Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC2-157

Sullivan 345 kV

October 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 #AC2-157, a 200.0 MW (76.0 MW Capacity) solar generating facility in Sullivan, IN (see Figure 2). The point of interconnection will be a direct connection to AEP's Sullivan 345 kV substation (see Figure 1).

The requested in service date is December 31, 2020.

Attachment Facilities

Point of Interconnection (Sullivan 345 kV Substation)

To accommodate the interconnection at the Sullivan 345 kV substation, the substation will have to be expanded requiring the installation of one (1) 345 kV circuit breaker (see Figure 1). Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required.

Sullivan Station Work:

- Install one (1) new 345 kV circuit breaker and associated bus work. Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required.
    - **Estimated Station Cost: $2,500,000**

Non-Direct Connection Cost Estimate

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

For AEP building Direct Connection cost estimates:

Description	Estimated Cost
345 kV Revenue Metering	**$350,000**
Upgrade line protection and controls at the expanded Sullivan 345 kV substation.	**$500,000**
Total	**$850,000**

Table 1

Interconnection Customer Requirements

It is understood that The IC is responsible for all costs associated with this interconnection. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the Sullivan 345 kV substation are not included in this report; these are assumed to be the 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.

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.

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

Network Impacts

The Queue Project AC2-157 was evaluated as a 200.0 MW (Capacity 76.0 MW) injection at the Sullivan 345 kV substation in the AEP area. Project AC2-157 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-157 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:

Contingencies	
Contingency Name	**Description**
8901	CONTINGENCY '8901' OPEN BRANCH FROM BUS 243216 TO BUS 247712 CKT 1 / 243216 05DARWIN 345 247712 05SULLIVAN 345 1 OPEN BRANCH FROM BUS 243217 TO BUS 247712 CKT 1 / 243217 05DEQUIN 345 247712 05SULLIVAN 345 1 END
16_B2_TOR1683	CONTINGENCY '16_B2_TOR1683' OPEN BRANCH FROM BUS 243209 TO BUS 243210 CKT 1 / 243209 05ROCKPT 765 243210 05SULLIVAN 765 1 END
1760_C2_05JEFRSO 765-A	CONTINGENCY '1760_C2_05JEFRSO 765-A' OPEN BRANCH FROM BUS 243207 TO BUS 243208 CKT 1 / 243207 05GRNTWN 765 243208 05JEFRSO 765 1 OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANG R 765 243208 05JEFRSO 765 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
4704_C2_05DEQUIN 345-B1	CONTINGENCY '4704_C2_05DEQUIN 345-B1' OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 1 / 243217 05DEQUIN 345 243878 05MEADOW 345 1 OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 / 243217 05DEQUIN 345 249525 08WESTWD 345 1 END
6472_B2_TOR15258	CONTINGENCY '6472_B2_TOR15258' OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 1 / 243217 05DEQUIN 345 243878 05MEADOW 345 1 END
6485_C2_05DEQUIN 345-C1	CONTINGENCY '6485_C2_05DEQUIN 345-C1' OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 2 / 243217 05DEQUIN 345 243878 05MEADOW 345 2

Contingencies	
Contingency Name	**Description**
	OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 / 243217 05DEQUIN 345 249525 08WESTWD 345 1 END
6490_B2_TOR16000	CONTINGENCY '6490_B2_TOR16000' OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 2 / 243217 05DEQUIN 345 243878 05MEADOW 345 2 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
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
8807_B2	CONTINGENCY '8807_B2' OPEN BRANCH FROM BUS 243878 TO BUS 255205 CKT 1 / 243878 05MEADOW 345 255205 17REYNOLDS 345 1 END
8905_B2_TOR1697	CONTINGENCY '8905_B2_TOR1697' OPEN BRANCH FROM BUS 243217 TO BUS 247712 CKT 1 / 243217 05DEQUIN 345 247712 05SULLIVAN 345 1 END
8906_C2_05SULLIVAN 345-C	CONTINGENCY '8906_C2_05SULLIVAN 345-C' OPEN BRANCH FROM BUS 243216 TO BUS 247712 CKT 1 / 243216 05DARWIN 345 247712 05SULLIVAN 345 1 OPEN BRANCH FROM BUS 243217 TO BUS 247712 CKT 1 / 243217 05DEQUIN 345 247712 05SULLIVAN 345 1 END

Table 2

Generator Deliverability

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

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)

