Generation Interconnection
System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position AC2-127

Ladysmith3 230kV
8.2 MW Capacity / 19 MW Energy

March 2019

Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, Section 205, as well as the System Impact Study Agreement between Virginia Electric and Power Company, the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Virginia Electric and Power Company (VEPCO).

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 IC. As a requirement for interconnection, the IC 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 IC 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 IC is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The IC has proposed to uprate the Ladysmith Unit 3 natural gas generating facility located in Woodford, VA (Carolina County). The installed facilities will have a total capability of 209 MW with 168 MW of this output being recognized by PJM as Capacity. This queue request is for an additional **19 MW** of energy and **8.2 MW** of capacity over the current Interconnection Agreement for Unit 3. The proposed in-service date for this project is 6/01/2017. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AC2-127 interconnects with the ITO transmission system at Ladysmith 230kV substation (Unit 3 uprate).

Cost Summary

The AC2-127 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 0
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 0**

Attachment Facilities

Existing Attachment Facilities are sufficient. The single line is shown below in **Attachment 1**.

Direct Connection Cost Estimate:

None

Non-Direct Connection Cost Estimate:

None

System Reinforcements

1. Baseline projects b3027.1 and b3027.2 were included in the stability evaluation for the AC2-125_126_127_128_129 uprates, and are required to be in service for these projects to be in-service. **The expected ISD for the baseline projects is 06/01/2021.**

Baseline Project	Description	In-Service Date
b3027.1	Add a 2nd 500/230 kV 840 MVA transformer at Dominion's Ladysmith Substation.	6/1/2021
b3027.2	Re-conductor Line #2089 between Ladysmith and Ladysmith CT Substations to increase the line rating from 1047 MVA to 1225 MVA.	6/1/2021

2. IC to provide the Transmission Provider proposed measures to address the reactive capability deficiency identified in **Attachment 2** on or before **May 15, 2019**. Transmission Provider and Interconnected Transmission Owner will evaluate the proposed solution(s) as part of the Facilities Study.

Interconnection Customer Requirements

ITO's Facility Connection Requirements as posted on PJM's website http://www.pjm.com/~/media/planning/plan-standards/private-dominion/facility-connection-requirements1.ashx

Revenue Metering and SCADA Requirements

PJM Requirements

The IC 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 Attachment O, Appendix 2, Section 8.

Interconnected Transmission Owner Requirements

Metering and SCADA/Communication equipment must meet the requirements outlined in section 3.1.6 Metering and Telecommunications of ITO's Facility Connection Requirement NERC Standard FAC-001 which is publically available at www.dom.com .

Network Impacts

Queue Project AC2-127 was evaluated as a 19 MW (Capacity 8.2 MW) uprate to Ladysmith Unit 3 in the ITO area. AC2-127 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-127 was studied with a commercial probability of 100%. Potential network impacts are identified in this section.

Summer Peak Analysis - 2020

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None

Contribution to Previously Identified Overloads

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

None

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The IC 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

Short Circuit

(Summary of impacted circuit breakers)

None

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

Stability

Baseline projects b3027.1 and b3027.2 were included in the stability evaluation for the AC2-125_126_127_128_129 uprates, and are required to be in service for these projects to be in-service. **The expected ISD for the baseline projects is 06/01/2021.**

Reactive Power Assessment

See **Attachment 2** for the Reactive Power Assessment for AC2-125 through AC2-129.

Affected System Analysis & Mitigation

None

Light Load Analysis - 2020

None

System Reinforcements

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

Stability

Baseline projects b3027.1 and b3027.2 were included in the stability evaluation for the AC2-125_126_127_128_129 uprates, and are required to be in service for these projects to be in-service. **The expected ISD for the baseline projects is 06/01/2021.**

Baseline Project	Description	In-Service Date
b3027.1	Add a 2nd 500/230 kV 840 MVA transformer at Dominion's Ladysmith Substation.	6/1/2021
b3027.2	Re-conductor Line #2089 between Ladysmith and Ladysmith CT Substations to increase the line rating from 1047 MVA to 1225 MVA.	6/1/2021

Reactive Power Assessment

IC to provide the Transmission Provider proposed measures to address the reactive capability deficiency identified in **Attachment 2** on or before **May 15, 2019**. Transmission Provider and Interconnected Transmission Owner will evaluate the proposed solution(s) as part of the Facilities Study.

