0.56*
274805	*UNIV PK N;1U*	*0.56*
274806	*UNIV PK N;2U*	*0.56*
274807	*UNIV PK N;3U*	*0.56*
274808	*UNIV PK N;4U*	*0.56*
274809	*UNIV PK N;5U*	*0.56*
274810	*UNIV PK N;6U*	*0.56*
274811	*UNIV PK N;7U*	*0.56*
274812	*UNIV PK N;8U*	*0.56*
274813	*UNIV PK N;9U*	*0.56*
274815	*UNIV PK N;XU*	*0.56*
274816	*UNIV PK N;YU*	*0.56*
295109	*WESTBROOK E*	*3.28*
274687	*WILL CNTY;4U*	*37.81*
247611	*X2-052*	*66.29*
920462	*Y2-103*	*26.02*
920472	*Y3-013 1*	*2.17*
920482	*Y3-013 2*	*2.17*
920492	*Y3-013 3*	*2.17*
LTF	*Z1-043*	*17.53*
247634	*Z1-051 E*	*-1.73*
916502	*Z1-106 E1*	*0.73*
916504	*Z1-106 E2*	*0.73*
916512	*Z1-107 E*	*1.51*
916522	*Z1-108 E*	*1.44*
LTF	*Z1-112*	*6.09*
916651	*Z1-127 1*	*0.96*
916652	*Z1-127 2*	*0.57*
920782	*Z2-081*	*0.96*
920882	*Z2-114 C*	*0.39*
920883	*Z2-114 E*	*0.39*
920932	*AA1-018 C*	*1.46*
920933	*AA1-018 E*	*9.77*
921012	*AA1-040 1*	*0.74*
921022	*AA1-040 2*	*0.74*
LTF	*AA1-071*	*4.06*
921222	*AA1-078*	*2.26*
918972	*AA1-116 E*	*1.5*
918982	*AA1-117 E*	*1.5*

921692	*AA2-035*	*74.56*
922053	*AA2-107 E*	*1.43*
922183	*AA2-123 E*	*1.42*
922592	*AB1-006 C*	*2.61*
922593	*AB1-006 E*	*17.48*
922912	*AB1-080*	*22.33*
923002	*AB1-089 C*	*39.07*
923012	*AB1-090 C*	*39.07*
923022	*AB1-091 C OP*	*41.02*
930751	*AB1-121*	*60.7*
930752	*AB1-121 E*	*57.57*
930761	*AB1-122 1*	*42.43*
930762	*AB1-122 2*	*41.54*
923562	*AB1-172*	*0.47*
LTF	*AB2-013*	*9.9*
924471	*AB2-096*	*24.72*
925301	*AB2-191 C*	*0.74*
925302	*AB2-191 E*	*0.66*
926311	*AC1-109*	*1.1*
926321	*AC1-109 2*	*1.1*
926331	*AC1-110*	*1.09*
926341	*AC1-110 2*	*1.09*
926351	*AC1-111*	*0.44*
926361	*AC1-111 2*	*0.44*
926371	*AC1-111 3*	*0.44*
926381	*AC1-111 4*	*0.44*
926391	*AC1-111 5*	*0.44*
926401	*AC1-111 6*	*0.44*
926421	*AC1-113 1*	*0.7*
926422	*AC1-113 2*	*0.7*
926431	*AC1-114*	*1.4*
926601	*AC1-142A*	*2.41*
926602	*AC1-142A 2*	*2.41*
926701	*AC1-153 C*	*45.15*
926711	*AC1-153 C2*	*46.12*
926702	*AC1-153 E*	*1.81*
926712	*AC1-153 E2*	*1.85*
926821	*AC1-168 C OP*	*0.72*
926822	*AC1-168 E OP*	*4.82*
927091	*AC1-204*	*41.63*
927092	*AC1-204 2*	*41.65*

Appendices – Option 2

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

(AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 101.52% to 103.56% (**DC power flow**) of its emergency rating (2938 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 60.01 MW to the thermal violation.