AC2-157 Contribution to Previously Identified Overloads															
	Contingency		Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	LFFB	1760_C2_05JEFRSO 765-A	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	124.05	125.78	ER	2045	35.33	1
2	N-1	363_B2_TOR1682	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	118.62	119.96	NR	971	12.97	2
3	N-1	16_B2_TOR1683	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	104.34	106.04	NR	971	16.49	
4	LFFB	8648_C2_05JEFRSO 765-B1	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	101.71	104.13	ER	1419	34.39	
5	LFFB	6485_C2_05DEQUIN 345-C1	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	107.12	108.45	ER	1959	25.95	3
6	LFFB	4704_C2_05DEQUIN 345-B1	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	152.71	154.6	ER	1304	24.66	4
7	LFFB	8648_C2_05JEFRSO 765-B1	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	100.28	101.32	ER	2938	30.5	5
8	N-1	363_B2_TOR1682	AEP - AEP	05SULLIVAN-05DARWIN 345 kV line	247712	243216	1	DC	118.62	119.96	NR	971	12.97	6
9	N-1	16_B2_TOR1683	AEP - AEP	05SULLIVAN-05DARWIN 345 kV line	247712	243216	1	DC	104.34	106.04	NR	971	16.49	
10	LFFB	8648_C2_05JEFRSO 765-B1	AEP - AEP	05SULLIVAN-05DARWIN 345 kV line	247712	243216	1	DC	101.71	104.13	ER	1419	34.39	
11	LFFB	8648_C2_05JEFRSO 765-B1	AEP - AEP	05SULLIVAN-05DEQUIN 345 kV line	247712	243217	1	DC	101.7	103.58	ER	1304	24.61	7
12	N-1	16_B2_TOR1683	AEP - AEP	05SULLIVAN-05DEQUIN 345 kV line	247712	243217	1	DC	101.92	103.08	NR	971	11.23	
13	LFFB	8906_C2_05SULLIVAN 345-C	AEP - MISO AMIL	05SULLIVAN-7CASEY 345 kV line	247712	346809	1	DC	108.59	113.19	ER	1466	67.5	8
14	DCTL	8901	AEP - MISO AMIL	05SULLIVAN-7CASEY 345 kV line	247712	346809	1	DC	108.59	113.19	ER	1466	67.5	
15	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	169.72	170.32	ER	1370	8.27	9

Table 3

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

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.

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.

AC2-157 Delivery of Energy Portion of Interconnection Request

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Cir.	PF	Loading Initial	Loading Final	Rating Type	Rating MVA	MW Con.
1	N-1	8649_B2_TOR546	AEP - OVEC	05JEFRSO-06CLIFTY 345 kV line	242865	248000	Z1	DC	108.81	109.1	NR	1756	26.29
2	N-1	363_B2_TOR1682	AEP - AEP	05DARWIN-05EUGENE 345 kV line	243216	243221	1	DC	145.67	149.18	NR	971	34.13
3	N-1	6490_B2_TOR16000	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	1	DC	145.25	147.07	NR	1409	25.74
4	N-1	6472_B2_TOR15258	AEP - AEP	05DEQUIN-05MEADOW 345 kV line	243217	243878	2	DC	198.97	201.49	NR	971	24.42
5	N-1	8905_B2_TOR1697	AEP - AEP	05EUGENE-05DEQUIN 345 kV line	243221	243217	1	DC	139.44	140.16	NR	971	15.56
6	N-1	8807_B2	AEP - AEP	05MEADOW-05OLIVE 345 kV line	243878	243229	1	DC	131.08	131.69	NR	971	13.21
7	N-1	363_B2_TOR1682	AEP - MISO NIPS	05MEADOW-17REYNOLDS 345 kV line	243878	255205	1	DC	133.63	135.03	NR	2114	29.41
8	N-1	363_B2_TOR1682	AEP - AEP	05SULLIVAN-05DARWIN 345 kV line	247712	243216	1	DC	145.67	149.18	NR	971	34.13
9	N-1	363_B2_TOR1682	AEP - AEP	05SULLIVAN-05DEQUIN 345 kV line	247712	243217	1	DC	132.04	134.53	NR	971	24.21
10	N-1	363_B2_TOR1682	AEP - MISO AMIL	05SULLIVAN-7CASEY 345 kV line	247712	346809	1	DC	100.46	104.77	NR	1334	57.5
11	N-1	363_B2_TOR1682	AEP - BREC	05ROCKPT-7COLEMAN 345 kV line	247851	340563	1	DC	122.3	124.33	NR	1409	28.56
12	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	182.41	183.12	ER	1370	21.76

AC2-157 Delivery of Energy Portion of Interconnection Request														
	Contingency		Affected		Bus				Loading		Rating		MW
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.
13	N-1	363_B2_TOR1682	AEP - AEP	AB2-028 TAP-05DESOTO 345 kV line	923880	243218	1	DC	108.85	109.53	NR	1016	15.39