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)

None

Contribution to Previously Identified System Reinforcements

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

None

Light Load 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)

None

Contribution to Previously Identified System Reinforcements

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

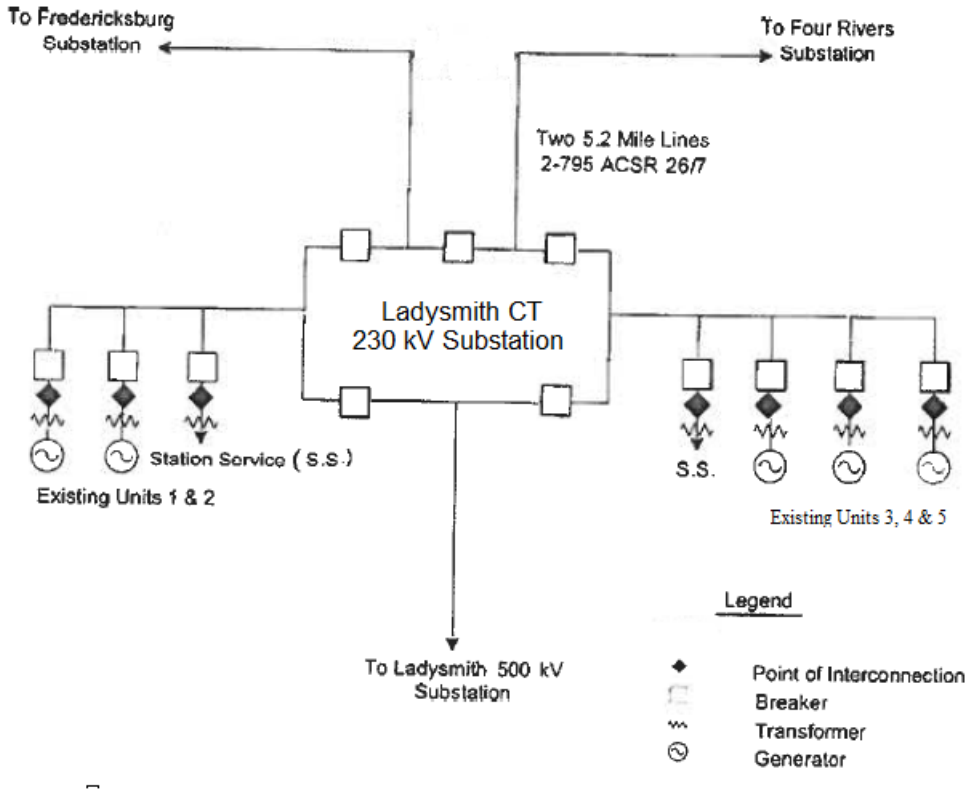
None

Incremental Capacity Transfer Rights (ICTRs)

This project does not have cost allocation towards any new network upgrades so no study is required for an increase to the CETL in the 2020/2021 BRA case.

Attachment 1.

System Configuration



Note: this AC2-127 Queue is to uprate the Existing Ladysmith Unit 3

Attachment 2.
AC2-125_126_127_128_129
Reactive power assessment

January 2019

Description

Generator Interconnection Request AC2-125_126_127_128_129 (95 MW uprate to existing Ladysmith units 1 to 5, 19MW each) is for a 1045 Maximum Facility Output (MFO) natural gas fired combustion turbine generation facility. This request results in an increase to Maximum Facility Output (MFO) from 950 MW to 1045 MW.

AC2-125_126_127_128_129 consists of 5 CT's with a Point of Interconnection (POI) at Ladysmith 230 kV station in the Dominion system.

	WINTER		
	Gross	Load	Net
Existing MW	191	~1	190
Increase MW	19		19
Total MW	210	~1	209

	SUMMER		
	Gross	Load	Net
Existing MW	152.1	~1	151.1
Increase MW	14.9		14.9
Total MW	167	~1	166

Reactive Power Design Criteria

The existing MW portion of each of the Ladysmith units shall retain its existing ability to maintain a power factor of at least 0.95 leading to 0.90 lagging measured at the generator's terminals.

The increases related to AC2-125_126_127_128_129 shall be designed with the ability to maintain a power factor of at least 1.0 (unity) to 0.90 lagging measured at the generator's terminals.

