Revised
Generation Interconnection
System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position AD1-103

"Davis Besse-Beaver 345 kV"

April 2021
First Revision

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 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.

Revision from December 2018 System Impact Study Report

The AD1-103 System Impact Study results were revised based on a retooled analysis considering changes to the status of queue positions prior to AD1-103. Retooled results show that the both the Beaver-Black River 138 kV line overload and Segreto-Benton 345 kV line overload were removed due to withdrawals of earlier queue positions. The only remaining overload is the Hayes 345/138 kV transformer. The AD1-103 project is still the driver for this overload and will be responsible for the system reinforcement to install a second Hayes 345/138 kV transformer (*PJM Network Upgrade Number N3308*).

See the Network Impacts section of this report for the revised results. No other information in this report was modified. The Facilities Study Report will have the updated scope and cost for the physical interconnection of AD1-103 to the ATSI system.

General

Emerson Creek Wind LLC, the Interconnection Customer (IC), has proposed a Wind generating facility located in Huron County, Ohio. The installed facilities will have a total capability of 500.4 MW with 65.05 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 18, 2020[1]. **This study does not imply a ATSI commitment to this in-service date.**

[1] This date will be updated in the Facilities Study Report.

Point of Interconnection

AD1-103 will interconnect with the ATSI transmission system along the Davis Besse – Beaver 345kV line.

Cost Summary[2]

The AD1-103 project will be responsible for the following costs:

Description	Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 275,100
Non Direct Connection Network Upgrades	$ $2,525,100
Allocation for New System Upgrades	$ 6,605,500
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 9,405,700**

General Information

Interconnection Customer ("IC"): Emerson Creek Wind, LLC Queue Position: AD1-103

Interconnected Transmission Owner ("TO"): American Transmission Systems, Incorporated ("ATSI")

Impacted TO(s) (if applicable): American Transmission Systems, Incorporated ("ATSI")

PJM Zone: ATSI

FE Operating Company or Planning Region: Ohio Edison

Customer Connection Request

Requested Backfeed Date: _____ Requested Commercial Operation Date:[1] 12/18/2020

This study does not imply a FirstEnergy commitment to these dates.

New Facilities		Existing Facilities	
Capacity:	65.052 MW	Capacity:	N/A
Energy:	500.4 MW	Energy:	N/A
MFO[3]:	500.4 MW	MFO:	N/A

[2] This cost will be updated in the Facilities Study Report.

Fuel: Wind Prior Queue Position(s): N/A

Point of Interconnection

Primary Point of Interconnection: Beaver-Davis Besse 345 kV

[3] Maximum Facility Output

Attachment Facilities

There are no Attachment Facilities are required to support this interconnection.

Direct Connection Cost Estimate[4]

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Activity Cost	Tax (if applicable)	Total Cost
Project Management, Commissioning, Environmental, and SCADA.	$ 270,300	$ 34,700	$ 305,000
Transmission Meter Engineering and Field Technical Support (FTS) labor associated with the revenue metering on the 345 kV Davis-Besse (TE) tie line exit at the new ring bus substation connected to the AC2-103 and AD1-103 wind generation facilities.	$ 4,800	$ 700	$ 5,500
Total Direct Connection Facility Costs	**$ 275,100**	**$ 35,400**	**$ 310,500**

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Activity Cost	Tax (if applicable)	Total Cost
Add one (1) 345 kV circuit breaker to the proposed AC2-103 POI to expand the substation into a four-circuit breaker ring bus @ AC2-103 Interconnection	$ 2,325,100	$ 298,400	$ 2,623,500
Remote relaying upgrades at the Beaver 345kV Substation	$ 100,000	$ 12,838	$ 112,838
Remote relaying upgrades at the Davis 345kV Substation	$ 100,000	$ 12,838	$ 112,838
Total Non-Direct Connection Facility Costs	**$ 2,525,100**	**$ 324,076**	**$ 2,849,176**

[4] The scope and cost of the physical interconnection of AD1-103 onto the ATSI system will be updated in the Facilities Study Report.

Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by expanding the AC2-103 new 345 kV three (3) breaker ring bus into four breaker ring bus. The Beaver-Davis Besse 345 kV line will loop in/out of the AC2-103 POI. The AD1-103 POI will be located approximately 28.1miles from Beaver and 31.8 miles from Davis Besse at the same POI as AC2-103. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection point and the associated attachment facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site. The project will also require non-direct connection upgrades at Beaver and Davis Besse substations.

A summary of the connection facilities that will be required for the Primary POI and their estimated costs are shown in the following table. Based on this scope of work, it is expected to take a minimum of 18 months after the signing of an Interconnection Construction Service Agreement. This assume that the AC2-103 three breaker ring bus switching substation construction has been completed and in-service. This includes preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the AD1-103 interconnection substation. This assumes there will be no environmental issues with any of the new properties associated with this project, there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and PJM will allow all transmission system outages when requested.

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated Beaver-Davis Besse 345 kV circuit breaker to protect the AD1-103 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.

2. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

3. The purchase and installation of supervisory control and data acquisition ("SCADA") equipment to provide information in a compatible format to the FE Transmission System Control Center.

4. Compliance with the FE and PJM generator power factor and voltage control requirements.

5. The execution of a back-up service agreement to serve the customer load supplied from the AD1-103 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

Power Factor Requirements

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

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

FE Requirements

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

http://www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

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

Network Impacts

The Queue Project AD1-103 was evaluated as a 500.4 MW (Capacity 65.1 MW)) injection into the X1-027A 345 kV substation (which is tap of the Davis Besse – Beaver 345 kV line) in the ATSI area. Project AD1-103 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-103 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
ADD200	CONTINGENCY 'ADD200' DISCONNECT BRANCH FROM BUS 238569 TO BUS 239289 CKT 1 /* 02BEAVER 345 02HAYES 345 DISCONNECT BRANCH FROM BUS 238569 TO BUS 907060 CKT 1 /* 02BEAVER 345 X1-027A TAP 345 END

Generator Deliverability

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

None.

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

None.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

Contingency			Affected	Bus				Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	DCTL	ADD200	FE - FE	02HAYES 345/138 kV transformer	239289	239290	1	AC	89.79	103.92	ER	485	68.5	1

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

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None.

Contributions to previously identified circuit breakers found to be over-duty:

None.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

Steady-State Voltage Requirements

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

See Attachment 4

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

See Attachment 4

New System Reinforcements

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

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AD1-103 Allocation
#1	Hayes 345/138 kV transformer	To resolve the Hayes 345/138 kV transformer overload: • Upgrade is to add a 2nd Hayes 345/138 kV transformer. Estimated Cost is $6.6055 M (without tax) and it will take an estimated 22 months to complete. PJM Network Upgrade N3308. AD1-103 is responsible for this cost.	N3308	**$ 6,605,500**	**$ 6,605,500**
			Total New Network Upgrades		**$ 6,605,500**

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)

