Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AB2-153

“Church-Price 69 kV IV”

May 2017

Preface

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

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

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The Interconnection Customer 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

OneEnergy Development, LLC, the Interconnection Customer (IC), has proposed a 20 MW (7.6 MWC) solar generating facility to be located in Sudlersville, Maryland. PJM studied AB2-153 as a 20 MW injection into the Delmarva Power and Light Company (DPL) system at a tap of the Church-Wye Mills 138 kV circuit and evaluated it for compliance with reliability criteria for summer peak conditions in 2020. The planned in-service date, as restated during the project kick-off call, is November 1, 2017.

Point of Interconnection

The Interconnection Customer requested a transmission level interconnection. As a result, AB2-153 will interconnect with the DPL system at the same Point of Interconnection (POI) as prior queue project AB2-032 (see Attachment 1).

Transmission Owner Scope of Attachment Facilities Work

Substation Interconnection Estimate

AB2-153 is a capacity and energy increase to PJM Queue Project AB2-032. No additional interconnection facilities are required if PJM Queue Project AB2-032 is constructed. AB2-153 will incur the costs for the interconnection facilities of AB2-032 in

the event of a cancellation to AB2-032. Any delay in construction to the interconnection facilities for AB2-032 will subsequently delay AB2-153.

Required Relaying and Communications
AB2-153 is a capacity and energy increase to PJM Queue Project AB2-032. No additional relay and communications work is required if PJM Queue Project AB2-032 is constructed.

Metering
AB2-153 is a capacity and energy increase to PJM Queue Project AB2-032. No additional metering work is required if PJM Queue Project AB2-032 is constructed.

Interconnection Customer Scope of Work
The Interconnection Customer is responsible for all design and construction related to activities on their side of the Point of Interconnection. Site preparation, including grading and an access road, as necessary, is assumed to be by the IC. Route selection, line design, and right-of-way acquisition of the direct connect facilities is not included in this report, and is the responsibility of the IC. Protective relaying and metering design and installation must comply with DPL's applicable standards. The IC is also required to provide revenue metering and real-time telemetering data to PJM in conformance with the requirements contained in PJM Manuals M-01 and M-14 and the PJM Tariff.

Special Operating Requirements

1. DPL will require the capability to remotely disconnect the generator from the grid by communication from its System Operations facility. Such disconnection may be facilitated by a generator breaker, or other method depending upon the specific circumstances and the evaluation by DPL.

2. DPL reserves the right to charge the Interconnection Customer operation and maintenance expenses to maintain the Interconnection Customer attachment facilities, including metering and telecommunications facilities, owned by DPL.

Summer Peak Analysis - 2020

Transmission Network Impacts
Potential transmission network impacts are as follows:

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)

1. (DP&L - PECO) The CLAY_230-LINWOOD 230 kV line (from bus 231000 to bus 213750 ckt 1) loads from 99.98% to 100.27% (AC power flow) of its emergency rating (1071 MVA) for the line fault with failed breaker contingency outage of 'LINWO225/* $ DELCO $ LINWO225 $ STBK'. This project contributes approximately 3.64 MW to the thermal violation.

   CONTINGENCY 'LINWO225/* $ DELCO $ LINWO225 $ STBK'
   TRIP BRANCH FROM BUS 213750 TO BUS 231001 CKT 1/* LINWOOD 230.00 EDGEMR 5 230.00 $ DELCO $ LINWO225 $ STBK
   REMOVE MACHINE 1 FROM BUS 213888/* PHLISCT1 18.00 $ DELCO $ LINWO225 $ STBK
   REMOVE MACHINE 1 FROM BUS 213889/* PHLISCT2 18.00 $ DELCO $ LINWO225 $ STBK
   END/*$ DELCO $ LINWO225 $ STBK

   Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

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)

1. (DP&L - DP&L) The MIDLTNTP-MT PLSNT 138 kV line (from bus 232106 to bus 232104 ckt 1) loads from 100.52% to 100.88% (AC power flow) of its emergency rating (348 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 7.85 MW to the thermal violation.

   CONTINGENCY 'DBL_4NC'/* RED LION-CEDAR CREEK 230;RED LION-CARTANZA 230
   OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
   OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
   END

   Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

2. (DP&L - DP&L) The TOWNSEND-MIDLTNTP 138 kV line (from bus 232107 to bus 232106 ckt 1) loads from 105.58% to 106.55% (AC power flow) of its emergency rating (348 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 7.85 MW to the thermal violation.

CONTINGENCY 'DBL_4NC' /* RED LION-CEDAR CREEK 230;RED LION-CARTANZA 230
OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
END

Please refer to Appendix 3 for a table containing the generators having contribution to this flowgate.

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.

1. (PECO - PECO) The CHICHST1-EDDYSTN4 230 kV line (from bus 213489 to bus 213588 ckt 1) loads from 99.91% to 100.11% (AC power flow) of its emergency rating (1078 MVA) for the single line contingency outage of '220-04/* $ DELCO $ 220-04 $ L'. This project contributes approximately 2.5 MW to the thermal violation.

   CONTINGENCY '220-04/* $ DELCO $ 220-04 $ L'
   DISCONNECT BUS 213627/* CHICHST1 230.00 FOULK8 230.00 $ DELCO $ 220-04 $ L
   END/*$ DELCO $ 220-04 $ L

2. (DP&L - DP&L) The AB2-036 TAP-OIL_CITY 138 kV line (from bus 923950 to bus 232801 ckt 1) loads from 83.34% to 86.63% (AC power flow) of its emergency rating (159 MVA) for the single line contingency outage of 'CKT 13808'. This project contributes approximately 6.22 MW to the thermal violation.

   CONTINGENCY 'CKT 13808'
   DISCONNECT BUS 232106/MOUNT PLEASANT - MIDDLETOWN - TOWNSEND 138
   DISCONNECT BUS 232804/MIDDLETOWN 138
   END

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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

1. To mitigate the (DP&L - PECO) CLAY_230-LINWOOD 230 kV line (from bus 231000 to bus 213750 ckt 1) overload will require terminal upgrades at both the Claymont and Linwood Substations. The estimate to perform this work is $800,000. The final ratings would be 1253/1519 MVA.

   Cost allocation is as follows:

Queue	MW contribution	Percentage of Cost	Cost($0.8M)	Contingency Name	Contingency Type
AB2-036	18.43	15.97%	$127,764.29	LINWO225/* $ DELCO $ LINWO225 $ STBK'	breaker
AB2-037	38.36	33.24%	$265,927.21	LINWO225/* $ DELCO $ LINWO225 $ STBK'	breaker
AB2-120	17.19	14.90%	$119,168.11	LINWO225/* $ DELCO $ LINWO225 $ STBK'	breaker
AB2-130	14.56	12.62%	$100,935.87	LINWO225/* $ DELCO $ LINWO225 $ STBK'	breaker
AB2-133	11.63	10.08%	$80,623.91	LINWO225/* $ DELCO $ LINWO225 $ STBK'	breaker
AB2-135	11.59	10.04%	$80,346.62	LINWO225/* $ DELCO $ LINWO225 $ STBK'	breaker
AB2-153	**3.64**	**3.15%**	**$25,233.96**	**LINWO225/* $ DELCO $ LINWO225 $ STBK'**	**breaker**

Note: There is a potential baseline to upgrade the ratings from 805 emergency to 1035 MVA, which is required to be built before this project can go into service.