CONTINGENCY '8648_C2_05JEFRSO 765-B1'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
OPEN BRANCH FROM BUS 243208 TO BUS 242865 CKT 2 / 243208 05JEFRSO 765 242865 05JEFRSO 345 2
OPEN BRANCH FROM BUS 242865 TO BUS 248000 CKT Z1 / 242865 05JEFRSO 345 248000 06CLIFTY 345 Z1
END

Bus Number	*Bus Name*	*Full Contribution*
243859	*05FR-11G C*	*1.76*
247900	*05FR-11G E*	*39.87*
243862	*05FR-12G C*	*1.73*
247901	*05FR-12G E*	*39.2*
243864	*05FR-21G C*	*1.85*
247902	*05FR-21G E*	*41.9*
243866	*05FR-22G C*	*1.76*
247903	*05FR-22G E*	*40.12*
243870	*05FR-3G C*	*3.57*
247904	*05FR-3G E*	*81.26*
243873	*05FR-4G C*	*2.77*
247905	*05FR-4G E*	*61.1*
246909	*05MDL-1G C*	*4.24*
247906	*05MDL-1G E*	*96.29*
246910	*05MDL-2G C*	*2.12*
247907	*05MDL-2G E*	*47.75*
246976	*05MDL-3G C*	*2.12*
247912	*05MDL-3G E*	*49.93*
246979	*05MDL-4G C*	*4.24*
247913	*05MDL-4G E*	*47.63*
243442	*05RKG1*	*27.98*
243443	*05RKG2*	*27.55*
931601	*AC2-080 C OP*	*7.8*
931602	*AC2-080 E OP*	*52.21*
998111	*J468*	*2.83*
998112	*J468 E*	*16.05*
998120	*J515*	*55.03*
247556	*T-127 C*	*12.22*
247943	*T-127 E*	*48.86*

900404	*X3-028 C*	*228.5*
900405	*X3-028 E*	*304.66*
247629	*Y3-038*	*4.34*
701171	*Y4-018 C*	*0.95*
701172	*Y4-018 E*	*3.8*
701461	*Y4-047*	*14.76*
701471	*Y4-048*	*17.16*
701842	*Y4-085 E*	*1.11*
LTF	*AA1-001*	*5.37*
922592	*AB1-006 C*	*15.68*
922593	*AB1-006 E*	*104.92*
922982	*AB1-087 C OP*	*83.78*
922992	*AB1-088 C OP*	*83.78*
LTF	*AC1-002*	*37.08*
927331	*AC1-040 C*	*6.3*
927332	*AC1-040 E*	*10.28*

Appendix 2

(AEP - AEP) The X2-052 TAP-05DUMONT 345 kV line (from bus 247610 to bus 243219 ckt 2) loads from 115.34% to 117.41% (**DC power flow**) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of '2978_C2_05DUMONT 765-B_A'. This project contributes approximately 43.49 MW to the thermal violation.

CONTINGENCY '2978_C2_05DUMONT 765-B_A'
OPEN BRANCH FROM BUS 243206 TO BUS 920251 CKT 1 / 243206 05DUMONT 765 920251 X1-020 TAP 765 1
OPEN BRANCH FROM BUS 243206 TO BUS 270644 CKT 1 / 243206 05DUMONT 765 270644 WILTON ; 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
247900	*05FR-11G E*	*6.99*
247901	*05FR-12G E*	*6.88*
247902	*05FR-21G E*	*7.35*
247903	*05FR-22G E*	*7.04*
247904	*05FR-3G E*	*14.26*
247905	*05FR-4G E*	*10.72*
246909	*05MDL-1G C*	*0.71*
247906	*05MDL-1G E*	*16.04*
246910	*05MDL-2G C*	*0.35*
247907	*05MDL-2G E*	*7.96*
246976	*05MDL-3G C*	*0.35*
247912	*05MDL-3G E*	*8.32*
246979	*05MDL-4G C*	*0.71*
247913	*05MDL-4G E*	*7.94*
931011	*AC2-007 C*	*0.49*
931012	*AC2-007 E*	*0.92*
931601	*AC2-080 C OP*	*5.65*
931602	*AC2-080 E OP*	*37.84*
290051	*GSG-6; E*	*6.12*
275149	*KEMPTON ;1E*	*10.51*
290108	*LEEDK;1U E*	*14.15*
274850	*MENDOTA H;RU*	*3.52*
275148	*MILKS GRV;1E*	*10.51*
293061	*N-015 E*	*9.04*
293644	*O22 E1*	*5.88*
293645	*O22 E2*	*11.42*
290021	*O50 E*	*11.38*
294392	*P-010 E*	*11.48*
274830	*PWR VTREC;1U*	*3.56*
274831	*PWR VTREC;2U*	*3.56*
274722	*S-055 E*	*6.51*