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

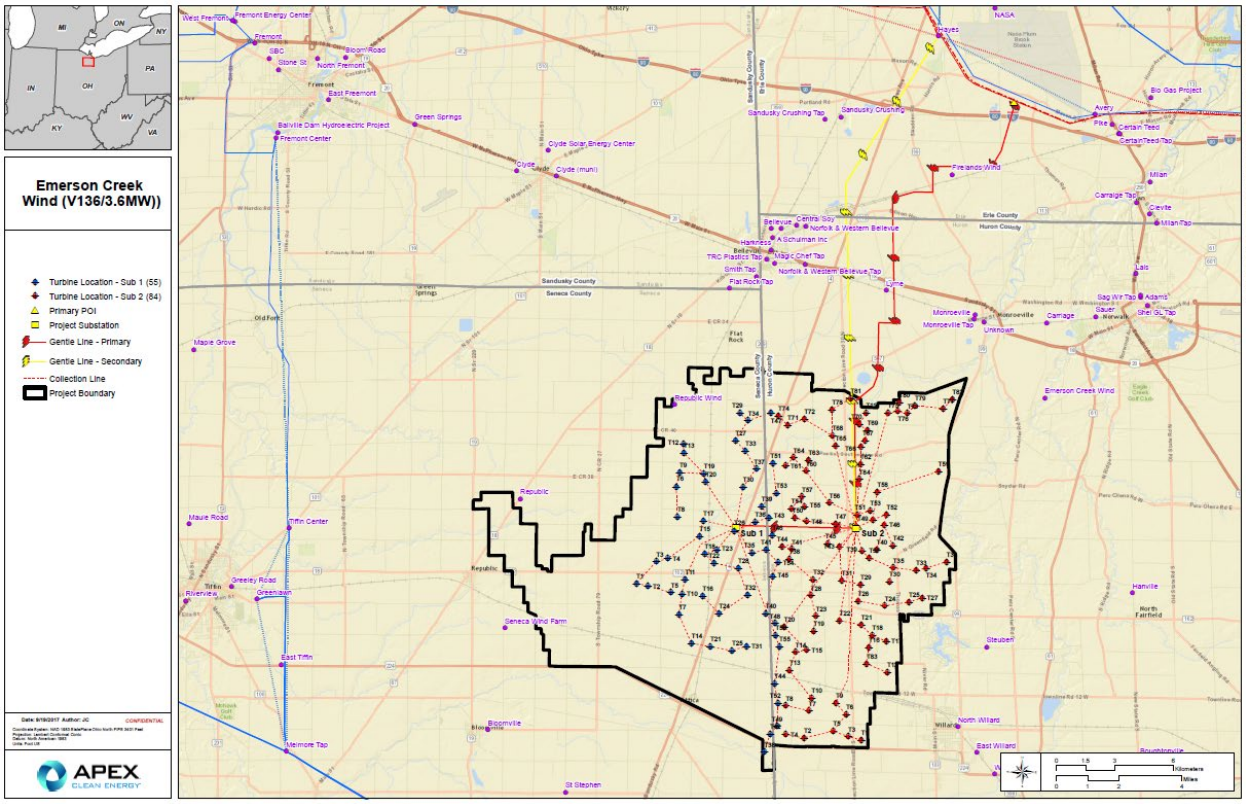
None

Affected System Analysis & Mitigation

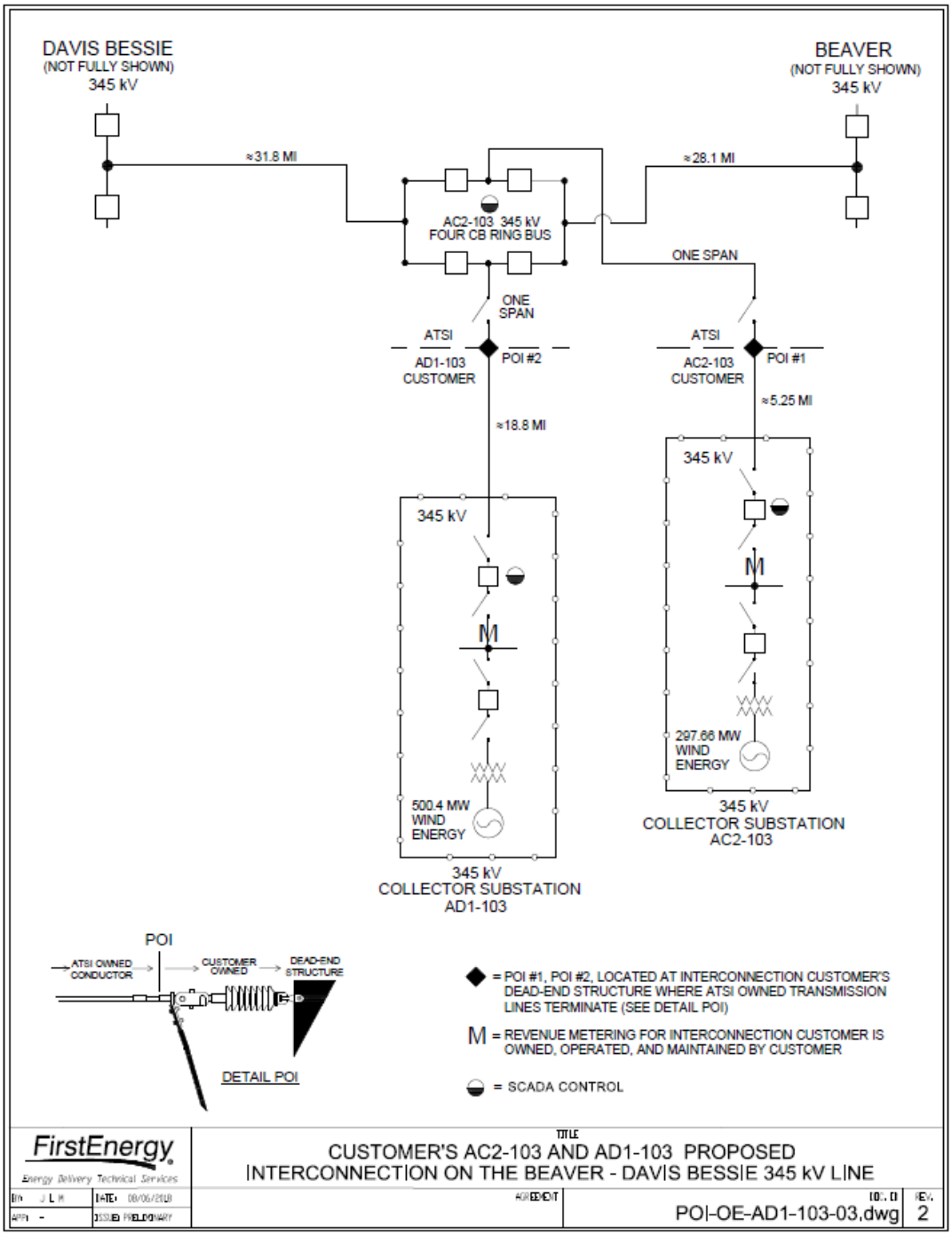
MISO Impacts:

No MISO Impacts were found in the Preliminary MISO affected system study. Final MISO impacts to be determined by MISO and any mitigations will need to be placed in-service prior to the customer going into Commercial Operation.

Attachment 1. Project Location



Attachment 2. Single Line Diagram



Attachment 3. Flowgate Details

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

It should be noted the project/generator MW contributions presented in the body of the report and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

Appendix 1

(FE - FE) The 02HAYES 345/138 kV transformer (from bus 239289 to bus 239290 ckt 1) loads from 97.25% to 110.59% (AC power flow) of its emergency rating (485 MVA) for the tower line contingency outage of 'ADD200'. This project contributes approximately 68.55 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
238670	02DVBSG1	26.33
238979	02NAPMUN	1.97
932791	AC2-103 C	5.3
932792	AC2-103 E	35.48
934761	AD1-103 C O1	8.91
934762	AD1-103 E O1	59.64
934891	AD1-118	5.31
LTF	CARR	0.58
LTF	CBM-S1	3.29
LTF	CBM-S2	1.21
LTF	CBM-W1	32.51
LTF	CBM-W2	24.09
LTF	CIN	3.89
LTF	CPLE	0.2
LTF	G-007	0.92
LTF	IPL	2.5
LTF	LGEE	0.68
LTF	MEC	7.97
LTF	MECS	18.68
LTF	O-066	3.13
LTF	RENSSELAER	0.45
LTF	ROSETON	3.26
LTF	WEC	1.31
LTF	Y3-032	15.95
931961	AB1-107 2	49.36

Attachment 4. Dynamic Simulation Analysis

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Executive Summary

Generator Interconnection Request AD1-103 is for a 500.40 MW Maximum Facility Output (MFO) wind generating facility. AD1-103 consists of 139 x 3.6 MW Vestas V136 Wind Turbines with a Point of Interconnection (POI) at a tap off of Davis Bessie to Beaver 345 kV stations in Huron County. AD1-103, AC2-103, and X1-027A would share the same POI switching station.

This report describes a dynamic simulation analysis of AD1-103 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2021 Summer Peak case, modified to include applicable queue projects. AD1-103 has been dispatched online at maximum power output, with POI voltage of (1.014 p.u.), consistent with the default generator reference voltage specified in PJM Manual 03 Transmission Operations Section 3.3.3 for generator connections to the PJM 345 kV system.