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)(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

1. To mitigate the (DP&L) MIDLTNTP-MT PLSNT 138 kV line (from bus 232106 to bus 232104 ckt 1) overload will require reinforcements to increase the emergency rating of the Middletown Tap to Mount Pleasant 138 kV line. Those reinforcements include rebuilding a small section of the circuit and installing new poles and the re-mounting of 138 kV disconnect switches. The estimated cost to perform this work is **$800,000** and will take **18 months** to complete following a fully executed Interconnection Services Agreement (ISA) and Interconnection Construction Services Agreement (CSA). (PJM Network Upgrade Number n5300)

   Cost allocation is as follows:

Queue	MW contribution	Percentage of Cost	Cost($0.8M)	Contingency Name	Contingency Type
AB2-032	7.84	3.32%	$26,546	DBL_4NC'	tower
AB2-036	30.169	12.77%	$102,151	DBL_4NC'	tower
AB2-037	33.53	14.19%	$113,532	DBL_4NC'	tower

AB2-063	7.56	3.20%	$25,598	DBL_4NC'	tower
AB2-120	19.70	8.34%	$66,704	DBL_4NC'	tower
AB2-130	17.30	7.32%	$58,577	DBL_4NC'	tower
AB2-133	28.36	12.00%	$96,026	DBL_4NC'	tower
AB2-135	27.49	11.64%	$93,080	DBL_4NC'	tower
AB2-136	10.70	4.53%	$36,230	DBL_4NC'	tower
AB2-153	**7.85**	**3.32%**	**$26,580**	**DBL_4NC'**	**tower**
AB2-172	10.81	4.58%	$36,602	DBL_4NC'	tower
AB2-179	34.96	14.80%	$118,374	DBL_4NC'	tower

2. To mitigate the (DP&L) TOWNSEND-MIDLTNTP 138 kV line (from bus 232107 to bus 232106 ckt 1) overload will require reinforcements to increase the emergency rating of the Townsend to Middletown Tap 138 kV line. Those reinforcements include rebuilding a small section of the circuit and installing new poles and the re-mounting of 138 kV disconnect switches. The estimated cost to perform this work is **$800,000** and will take **18 months** to complete following a fully executed Interconnection Services Agreement (ISA) and Interconnection Construction Services Agreement (CSA). (PJM Network Upgrade Number n5301)

   Cost allocation is as follows:

Queue	MW contribution	Percentage of Cost	Cost($0.8M)	Contingency Name	Contingency Type
AB2-032	7.84	3.32%	$26,547.02	DBL_4NC'	tower
AB2-036	30.16	12.77%	$102,124.78	DBL_4NC'	tower
AB2-037	33.53	14.19%	$113,535.93	DBL_4NC'	tower
AB2-063	7.56	3.20%	$25,598.92	DBL_4NC'	tower
AB2-120	19.70	8.34%	$66,706.17	DBL_4NC'	tower
AB2-130	17.30	7.32%	$58,579.53	DBL_4NC'	tower
AB2-133	28.36	12.00%	$96,029.80	DBL_4NC'	tower
AB2-135	27.49	11.64%	$93,083.89	DBL_4NC'	tower
AB2-136	10.70	4.53%	$36,231.27	DBL_4NC'	tower
AB2-153	**7.85**	**3.32%**	**$26,580.89**	**DBL_4NC'**	**tower**
AB2-172	10.81	4.58%	$36,603.74	DBL_4NC'	tower
AB2-179	34.96	14.80%	$118,378.06	DBL_4NC'	tower

Short Circuit

No issues identified.

Stability and Reactive Power Requirement

No issues identified. See Attachment 2 for full report.

Light Load Analysis - 2020

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

Facilities Study Estimate

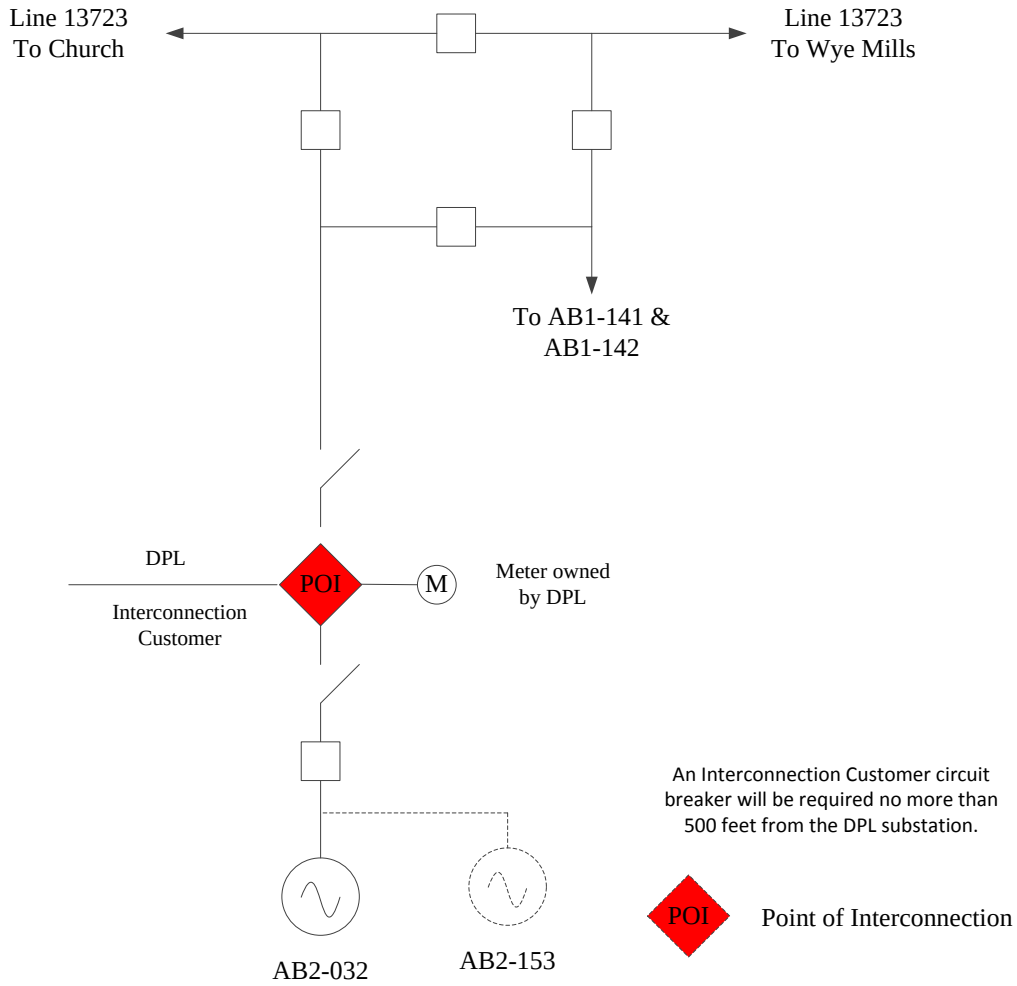
- 7 months to complete following return of Facilities Study Agreement
- Study Deposit will be $50,000

Delmarva Power and Light Costs

Cost estimates will further be refined as a part of the Facilities Study for this project. The Interconnection Customer will be responsible for all costs incurred by DPL in connection with the AB2-153 project. Such costs may include, but are not limited to, any transmission system assets currently in DPL's rate base that are prematurely retired due to the AB2-032 project. PJM shall work with DPL to identify these retirement costs and any additional expenses. DPL reserves the right to reassess issues presented in this document and, upon appropriate justification, submit additional costs related to the AB2-153 project.

Attachment 1

AB2-153
Church – Price 69kV IV
New 138 kV Substation



Attachment 2

AB2-032_AB2-153

System Impact Study

Dynamic Simulation Analysis

December 28, 2016

TABLE OF CONTENTS

Executive Summary

Generator Interconnection Request AB2-032 / AB2-153 is for a 40 MW Maximum Facility Output (MFO) solar generation plant with a Point of interconnection (POI) on the Church – Wye Mills 138 kV circuit in the Delmarva Power and Light Company's (DPL) Transmission system, Queen Anne County, Maryland.

This report describes a dynamic simulation analysis of AB2-032_AB2-153 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2020 summer peak case, modified to include applicable queue projects. AB2-032_AB2-153 has been dispatched online at maximum power output, with approximately unity power factor and 1.0 pu voltage at the generator bus.

AB2-032_AB2-153 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. Each with a 20 second simulation time period. Studied faults included:

a) Steady state operation (20 second simulation);

b) Three phase faults with normal clearing time;

c) Single-phase faults with stuck breaker;

d) Single-phase faults placed at 80% of the line with delayed (Zone 2) clearing at line end remote from fault due to primary communications/relay failure.

e) Single phase faults with loss of multiple-circuit tower line

No relevant Bus or High Speed Reclosing (HSR) contingencies were identified.

For all simulations, the queue project under study along with the rest of the PJM system were required to maintain synchronism and with all states returning to an acceptable new condition following the disturbance.

For the all fault contingencies tested on the 2020 summer peak case:

a) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

a) The AB2-032_AB2-153 generator was able to ride through all faults (except for faults where protective action trips a generator(s)).