Table 4

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

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

1. To relieve all AEP (and AEP tie line) constraints identified in this report:
    a. The planned upgrade is to build a new Sullivan – Reynolds 765 kV line (N5034). The need is driven by the X3-028 MTX project.
        i. Sullivan – Reynolds 765 kV line: $442 million
        ii. Work at Sullivan Station: $6 million
        iii. Work at Reynolds Station: $16 million
        iv. Total Cost: $464 million
        v. It would take (3) three to (4) four years to build the Sullivan - Reynolds 765 kV line from the time the CSA is signed. AC1-157 will need this project in-service in order to be fully deliverable to the PJM system.
        vi. AB1-087 will receive cost allocation.

2. To relieve the Trimble – Clifty 345 kV line constraint identified: A second Trimble – Clifty 345 kV line would need to be built.
    a. Total Cost: $59 million.
    b. The AC2-157 will receive cost allocation.

3. Supplemental project S1094 (AEP portion of work for MISO Duff-Rockport-Coleman project). The projected in-service date of S1094 is presently January 2021. AEP is responsible for this cost ($85.3M).
    a. The expected cost responsibility for AC2-157 is $0. AC2-157 will need the S1094 project in-service in order to be fully deliverable to the PJM system.

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 or associated network upgrades caused by the X3-028 project are required. If line work is required, construction time would be between 36 to 48 months after signing an Interconnection Construction Service Agreement (ICSA).

Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed In-Service 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 (76.0 MW Capacity) solar generating facility of The IC (PJM Project #AC2-157) will require the following additional interconnection charges. This plan of service will interconnect the proposed solar generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the The IC generating facility.

Cost Breakdown for Point of Interconnection (Sullivan 345 kV Substation)		
Attachment Cost	Expand Sullivan 345 kV Substation	**$2,500,000**
Non-Direct Connection Cost Estimate	345 kV Revenue Metering	**$350,000**
	Upgrade line protection and controls at the expanded Sullivan 345 kV substation.	**$500,000**
	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)*	**$523,000,000**
	Total Estimated Cost for Project AC2-157	**$526,350,000**

Table 5

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.

Figure 1: Point of Interconnection (Sullivan 345 kV Substation)