Reactive power assessment AC2-125_126 (CT 1 & 2)

AC2-125_126 queue projects were evaluated for compliance with the reactive power requirements of the OATT.

Specific requirements are summarized in Tables 1 and 2. The design capability curves for the units are provided in Appendix A. Available reactive power was obtained based on design capability curve information. The 40 C Cold Gas curve was used for the CT 1 and 2 for winter and summer reactive capability calculations.

Reactive Capability (Winter):

Table 1. AC2-125_126: Reactive Power Assessment for CT 1 & 2 at Gross Winter MW

CT 1 & 2 234 MVA

		Required PF range			
	MW	**Lagging**	**Leading**	**MAX MVAR**	**MIN MVAR**
Existing MW (Gross)	191	0.9	0.95	92.5	62.7
MW increase (Gross)	19	0.9	1	9.2	0.00
Total Requirements (Gross)	210			101.7	62.7
Available reactive power at 210 MW*				103	79
Total deficiency in MVAR				**1.3**	**16.3**

*The available reactive power capability is determined using the design capability curve of the machine at the machine gross active power output.

Reactive Capability (Summer):

Table 2. AC2-125_126: Reactive Power Assessment for CT 1 & 2 at Gross Summer MW

CT 1 & 2	234	MVA			
		Required PF range			
	MW	**Lagging**	**Leading**	**MAX MVAR**	**MIN MVAR**
Existing MW (Gross)	152.1	0.9	0.95	73.66	50
MW increase (Gross)	14.9	0.9	1	7.21	0.00
Total Requirements (Gross)	167			80.87	50
Available reactive power at 167 MW*				145	90
Total deficiency in MVAR				**64.13**	**40**

*The available reactive power capability is determined using the design capability curve of the machine at the machine gross active power output.

The AC2-125_126 queue projects were found to be **compliant** for the MFO values requested for Winter and **compliant** for the MFO values requested for Summer based on the suggested operating point and the project design capability.

Reactive power assessment AC2-127_128 (CT 3 & 4)

AC2-127_128 queue projects were evaluated for compliance with the reactive power requirements of the OATT.

Specific requirements are summarized in Tables 3 and 4. The design capability curves for the units are provided in Appendix A. Available reactive power was obtained based on design capability curve information. The 40 C Cold Gas curve was used for the CT 3 and 4 for winter and summer reactive capability calculations.

Reactive Capability (Winter):

Table 3. AC2-127_128: Reactive Power Assessment for CT 3 & 4 at Gross Winter MW

CT 3 & 4	226	MVA			
		Required PF range			
	MW	**Lagging**	**Leading**	**MAX MVAR**	**MIN MVAR**
Existing MW (Gross)	191	0.9	0.95	92.5	62.7
MW increase (Gross)	19	0.9	1	9.2	0.00
Total Requirements (Gross)	210			101.7	62.7
Available reactive power at 210 MW*				85	73
Total deficiency in MVAR				**16.7**	**10.3**

*The available reactive power capability is determined using the design capability curve of the machine at the machine gross active power output.

Reactive Capability (Summer):

Table 4. AC2-127_128: Reactive Power Assessment for CT 3 & 4 at Gross Summer MW

CT 3 & 4	226	MVA			
		Required PF range			
	MW	**Lagging**	**Leading**	**MAX MVAR**	**MIN MVAR**
Existing MW (Gross)	152.1	0.9	0.95	73.66	50
MW increase (Gross)	14.9	0.9	1	7.21	0.00
Total Requirements (Gross)	167			80.87	50
Available reactive power at 167 MW*				135	85
Total deficiency in MVAR				**54.13**	**35**

*The available reactive power capability is determined using the design capability curve of the machine at the machine gross active power output.

The AC2-127_128 queue projects were found to be **deficient** for the MFO values requested for Winter and **compliant** for the MFO values requested for Summer based on the suggested operating point and the project design capability.

Reactive power assessment AC2-129 (CT 5)

AC2-129 queue project was evaluated for compliance with the reactive power requirements of the OATT.

Specific requirements are summarized in Tables 5 and 6. The design capability curves for the units are provided in Appendix A. Available reactive power was obtained based on design capability curve information. The 40 C Cold Gas curve was used for the CT 5 for winter and summer reactive capability calculations.