No mitigations were found to be required.

1. Introduction

Generator Interconnection Request AB2-032 / AB2-153 is for a 40 MW Maximum Facility Output (MFO) solar generation plant with a Point of interconnection (POI) on the Church – Wye Mills 138 kV circuit in the Delmarva Power and Light Company's (DPL) Transmission system, Queen Anne County, Maryland.

This analysis is effectively a screening study to determine whether the addition of AB2-032_AB2-153 will meet the dynamic requirements of the NERC, PJM and Transmission Owner reliability standards.

In this report the AB2-032_AB2-153 project and how it is proposed to be connected to the grid are first described, followed by a description of how the project is modeled in this study. The fault cases are then described and analyzed, and lastly a discussion of the results is provided.

2. Description of Project

Sharing the same collector system, AB2-032 and AB2-153 each consists of 3 x 2.507 MW PowerElectronics FS2400CH15 solar inverters and 8 x 1.56 MW PowerElectronics FS1475CH15 solar inverters. AB2-032_AB2-153 Point of Interconnection (POI) is on the Church – Wye Mills 138 kV circuit as shown in Figure 1.
Table 1 lists the parameters given in the impact study data and the corresponding parameters of the AB2-032_AB2-153 loadflow models.
The dynamic model for the AB2-032_AB2-153 plant is based on the PowerElectronics Solar inverter PSS/E user defined model supplied by the Developer.
Additional project details are provided in Attachments.

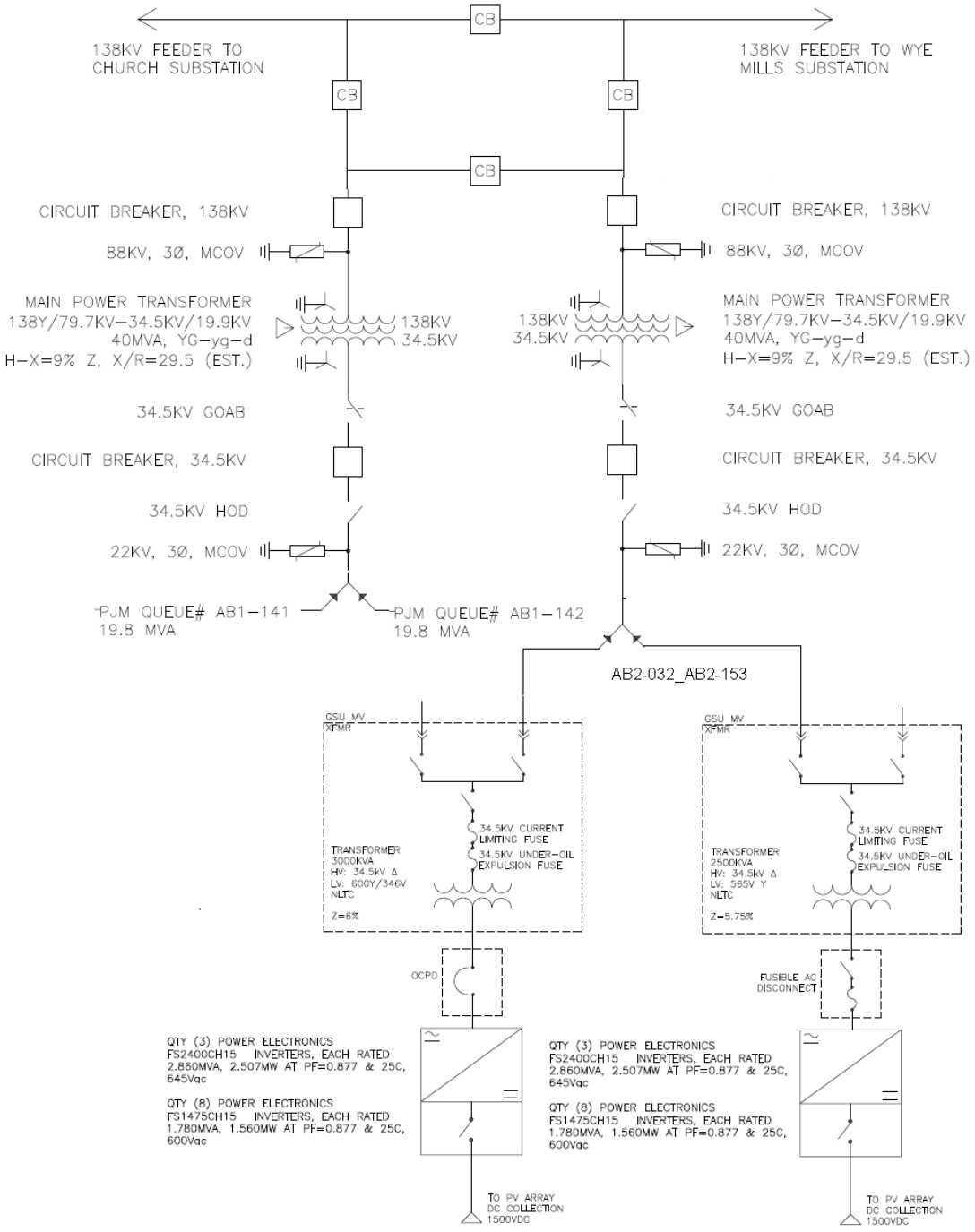


Figure 1: AB2-032_AB2-153 Plant Model

Table 1: AB2-032 (identical to AB2-153) Plant Model

	Impact Study Data	Model
Inverters	3 x 2.507 MW PE FS2400CH15 Solar Inverters MVA base = 2.86 MVA Vt = 0.60 kV 8 x 1.56 MW PE FS1475CH15 Solar Inverters MVA base = 1.78 MVA Vt = 0.6 kV	Lumped equivalent representing 3 PE 2.507MW + 8 1.56 MW Solar Inverters Pgen 20 MW Pmax 20 MW Pmin 0 MW Qgen 0 MVAr Qmax 6.58 MVAr Qmin -6.58 MVAr Mbase 22.82 MVA Zsource 0.000 + j1.0 pu @Mbase
GSU transformer	3 x 34.5/0.645/0.372 kV three winding transformers Transformer base = 2.86 MVA 8 x 34.5/0.6/0.346 kV three winding transformers Transformer base = 1.78 MVA Impedance = 0.005 + j0.06 pu @ MVA base Number of taps = N/A Tap step size = N/A	Lumped equivalent representing 11 x 34.5 / 0.6 kV 22.82 MVA two winding transformers Transformer base = 22.82 MVA Impedance = 0.005 + j0.06 pu @ MVA base Number of taps = 5 Tap step size = 2.5%
Collector step-up transformer	1 x 138/34.5/13.8 kV three winding transformer Transformer base = 24 MVA Rating = 24/32/40 MVA (ONAN/ONAF/ONAF) Impedance High to low: 0.005 + j0.09 High to tertiary: 0.005 + j0.05 Low to tertiary: 0.005 + j0.05 All impedances are @ MVA base Number of taps = N/A Tap step size = N/A	1 x 138/34.5/13.8 kV three winding transformer Transformer base = 24 MVA Rating = 24/32/40 MVA Impedance High to low: 0.005 + j0.09 High to tertiary: 0.005 + j0.05 Low to tertiary: 0.005 + j0.05 All impedances are @ MVA base Number of taps = 5 Tap step size = 2.5%
Auxiliary load	N/A	N/A
Station load	N/A	N/A

Transmission line	N/A	N/A

Loadflow and Dynamics Case Setup

The dynamics simulation analysis was carried out using PSS/E Version 33.7.
The load flow scenario and fault cases for this study are based on PJM's Regional Transmission Planning Process[1].
The selected load flow scenario is the RTEP 2020 summer peak case with the following modifications:

a) Addition of all applicable queue projects prior to AB2-032_AB2-153.

b) Addition of AB2-032_AB2-153 queue project.

c) Removal of withdrawn and subsequent queue projects in the vicinity of AB2-032_AB2-153.

d) Dispatch of units in the PJM system to maintain slack generators within limits.

The AB2-032 / AB2-153 initial conditions are listed in Table 2, indicating maximum power output, with unity power factor and approximately 1.0 pu voltage at the generator bus.