Single-Line Diagram

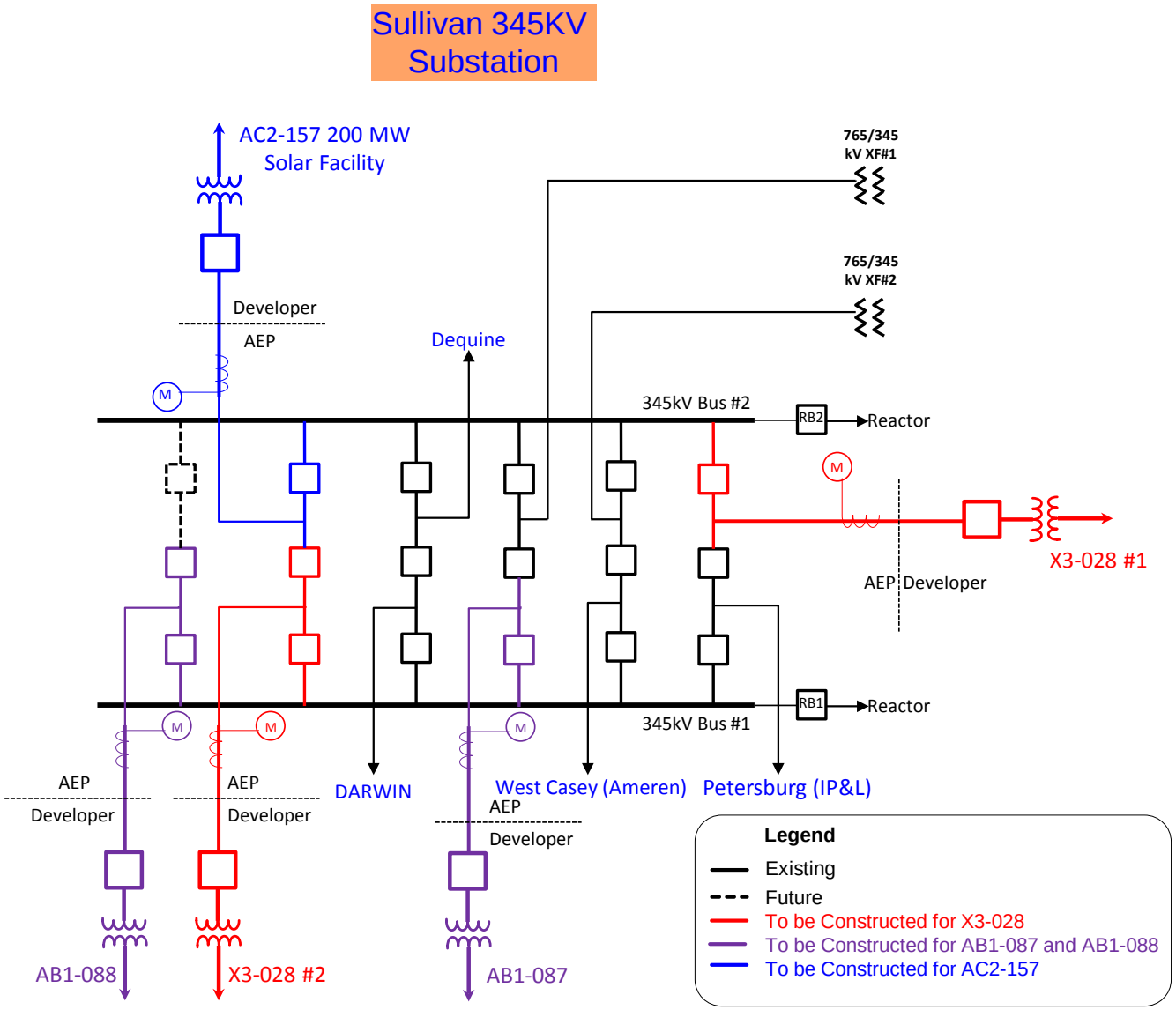
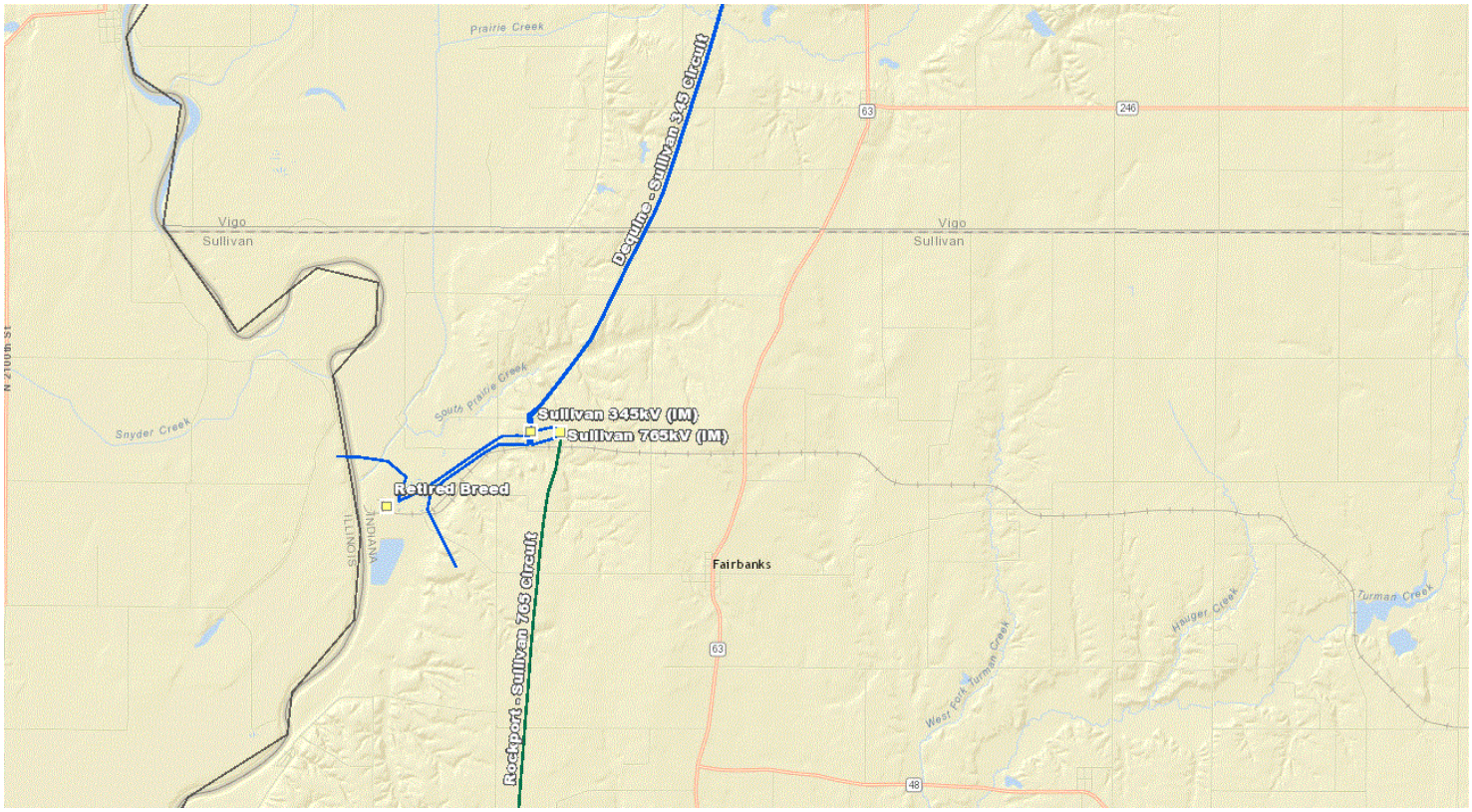