The AD1-103 queue project was tested for compliance with NERC, PJM and other applicable criteria. The range of contingencies evaluated was limited to that necessary to assess compliance and each was limited to a 20-second simulation time period.

Simulated NERC Standard TPL-001 faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Operating of a line section w/o a fault, Single-line-to-ground (slg) on Bus Section and Breaker. (Category P2)
3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5)
5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P3 and P6 faults will be studied on an as needed basis. In this study, P2 contingencies are covered by P1 and P4 contingencies.

The system was tested for a system intact condition and the fault types listed above. Specific fault descriptions and breaker clearing times used for this study are provided in the result table.

No relevant 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 remaining fault contingencies tested on the 2021 Summer Peak case:

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

b) The AD1-103 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.

1. Introduction

Generator Interconnection Request AD1-103 is for a 500.40 MW Maximum Facility Output (MFO) wind generating facility. AD1-103 consists of 139 x 3.6 MW Vestas V136 Wind Turbines with a Point of Interconnection (POI) at a tap off of Davis Bessie to Beaver 345 kV stations in Huron County. AD1-103, AC2-103, and X1-027A would share the same POI switching station.

This analysis is effectively a screening study to determine whether the addition of AD1-103 will meet the dynamic requirements of the NERC, PJM and Transmission Owner reliability standards.

In this report the AD1-103 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

Generator Interconnection Request AD1-103 is for a 500.40 MW Maximum Facility Output (MFO) wind generating facility. AD1-103 consists of 139 x 3.6 MW Vestas V136 Wind Turbines with a Point of Interconnection (POI) at a tap off of Davis Bessie to Beaver 345 kV stations in Huron County. AD1-103, AC2-103, and X1-027A would share the same POI switching station.

Figure 1 shows the simplified one-line diagram of the AD1-103 loadflow model. Table 1 lists the parameters given in the impact study data and the corresponding parameters of the AD1-103 loadflow model.

The dynamic model for the AD1-103 plant is based on a Vestas user written model supplied by the developer as an attachment to the System Impact Study Datasheet.

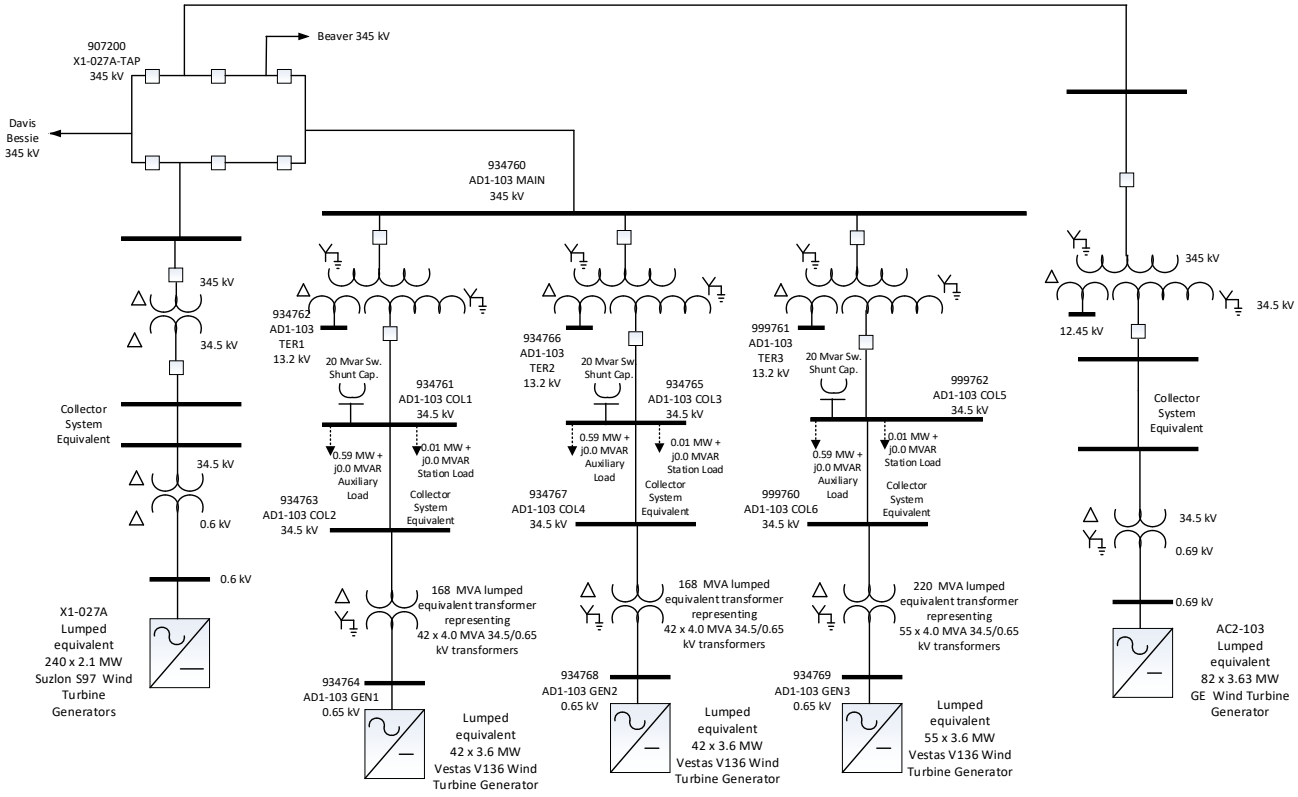

Figure 1: AD1-103 Plant Model

Table 1: AD1-103 Plant Model

	Impact Study Data	Model
WT Generators	139 x 3.6 MW Vestas V136 Wind Turbines MVA base = 3.8 MVA Vt = 0.65 kV Unsaturated sub-transient reactance = N/A	42 x 3.6 MW Vestas V136 Wind Turbines Pgen = 151.2 MW Pmax = 151.2 MW Pmin = 0 MW Qmax = 49.59 MVAr Qmin = - 49.59 MVAr Mbase = 159.6 MVA Zsource = N/A 42 x 3.6 MW Vestas V136 Wind Turbines Pgen = 151.2 MW Pmax = 151.2 MW Pmin = 0 MW Qmax = 49.59 MVAr Qmin = - 49.59 MVAr Mbase = 159.6 MVA Zsource = N/A 55 x 3.6 MW Vestas V136 Wind Turbines Pgen = 198 MW Pmax = 198 MW Pmin = 0 MW Qmax = 64.94 MVAr Qmin = -64.94 MVAr Mbase = 209 MVA Zsource = N/A

Inverter Based Step-Up Transformer	139 x 34.5/0.65 kV two winding transformer Rating = 556 MVA Transformer base = 4 MVA Impedance: High to Low: 0.006955 +j 0.089730 p.u Number of taps = 5 Tap step size = 2.5%	42 x 34.5/0.65 kV two winding transformer Rating = 168 MVA Transformer base = 168 MVA Impedance: High to Low: 0.006955 +j 0.089730 p.u Number of taps = 5 Tap step size = 2.5% 42 x 34.5/0.65 kV two winding transformer Rating = 168 MVA Transformer base = 168 MVA Impedance: High to Low: 0.006955 +j 0.089730 p.u Number of taps = 5 Tap step size = 2.5% 55 x 34.5/0.65 kV two winding transformer Rating = 220 MVA Transformer base = 220 MVA Impedance: High to Low: 0.006955 +j 0.089730 p.u Number of taps = 5 Tap step size = 2.5%