Table 2: AB2-032_AB2-153 machine initial conditions

Bus	Name	Unit	PGEN	QGEN	ETERM	POI Voltage
923923	AB2-032 GEN	1	20	-0.45	1.0000	1.0371
924973	AB2-153 GEN	1	20	-0.45	1.0000	1.0371

Generation within the vicinity of AB2-032_AB2-153 has been dispatched online at maximum output (PMAX). The dispatch of generation in the vicinity of AB2-032_AB2-153 is given in Attachment 3.

[1] Manual 14B: PJM Region Transmission Planning Process, Rev 33, May 5 2016, Attachment G : PJM Stability, Short Circuit, and Special RTEP Practices and Procedures.

3. Fault Cases

Tables 3 to 7 list the contingencies that were studied, with representative worst case total clearing times provided by PJM. Each contingency was studied over a 20 second simulation time interval.
The studied contingencies include:

a) Steady state operation (20 second simulation);

b) Three phase faults with normal clearing time;

c) Single-phase faults with stuck breaker;

d) Single-phase faults placed at 80% of the line with delayed (Zone 2) clearing at line end remote from fault due to primary communications/relay failure.

e) Single phase faults with loss of multiple-circuit tower line

No relevant Bus or High Speed Reclosing (HSR) contingencies were identified.

The three phase faults with normal clearing time were performed under network intact conditions.
Additional delayed (Zone 2) clearing at remote and faults will be applied on lines from Townsend 138 kV and Steele 138 kV towards the queue project.
Clearing times listed in Tables 3 to 7 are as per Revision 19 of "*2016 Revised Clearing time for each PJM company_update_busfault_Rev19"* spreadsheet.
The positive sequence fault impedances for single line to ground faults were estimated through from a separate short circuit case, modified to ensure that connected generators in the vicinity of AB2-032_AB2-153 have not withdrawn from the PJM queue, and are not greater than the queue position under study.

4. Evaluation Criteria

This study is focused on AB2-032_AB2-153, along with the rest of the PJM system, maintaining synchronism and having all states return to an acceptable new condition following the disturbance. The recovery criteria applicable to this study are as per PJM's Regional Transmission Planning Process and Transmission Owner criteria:

a) The system with AB2-032_AB2-153 included is transiently stable and post-contingency oscillations should be positively damped with a damping margin of at least 3%.

b) The AB2-032_AB2-153 is able to ride through faults (except for faults where protective action trips AB2-032_AB2-153).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

6. Summary of Results

Plots from the dynamic simulations are provided in Attachment 4, with results summarized in Table 3 through Table 7.
For all fault contingencies tested on the 2020 summer peak case:

a) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

b) The AB2-032_AB2-153 generator was able to ride through all faults (except for faults where protective action trips a generator(s)).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

No mitigations were found to be required.

Table 3: Steady State Operation

Fault ID	Duration	AB2-032_AB2-153 No Mitigation
SS.00	Steady state 30 sec	Stable

Table 4: Three-phase Faults With Normal Clearing

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	AB2-032_AB2-153 No Mitigation
P1.01	Fault at AB1-141_AB1-142 138 kV POI on AB1-141_AB1-142 circuit. Trips AB1-141_AB1-142.	9	Stable
P1.02	Fault at AB2-032_AB2-153 138 kV POI on Church circuit 13723.	9	Stable
P1.03	Fault at AB2-032_AB2-153 138 kV POI on Wye Mills circuit 13723.	9	Stable
P1.04	Fault at Church 138 kV on AB2-032_AB2-153 circuit 13723.	9	Stable
P1.05	Fault at Church 138 kV on AB2-036 circuit 13701.	9	Stable
P1.06	Fault at Church 138 kV on Townsend circuit 13833.	9	Stable
P1.07	Fault at Church 138 kV on Church 138 kV / 69 kV Transformer AT1.	9	Stable
P1.08	Fault at Church 138 kV on Church 138 kV / 69 kV Transformer AT2.	9	Stable
P1.09	Fault at Wye Mills 138 kV on AB2-032_AB2-153 circuit 13723.	9	Stable
P1.10	Fault at Wye Mills 138 kV on Hillsboro – Steele circuit 13788/13761.	9	Stable
P1.11	Fault at Wye Mills 138 kV on 138 kV / 69 kV Transformer AT1.	9	Stable
P1.12	Fault at Wye Mills 138 kV on 138 kV / 69 kV Transformer AT2.	9	Stable
P1.13	Fault at AB2-036 138 kV on Oil City – Steele circuit 13701.	9	Stable
P1.14	Fault on Steele 138kV on Easton circuit 13712	9	Stable

Table 5: Single-phase Faults With Stuck Breaker

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	AB2-032_AB2-153 No Mitigation
P4.01	Fault at AB2-032_AB2-153 138 kV POI on AB2-032_AB2-153 circuit. Breaker stuck to AB2-032_AB2-153 circuit. Fault cleared with loss of Wye Mills circuit 13723. Trips AB2-032_AB2-153.	9 / 21	Stable
P4.02	Fault at AB1-141_AB1-142 138 kV POI on AB1-141_AB1-142 circuit. Breaker stuck to AB1-141_AB1-142 circuit. Fault cleared with loss of AB2-032_AB2-153 138 kV POI on AB2-032_AB2-153 circuit. Trips AB1-141_AB1-142 and AB2-032_AB2-153.	9 / 21	Stable
P4.03	Fault at AB1-141_AB1-142 138 kV POI on AB1-141_AB1-142 circuit. Breaker stuck to AB1-141_AB1-142 circuit. Fault cleared with loss of Church circuit 13723. Trips AB1-141_AB1-142.	9 / 21	Stable
P4.04	Fault at AB2-032_AB2-153 138 kV POI on Wye Mills circuit 13723. Breaker stuck to Wye Mills circuit. Fault cleared with loss of Church circuit 13723. Trips AB1-141_AB1-142 and AB2-032_AB2-153.	9 / 21	Stable
P4.05	Fault at Church 138 kV on AB2-032_AB2-153 circuit 13723. Breaker 130 stuck. Fault cleared with loss of Church CAP1 and CAP2.	9 / 21	Stable
P4.06	Fault at Church 138 kV on AB2-032_AB2-153 circuit 13723. Breaker 133 stuck. Fault cleared with loss of AB2-036 circuit 13701.	9 / 21	Stable
P4.07	Fault at Church 138 kV on AB2-036 circuit 13701. Breaker 133 stuck. Fault cleared with loss of AB2-032_AB2-153 circuit 13723.	9 / 21	Stable
P4.08	Fault at Church 138 kV on AB2-036 circuit 13701. Breaker 8430 stuck. Fault cleared with loss of Church 138 kV / 69 kV Transformer AT1.	9 / 21	Stable
P4.09	Fault at Church 138 kV on Townsend circuit 13833. Breaker 131 stuck. Fault cleared with loss of Church CAP1 and CAP2.	9 / 21	Stable

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	AB2-032_AB2-153 No Mitigation
P4.10	Fault at Church 138 kV on Townsend circuit 13833. Breaker 8420 stuck. Fault cleared with loss of Church 138 kV / 69 kV Transformer AT2.	9 / 21	Stable
P4.11	Fault at Church 138 kV on Church 138 kV / 69 kV Transformer AT1. Breaker 8430 stuck. Fault cleared with loss of AB2-036 circuit 13701.	9 / 21	Stable
P4.12	Fault at Church 138 kV on Church 138 kV / 69 kV Transformer AT2. Breaker 8420 stuck. Fault cleared with loss of Townsend circuit 13833.	9 / 21	Stable
P4.13	Fault at Church 138 kV on Church 138 kV / 69 kV Transformer AT2. Breaker 132 stuck. Fault cleared with loss of Church 138 kV / 69 kV Transformer AT1.	9 / 21	Stable
P4.14	Fault at Wye Mills 138 kV on AB2-032_AB2-153 circuit 13723. Breaker 132 stuck. Fault cleared with loss of Wye Mills 138 kV / 69 kV Transformer AT1.	9 / 21	Stable
P4.15	Fault at Wye Mills 138 kV on AB2-032_AB2-153 circuit 13723. Breaker 133 stuck. Fault cleared with loss of Wye Mills 138 kV / 69 kV Transformer AT2.	9 / 21	Stable
P4.16	Fault at Wye Mills 138 kV on Hillsboro – Steele circuit 13788/13761. Breaker 8680 stuck. Fault cleared with loss of Wye Mills 138 kV / 69 kV Transformer AT2.	9 / 21	Stable
P4.17	Fault at Wye Mills 138 kV on Hillsboro – Steele circuit 13788/13761. Breaker 130 stuck. Fault cleared with loss of Wye Mills CAP3 and CAP4.	9 / 21	Stable
P4.18	Fault at Wye Mills 138 kV on 138 kV / 69 kV Transformer AT1. Breaker 131 stuck. Fault cleared with loss of Wye Mills CAP3 and CAP4.	9 / 21	Stable
P4.19	Fault at Wye Mills 138 kV on 138 kV / 69 kV Transformer AT1. Breaker 132 stuck. Fault cleared with loss of AB2-032_AB2-153 circuit 13723.	9 / 21	Stable