Figure 2: Point of Interconnection (Sullivan 345 kV Substation)



Appendices Primary POI Sullivan 345 kV

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 - OVEC) The 05JEFRSO-06CLIFTY 345 kV line (from bus 242865 to bus 248000 ckt Z1) loads from 124.05% to 125.78% (**DC power flow**) of its emergency rating (2045 MVA) for the line fault with failed breaker contingency outage of '1760_C2_05JEFRSO 765-A'. This project contributes approximately 35.33 MW to the thermal violation.

CONTINGENCY '1760_C2_05JEFRSO 765-A'
OPEN BRANCH FROM BUS 243207 TO BUS 243208 CKT 1 / 243207 05GRNTWN 765 243208 05JEFRSO 765 1
OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANGR 765 243208 05JEFRSO 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
247900	*05FR-11G E*	*5.18*
247901	*05FR-12G E*	*5.09*
247902	*05FR-21G E*	*5.44*
247903	*05FR-22G E*	*5.21*
247904	*05FR-3G E*	*10.56*
247905	*05FR-4G E*	*7.94*
247906	*05MDL-1G E*	*9.05*
247907	*05MDL-2G E*	*4.49*
247912	*05MDL-3G E*	*4.69*
247913	*05MDL-4G E*	*4.48*
243442	*05RKG1*	*69.93*
243443	*05RKG2*	*68.87*
932341	*AC2-147 C*	*0.38*
932342	*AC2-147 E*	*0.62*
932351	*AC2-148 C*	*0.39*
932352	*AC2-148 E*	*0.63*
932371	*AC2-150 C*	*0.39*
932372	*AC2-150 E*	*0.63*
932391	*AC2-152 C*	*0.22*
932392	*AC2-152 E*	*0.37*
932441	*AC2-157 C*	*13.42*
932442	*AC2-157 E*	*21.9*
274832	*ANNAWAN ; 1U*	*5.47*
294401	*BSHIL;1U E*	*4.39*
294410	*BSHIL;2U E*	*4.39*
274890	*CAYUG;1U E*	*6.72*
274891	*CAYUG;2U E*	*6.72*
274849	*CRESCENT ;1U*	*2.99*
274859	*EASYR;U1 E*	*4.84*
274860	*EASYR;U2 E*	*4.84*
990901	*L-005 E*	*6.72*

293516	*O-009 E1*	*4.3*
293517	*O-009 E2*	*2.19*
293518	*O-009 E3*	*2.41*
293715	*O-029 E*	*4.6*
293716	*O-029 E*	*2.52*
293717	*O-029 E*	*2.32*
293771	*O-035 E*	*3.25*
296308	*R-030 C1*	*1.97*
296271	*R-030 C2*	*1.97*
296125	*R-030 C3*	*1.99*
296309	*R-030 E1*	*7.86*
296272	*R-030 E2*	*7.86*
296128	*R-030 E3*	*7.96*
247556	*T-127 C*	*1.15*
247943	*T-127 E*	*4.59*
274853	*TWINGROVE;U1*	*10.25*
274854	*TWINGROVE;U2*	*10.25*
276150	*W2-048 E*	*4.49*
905081	*W4-005 C*	*3.14*
905082	*W4-005 E*	*21.03*
909052	*X2-022 E*	*13.56*
900404	*X3-028 C*	*264.96*
900405	*X3-028 E*	*353.28*
913222	*Y1-054 E*	*-1.35*
247629	*Y3-038*	*11.68*
915662	*Y3-099 E*	*0.15*
915672	*Y3-100 E*	*0.15*
LTF	*Z1-043*	*14.05*
916182	*Z1-065 E*	*0.38*
916272	*Z1-080 E*	*0.3*
LTF	*Z1-112*	*5.89*
920792	*Z2-087 C*	*1.54*
920793	*Z2-087 E*	*10.32*
LTF	*AA1-001*	*5.9*
LTF	*AA1-071*	*3.93*
921632	*AA1-146*	*8.04*
921682	*AA2-030*	*8.04*
921702	*AA2-039 C*	*1.07*
921703	*AA2-039 E*	*7.16*
922592	*AB1-006 C*	*1.47*
922593	*AB1-006 E*	*9.86*
922982	*AB1-087 C OP*	*97.15*
922992	*AB1-088 C OP*	*97.15*
LTF	*AB2-013*	*8.27*
924041	*AB2-047 C OP*	*1.94*