Wind Farm Generator Main Transformer	2 x 345/34.5/13.2 kV Rating = 100/134/167 MVA Transformer MVA Base = 100 MVA Impedance: High to Low = 0.002251 + j0.088471 p.u High to Tert = 0.002994 + j0.115261 p.u Low to Tert = 0.001208 + j0.046784 p.u Number of taps = N/A Tap step size = N/A 1 x 345/34.5/13.2 kV Rating = 134/178/222 MVA Transformer MVA Base = 134 MVA Impedance: High to Low = 0.002751 + j0.094970 p.u High to Tert = 0.003208 + j0.167 p.u Low to Tert = 0.003111 + j0.0680 p.u Number of taps = N/A Tap step size = N/A	2 x 345/34.5/13.2 kV Rating = 100/134/167 MVA Transformer MVA Base = 100 MVA Impedance: High to Low = 0.002251 + j0.088471 p.u High to Tert = 0.002994 + j0.115261 p.u Low to Tert = 0.001208 + j0.046784 p.u Number of taps = N/A Tap step size = N/A 1 x 345/34.5/13.2 kV Rating = 134/178/222 MVA Transformer MVA Base = 134 MVA Impedance: High to Low = 0.002751 + j0.094970 p.u High to Tert = 0.003208 + j0.167 p.u Low to Tert = 0.003111 + j0.0680 p.u Number of taps = N/A Tap step size = N/A
Auxiliary Load	0.59 MW + j0.0 Mvar at low voltage side of the GSU (Switched Offline)	0.59 MW + j0.0 Mvar at low voltage side of the GSU (Switched offline)
Station Load	0.01 MW + j0.0 Mvar at low voltage side of the GSU (Switched Offline)	0.01 MW + j0.0 Mvar at low voltage side of the GSU (Switched Offline)
Collector System Equivalent 1	Voltage Level = 34.5 kV MVA Base = 100 MVA Impedance = 0.003310 + j0.004070 p.u Charging susceptance = j0.056404 p.u	Voltage Level = 34.5 kV MVA Base = 100 MVA Impedance = 0.003310 + j0.004070 p.u Charging susceptance = j0.056404 p.u

Collector System Equivalent 2	Voltage Level = 34.5 kV MVA Base = 100 MVA Impedance = 0.002858 + j0.003030 p.u Charging susceptance = j0.050706 p.u	Voltage Level = 34.5 kV MVA Base = 100 MVA Impedance = 0.002858 + j0.003030 p.u Charging susceptance = j0.050706 p.u
Collector System Equivalent 3	Voltage Level = 34.5 kV MVA Base = 100 MVA Impedance = 0.003757 + j0.004461 p.u Charging susceptance = j0.074298 p.u	Voltage Level = 34.5 kV MVA Base = 100 MVA Impedance = 0.003757 + j0.004461 p.u Charging susceptance = j0.074298 p.u
Attachment Line	15.16 mile 345 kV line Impedance = 0.000840 + j0.007667 p.u Charging susceptance = j0.129540 p.u (Impedance on 100 MVA Base)	15.16 mile 345 kV line Impedance = 0.000840 + j0.007667 p.u Charging susceptance = j0.129540 p.u (Impedance on 100 MVA Base)

3. 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[5].

The selected load flow scenario is the RTEP 2021 Summer Peak case with the following modifications:

a) Addition of all applicable queue projects prior to AD1-103.

b) Addition of AD1-103 queue project.

c) Removal of withdrawn and subsequent queue projects in the vicinity of AD1-103.

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

The AD1-103 initial conditions are listed in Table 2, indicating maximum power output, with AD1-103 regulating POI voltage of (1.014 p.u.), consistent with the default generator reference voltage specified in PJM Manual 03 Transmission Operations Section 3.3.3 for generator connections to the PJM 345 kV system.

Table 2: AD1-103 machine initial conditions

Bus	Name	Unit	PGEN (MW)	QGEN (MVAR)	ETERM (p.u.)	POI Voltage (p.u.)
934764	AD1-103 GEN10.6500	1	151.2	26.7	1.05	1.0145
934768	AD1-103 GEN20.6500	1	151.2	26.7	1.05	1.0145
934769	AD1-103 GEN30.6500	1	198.0	26.7	1.04	1.0145

Generation within the vicinity of AD1-103 has been dispatched online at maximum output (PMAX). The dispatch of generation in the vicinity of AD1-103 is given in Attachment 3.

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

4. Fault Cases

Tables 3 listed the contingencies and results that were studied, with representative worst case total clearing times provided by PJM. Each contingency was studied over a 20 second simulation time interval.

Simulated NERC Standard TPL-001 faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Operating of a line section w/o a fault, Single-line-to-ground (slg) on Bus Section and Breaker. (Category P2)
3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5)
5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P3 and P6 faults will be studied on an as needed basis. In this study, P2 contingencies are covered by P1 and P4 contingencies.

The system was tested for a system intact condition and the fault types listed above. No relevant High Speed Reclosing (HSR) contingencies were studied.

5. Evaluation Criteria

This study is focused on AD1-103, 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 AD1-103 included is transiently stable and post-contingency oscillations should be positively damped with a damping margin of at least 3%.

b) The AD1-103 is able to ride through faults (except for faults where protective action trips AD1-103).

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.

The frequency protection was disabled due to the PSSE deficiency in calculating frequencies for 3ph fault at POIs.

For the fault contingencies tested in this study:

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

b) The AD1-103 generator was able to withstand all contingencies.

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.

7. Mitigations

No Mitigations were found to be required.

Table 3: Fault list

P0: Steady State

Fault ID	Duration
P0.00	Steady State 20 sec run

P1: Three Phase Faults with normal clearing

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P1.00	3ph @ X1-027A POI – X1-027A Main 345kV line, normal clear loss of X1-027A	5	Stable
P1.01	3ph @ X1-027A POI – AC2-103 345kV line, normal clear loss of AC2-103	5	Stable
P1.02	3ph @ X1-027A POI – Beaver 345kV line, normal clear	5	Stable
P1.03	3ph @ X1-027A POI – Davis Besse 345kV line, normal clear	5	Stable
P1.04	3ph @ Beaver – West Lorain 345kV line, normal clear loss of West Lorain unit 2, 3, 4, 5	5	Stable
P1.05	3ph @ Beaver – Lake Ave 345kV line #1, normal clear	5	Stable
P1.06	3ph @ Beaver – Lake Ave 345kV line #2, normal clear	5	Stable
P1.07	3ph @ Beaver – Carlisle 345kV line, normal clear	5	Stable
P1.08	3ph @ Beaver – X1-027A POI 345kV line, normal clear	5	Stable
P1.09	3ph @ Beaver – Hayes 345kV line, normal clear	5	Stable
P1.10	3ph @ Beaver 345/138kV TF #1, normal clear	5	Stable
P1.11	3ph @ Beaver 345/138kV TF #2, normal clear	5	Stable
P1.12	3ph @ Lake Ave – Beaver 345kV line #1, normal clear	5	Stable
P1.13	3ph @ Lake Ave – Beaver 345kV line #2, normal clear	5	Stable
P1.14	3ph @ Lake Ave – Avon 345kV line #1, normal clear	5	Stable
P1.15	3ph @ Lake Ave – Avon 345kV line #2, normal clear	5	Stable

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P1.16	3ph @ Lake Ave 345/138kV TF #1, normal clear	5	Stable
P1.17	3ph @ Lake Ave 345/138kV TF #2, normal clear	5	Stable
P1.18	3ph @ Avon – Lake Ave 345kV line #1, normal clear	5	Stable
P1.19	3ph @ Avon – Lake Ave 345kV line #2, normal clear	5	Stable
P1.20	3ph @ Avon 345/138kV TF #91, normal clear	5	Stable
P1.21	3ph @ Avon 345/138kV TF #92, normal clear	5	Stable
P1.22	3ph @ Avon – Juniper 345kV line, normal clear	5	Stable
P1.23	3ph @ Avon unit 9 GSU, normal clear loss of Avon unit 9	5	Stable
P1.24	3ph @ Hayes – Beaver 345kV line, normal clear	5	Stable
P1.25	3ph @ Hayes – Davis Besse 345kV line, normal clear	5	Stable
P1.26	3ph @ Hayes 345/138kV TF, normal clear	5	Stable
P1.27	3ph @ Davis Besse – X1-027A POI 345kV line, normal clear	5	Stable
P1.28	3ph @ Davis Besse – Hayes 345kV line, normal clear	5	Stable
P1.29	3ph @ Davis Besse – Bayshore 345kV line, normal clear	5	Stable
P1.30	3ph @ Davis Besse – Lemoyne 345kV line, normal clear	5	Stable
P1.31	3ph @ Davis Besse unit GSU, normal clear loss of the unit	5	Stable
P1.32	3ph @ Bayshore – Lallendorf 345kV line #1, normal clear	5	Stable
P1.33	3ph @ Bayshore – Lallendorf 345kV line #2, normal clear	5	Stable
P1.34	3ph @ Bayshore – Davis Besse 345kV line, normal clear	5	Stable
P1.35	3ph @ Bayshore 345/138kV TF #1, normal clear	5	Stable
P1.36	3ph @ Bayshore 345/138kV TF #2, normal clear	5	Stable
P1.37	3ph @ Lemoyne – Midway 345kV line, normal clear	5	Stable