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	AB2-032_AB2-153 No Mitigation
P4.20	Fault at Wye Mills 138 kV on 138 kV / 69 kV Transformer AT2. Breaker 133 stuck. Fault cleared with loss of AB2-032_AB2-153 circuit 13723.	9 / 21	Stable
P4.21	Fault at Wye Mills 138 kV on 138 kV / 69 kV Transformer AT2. Breaker 8680 stuck. Fault cleared with loss of Hillsboro – Steele circuit 13788/13761.	9 / 21	Stable

Table 6: Single-phase Faults With Delayed Clearing at line end closest to AB2-032_AB2-153 POI

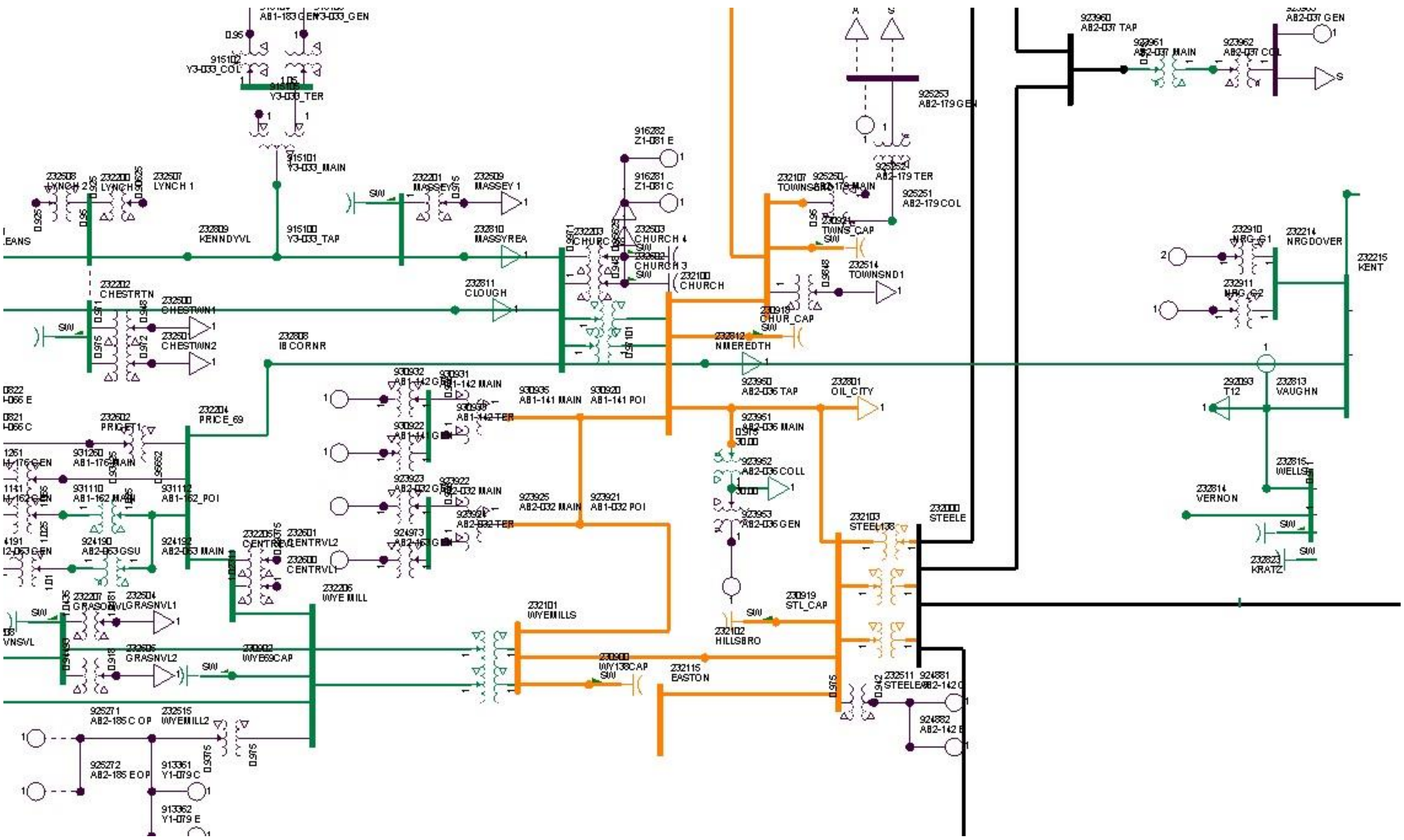
Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	AB2-032_AB2-153 No Mitigation
P5.01	Fault at 80% of 138 kV line from AB2-032_AB2-153 138 kV POI to Church. Delayed clearing at AB2-032_AB2-153.	9 / 37	Stable
P5.02	Fault at 80% of 138 kV line from Church 138 kV to AB2-032_AB2-153 POI. Delayed clearing at Church.	9 / 37	Stable
P5.03	Fault at 80% of 138 kV line from AB2-032_AB2-153 138 kV POI to Wye Mills. Delayed clearing at AB2-032_AB2-153.	9 / 37	Stable
P5.04	Fault at 80% of 138 kV line from Wye Mills 138 kV to AB2-032_AB2-153 POI. Delayed clearing at AB2-032_AB2-153.	9 / 37	Stable
P5.05	Fault at 80% of 138 kV line from Church 138 kV to AB2-036 circuit 13701. Delayed clearing at Church.	9 / 37	Stable
P5.06	Fault at 80% of 138 kV line from AB2-036 138 kV to Church circuit 13701. Delayed clearing at AB2-036.	9 / 37	Stable
P5.07	Fault at 80% of 138 kV line from AB2-036 138 kV to Oil City – Steele circuit 13701. Delayed clearing at AB2-036.	9 / 37	Stable
P5.08	Fault at 80% of 138 kV line from AB2-036 138 kV to Oil City – Steele circuit 13701. Delayed clearing at Steele.	9 / 37	Stable
P5.09	Fault at 80% of 138 kV line from Wye Mills 138 kV to Hillsboro – Steele circuit 13788/13761. Delayed clearing at Wye Mills.	9 / 37	Stable
P5.10	Fault at 80% of 138 kV line from Church 138 kV to Townsend circuit 13833. Delayed clearing at Church.	9 / 37	Stable

Table 7: Single-phase Faults With Tower Failure Clearing at line end closest to AB2-032_AB2-153 POI

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	AB2-032_AB2-153 No Mitigation

Fault ID	Fault description	Clearing Time Near & Remote (Cycles)	AB2-032_AB2-153 No Mitigation
P7.01	CONTINGENCY 'DBL_1NCB_A' Fault at AB2-037 230kV on Keeney 230kV line, tower failure normal clearing loss of Keeney – Steele 230kV line	7	Stable
P7.02	CONTINGENCY 'DBL_1NCB_B' Fault at AB2-037 230kV on Steele 230kV line, tower failure normal clearing loss of Keeney – Steele 230kV line	7	Stable