924042	*AB2-047 E OP*	*13.01*
924261	*AB2-070 C OP*	*1.84*
924262	*AB2-070 E OP*	*12.33*
925161	*AB2-173 C*	*1.43*
925242	*AB2-178 E*	*1.44*
LTF	*AC1-002*	*40.98*
925581	*AC1-033 C*	*0.72*
925582	*AC1-033 E*	*4.81*
927331	*AC1-040 C*	*15.07*
927332	*AC1-040 E*	*24.59*
925771	*AC1-053 C*	*1.84*
925772	*AC1-053 E*	*12.33*
926821	*AC1-168 C OP*	*0.53*
926822	*AC1-168 E OP*	*3.58*
926841	*AC1-171 C OP*	*0.62*
926842	*AC1-171 E OP*	*4.17*
926981	*AC1-185 1*	*0.3*
926982	*AC1-185 2*	*0.3*
926983	*AC1-185 3*	*0.3*
926984	*AC1-185 4*	*0.3*
926985	*AC1-185 5*	*0.3*
926986	*AC1-185 6*	*0.3*
926987	*AC1-185 7*	*0.3*
926988	*AC1-185 8*	*0.3*
927201	*AC1-214 C*	*1.08*
927202	*AC1-214 E*	*3.28*

Appendix 2

(AEP - AEP) The 05DARWIN-05EUGENE 345 kV line (from bus 243216 to bus 243221 ckt 1) loads from 118.62% to 119.96% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 12.97 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*24.27*
243443	*05RKG2*	*23.9*
932441	*AC2-157 C*	*12.97*
900405	*X3-028 E*	*341.3*
247629	*Y3-038*	*4.05*
922982	*AB1-087 C OP*	*93.86*
922992	*AB1-088 C OP*	*93.86*
927331	*AC1-040 C*	*5.38*

Appendix 3

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 1) loads from 107.12% to 108.45% (**DC power flow**) of its emergency rating (1959 MVA) for the line fault with failed breaker contingency outage of '6485_C2_05DEQUIN 345-C1'. This project contributes approximately 25.95 MW to the thermal violation.

CONTINGENCY '6485_C2_05DEQUIN 345-C1'
OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 2 / 243217 05DEQUIN 345 243878 05MEADOW 345 2
OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 / 243217 05DEQUIN 345 249525 08WESTWD 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
243859	*05FR-11G C*	*1.83*
247900	*05FR-11G E*	*44.67*
243862	*05FR-12G C*	*1.8*
247901	*05FR-12G E*	*43.93*
243864	*05FR-21G C*	*1.92*
247902	*05FR-21G E*	*46.95*
243866	*05FR-22G C*	*1.84*
247903	*05FR-22G E*	*44.96*
243870	*05FR-3G C*	*3.72*
247904	*05FR-3G E*	*91.06*
243873	*05FR-4G C*	*2.88*
247905	*05FR-4G E*	*68.46*
932441	*AC2-157 C*	*9.86*
932442	*AC2-157 E*	*16.09*
998111	*J468*	*3.01*
998112	*J468 E*	*17.07*
998120	*J515*	*61.09*
961651	*J642*	*10.8*
900404	*X3-028 C*	*194.61*
900405	*X3-028 E*	*259.48*
701171	*Y4-018 C*	*1.07*
701172	*Y4-018 E*	*4.29*
701461	*Y4-047*	*16.39*
701471	*Y4-048*	*18.46*
701481	*Y4-049*	*3.55*
701842	*Y4-085 E*	*1.07*
LTF	*AA1-001*	*4.37*
922982	*AB1-087 C OP*	*71.36*
922992	*AB1-088 C OP*	*71.36*
LTF	*AC1-002*	*30.06*

Appendix 4

(AEP - AEP) The 05DEQUIN-05MEADOW 345 kV line (from bus 243217 to bus 243878 ckt 2) loads from 152.71% to 154.6% (**DC power flow**) of its emergency rating (1304 MVA) for the line fault with failed breaker contingency outage of '4704_C2_05DEQUIN 345-B1'. This project contributes approximately 24.66 MW to the thermal violation.