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P1.38	3ph @ Lemoyne – Dowling 345kV line, normal clear	5	Stable
P1.39	3ph @ Lemoyne – Davis Besse 345kV line, normal clear	5	Stable
P1.40	3ph @ Lemoyne – Majestic 345kV line, normal clear	5	Stable
P1.41	3ph @ Lemoyne – Fostoria Central 345kV line, normal clear	5	Stable
P1.42	3ph @ Lemoyne – Troy 345kV line, normal clear loss of Lemoyne units	5	Stable
P1.43	3ph @ Lemoyne 345/138kV TF #1, normal clear	5	Stable
P1.44	3ph @ Lemoyne 345/138kV TF #2, normal clear	5	Stable
P1.45	3ph @ X1-027A POI – AD1-103 345kV line, normal clear loss of AD1-103	5	Stable

P4: SLG Stuck Breaker (SB) Faults at Backup Clearing

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.01	SLG @ X1-027A POI 345kV, normal clear loss of X1-027A – Davis Besse 345kV line, SB @ X1-027A POI 345kV, delayed clear loss of X1-027A	5/14	Stable
P4.02	SLG @ X1-027A POI 345kV, normal clear loss of X1-027A – Davis Besse 345kV line, SB @ X1-027A POI 345kV, delayed clear loss of AC2-103	5/14	Stable
P4.03	SLG @ X1-027A POI 345kV, normal clear loss of X1-027A – Beaver 345kV line, SB @ X1-027A POI 345kV, delayed clear loss of AC2-103	5/14	Stable
P4.04	SLG @ X1-027A POI 345kV, normal clear loss of X1-027A – Beaver 345kV line, SB @ X1-027A POI 345kV, delayed clear loss of AD1-103	5/14	Stable
P4.05	SLG @ Beaver 345kV N Bus, normal clear, SB @ Beaver 345kV, delayed clear loss of Beaver 345/138kV TF #1	5/14	Stable

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.06	SLG @ Beaver 345kV N Bus, normal clear, SB @ Beaver 345kV, delayed clear loss of West Lorain unit 2, 3, 4, 5	5/14	Stable
P4.07	SLG @ Beaver 345kV N Bus, normal clear, SB @ Beaver 345kV, delayed clear loss of Beaver – Lake Ave 345kV line #1	5/14	Stable
P4.08	SLG @ Beaver 345kV N Bus, normal clear, SB @ Beaver 345kV, delayed clear loss of Beaver – Lake Ave 345kV line #2	5/14	Stable
P4.09	SLG @ Beaver 345kV S Bus, normal clear loss of Beaver 345/138kV TF #2, SB @ Beaver 345kV, delayed clear loss of Beaver – Hayes 345kV line	5/14	Stable
P4.10	SLG @ Beaver 345kV S Bus, normal clear loss of Beaver 345/138kV TF #2, SB @ Beaver 345kV, delayed clear loss of Beaver – X1-027A POI 345kV line	5/14	Stable
P4.11	SLG @ Beaver 345kV S Bus, normal clear loss of Beaver 345/138kV TF #2, SB @ Beaver 345kV, delayed clear loss of Beaver – Carlisle 345kV line	5/65	Stable
P4.12	SLG @ Beaver 345kV S Bus, normal clear loss of Beaver 345/138kV TF #2, SB @ Beaver 345kV, delayed clear loss of Beaver – Lake Ave 345kV line #2	5/14	Stable
P4.13	SLG @ Beaver 345/138kV TF #1, normal clear, SB @ Beaver 345kV, delayed clear loss of Beaver – Hayes 345kV line	5/14	Stable
P4.14	SLG @ Beaver – West Lorain 345kV line, normal clear loss of West Lorain unit 2, 3, 4, 5, SB @ Beaver 345kV, delayed clear loss of Beaver – X1-027A 345kV line	5/14	Stable
P4.15	SLG @ Beaver – Lake Ave 345kV line #1, normal clear, SB @ Beaver 345kV, delayed clear loss of Beaver – Carlisle 345kV line	5/14	Stable
P4.16	SLG @ Lake Ave 345/138kV TF #1, normal clear, SB @ Lake Ave, delayed clear loss of Lake Ave – Beaver 345kV line #1	5/14	Stable
P4.17	SLG @ Lake Ave 345/138kV TF #1, normal clear, SB @ Lake Ave, delayed clear loss of Lake Ave – Beaver 345kV line #2	5/14	Stable
P4.18	SLG @ Lake Ave 345/138kV TF #2, normal clear, SB @ Lake Ave, delayed clear loss of Lake Ave – Avon 345kV line #1	5/14	Stable

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.19	SLG @ Lake Ave 345/138kV TF #2, normal clear, SB @ Lake Ave, delayed clear loss of Lake Ave – Avon 345kV line #2	5/14	Stable
P4.20	SLG @ Lake Ave – Avon 345kV line #1, normal clear, SB @ Lake Ave, delayed clear loss of Lake Ave – Beaver 345kV line #1	5/14	Stable
P4.21	SLG @ Lake Ave – Avon 345kV line #2, normal clear, SB @ Lake Ave, delayed clear loss of Lake Ave – Beaver 345kV line #2	5/14	Stable
P4.22	SLG @ Avon – Lake Ave 345kV line #1, normal clear, SB @ Avon, delayed clear loss of Avon unit 9	5/14	Stable
P4.23	SLG @ Avon – Lake Ave 345kV line #1, normal clear, SB @ Avon, delayed clear loss of Avon – Lake Ave 345kV line #2	5/14	Stable
P4.24	SLG @ Avon – Lake Ave 345kV line #2, normal clear, SB @ Avon, delayed clear loss of Avon 345/138kV TF 91	5/14	Stable
P4.25	SLG @ Avon – Juniper 345kV line, normal clear, SB @ Avon, delayed clear loss of Avon 345/138kV TF 91	5/14	Stable
P4.26	SLG @ Avon – Juniper 345kV line, normal clear, SB @ Avon, delayed clear loss of Avon 345/138kV TF 92	5/14	Stable
P4.27	SLG @ Avon 345/138kV TF 92, normal clear, SB @ Avon, delayed clear loss of Avon unit 9	5/14	Stable
P4.28	SLG @ Carlisle – North Medina 345kV line, normal clear, SB @ Carlisle, delayed clear loss of Carlisle 345kV bus	5/14	Stable
P4.29	SLG @ Hayes 345kV, normal clear loss of Hayes 345/138kV TF, SB @ Hayes 345kV, delayed clear loss of Hayes – Beaver 345kV line	5/14	Stable
P4.30	SLG @ Hayes 345kV, normal clear loss of Hayes 345/138kV TF, SB @ Hayes 345kV, delayed clear loss of Hayes – Davis Besse 345kV line	5/14	Stable
P4.31	SLG @ Hayes 345kV, normal clear loss of Hayes – Davis Besse 345kV line, SB @ Hayes 345kV, delayed clear loss of Hayes – Beaver 345kV line	5/14	Stable