Attachment 1. PSS/E Model One Line Diagram



Attachment 2. AB2-032_AB2-153 PSS/E Dynamic Model

```
1    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     WED, DEC 28 2016  13:10
 2014 SERIES, ERAG/MMWG BASE CASE LIBRARY (CEII)
 2020 SUMMER PEAK LOAD CASE, FINAL; FOR DYN

 PLANT MODELS

 REPORT FOR PLANT MODELS                  BUS 923923 [AB2-032 GEN 0.6000] MODELS


 ** GEPVG **  BUS X-- NAME --X   BASEKV MC  C O N S     S T A T E S        VAR         ICON
            923923    AB2-032 G 0.6000 1  100115-100127  42147-42149   16479-16483    2040-2041

   PRATE       XEQ     VHVRCR2  CURHVRCR2  RIp_LVPL T_LVPL
  22.8200       1.0    2.0000    1.0000    1.0000    0.0200

   LVPL1V   LVPL1P    LVPL2V    LVPL2P     LVPL3V     XLVPL
   0.7000    0.0000    0.8000    0.5000    0.8500    1.0000


   XLVPL
   0.0000



 ** GEPVE OF GEPVG **  BUS X-- NAME --X BASEKV MC       C O N S       S T A T E S     VAR
ICON
                      923923 AB2-032 GEN  0.6000 1  244838-244864  98570-98577   28848-28855
14680-14687

   TFV      KPV        KIV       RC        XC        QMX       QMN
   0.0000   60.0000    1.0000    0.0000    0.0000    0.6000   -0.6000

   IPMAX     TRV       KQi       VMINCL    VMAXCL    KVi     XIQmin
   0.8000    0.0200    0.0300    0.9500    1.0500  480.0000   -0.6000

   XIQmax    Tv        Tp        Fn        ImaxTD    Iphl    Iqhl
   0.6000    0.0000    0.0200    1.0000    1.2000    1.0000    0.6000

   TIpqd     Kqd       Xqd       Vermx     Vermn     Vfrz
   5.0000    0.0000    0.0000    0.1000   -0.1000    0.8400



 Remote controlled Bus #         2
               VARFLG =  0 PFAFLG =  0
               PQFLAG =  1
 Q Droop Branch FROM Bus=       0  TO Bus =       0  ID =  0

1    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     WED, DEC 28 2016  13:08
 2014 SERIES, ERAG/MMWG BASE CASE LIBRARY (CEII)
 2020 SUMMER PEAK LOAD CASE, FINAL; FOR DYN

 PLANT MODELS

 REPORT FOR PLANT MODELS                  BUS 924973 [AB2-153 GEN 0.6000] MODELS


 ** GEPVG **  BUS X-- NAME --X   BASEKV MC  C O N S     S T A T E S        VAR         ICON
            924973    AB2-153 G 0.6000 1  100128-100140  42150-42152   16484-16488    2042-2043

   PRATE       XEQ     VHVRCR2  CURHVRCR2  RIp_LVPL T_LVPL
  22.8200       1.0    2.0000    1.0000    1.0000    0.0200
```

```
   LVPL1V   LVPL1P    LVPL2V    LVPL2P     LVPL3V     XLVPL
   0.7000    0.0000    0.8000    0.5000    0.8500    1.0000


   XLVPL
   0.0000



 ** GEPVE OF GEPVG **  BUS X-- NAME --X BASEKV MC       C O N S       S T A T E S     VAR
ICON
                       924973 AB2-153 GEN  0.6000 1  244865-244891  98578-98585   28856-28863
14688-14695

   TFV      KPV        KIV       RC        XC        QMX       QMN
   0.0000   60.0000    1.0000    0.0000    0.0000    0.6000   -0.6000

   IPMAX     TRV       KQi       VMINCL    VMAXCL    KVi      XIQmin
   0.8000    0.0200    0.0300    0.9500    1.0500  480.0000   -0.6000

   XIQmax    Tv        Tp        Fn        ImaxTD    Iphl    Iqhl
   0.6000    0.0000    0.0200    1.0000    1.2000    1.0000    0.6000

   TIpqd     Kqd       Xqd       Vermx     Vermn     Vfrz
   5.0000    0.0000    0.0000    0.1000   -0.1000    0.8400



 Remote controlled Bus #         2
               VARFLG =  0 PFAFLG =  0
               PQFLAG =  1
 Q Droop Branch FROM Bus=       0  TO Bus =       0  ID =  0
```

Attachment 3. AB2-032_AB2-153 PSS/E Case Dispatch

Bus Number	Bus Name	Id	PGen (MW)	PMax (MW)	PMin (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)
230927	CDRCRK_REAC 230.00	1	0	0	0	-20	0	-20
231131	BLOOM ENRGY 138.00	1	27	27	0	0	0	0
231902	DC CT7 13.800	1	62.1	62.1	0	-3.067	65.056	-3.067
231903	GEN4 13.800	4	72	72	0	0	0	0
231904	DC1 NUG 13.800	1	0	0	0	0	0	0
231905	DC2 NUG 13.800	1	0	0	0	0	0	0
231907	DC10 13.800	1	17.8	17.8	0	1.2152	12.1	-5
231915	DC CT6 13.800	1	55	55	0	-17.02	15	-17.02
232227	EASTN_69 69.000	1	0	0	0	-30	0	-30
232616	GEN FOOD 13.200	1	15.2	15.2	0	0	1	0
232632	IR SVC 16.000	1	0	0	0	72.2771	150	-150
232813	VAUGHN 69.000	1	3	3	0	0	0	0
232901	NORTHST 69.000	1	45	45	5	0	15.6	0
232902	EASTMUNI 69.000	1	69	69	0	19.374	34.6	0
232904	IR4 26.000	4	414.2	414.2	0	4.9	4.9	-2.93
232910	NRG_G1 13.800	2	44	44	0	-9.2018	27	-20
232911	NRG_G2 13.800	1	44	44	0	-9.2018	27	-20
232922	MR3 13.000	3	102	102	35	0	35	0
232923	MR1 12.500	1	17	17	6	0	12	0
232924	MR2 12.500	2	17	17	6	0	12	0

910821	X3-066 C 12.500	1	2.28	2.28	0	0	0	0
910822	X3-066 E 12.500	1	3.72	3.72	0	0	0	0
913361	Y1-079 C 24.900	1	3.8	3.8	0	0	0	0
913362	Y1-079 E 24.900	1	6.2	6.2	0	0	0	0
915103	Y3-033_GEN 0.6900	1	39	39	0	0	0	0
915104	AB1-183 GEN 0.3850	1	60	60	0	0	0	0
916281	Z1-081 C 24.900	1	2.28	2.28	0	0	0	0
916282	Z1-081 E 24.900	1	3.72	3.72	0	0	0	0
923923	AB1-032 GEN 0.6000	1	20	20	0	-0.7043	6.58	-6.58
923953	AB2-036 GEN 0.3850	1	102.41	102.41	0	-33.66	33.66	-33.66
924191	AB2-063 GEN 0.4180	1	20	20	0	-6.573	6.573	-6.573
924881	AB2-142 C 24.900	1	5.1	5.1	0	0	0	0
924882	AB2-142 E 24.900	1	8.3	8.3	0	0	0	0
924973	AB1-153 GEN 0.6000	1	20	20	0	-0.7043	6.58	-6.58
925111	AB2-168 C 34.500	1	0	3.8	0	0	0	0
925112	AB2-168 E 34.500	1	0	5.2	0	0	0	0
925253	AB2-179 GEN 0.3850	1	0	50	0	-16.5	16.5	-16.5
925271	AB2-185 C OP24.900	1	0	14	0	0	0	0
925272	AB2-185 E OP24.900	1	0	6	0	0	0	0
930922	AB1-141 GEN 0.5500	1	20	20	0	-0.7043	6.58	-6.58
930932	AB1-142 GEN 0.5500	1	20	20	0	-0.7043	6.58	-6.58

931111	AB1-162 GEN 0.4180	1	16.7	16.7	0	-0.2534	5.479	-5.479
931261	AB1-176 GEN 0.4800	1	9	9	0	0	0	0

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

(DP&L - PECO) The CLAY_230-LINWOOD 230 kV line (from bus 231000 to bus 213750 ckt 1) loads from 99.98% to 100.27% (AC power flow) of its emergency rating (1071 MVA) for the line fault with failed breaker contingency outage of 'LINWO225/* $ DELCO $ LINWO225 $ STBK'. This project contributes approximately 3.64 MW to the thermal violation.