CONTINGENCY '4704_C2_05DEQUIN 345-B1'
OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 1 / 243217 05DEQUIN 345 243878 05MEADOW 345 1
OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 / 243217 05DEQUIN 345 249525 08WESTWD 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
243859	*05FR-11G C*	*1.74*
247900	*05FR-11G E*	*42.46*
243862	*05FR-12G C*	*1.71*
247901	*05FR-12G E*	*41.75*
243864	*05FR-21G C*	*1.82*
247902	*05FR-21G E*	*44.62*
243866	*05FR-22G C*	*1.74*
247903	*05FR-22G E*	*42.73*
243870	*05FR-3G C*	*3.53*
247904	*05FR-3G E*	*86.54*
243873	*05FR-4G C*	*2.74*
247905	*05FR-4G E*	*65.07*
932441	*AC2-157 C*	*9.37*
932442	*AC2-157 E*	*15.29*
998111	*J468*	*2.86*
998112	*J468 E*	*16.22*
998120	*J515*	*58.06*
961651	*J642*	*10.26*
900404	*X3-028 C*	*184.95*
900405	*X3-028 E*	*246.6*
701171	*Y4-018 C*	*1.02*
701172	*Y4-018 E*	*4.07*
701461	*Y4-047*	*15.57*
701471	*Y4-048*	*17.55*
701842	*Y4-085 E*	*1.01*
LTF	*AA1-001*	*4.15*
922982	*AB1-087 C OP*	*67.82*
922992	*AB1-088 C OP*	*67.82*
LTF	*AC1-002*	*28.57*

Appendix 5

(AEP - MISO NIPS) The 05MEADOW-17REYNOLDS 345 kV line (from bus 243878 to bus 255205 ckt 1) loads from 100.28% to 101.32% (**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 30.5 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*	*1.63*
247900	*05FR-11G E*	*39.88*
243862	*05FR-12G C*	*1.61*
247901	*05FR-12G E*	*39.22*
243864	*05FR-21G C*	*1.71*
247902	*05FR-21G E*	*41.92*
243866	*05FR-22G C*	*1.64*
247903	*05FR-22G E*	*40.14*
243870	*05FR-3G C*	*3.32*
247904	*05FR-3G E*	*81.29*
243873	*05FR-4G C*	*2.57*
247905	*05FR-4G E*	*61.12*
246909	*05MDL-1G C*	*3.94*
247906	*05MDL-1G E*	*96.32*
246910	*05MDL-2G C*	*1.97*
247907	*05MDL-2G E*	*47.77*
246976	*05MDL-3G C*	*1.97*
247912	*05MDL-3G E*	*49.94*
246979	*05MDL-4G C*	*3.94*
247913	*05MDL-4G E*	*47.65*
243442	*05RKG1*	*26.02*
243443	*05RKG2*	*25.62*
932441	*AC2-157 C*	*11.59*
932442	*AC2-157 E*	*18.91*
998111	*J468*	*2.83*
998112	*J468 E*	*16.05*
998120	*J515*	*55.03*
247556	*T-127 C*	*12.22*
247943	*T-127 E*	*48.88*

900404	*X3-028 C*	*228.78*
900405	*X3-028 E*	*305.04*
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*	*5.38*
922592	*AB1-006 C*	*15.68*
922593	*AB1-006 E*	*104.95*
922982	*AB1-087 C OP*	*83.89*
922992	*AB1-088 C OP*	*83.89*
LTF	*AC1-002*	*37.18*
927331	*AC1-040 C*	*6.31*
927332	*AC1-040 E*	*10.3*

Appendix 6

(AEP - AEP) The 05SULLIVAN-05DARWIN 345 kV line (from bus 247712 to bus 243216 ckt 1) loads from 118.62% to 119.96% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 12.97 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*24.27*
243443	*05RKG2*	*23.9*
932441	*AC2-157 C*	*12.97*
900405	*X3-028 E*	*341.3*
247629	*Y3-038*	*4.05*
922982	*AB1-087 C OP*	*93.86*
922992	*AB1-088 C OP*	*93.86*
927331	*AC1-040 C*	*5.38*

Appendix 7

(AEP - AEP) The 05SULLIVAN-05DEQUIN 345 kV line (from bus 247712 to bus 243217 ckt 1) loads from 101.7% to 103.58% (**DC power flow**) of its emergency rating (1304 MVA) for the line fault with failed breaker contingency outage of '8648_C2_05JEFRSO 765-B1'. This project contributes approximately 24.61 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*
932441	*AC2-157 C*	*9.35*
932442	*AC2-157 E*	*15.26*
900404	*X3-028 C*	*184.59*
900405	*X3-028 E*	*246.12*
247629	*Y3-038*	*3.21*
922982	*AB1-087 C OP*	*67.68*
922992	*AB1-088 C OP*	*67.68*
927331	*AC1-040 C*	*4.47*
927332	*AC1-040 E*	*7.3*

Appendix 8

(AEP - MISO AMIL) The 05SULLIVAN-7CASEY 345 kV line (from bus 247712 to bus 346809 ckt 1) loads from 108.59% to 113.19% (**DC power flow**) of its emergency rating (1466 MVA) for the line fault with failed breaker contingency outage of '8906_C2_05SULLIVAN 345-C'. This project contributes approximately 67.5 MW to the thermal violation.