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.32	SLG @ Hayes 345kV, normal clear loss of Hayes – Beaver 345kV, SB @ Hayes 345kV, delayed clear loss of line Hayes – Davis Besse 345kV line	5/14	Stable
P4.33	SLG @ Davis Besse 345kV bus 1, normal clear, SB @ Davis Besse, delayed clear loss of Davis Besse – Hayes 345kV line	5/14	Stable
P4.34	SLG @ Davis Besse 345kV bus 1, normal clear, SB @ Davis Besse, delayed clear loss of Davis Besse – Lemoyne 345kV line	5/14	Stable
P4.35	SLG @ Davis Besse 345kV bus 1, normal clear, SB @ Davis Besse, delayed clear loss of Davis Besse unit	5/14	Stable
P4.36	SLG @ Davis Besse 345kV bus 2, normal clear, SB @ Davis Besse, delayed clear loss of Davis Besse – Hayes 345kV line	5/14	Stable
P4.37	SLG @ Davis Besse 345kV bus 2, normal clear, SB @ Davis Besse, delayed clear loss of Davis Besse – Bayshore 345kV line	5/14	Stable
P4.38	SLG @ Davis Besse 345kV bus 2, normal clear, SB @ Davis Besse, delayed clear loss of Davis Besse – X1-027A POI 345kV line	5/14	Stable
P4.39	SLG @ Davis Besse – Bayshore 345kV line, normal clear, SB @ Davis Besse, delayed clear loss of Davis Besse unit	5/14	Stable
P4.40	SLG @ Davis Besse – Lemoyne 345kV line, normal clear, SB @ Davis Besse, delayed clear loss of Davis Besse – X1-027A POI 345kV line	5/14	Stable
P4.41	SLG @ Bayshore 345kV, normal clear loss of Bayshore 345/138kV TF #1, SB @ Bayshore, delayed clear loss of Bayshore – Lallendorf 345kV line #1	5/14	Stable
P4.42	SLG @ Bayshore 345kV, normal clear loss of Bayshore 345/138kV TF #1, SB @ Bayshore, delayed clear loss of Bayshore – Lallendorf 345kV line #2	5/14	Stable
P4.43	SLG @ Bayshore 345kV, normal clear loss of Bayshore 345/138kV TF #2, SB @ Bayshore, delayed clear loss of Bayshore – Lallendorf 345kV line #1	5/14	Stable
P4.44	SLG @ Bayshore 345kV, normal clear loss of Bayshore 345/138kV TF #2, SB @ Bayshore, delayed clear loss of Bayshore – Davis Besse 345kV line	5/14	Stable

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.45	SLG @ Bayshore 345kV, normal clear loss of Bayshore – Lallendorf 345kV line #2, SB @ Bayshore, delayed clear loss of Bayshore – Davis Besse 345kV line	5/14	Stable
P4.46	SLG @ Lemoyne 345kV, normal clear loss of Lemoyne 345/138kV TF #1, SB @ Lemoyne 345kV, delayed clear loss of Lemoyne – Davis Besse 345kV line	5/14	Stable
P4.47	SLG @ Lemoyne 345kV, normal clear loss of Lemoyne 345/138kV TF #1, SB @ Lemoyne 345kV, delayed clear loss of Lemoyne – Majestic 345kV line	5/14	Stable
P4.48	SLG @ Lemoyne 345kV, normal clear loss of Lemoyne 345/138kV TF #2, SB @ Lemoyne 345kV, delayed clear loss of Lemoyne – Davis Besse 345kV line	5/14	Stable
P4.49	SLG @ Lemoyne 345kV, normal clear loss of Lemoyne 345/138kV TF #2, SB @ Lemoyne 345kV, delayed clear loss of Lemoyne – Midway 345kV line	5/14	Stable
P4.50	SLG @ Lemoyne 345kV, normal clear loss of Lemoyne – Midway 345kV line, SB @ Lemoyne 345kV, delayed clear loss of Lemoyne – Dowling 345kV line	5/14	Stable
P4.51	SLG @ Lemoyne 345kV, normal clear loss of Lemoyne – Dowling 345kV line, SB @ Lemoyne 345kV, delayed clear loss of Lemoyne units	5/14	Stable
P4.52	SLG @ Lemoyne 345kV, normal clear loss of Lemoyne – Fostoria Central 345kV line, SB @ Lemoyne 345kV, delayed clear loss of Lemoyne units	5/14	Stable
P4.53	SLG @ Lemoyne 345kV, normal clear loss of Lemoyne – Fostoria Central 345kV line, SB @ Lemoyne 345kV, delayed clear loss of Lemoyne – Majestic 345kV line	5/14	Stable

P5: SLG Fault with Delayed (Zone 2) Clearing

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P5.01	SLG @ 80% of X1-027A POI – Beaver 345kV line, relay failure @ X1-027A POI, delayed clear	5/65	Stable
P5.02	SLG @ 80% of X1-027A POI – Davis Besse 345kV line, relay failure @ X1-027A POI, delayed clear	5/65	Stable
P5.03	SLG @ 80% of Beaver – X1-027A POI 345kV line, relay failure @ Beaver, delayed clear	5/65	Stable
P5.04	SLG @ 80% of Beaver – Hayes 345kV line, relay failure @ Beaver, delayed clear	5/65	Stable

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P5.05	SLG @ 80% of Beaver – Lake Ave 345kV line #1, relay failure @ Beaver, delayed clear	5/65	Stable
P5.06	SLG @ 80% of Beaver – Lake Ave 345kV line #2, relay failure @ Beaver, delayed clear	5/65	Stable
P5.07	SLG @ 80% of Beaver – Carlisle 345kV line, relay failure @ Beaver, delayed clear	5/65	Stable
P5.08	SLG @ 80% of Davis Besse – X1-027A POI 345kV line, relay failure @ Davis Besse, delayed clear	5/65	Stable
P5.09	SLG @ 80% of Davis Besse – Hayes 345kV line, relay failure @ Davis Besse, delayed clear	5/65	Stable
P5.10	SLG @ 80% of Davis Besse – Bayshore 345kV line, relay failure @ Davis Besse, delayed clear	5/65	Stable
P5.11	SLG @ 80% of Davis Besse – Lemoyne 345kV line, relay failure @ Davis Besse, delayed clear	5/65	Stable

P7: Tower Failure

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P7.01	CONTINGENCY 'C5-CEI-345-001' /* AVON-Lake Ave #1 AND #2 345KV LINE OUTAGES	5	Stable
P7.02	CONTINGENCY 'C5-CEI-345-002' /* AVON-JUNIPER AND AVON-Lake Ave #1 345KV LINE OUTAGES	5	Stable
P7.03	CONTINGENCY 'C5-CEI-345-010' /* AVON-JUNIPER AND HARDING-CHAMBERLIN 345KV LINE OUTAGES	5	Stable
P7.04	CONTINGENCY 'C5-CEI-345-011' /* AVON-JUNIPER AND EMILY-FOX 138KV LINE OUTAGES	5	Stable
P7.05	CONTINGENCY 'C5-OEC-138-015' /* BEAV-CARL, BEAV-DAVISBESSE 345	5	Stable
P7.06	CONTINGENCY 'C5-OEC-345-001' /* BEAVER-LAKAVE 345 CK 1 & 2	5	Stable
P7.07	CONTINGENCY 'C5-TE-138-021' /* BAYSH - Y1-069 1 & 2 345	5	Stable
P7.08	CONTINGENCY 'C5-TE-138-022' /* Y1-069-MONROE/LEMOYNE-MAJ 345	5	Stable
P7.09	CONTINGENCY 'C5-TE-138-023' /* Y1-069-FOSTORIA/LEMOYNE-MAJ 345	5	Stable

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P7.10	CONTINGENCY 'C5-TE-138-024' /* Y1-069-FOSTORIA/LEMOYNE-FOSTORIA 345	5	Stable
P7.11	Beaver – Hayes 345kV line Beaver – X1-027A POI 345kV line	5	Stable
P7.12	Beaver – Hayes 345kV line Davis Besse – X1-027A POI 345kV line	5	Stable
P7.13	Davis Besse – Hayes 345kV line Davis Besse – X1-027A POI 345kV line	5	Stable

