DISCUSSION OF [redacted] ("Customer") GENERATION SYSTEM IMPACT STUDY RESULTS FOR THE PROPOSED GENERATING FACILITY NEAR ERNEST SWITCHING STATION. TOTAL SUMMER PEAK OUTPUT IS EXPECTED TO BE 700 MW

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SOURCE: DUKE ENERGY CAROLINAS, LLC (TRANSMISSION) ("Transmission Provider")

Following are the results of the Generation System Impact Study for the installation of an additional 700 MW Summer/740 MW Winter of generating capacity in Rockingham County, NC. The site is located near Ernest Switching Station and has an estimated Commercial Operation Date of January 1, 2014. The study evaluated the requested Network Resource Interconnection Service (NRIS).

A. Study Assumptions and Methodology

The power flow cases used in the study were developed from the Customer internal year 2014 summer peak case. This case contains the planned generation additions at Buck, Cleveland County and Dan River. The results of Customer's annual screening were used as a baseline to identify the impact of the new generation. To determine the thermal impact on Customer's transmission system, the new generation was modeled directly connected to the 230 kV bus at Ernest Switching Station. The economic generation dispatch was also changed by adding the new generation and forcing it on prior to the dispatch of the remaining Customer 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 Customer Power Delivery's annual internal screening as a baseline to determine the impact of the new generation. The annual internal screening identifies violations of the Customer 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 Customer 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 2014 summer model was used for this study. 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. These were included in the case to perform the stability studies. 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.

B. Thermal Study Results

NRIS Evaluation

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

Facility Name/Upgrade	Existing Size/Type	Proposed Size/Type	Mileage	Estimated Cost	Lead Time (months)
1. Jacobs 230 kV line (Ernest to Belews Creek) Upgrade	1272 ACSR	B1272 ACSR	13.7	$15.1M	42
2. Sadler 230 kV line (Ernest to Sadler) Upgrade	1272 ACSR	B1272 ACSR	12.6	$13.9M	42
3. Sadler 100/230 kV Transformer Addition				$7.2M	42
3. Pine Hall 100 kV line (Madison to Unifi) Upgrade	477 ACSR	B477 ACSR	0.5	$0.7M	18
4. Interconnection cost including expansion of Ernest 230 kV Tie Substation Yard, Transformer Yard for Unit Tie, Bus lines and Jacobs 230 kV Tower Relocation				$7.2M	24
CUSTOMER TOTAL COST ESTIMATE				**$44.1M**	

C. Stability Study Results

The less severe, more typical NERC Category B scenarios and the more severe NERC Category C scenarios could cause instability. **Implementing dual pilot tripping on the Jacobs lines will resolve concerns with all NERC Category B and C scenarios studied.**

Almost all NERC Category D scenarios could cause instability. 3LG transmission line, bus section, and breaker faults with delayed clearing will result in some instability. Faster breaker failure tripping, direct transfer tripping, and remote pilot clearing are critical for these scenarios. Implementing these modifications will resolve concerns with all NERC Category D scenarios studied.

The Transmission Provider requires out-of-step protection on generators that have gone unstable in any of the simulations. **Out-of-step protection must be added to all new and existing Rockingham units.**

The manufacturer proposed power system stabilizers (PSS) were not studied because there was sufficient damping without them. However, a PSS should be purchased along with each exciter. If problems arise in the future, then the facility can quickly implement a PSS solution.

D. Fault Duty Study Results

The following breakers will need to be replaced:

1. Sadler Tie, the Elon Black and White 100 kV breakers ($0.24M)
2. At Dan River, the Motley Black 100 kV breaker ($0.12M)

Total estimated cost for breaker replacements: $0.36M

E. 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 Ernest Switching Station indicates adequate reactive support exists in the region. Should future studies show the need for additional support, Transmission Provider will evaluate solutions and make appropriate changes to the system.

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