CONTINGENCY 'LINWO225/* $ DELCO $ LINWO225 $ STBK'
TRIP BRANCH FROM BUS 213750 TO BUS 231001 CKT 1 /* LINWOOD 230.00 EDGEMR 5 230.00 $ DELCO $ LINWO225 $ STBK
REMOVE MACHINE 1 FROM BUS 213888 /* PHLISCT1 18.00 $ DELCO $ LINWO225 $ STBK
REMOVE MACHINE 1 FROM BUS 213889 /* PHLISCT2 18.00 $ DELCO $ LINWO225 $ STBK
END/* $ DELCO $ LINWO225 $ STBK

Bus Number	*Bus Name*	*Full Contribution*
231917	*EM10*	*1.08*
231916	*EM3*	*6.48*
231901	*EM4*	*13.01*
231900	*EM5*	*46.75*
231908	*HR1*	*9.35*
231909	*HR2*	*9.42*
231910	*HR3*	*9.35*
231505	*HR4*	*19.22*
232923	*MR1*	*2.75*
232924	*MR2*	*2.75*
213641	*PELTZ*	*-0.32*
297077	*V2-028 E*	*0.65*
904212	*V4-022E*	*0.53*
901004	*W1-003 E*	*0.78*
901014	*W1-004 E*	*0.78*
901024	*W1-005 E*	*0.78*

901034	*W1-006 E*	*0.78*
907052	*X1-032 E*	*0.69*
907211	*X1-074*	*44.04*
907324	*X1-096 E*	*16.03*
910572	*X3-008 E*	*2.18*
910592	*X3-015 E*	*2.11*
910822	*X3-066 E*	*0.67*
910902	*X3-081 E*	*-0.07*
913362	*Y1-079 E*	*1.12*
913412	*Y1-080 E*	*0.37*
915542	*Y3-058 E*	*1.61*
920582	*Z1-076 C*	*0.91*
920583	*Z1-076 E*	*1.49*
920592	*Z1-077 C*	*0.65*
920593	*Z1-077 E*	*1.07*
916282	*Z1-081 E*	*0.68*
917082	*Z2-012 E*	*2.13*
920763	*Z2-076 E*	*0.34*
920773	*Z2-077 E*	*0.34*
920813	*Z2-097 E*	*0.27*
921123	*AA1-059 E*	*0.29*
921142	*AA1-061 C*	*2.35*
921143	*AA1-061 E*	*1.16*
921443	*AA1-110 E*	*0.36*
921592	*AA1-140 C*	*1.29*
921593	*AA1-140 E*	*2.11*
921602	*AA1-141 C*	*0.98*
921603	*AA1-141 E*	*1.6*
921872	*AA2-069*	*85.66*
922213	*AA2-129 E*	*3.44*
922222	*AA2-130*	*0.34*
922752	*AB1-056 C OP*	*10.93*
922753	*AB1-056 E OP*	*31.14*
922762	*AB1-057 C*	*11.1*
922763	*AB1-057 E*	*31.65*
923282	*AB1-137 C*	*2.38*
923283	*AB1-137 E*	*1.02*
923322	*AB1-141 C OP*	*2.46*
923323	*AB1-141 E OP*	*1.15*
923332	*AB1-142 C OP*	*2.46*
923333	*AB1-142 E OP*	*1.15*
923452	*AB1-162 C OP*	*1.15*
923453	*AB1-162 E OP*	*1.88*
923602	*AB1-176 C*	*0.62*
923603	*AB1-176 E*	*1.02*

923902	*AB2-030 E*	*0.69*
923921	*AB2-032 C*	*2.48*
923922	*AB2-032 E*	*1.17*
923931	*AB2-033 C*	*1.23*
923932	*AB2-033 E*	*0.49*
923951	*AB2-036 C*	*7.*
923952	*AB2-036 E*	*11.44*
923961	*AB2-037 C*	*14.57*
923962	*AB2-037 E*	*23.79*
924191	*AB2-063 C*	*1.38*
924192	*AB2-063 E*	*2.25*
924361	*AB2-084 C*	*0.65*
924362	*AB2-084 E*	*1.07*
924681	*AB2-120 C OP*	*6.53*
924682	*AB2-120 E OP*	*10.66*
924781	*AB2-130 C OP*	*5.53*
924782	*AB2-130 E OP*	*9.03*
924801	*AB2-133 C OP*	*5.83*
924802	*AB2-133 E OP*	*5.81*
924821	*AB2-135 C*	*5.41*
924822	*AB2-135 E*	*6.17*
924832	*AB2-136 E*	*4.6*
924881	*AB2-142 C*	*0.92*
924882	*AB2-142 E*	*1.49*
924971	*AB2-153 C*	*1.38*
924972	*AB2-153 E*	*2.26*
925091	*AB2-166 C*	*0.34*
925092	*AB2-166 E*	*0.6*
925101	*AB2-167 C*	*0.91*
925102	*AB2-167 E*	*1.5*
925111	*AB2-168 C*	*0.74*
925112	*AB2-168 E*	*1.01*
925151	*AB2-172 C OP*	*3.33*
925152	*AB2-172 E OP*	*5.44*
925231	*AB2-177 C*	*0.43*
925232	*AB2-177 E*	*0.7*
925251	*AB2-179 C OP*	*7.1*
925252	*AB2-179 E OP*	*2.34*
925261	*AB2-180 C*	*2.42*
925262	*AB2-180 E*	*1.04*
925271	*AB2-185 C OP*	*2.53*
925272	*AB2-185 E OP*	*1.08*

Appendix 2

(DP&L - DP&L) The MIDLTNTP-MT PLSNT 138 kV line (from bus 232106 to bus 232104 ckt 1) loads from 100.52% to 100.88% (AC power flow) of its emergency rating (348 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 7.85 MW to the thermal violation.

CONTINGENCY 'DBL_4NC' /* RED LION-CEDAR CREEK 230;RED LION-CARTANZA 230
OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
END

Bus Number	*Bus Name*	*Full Contribution*
232900	*DEMECSMY*	*2.25*
232851	*DUP-SFR1*	*0.43*
232902	*EASTMUNI*	*3.57*
232923	*MR1*	*3.36*
232924	*MR2*	*3.36*
232910	*NRG_G1*	*2.55*
232911	*NRG_G2*	*2.55*
297077	*V2-028 E*	*0.75*
904212	*V4-022E*	*0.61*
232813	*VAUGHN*	*0.16*
901004	*W1-003 E*	*0.89*
901014	*W1-004 E*	*0.89*
901024	*W1-005 E*	*0.89*
901034	*W1-006 E*	*0.89*
901411	*W1-062*	*2.39*
907052	*X1-032 E*	*0.79*
907324	*X1-096 E*	*18.27*
910571	*X3-008 C*	*0.34*
910572	*X3-008 E*	*2.68*
910591	*X3-015 C*	*0.32*
910592	*X3-015 E*	*2.51*
910821	*X3-066 C*	*0.18*
910822	*X3-066 E*	*1.41*
913361	*Y1-079 C*	*0.25*
913362	*Y1-079 E*	*1.96*
913411	*Y1-080 C*	*0.05*
913412	*Y1-080 E*	*0.43*
915751	*Y3-033*	*1.19*
915752	*Y3-033*	*7.92*
915542	*Y3-058 E*	*1.86*
920582	*Z1-076 C*	*1.05*
920583	*Z1-076 E*	*1.71*
920592	*Z1-077 C*	*0.75*
920593	*Z1-077 E*	*1.22*

