DISCUSSION OF [redacted] ("Customer") GENERATION SYSTEM IMPACT STUDY RESULTS FOR THE PROPOSED GENERATING FACILITY NEAR WOODLEAF SWITCHING STATION. TOTAL SUMMER PEAK OUTPUT IS EXPECTED TO BE 714 MW

REPORT DATE: March 8, 2010

Following are the results of the Generation System Impact Study for the installation of 714 MW Summer/752 MW Winter of generating capacity in Rowan County, NC. The site is located near Woodleaf Switching Station and has an estimated Commercial Operation Date of June 1, 2013. The study evaluated the requested Network Resource Interconnection Service (NRIS) and Energy Resource Interconnection Service (ERIS).

A. Study Assumptions and Methodology

The power flow cases used in the study were developed from the Duke internal year 2013 summer peak case. This case contains the planned generation additions at Buck, Cleveland County, Cliffside and Dan River. 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 connected to the 500 kV bus at Woodleaf through a ½ mile 3-1033 ACSR line. 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 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 Duke 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. The SERC dynamically reduced 2011 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 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.

B. Thermal Study Results

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. Dooley Tie substation addition with 230kV / 500kV Banks	N/A	1680 MVA	N/A	$53M	24
2. Dooley Lines South (Winecoff to Dooley) Upgrade	1272 ACSR	B1272 ACSR	11.2	$13.3M	42
3. Interconnection cost at Woodleaf Switching Station (terminal)				$2.3M	12
CUSTOMER TOTAL COST ESTIMATE				$68.6M	

Three additional alternatives were considered for meeting the reliability requirements. These alternatives, along with an estimated cost are listed below. The cost estimates for these solutions do not take into account any changes due to previously queued projects or dynamic stability concerns which could significantly affect the total cost of the solution. These alternatives are:

- The addition of a new 230kV / 500kV station 6.25 miles north of Woodleaf via a new 500kV line and folding into the 230kV lines between Marshall Steam Station and Beckerdite Tie (Marshall Lines). This cost was estimated to be approximately $94M in upgrades.

- Connecting a 500kV line from Buck to Woodleaf and the addition of a 500kV switchyard and 230kV / 500kV transformer at Buck. This cost was estimated to be approximately $138M in upgrades.

- Connecting a 230kV line from Buck to Woodleaf, using the existing 230kV / 500kV transformer at Woodleaf as a networked transmission element. The cost of the 230kV line, including upgrades, is estimated to be approximately $56.9M plus the cost of expanding the 230kV Woodleaf switchyard and the use of the existing 230kV / 500kV transformer as a networked transmission asset.

ERIS Evaluation

Under the terms of ERIS service, the full 714 MW can be delivered to the point of interconnection without any network upgrades.

C. Fault Duty Study Results

The following breakers will need to be replaced:

1. At Marshall, seven 230 kV breakers: PCB 9, 12, 16, 18, 19, 21 & 24 ($1.75M)
2. At Winecoff, two 230 kV breakers: The Dooley Black and White breakers ($.35M)
3. At Pleasant Garden, one 230 kV breaker: PCB 26 ($.175M)
4. At Greensboro Main, one 100 kV breaker: CBK 2 ($.12M)

Total estimated cost for breaker replacements: $2.295M

*If the generator with **queue position 39610** is withdrawn from the Generator Interconnect Queue, the 230 kV breaker at Pleasant Garden and the 100 kV breaker at Greensboro Main will require replacement.*

D. Stability Study Results

Under the projected system conditions there are two tested contingencies that are problematic. With total generation at the Rowan plant greater than 1365MW, all generators at the plant go unstable following a normally cleared fault on either the Guardian North 500 kV line (Woodleaf-Dooley) or the Pleasant Garden 500/230 kV autotransformer if the other facility is already out of service. The plant will remain stable if the Rowan Plant total generation is 1365 MW or less at the time of the fault and Power System Stabilizers (PSS) are in place (note that 1365 MW represents a 294 MW reduction from total plant capacity). Because these contingencies result in the loss of stability only at the customer's Rowan Plant, Duke does not require the customer to reduce the total plant generation.

For several simulated faults, Power System Stabilizers were shown to be needed for unit stability. Power System Stabilizers must be installed, tuned, and operated on the new and existing Rowan generators. 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 all new and existing Rowan units, if not already installed.

The addition of the proposed 714 MW expansion to the Rowan plant does present some stability concerns. However, with the solutions outlined in this report, the Customer's proposed Rowan Plant expansion will not negatively impact the overall reliability of other generators or the interconnected transmission system.

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 Woodleaf Switching Station indicates adequate reactive support exists in the region.

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