Attachment 1. PSS/E Model One Line Diagram

Attachment 2. PSS/E Dynamic Model

```
/*****************************************************************
/*** Project:            AD1-103
/*** POI:                   Davis Besse - Beaver 345kV (FE)
/*** Inverter:           Vestas V136
/*** Size:                  3.6 MW x 139 (MFO 500.4MW)
/*** PSSE Version:    33
/*** DLL/LIB:      VestasWF_V7.3.0.00_PSSEV33.dll, VestasModels_x86_3.0.dll (In Vestas
Folder)
/***            VestasWF_V7.2.19_PSSEV33.dll, VestasModels_x86_2.19.dll (In Vestas Folder)
/*****************************************************************

/Generator 1

934764,'USRMDL','1','CP3000', 101 1 6 561 10 50, 37201705 83 17 0 3 0
3.0000          0.0000          0.0000          1.0000          0.0010
          3600.0000       3600000.0000
1.0000          2.0000          4.0000          0.0000          1.0000
          -1.4000                 1.0000
0.0000          0.0000          0.8500          0.9000          1.2500
          1.2000          0.6000
650.0000        40.0000                 1.0000          3.0000
        0.0000          375.3000        60.0000
0.0005          1.0000          2.0000          0.9000          1.1000
          100.0000        200.0000
10.0000                 10.0000                 1507.4000       3.0000
        1.4400          0.8000          0.5000
0.4000          0.4900          0.1000          0.3900          1.2000
          0.0000          0.8500
0.0000          0.1500          0.0500          0.0500          0.1200
          2.5000          0.6000
0.0000          0.1000          0.2000          1.2000          1.3000
          1.1300          0.8700
1.0000          0.1000          1.0800          1.0000          0.0000
          1.0050          0.0300
0.0100          0.0100          0.0000          1.0000
        1000.0000       55.7500                 0.0000
200.0000        0.7000          1.3000          0.2000
        20.0000                 1.0000          5.0000
2.0000          4444444.00001500.0000           100.0000        1.1500
        200.0000        0.3500
7.8500          1.0440          -1.0440                 1.0440
        -1.0440                 -2.0880                 100000.0000
1.0000          1.0440          0.8500          0.7500          1.0440
          -0.2090                 5.0000
400.0000        100.0000        1.0440          20.0000
        -20.0000        100.0000        0.0001
940.0000        0.0000          0.7000          0.5500          3.5600
          0.1300          60.0000
```

0.1300 3600.0000 0.2000 12.0000
0.8000 1.3000 0.2500
2.0000 0.3600 0.1500 0.0600 0.0600
0.2000 0.2000
0.0000 120.0000 1000.0000 31.4000
62.8300 2.6180 0.2000
0.2500 1.0000 0.0000 0.0000
3200000.0000-200000.0000 0.0000
0.0000 0.0000 100.0000 160.0000
160.0000 10.0000 0.0000
0.0000 1.0000 1.0000 1.0000 0.0000
0.8973 0.9303
0.0000 3600000.00001200000.00003600000.00000.0000
733330.0000 -733330.0000
2200000.0000-2200000.0000 0.0000 -0.2987 0.5506
0.0000 -500000.0000
1.0000 1.0000 1.0000 0.0000 0.6435
0.6435 0.8700
1.1300 1.3565 1.3565 0.0500
20.0000 20.0000 1.1000
3.0000 0.8500 0.8700 0.9000 1.0000
1.1000 1.1300
1.2000 0.0000 1.0000 0.8000 1.2500
0.0000 2100000.0000
3600000.00003601000.00003602000.00000.0000 2100000.00003600000.0000
3601000.0000
3602000.00002200000.00002200000.00001222000.00001222000.00001222000.00000.0000
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2100000.00003450000.0000
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3452000.0000
2200000.00002200000.00001320000.00001320000.00001320000.00000.0000
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0.0000 0.0000 0.0000 0.0000
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2200000.0000-1117000.0000
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-1225000.0000 0.0000 2100000.00003600000.00003601000.0000
3602000.00000.0000
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-1117000.0000 -1117000.0000

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2100000.0000
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1664000.0000
1664000.0000-2200000.0000 -2200000.0000 -1225000.0000 -
1225000.0000-1225000.0000 0.0000
2100000.00003600000.00003601000.00003602000.00000.0000 2100000.0000
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0.1100 0.3000 0.2000 0.0000 0.4000
0.1200 0.4000
0.1200 1.8600 1450.0000 3.0000 0.1500
165.2000 2541.3000
7.3300 15.0000 0.1210 0.1665
0.2221 0.2862 0.3611
0.4467 0.5445 0.6550 0.7786 0.9148
1.0000 0.5935
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0.8955 0.9477
0.9998 0.9999 1.0000 35.0000
0.1000 0.0200 30.0000
10.0000 0.1000 -0.0208 0.0700
9.0000 11.0000 -0.0208
0.0700 -0.0208 0.0700 18.8330
11.0000 0.0420 9.0000
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0.3000 45.0000 -10.0000
1.0000 0.1000 0.1000 3.2500 2.5000
0.5000 0.0100
104.4000/

/Generator 2
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-1.4000 1.0000
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650.0000 40.0000 1.0000 3.0000
0.0000 375.3000 60.0000
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100.0000 200.0000
10.0000 10.0000 1507.4000 3.0000
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0.0000 0.8500
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2.5000 0.6000
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1.1300 0.8700
1.0000 0.1000 1.0800 1.0000 0.0000
1.0050 0.0300

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200.0000 0.7000 1.3000 0.2000
20.0000 1.0000 5.0000
2.0000 4444444.00001500.0000 100.0000 1.1500
200.0000 0.3500
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-1.0440 -2.0880 100000.0000
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400.0000 100.0000 1.0440 20.0000
-20.0000 100.0000 0.0001
940.0000 0.0000 0.7000 0.5500 3.5600
0.1300 60.0000
0.1300 3600.0000 0.2000 12.0000
0.8000 1.3000 0.2500
2.0000 0.3600 0.1500 0.0600 0.0600
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0.0000 -2200000.0000 -2200000.0000 -1467000.0000 -
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0.1100 0.3000 0.0200
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0.1200 0.4000
0.1200 1.8600 1450.0000 3.0000 0.1500
165.2000 2541.3000
7.3300 15.0000 0.1210 0.1665
0.2221 0.2862 0.3611
0.4467 0.5445 0.6550 0.7786 0.9148
1.0000 0.5935
0.6326 0.6716 0.7274 0.7832 0.8394
0.8955 0.9477
0.9998 0.9999 1.0000 35.0000
0.1000 0.0200 30.0000
10.0000 0.1000 -0.0208 0.0700
9.0000 11.0000 -0.0208
0.0700 -0.0208 0.0700 18.8330
11.0000 0.0420 9.0000
-2.4377 0.2753 0.0200 100.0000
0.3000 45.0000 -10.0000
1.0000 0.1000 0.1000 3.2500 2.5000
0.5000 0.0100
104.4000/

/Generator 3

934769,'USRMDL','1','CP3000', 101 1 6 561 10 50, 37201705 83 17 0 3 0
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0.0000 0.0000 0.8500 0.9000 1.2500
1.2000 0.6000

650.0000 40.0000 1.0000 3.0000
0.0000 375.3000 60.0000
0.0005 1.0000 2.0000 0.9000 1.1000
100.0000 200.0000
10.0000 10.0000 1507.4000 3.0000
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0.0000 0.1500 0.0500 0.0500 0.1200
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1.1300 0.8700
1.0000 0.1000 1.0800 1.0000 0.0000
1.0050 0.0300
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200.0000 0.3500
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-20.0000 100.0000 0.0001
940.0000 0.0000 0.7000 0.5500 3.5600
0.1300 60.0000
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0.0000 0.0000
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15.0000 3600.0000 0.0050 0.0200
0.1100 0.3000 0.0200
0.1100 0.3000 0.2000 0.0000 0.4000
0.1200 0.4000
0.1200 1.8600 1450.0000 3.0000 0.1500
165.2000 2541.3000
7.3300 15.0000 0.1210 0.1665
0.2221 0.2862 0.3611
0.4467 0.5445 0.6550 0.7786 0.9148
1.0000 0.5935
0.6326 0.6716 0.7274 0.7832 0.8394
0.8955 0.9477
0.9998 0.9999 1.0000 35.0000
0.1000 0.0200 30.0000
10.0000 0.1000 -0.0208 0.0700
9.0000 11.0000 -0.0208
0.0700 -0.0208 0.0700 18.8330
11.0000 0.0420 9.0000
-2.4377 0.2753 0.0200 100.0000
0.3000 45.0000 -10.0000

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1.0000                  0.1000                  0.1000                  3.2500                  2.5000
                0.5000                  0.0100
104.4000/