916281	*Z1-081 C*	*0.21*
916282	*Z1-081 E*	*1.65*
917082	*Z2-012 E*	*2.44*
920763	*Z2-076 E*	*0.4*
920773	*Z2-077 E*	*0.4*
920812	*Z2-097 C*	*0.32*
920813	*Z2-097 E*	*0.65*
921123	*AA1-059 E*	*0.33*
921142	*AA1-061 C*	*2.87*
921143	*AA1-061 E*	*1.42*
921442	*AA1-110 C*	*0.36*
921443	*AA1-110 E*	*0.89*
921592	*AA1-140 C*	*1.51*
921593	*AA1-140 E*	*2.47*
921602	*AA1-141 C*	*1.13*
921603	*AA1-141 E*	*1.84*
921872	*AA2-069*	*104.83*
922213	*AA2-129 E*	*3.94*
922222	*AA2-130*	*0.39*
922752	*AB1-056 C OP*	*12.8*
922753	*AB1-056 E OP*	*36.44*
922762	*AB1-057 C*	*12.99*
922763	*AB1-057 E*	*37.04*
923282	*AB1-137 C*	*2.79*
923283	*AB1-137 E*	*1.2*
923322	*AB1-141 C OP*	*5.3*
923323	*AB1-141 E OP*	*2.47*
923332	*AB1-142 C OP*	*5.3*
923333	*AB1-142 E OP*	*2.47*
923452	*AB1-162 C OP*	*2.4*
923453	*AB1-162 E OP*	*3.92*
923602	*AB1-176 C*	*1.29*
923603	*AB1-176 E*	*2.12*
923902	*AB2-030 E*	*0.79*
923921	*AB2-032 C*	*5.34*
923922	*AB2-032 E*	*2.51*
923931	*AB2-033 C*	*1.41*
923932	*AB2-033 E*	*0.56*
923951	*AB2-036 C*	*11.45*
923952	*AB2-036 E*	*18.72*
923961	*AB2-037 C*	*12.73*
923962	*AB2-037 E*	*20.8*
924191	*AB2-063 C*	*2.87*
924192	*AB2-063 E*	*4.69*
924361	*AB2-084 C*	*0.75*

924362	*AB2-084 E*	*1.22*
924681	*AB2-120 C OP*	*7.49*
924682	*AB2-120 E OP*	*12.22*
924781	*AB2-130 C OP*	*6.58*
924782	*AB2-130 E OP*	*10.73*
924801	*AB2-133 C OP*	*14.2*
924802	*AB2-133 E OP*	*14.16*
924821	*AB2-135 C*	*12.84*
924822	*AB2-135 E*	*14.65*
924831	*AB2-136 C*	*1.07*
924832	*AB2-136 E*	*5.51*
924881	*AB2-142 C*	*1.14*
924882	*AB2-142 E*	*1.85*
924971	*AB2-153 C*	*2.98*
924972	*AB2-153 E*	*4.87*
925091	*AB2-166 C*	*0.4*
925092	*AB2-166 E*	*0.7*
925101	*AB2-167 C*	*1.05*
925102	*AB2-167 E*	*1.72*
925151	*AB2-172 C OP*	*4.11*
925152	*AB2-172 E OP*	*6.7*
925231	*AB2-177 C*	*0.49*
925232	*AB2-177 E*	*0.81*
925251	*AB2-179 C OP*	*26.29*
925252	*AB2-179 E OP*	*8.67*
925261	*AB2-180 C*	*2.8*
925262	*AB2-180 E*	*1.2*
925271	*AB2-185 C OP*	*4.42*
925272	*AB2-185 E OP*	*1.89*

Appendix 3

(DP&L - DP&L) The TOWNSEND-MIDLTNTP 138 kV line (from bus 232107 to bus 232106 ckt 1) loads from 105.58% to 106.55% (AC power flow) of its emergency rating (348 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 7.85 MW to the thermal violation.

```
CONTINGENCY 'DBL_4NC'                          /* RED LION-CEDAR CREEK
230;RED LION-CARTANZA 230
  OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
  OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
  END
```

Bus Number	*Bus Name*	*Full Contribution*
232900	*DEMECSMY*	*2.25*
232851	*DUP-SFR1*	*0.43*

232902	*EASTMUNI*	*3.57*
232923	*MR1*	*3.36*
232924	*MR2*	*3.36*
232910	*NRG_G1*	*2.55*
232911	*NRG_G2*	*2.55*
297077	*V2-028 E*	*0.75*
904212	*V4-022E*	*0.61*
232813	*VAUGHN*	*0.16*
901004	*W1-003 E*	*0.89*
901014	*W1-004 E*	*0.89*
901024	*W1-005 E*	*0.89*
901034	*W1-006 E*	*0.89*
901411	*W1-062*	*2.39*
907052	*X1-032 E*	*0.79*
907324	*X1-096 E*	*18.27*
910571	*X3-008 C*	*0.34*
910572	*X3-008 E*	*2.68*
910591	*X3-015 C*	*0.32*
910592	*X3-015 E*	*2.51*
910821	*X3-066 C*	*0.18*
910822	*X3-066 E*	*1.41*
913361	*Y1-079 C*	*0.25*
913362	*Y1-079 E*	*1.96*
913411	*Y1-080 C*	*0.05*
913412	*Y1-080 E*	*0.43*
915751	*Y3-033*	*1.19*
915752	*Y3-033*	*7.92*
915542	*Y3-058 E*	*1.86*
920582	*Z1-076 C*	*1.05*
920583	*Z1-076 E*	*1.71*
920592	*Z1-077 C*	*0.75*
920593	*Z1-077 E*	*1.22*
916281	*Z1-081 C*	*0.21*
916282	*Z1-081 E*	*1.65*
917082	*Z2-012 E*	*2.44*
920763	*Z2-076 E*	*0.4*
920773	*Z2-077 E*	*0.4*
920812	*Z2-097 C*	*0.32*
920813	*Z2-097 E*	*0.65*
921123	*AA1-059 E*	*0.33*
921142	*AA1-061 C*	*2.87*
921143	*AA1-061 E*	*1.42*
921442	*AA1-110 C*	*0.36*
921443	*AA1-110 E*	*0.89*
921592	*AA1-140 C*	*1.51*

921593	*AA1-140 E*	*2.47*
921602	*AA1-141 C*	*1.13*
921603	*AA1-141 E*	*1.84*
921872	*AA2-069*	*104.83*
922213	*AA2-129 E*	*3.94*
922222	*AA2-130*	*0.39*
922752	*AB1-056 C OP*	*12.8*
922753	*AB1-056 E OP*	*36.44*
922762	*AB1-057 C*	*12.99*
922763	*AB1-057 E*	*37.04*
923282	*AB1-137 C*	*2.79*
923283	*AB1-137 E*	*1.2*
923322	*AB1-141 C OP*	*5.3*
923323	*AB1-141 E OP*	*2.47*
923332	*AB1-142 C OP*	*5.3*
923333	*AB1-142 E OP*	*2.47*
923452	*AB1-162 C OP*	*2.4*
923453	*AB1-162 E OP*	*3.92*
923602	*AB1-176 C*	*1.29*
923603	*AB1-176 E*	*2.12*
923902	*AB2-030 E*	*0.79*
923921	*AB2-032 C*	*5.34*
923922	*AB2-032 E*	*2.51*
923931	*AB2-033 C*	*1.41*
923932	*AB2-033 E*	*0.56*
923951	*AB2-036 C*	*11.45*
923952	*AB2-036 E*	*18.72*
923961	*AB2-037 C*	*12.73*
923962	*AB2-037 E*	*20.8*
924191	*AB2-063 C*	*2.87*
924192	*AB2-063 E*	*4.69*
924361	*AB2-084 C*	*0.75*
924362	*AB2-084 E*	*1.22*
924681	*AB2-120 C OP*	*7.49*
924682	*AB2-120 E OP*	*12.22*
924781	*AB2-130 C OP*	*6.58*
924782	*AB2-130 E OP*	*10.73*
924801	*AB2-133 C OP*	*14.2*
924802	*AB2-133 E OP*	*14.16*
924821	*AB2-135 C*	*12.84*
924822	*AB2-135 E*	*14.65*
924831	*AB2-136 C*	*1.07*
924832	*AB2-136 E*	*5.51*
924881	*AB2-142 C*	*1.14*
924882	*AB2-142 E*	*1.85*

924971	*AB2-153 C*	*2.98*
924972	*AB2-153 E*	*4.87*
925091	*AB2-166 C*	*0.4*
925092	*AB2-166 E*	*0.7*
925101	*AB2-167 C*	*1.05*
925102	*AB2-167 E*	*1.72*
925151	*AB2-172 C OP*	*4.11*
925152	*AB2-172 E OP*	*6.7*
925231	*AB2-177 C*	*0.49*
925232	*AB2-177 E*	*0.81*
925251	*AB2-179 C OP*	*26.29*
925252	*AB2-179 E OP*	*8.67*
925261	*AB2-180 C*	*2.8*
925262	*AB2-180 E*	*1.2*
925271	*AB2-185 C OP*	*4.42*
925272	*AB2-185 E OP*	*1.89*