CONTINGENCY '8906_C2_05SULLIVAN 345-C'
OPEN BRANCH FROM BUS 243216 TO BUS 247712 CKT 1 / 243216 05DARWIN 345 247712 05SULLIVAN 345 1
OPEN BRANCH FROM BUS 243217 TO BUS 247712 CKT 1 / 243217 05DEQUIN 345 247712 05SULLIVAN 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*31.47*
243443	*05RKG2*	*30.99*
932441	*AC2-157 C*	*25.65*
932442	*AC2-157 E*	*41.85*
998321	*J496*	*8.03*
998571	*J537*	*10.53*
998581	*J538*	*7.77*
961341	*J601*	*5.29*
961351	*J602*	*10.09*
900404	*X3-028 C*	*506.28*
900405	*X3-028 E*	*675.04*
247629	*Y3-038*	*5.25*
701261	*Y4-027 C*	*0.2*
701262	*Y4-027 E*	*0.81*
701341	*Y4-035 C*	*0.07*
701342	*Y4-035 E*	*0.28*
701421	*Y4-043 C*	*0.04*
701422	*Y4-043 E*	*0.13*
701431	*Y4-044 C*	*1.57*
701432	*Y4-044 E*	*4.7*
701491	*Y4-050 C*	*1.05*
701492	*Y4-050 E*	*3.14*
701531	*Y4-054 C*	*0.54*
701532	*Y4-054 E*	*1.63*
701571	*Y4-058*	*5.28*
701581	*Y4-059*	*15.79*
701601	*Y4-061*	*7.93*
701701	*Y4-071*	*1.55*
701781	*Y4-079*	*5.51*
701791	*Y4-080*	*1.59*
701842	*Y4-085 E*	*1.03*

701881	*Y4-089*	*7.9*
701891	*Y4-090*	*1.56*
916522	*Z1-108 E*	*1.19*
LTF	*AA1-051*	*6.23*
LTF	*AA1-055*	*185.08*
922982	*AB1-087 C OP*	*185.64*
922992	*AB1-088 C OP*	*185.64*
927331	*AC1-040 C*	*6.97*
927332	*AC1-040 E*	*11.37*
LTF	*AC1-056*	*16.83*

Appendix 9

(LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 169.72% to 170.32% (**DC power flow**) of its emergency rating (1370 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 8.27 MW to the thermal violation.

CONTINGENCY '363_B2_TOR1682'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

Bus Number	*Bus Name*	*Full Contribution*
243442	*05RKG1*	*32.93*
243443	*05RKG2*	*32.43*
342900	*1COOPER1 G*	*2.64*
342903	*1COOPER2 G*	*5.13*
342918	*1JKCT 1G*	*2.08*
342921	*1JKCT 2G*	*2.08*
342924	*1JKCT 3G*	*2.08*
342927	*1JKCT 4G*	*1.38*
342930	*1JKCT 5G*	*1.38*
342933	*1JKCT 6G*	*1.38*
342936	*1JKCT 7G*	*1.38*
342939	*1JKCT 9G*	*1.41*
342942	*1JKCT 10G*	*1.41*
342945	*1LAUREL 1G*	*1.49*
931551	*AC2-075 C*	*4.67*
931871	*AC2-114 C*	*3.65*
932441	*AC2-157 C*	*8.27*
274650	*KINCAID ;1U*	*5.53*
900405	*X3-028 E*	*217.56*
LTF	*Y2-006*	*16.21*
247629	*Y3-038*	*5.5*
LTF	*Z1-046*	*18.6*
LTF	*AA1-001*	*6.07*
LTF	*AA1-004*	*15.39*
922982	*AB1-087 C OP*	*59.83*
922992	*AB1-088 C OP*	*59.83*
924261	*AB2-070 C OP*	*1.32*
LTF	*AC1-002*	*42.39*
927331	*AC1-040 C*	*9.49*
925771	*AC1-053 C*	*1.32*
925981	*AC1-074 C OP*	*4.67*