884780	*S-058 C*	*28.93*
884781	*S-058 E*	*86.78*
295111	*SUBLETTE E*	*1.59*
247556	*T-127 C*	*2.04*
247943	*T-127 E*	*8.14*
291984	*U4-033*	*0.72*
274814	*UNIV PK N;0U*	*0.56*
274805	*UNIV PK N;1U*	*0.56*
274806	*UNIV PK N;2U*	*0.56*
274807	*UNIV PK N;3U*	*0.56*
274808	*UNIV PK N;4U*	*0.56*
274809	*UNIV PK N;5U*	*0.56*
274810	*UNIV PK N;6U*	*0.56*
274811	*UNIV PK N;7U*	*0.56*
274812	*UNIV PK N;8U*	*0.56*
274813	*UNIV PK N;9U*	*0.56*
274815	*UNIV PK N;XU*	*0.56*
274816	*UNIV PK N;YU*	*0.56*
295109	*WESTBROOK E*	*3.28*
274687	*WILL CNTY;4U*	*37.81*
247611	*X2-052*	*66.29*
920462	*Y2-103*	*26.02*
920472	*Y3-013 1*	*2.17*
920482	*Y3-013 2*	*2.17*
920492	*Y3-013 3*	*2.17*
LTF	*Z1-043*	*17.53*
247634	*Z1-051 E*	*-1.73*
916502	*Z1-106 E1*	*0.73*
916504	*Z1-106 E2*	*0.73*
916512	*Z1-107 E*	*1.51*
916522	*Z1-108 E*	*1.44*
LTF	*Z1-112*	*6.09*
916651	*Z1-127 1*	*0.96*
916652	*Z1-127 2*	*0.57*
920782	*Z2-081*	*0.96*
920882	*Z2-114 C*	*0.39*
920883	*Z2-114 E*	*0.39*
920932	*AA1-018 C*	*1.46*
920933	*AA1-018 E*	*9.77*
921012	*AA1-040 1*	*0.74*
921022	*AA1-040 2*	*0.74*
LTF	*AA1-071*	*4.06*
921222	*AA1-078*	*2.26*
918972	*AA1-116 E*	*1.5*
918982	*AA1-117 E*	*1.5*

921692	*AA2-035*	*74.56*
922053	*AA2-107 E*	*1.43*
922183	*AA2-123 E*	*1.42*
922592	*AB1-006 C*	*2.61*
922593	*AB1-006 E*	*17.48*
922912	*AB1-080*	*22.33*
923002	*AB1-089 C*	*39.07*
923012	*AB1-090 C*	*39.07*
923022	*AB1-091 C OP*	*41.01*
930751	*AB1-121*	*60.69*
930752	*AB1-121 E*	*57.56*
930761	*AB1-122 1*	*42.43*
930762	*AB1-122 2*	*41.54*
923562	*AB1-172*	*0.47*
LTF	*AB2-013*	*9.9*
924471	*AB2-096*	*24.72*
925301	*AB2-191 C*	*0.74*
925302	*AB2-191 E*	*0.66*
926311	*AC1-109*	*1.1*
926321	*AC1-109 2*	*1.1*
926331	*AC1-110*	*1.09*
926341	*AC1-110 2*	*1.09*
926351	*AC1-111*	*0.44*
926361	*AC1-111 2*	*0.44*
926371	*AC1-111 3*	*0.44*
926381	*AC1-111 4*	*0.44*
926391	*AC1-111 5*	*0.44*
926401	*AC1-111 6*	*0.44*
926421	*AC1-113 1*	*0.7*
926422	*AC1-113 2*	*0.7*
926431	*AC1-114*	*1.4*
926601	*AC1-142A*	*2.41*
926602	*AC1-142A 2*	*2.41*
926701	*AC1-153 C*	*45.15*
926711	*AC1-153 C2*	*46.12*
926702	*AC1-153 E*	*1.81*
926712	*AC1-153 E2*	*1.85*
926821	*AC1-168 C OP*	*0.72*
926822	*AC1-168 E OP*	*4.82*
927091	*AC1-204*	*41.63*
927092	*AC1-204 2*	*41.64*