/************************  PPC dynamic data start*************************************
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  323001     1000          2000          0             2     19
  934760 907200  1   934760 907200  1
  0      0              0             0             0             0
  0       0         0            0,           0    0
  0              0       934764    1       934768        1
  934769   1       0       0       0        0
  0       0       0       0        0        0
  0       0       0       0       0        0
  0       0       0       0       0        0
  0       0       0       0       0 0,
  500400   0.01           0.01          0.01          0.01          -0.1
  0.0           0.0 /
934764,'USRMDL','1','PMM219', 105  0  0  24  0  0,
  1.1           0.9           3000          1.0           500           1000
  0.85          0.9,
  0.0           1             0.05          30            0.025,
  1.0           1.15          1.10          1.0           2.0           1.1
  0.0           0.09          5000.0        1.0           3000.0/
934764,'USRMDL','1','APW219', 106  0  0  37  0  0,
  1             0.0           0.0           1000.00       1000.00       0.0
  0.0           50.           100.0,
  1.0           4.0           4.0           2.0           0.015         -0.015
  0.5           2000.0        2000.0,
  2.0           -2.0          0.0           -0.015        10.0          0.015
  10            1.0           50            2.0           100           3.0
  100           0.015         2000          2000,
  0.0           10000.0       0.0/
934764,'USRMDL','1','RPW219', 107  0  0  71  0  0,
  3   0   0.0           0.0           250200        250200
  5      0.0           0.005         0.0           1       0.0
  164473        164473        0.0           0.95          -0.95         1.0
  4.0           0.0           0.25          0.1           1.0           1.0
  0.0,          0.01,
  0.09          0.09          164473        0.5           0.5           0.01
  0.01,
  0.204         0.67,
  0.            5000.         100000.       0.2           0.4           0.60
  0.80          1.00          1.00          1.00          1.00          1.0
  0.00          0.1041        0.2083        0.3           0.4           0.1
  0.2           0.3           0.4           0.008         0.05          -1000
  1000          1000          1000          0             0             0
  0             0,
  4600          4600          2.0           10000.0/
/************************  End of PPC dynamic data ************************************
/************************  AD1-103 ENDS ***********************************
```

Attachment 3. PSS/E Case Dispatch

Bus Number	Bus Name	Id	In Service	PGen (MW)	PMax (MW)	PMin (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)
238555	02AVONG9 20.000	9	1	640	640	0	223.4	308.46	-263.1
238564	02BAYSG1 18.000	1	1	136	136	0	25.384	62.333	-29.78
238571	02BEAVGA 13.800	A	1	51.6	51.6	10	23.914	23.914	-6
238572	02BEAVGB 13.800	B	1	53.6	53.6	10	22.2	22.2	-6
238601	02FRMENG 1 18.000	1	1	209.6	209.6	0	-6.496	80	-70
238602	02FRMENG 2 18.000	2	1	209.6	209.6	0	-6.496	80	-70
238603	02FRMENG 3 23.000	3	1	343	343	0	-6.496	225	-170
238670	02DVBSG1 25.000	1	1	896	896	0	52.6	478.8	52.6
238683	02EASTG5 24.000	S5	1	0	0	0	-12.91	519	-150
238885	02LEMOG1 18.000	1	1	161	161	90	37.081	100	-45
238886	02LEMOG2 18.000	2	1	161	161	90	37.081	100	-45
238887	02LEMOG3 18.000	3	1	161	161	90	37.081	100	-45
238888	02LEMOG4 18.000	4	1	161	161	90	37.081	100	-45
238965	02MNFDG1 18.000	1	1	830	830	400	65.234	260	-435
238966	02MNFDG2 18.000	2	1	830	830	400	65.234	250	-435
238967	02MNFDG3 18.000	3	1	830	830	400	65.234	270	-435
238979	02NAPMUN 138.00	1	1	25	25	24	-6.953	14	-10
238979	02NAPMUN 138.00	2	1	12	12	10	-3.337	5	-6
239035	02PERRG1 22.000	1	1	1348.8	1348.8	1294	-66.6	600	-270
239087	02SAMMG3 20.000	3	1	176	176	55	37.063	114.67	-39.33
239088	02SAMMG4 20.000	4	1	172.6	172.6	77	37.063	118.13	-42.92
239089	02SAMMG5 24.000	5	1	291.3	291.3	135	37.063	104.95	-27.98
239090	02SAMMG6 20.000	6	1	600	600	250	37.063	165.27	-175.1
239091	02SAMMG7 20.000	7	1	600	600	250	37.063	200.62	-225.6
239171	02WLORG-2 13.800	2	1	82.6	82.6	45	29.238	63.943	-26.49
239172	02WLORG-3 13.800	3	1	84.9	84.9	45	29.238	64.343	-26.59
239173	02WLORG-4 13.800	4	1	84.7	84.7	45	29.238	62.867	-26.22
239174	02WLORG-5 13.800	5	1	85	85	45	29.238	63.714	-26.43
239175	02WLORG-6 13.800	6	1	85	85	45	58.872	63.143	-26.29
239267	02AVG10 13.800	10	1	21	21	0	5	5	5
239293	02BS-PKR 4.1600	99	1	14.6	14.6	0	-0.003	8	-4
240950	02BG5 69.000	1	1	11	11	0	0	20	0
240950	02BG5 69.000	2	1	11	11	0	0	12.7	0
247270	05RPMNG1 18.000	1	1	151.1	151.1	75	12.217	88.48	-57.32
247271	05RPMNG2 18.000	2	1	151	151	75	12.217	105.13	-56.17
247272	05RPMNG3 18.000	3	1	151	151	75	12.217	84.87	-56.79

247549	V3-028 C 345.00	1C	1	7.6	7.6	0	0	0	0
247940	U4-028 0.6900	1	1	100.8	100.8	0	0	0	0
247941	U4-029 0.6900	1	1	100.8	100.8	0	0	0	0
247948	V3-028 E 345.00	1E	1	12.4	12.4	0	0	0	0
253900	15BVRVL1 22.000	1	1	998	998	998	194.51	412	37.8
253901	15BVRVL2 22.000	2	1	999	999	999	194.51	411	38.2
256338	18PALISD 22.000	1	1	822.82	822.82	150	349.2	349.2	-312.3
264500	19COLFX 41.570	11	1	12.1	12.1	0	0	0	0
264759	19MON12P 345.00	11	1	12.05	12.05	0	0	0	0
264854	19ENFPP 22.000	1	1	1176.5	1176.5	1102.2	423.29	430	-40
264871	19MON1 26.000	1	1	806.84	806.84	350	161.15	327	-184
264872	19MON2 26.000	2	1	821.3	821.3	370	161.15	452	-175
264873	19MON3 26.000	3	1	828.08	828.08	325	216.45	492	-150
264874	19MON4 26.000	4	1	807.07	807.07	350	216.45	441	-164
907210	X1-027A WT1 0.6000	1	1	126	126	1	0	0	0
907211	X1-027A WT2 0.6000	1	1	126	126	1	0	0	0
907212	X1-027A WT3 0.6000	1	1	126	126	1	0	0	0
907213	X1-027A WT4 0.6000	1	1	126	126	1	0	0	0
913441	AA1-056_ST1 19.000	1	1	336.2	336.2	0	94.383	220	-163
913442	AA1-056_CT2 19.000	1	1	324.3	324.3	0	94.383	202	-151
913443	AA1-056_CT1 19.000	1	1	324.3	324.3	0	94.383	202	-151
918001	AA1-006 69.000	1	1	0.4	0.4	0	0.192	0.192	-0.132
930631	AB1-107 CT1 20.000	1	1	313.5	313.5	0	68.91	150	-100
930632	AB1-107 CT2 20.000	1	1	313.5	313.5	0	102.59	150	-100
930633	AB1-107 ST1 19.000	1	1	353	353	0	102.59	170	-115
931798	AC2-103 GEN1 0.6900	1	1	148.83	148.83	0	26.695	58.785	-58.79
931799	AC2-103 GEN2 0.6900	1	1	148.83	148.83	0	26.695	58.785	-58.79
934764	AD1-103 GEN1 0.6500	1	1	151.2	151.2	0	26.695	49.59	-49.59
934768	AD1-103 GEN2 0.6500	1	1	151.2	151.2	0	26.695	49.59	-49.59
934769	AD1-103 GEN3 0.6500	1	1	198	198	0	26.695	64.94	-64.94

Attachment 4. Plots from Dynamic Simulations (See separated .PDF file)