System Impact Study Report

For: Duke Energy ("Customer")

Queue #: 41439-01

Service Location: Rockingham County, NC

Total Output: additional 36 MW

Commercial Operation Date: 10/25/2015

Prepared by:
Orvane Piper, Duke Energy Carolinas

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1.0 Introduction

Following are the results of the Generation System Impact Study for the installation of an additional 36 MW of generating capacity in Rockingham County, NC. This site is Dan River Combined Cycle Station and has an estimated Commercial Operation Date of 10/25/2015. This study includes Network Resource Interconnection Service (NRIS).

2.0 Study Assumptions and Methodology

The power flow cases used in the study were developed from the Duke internal year 2016 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 as an increase to the existing plant output. 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 impacts of changes in the Generator Interconnection Queue were evaluated by creating models with previously queued generators removed. The study cases were re-dispatched, solved and saved for use.

The NRIS thermal study uses the results of Duke Energy Transmission Planning'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 Energy 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. The SERC dynamically reduced 2016 summer peak case was used for this study. The case was modified to reduce output of 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

No network upgrades were identified as being attributable to the studied generating facility.

4.0 Fault Duty Study Results

No fault duty study was performed because the generation addition does not provide a material change to the fault duty at any station.

5.0 Stability Study Results

Category C and D faults that trip both Steam B&W 100 kV lines result in transient or oscillatory instability, depending on the severity of the fault. The oscillatory issues can be eliminated by placing power system stabilizers (PSS's) in service on the Dan River CC generators. These PSS's should be placed in service as soon as practical. For transient instability, the existing Dan River CC out-of-step relays should trip the generators. Duke considers OOS tripping a planned and controlled tripping action that meets the NERC TPL Standards.

NERC does not require stability for Category D faults because of their low probability of occurrence. As such, no solutions are required for the unstable Category D faults.

The addition of the proposed 36 MW to the Customer's facility does present some problems. However, with the solutions outlined in this report, the Customer's proposed 36 MW increase will not negatively impact the overall reliability of the generators or the interconnected transmission system.

6.0 Reactive Capability Study Results

With the proposed addition, 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 Dan River Steam Station indicates adequate reactive support exists in the region.

Study completed by: _____
Orvane Piper, Duke Energy Carolinas

Reviewed by: _____
Ben Harrison, Duke Energy Carolinas
Director, Transmission Planning Carolinas

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