Reactive Capability (Winter):

Table 5. AC2-129: Reactive Power Assessment for CT 5 at Gross Winter MW

CT 5	226	MVA			
		Required PF range			
	MW	**Lagging**	**Leading**	**MAX MVAR**	**MIN MVAR**
Existing MW (Gross)	191	0.9	0.95	92.5	62.7
MW increase (Gross)	19	0.9	1	9.2	0.00
Total Requirements (Gross)	210			101.7	62.7
Available reactive power at 210 MW*				85	70
Total deficiency in MVAR				**16.7**	**7.3**

*The available reactive power capability is determined using the design capability curve of the machine at the machine gross active power output.

Reactive Capability (Summer):

Table 6. AC2-129: Reactive Power Assessment for CT 5 at Gross Summer MW

CT 5	226 MVA				
		Required PF range			
	MW	Lagging	Leading	MAX MVAR	MIN MVAR
Existing MW (Gross)	152.1	0.9	0.95	73.66	50
MW increase (Gross)	14.9	0.9	1	7.21	0.00
Total Requirements (Gross)	167			80.87	50
Available reactive power at 167 MW*				135	85
Total deficiency in MVAR				**54.13**	**35**

*The available reactive power capability is determined using the design capability curve of the machine at the machine gross active power output.

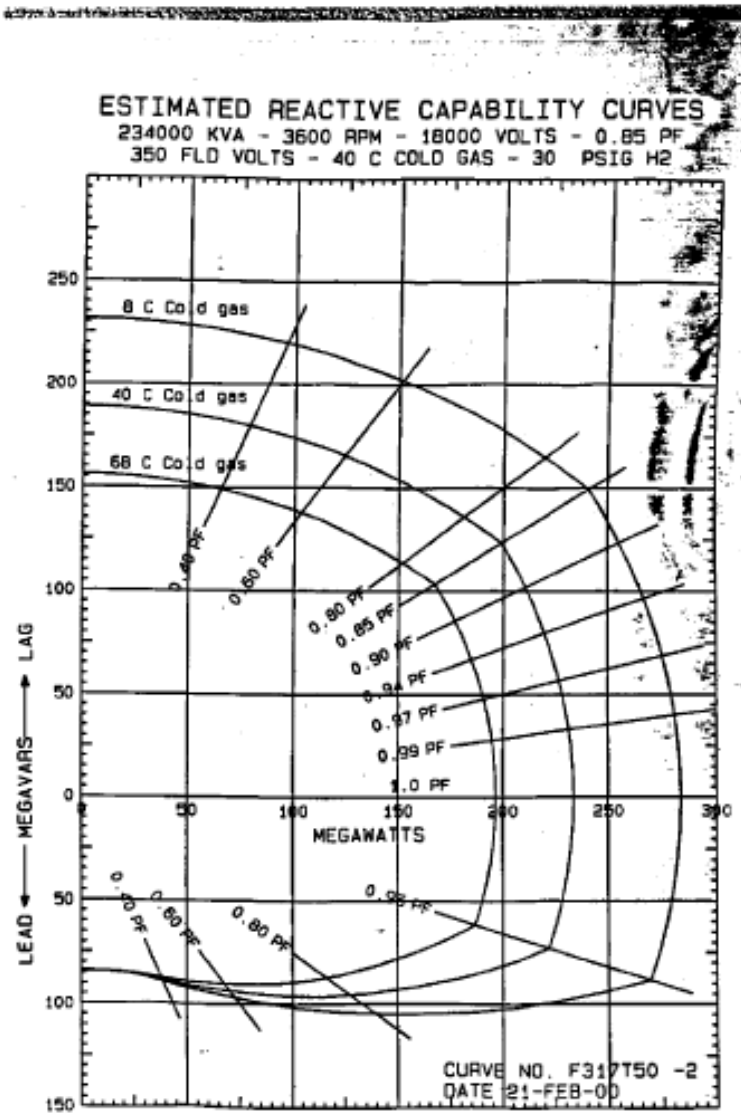
The AC2-129 queue project was found to be **deficient** for the MFO values requested for Winter and **compliant** for the MFO values requested for Summer based on the suggested operating point and the project design capability.

