Generator Interconnection Request

System Impact Study

For: Lee Nuclear

Service Location: Cherokee County, SC

Total Output: 2,344 MW

In-Service Date: 6/1/2018

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Date: 8/9/2011

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1.0 Introduction

Following are the results of the Generation System Impact Study for the installation of 2,344 MW of generating capacity in Cherokee County, SC. This site is located at a new switching station, southeast of Riverview Switching Station and north of the 230 kV lines between Catawba and Pacolet and has an estimated Commercial Operation Date of January 1, 2021 for unit 1 and January 1, 2022 for unit 2.

2.0 Study Assumptions and Methodology

The power flow cases used in the study were developed from the Duke internal year 2021 summer peak case. The results of Duke's annual screening were used as a baseline to identify the impact of the new generation. To determine the thermal impact on Duke's transmission system, the new generation was modeled with Unit 1 connected to the 230 kV grid, Unit 2 connected to the 525 kV grid, and two 500/230 kV auto-transformer banks connecting the 230 kV and the 525 kV grid. The economic generation dispatch was also changed by adding the new generation and forcing it on prior to the dispatch of the remaining Duke Balancing Authority Area units. The study cases were re-dispatched, solved and saved for use.

The NRIS thermal study uses the results of Duke Energy Power Delivery's annual internal screening as a baseline to determine the impact of new generation. The annual internal screening identifies violations of the Duke Energy Power Transmission System Planning Guidelines and this information is used to develop the transmission asset expansion plan. The annual screening provides branch loading for postulated transmission line or transformer contingencies under various generation dispatches. The thermal study results following the inclusion of the new generation were obtained by the same methods, and are therefore comparable to the annual screening. The results are compared to identify significant impacts to the Duke transmission system.

Stability studies are performed using an MMWG dynamics model that has been updated with the appropriate generator and equipment parameters for the new units. For this study, the SERC dynamically reduced 2016 summer peak case was taken and modified by removing the Duke system and inserting the Duke internal 2021 summer peak case. The case was modified to turn off some units to offset the new generation. Several transmission system improvements were identified for the addition of these units during the power flow portion of the interconnection request and were added to the dynamics case. NERC Category B, Category C, and Category D faults were evaluated.

Fault studies are performed by modeling the new generator and previously queued generation ahead of the new generator in the interconnection queue. Any significant changes in fault duty resulting from the new generator's installation are identified. Various faults are placed on the system and their impact versus equipment rating is evaluated.

Reactive Capability is evaluated by modeling a facility's generators and step-up transformers (GSU's) at various taps and system voltage conditions. The reactive capability of the facility can be affected by many factors including generator capability limits, excitation limits, and bus voltage limits. The evaluation determines whether sufficient reactive support will be available at the Connection Point.

3.0 Thermal Study Results

3.1 NRIS Evaluation

The following network upgrades were identified as being attributable to the studied generating facility:

WITH ALL PREVIOUSLY QUEUED PROJECTS:

Facility Name/Upgrade	Existing Size/Type	Proposed Size/Type	Mileage	Estimated Cost	Lead Time (months)
1. Asbury 500 kV Line (Fold-in to site)	New ROW	B2515 ACSR	29.2	$58.4MM	42
2. Earl 100 kV Lines (Shelby Tie – Transco Tap)	B336 ACSR	B954 ACSR	5.01	$3.3MM	19
3. Gardner 100 kV Lines (Peacock Tie – McAdenville Junction)	795 ACSR	B795 ACSR	7.82	$5.1MM	19
4. Hook 100 kV Lines (Newport Tie – Wylie Switching Station)	795 ACSR	B795 ACSR	7.47	$4.9MM	19
5. Lee Nuclear 500/230 kV Switchyard	N/A	N/A	N/A	$18MM	
6. Lee Nuclear 500/230 kV Transformers (2)	N/A	750 MVA	N/A	$28MM	
7. Peacock Add Third 230/100 kV Transformer	N/A	400 MVA	N/A	$5.2MM	14
8. Roddey East 230 kV Lines (Catawba to fold-in)	954 ACSR	B1272 ACSR	21.5	$32.3MM	30
9. Roddey East 230 kV Lines (Fold-in to site)	New ROW	B1272 ACSR	7.5	$11.3MM	42
10. Roddey West 230 kV Lines (Pacolet to fold-in)	954 ACSR	B954 ACSR	14.25	$21.4MM	30
11. Roddey West 230 kV Lines (Fold-in to site)	New ROW	B954 ACSR	7.5	$11.3MM	42
CUSTOMER TOTAL COST ESTIMATE				$199.2MM	42

4.0 Fault Duty Study Results

The following breakers will need to be replaced:

1. At Catawba Nuclear Station the following two 230 kV breakers: PCB 26, PCB 29
2. At McAdenville Junction the following four 100 kV breakers: Mountain Island Bl & Wh, Pinhook Bl & Wh
3. At Pacolet Tie the following four 230 kV breakers: Bank 1 & 2 HT, bus junction, Kelsey Creek Wh
4. At Peacock Tie the following four 100 kV breakers: Bank 1 LT Red & Yellow, Bank 2 LT Red & Yellow
5. At Shelby Tie the following three 100 kV breakers: Bank 2 LT Red, Bank 3 LT Red & Yellow
6. At Tiger Tie the following two 230 kV breakers: Flint Bl & Wh
7. At Wylie Switching Station the following two 100 kV breakers: Weddington Wh & Wylie Bl

Total estimated cost for breaker replacements: $3.63MM

5.0 Stability Study Results

The proposed 2344 MW Facility does present some stability concerns. However, with the solutions outlined in this report, the Customer's proposed 2344 MW plant will not negatively impact the overall reliability of the generators or the interconnected transmission system.

All of the 500 kV breaker failure faults were stable because 500 kV breakers have independent pole operation (IPO). With IPO, failure of one phase to open does not prevent the other two phases from opening. Therefore it is expected that all 500 kV breakers will be IPO breakers.

230 kV breakers do not normally have IPO, but upgrading to IPO breakers, if available, would prevent instability for 230 kV breaker failure faults. Alternatively, reducing the 230 kV breaker failure delay time from 12 cycles to 5.5 cycles would also ensure stability. If 5.5 cycles is not achievable, it is recommended that all IPO breakers be installed in the new 230 kV switchyard.

Two of the Category C3 faults (outage of both 500 kV lines) and the two Category D7 faults (outage of entire west or east right-of-way) resulted in extended oscillations of the proposed and nearby plants. The Power System Stabilizer (PSS) models provided by the Customer make the oscillations worse, but some oscillations are still present without the PSS's. It is required that the PSS's be properly tuned for weak network conditions and the latest LNS design parameters.

Duke Energy requires out-of-step protection on generators that lost stability in any of the simulations. Out-of-step protection must be added to the Customer's units.

Given the assumptions and recommendations in this study, the proposed facility should be able to reliably connect to the Duke Energy Carolinas electric transmission system.

6.0 Reactive Capability Study Results

With the proposed generating facility, the level of reactive support supplied by the units has been determined to be acceptable at this time. Evaluation of MVAR flow and voltages in the vicinity of the new switching station, southeast of Riverview Switching Station and north of the 230 kV lines between Catawba and Pacolet, indicates adequate reactive support exists in the region.

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