Conclusions

The combined Ladysmith CT units at the uprated MW's were found to be **deficient by 47.5 MVAR lagging for Winter** MFO calculations

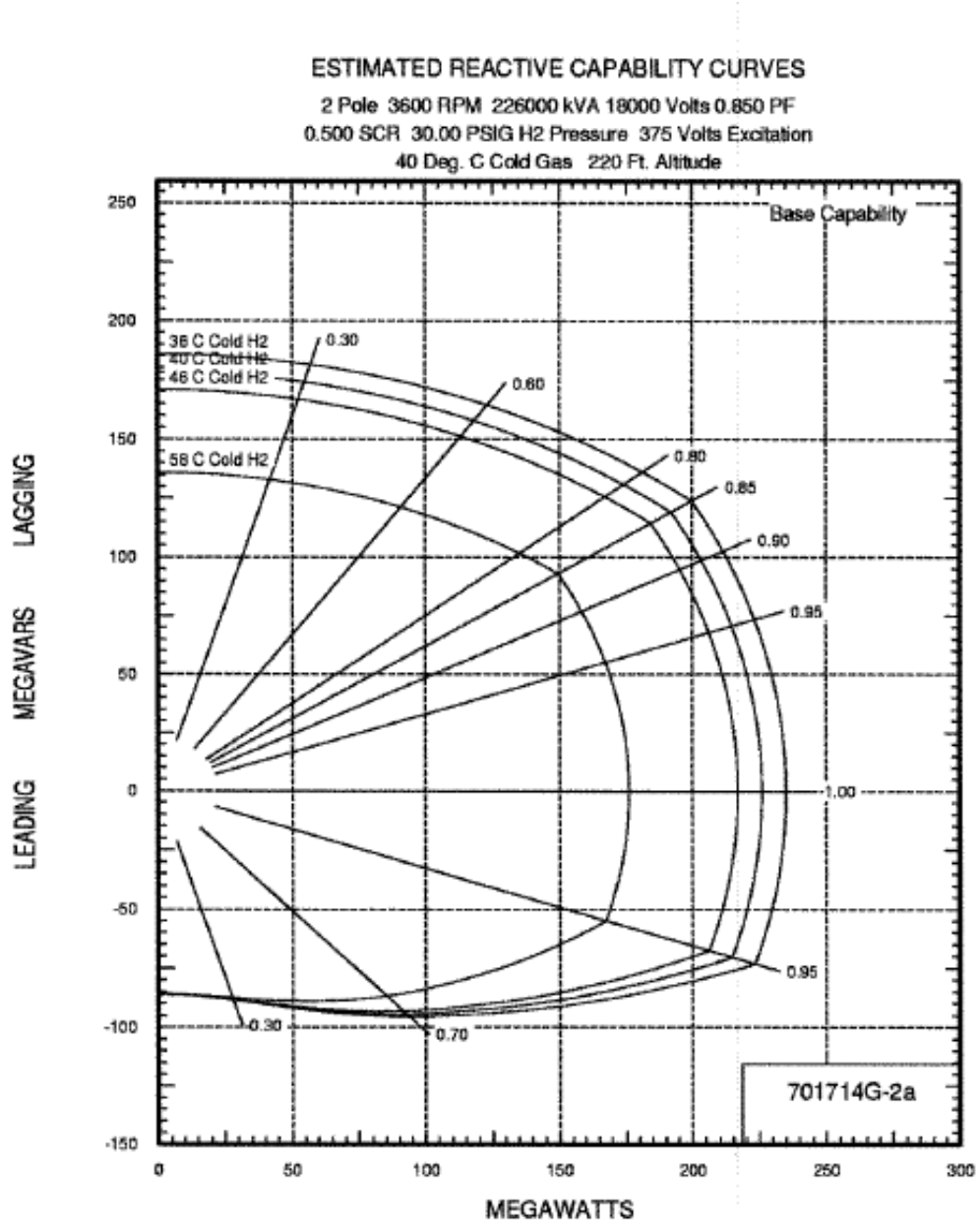
APPENDIX A: Ladysmith CT 1 & 2 Reactive Curve

SIZE	DWG NO	SH	REV
A	364A2124	5	-



GENERAL ELECTRIC COMPANY	SIZE	CAGE CODE	DWG NO
GE Power Generation SCHENECTADY, NY	A		364A2124
DRAWN			
ISSUED	SCALE		SHEET 5

Ladysmith CT 3 & 4 Reactive Curve



Ladysmith CT 5 Reactive Curve