Transmission System Facilities Study Report -

Designated Network Resource
OASIS #71196974
Duke 600 MW
07/01/2012 to 06/30/2022

July 26, 2007
Transmission Operations & Planning Department
Purpose
A System Impact Study Report dated June 15, 2007 was performed for the Designated Network Resource request identified in Table 1. The purpose of this study is to determine the facilities on the Progress Energy Carolina (PEC) Transmission System needed to accommodate the Customer’s request.

Table 1

<table>
<thead>
<tr>
<th>OASIS</th>
<th>MW</th>
<th>Source/Sink</th>
<th>POR/POD</th>
<th>Start Date</th>
<th>Stop Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>71196974</td>
<td>600</td>
<td>DUKE/CPLE</td>
<td>DUKE/CPLE</td>
<td>07/01/2012</td>
<td>06/30/2022</td>
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Assumptions
This analysis includes the impact of other firm transactions from known sources and sinks, confirmed generator interconnections, and any committed transmission system upgrades for the PEC transmission system. Specifically, facility upgrades from higher queued requests OASIS #391609, OASIS #70899327, and generator interconnection OASIS requests #132, #133, and #134 are assumed to be completed in this analysis. Changes to the status of higher queued requests not in a final state may require restudy for this request to insure necessary upgrades are addressed. A 600 MW import was studied, but as per OATT section 30.8, the total interface capacity to be reserved cannot exceed the customer’s load. PEC has assumed that the Customer’s load will grow to 600 MW by 7/1/2012.

Methodology
The results were obtained using the Siemens PTI (Power Technologies International) PSS/E and MUST software packages and an updated version of the NERC MMWG model for the summer of 2012. The MW amount of the request was modeled source/sink as described above in Table 1. The analysis of this 600 MW import request included scenarios with the Customer’s existing generation resources (225 MW) off-line. The resultant flows and impacts on the system were then analyzed and impacts documented.

Results
Thermal Power-flow
PEC has identified the following preferred solutions to remedy the impacts identified for the Customer’s request in the System Impact Study Report.

Impacted Facilities
- Weatherpoon-Marion 115 kV Line

Solution: An operating procedure can be utilized to address loading issues on this facility.
Schedule: The operating procedure is effective in this period.
• Wake 500/230 kV Transformer Banks #1 and #2

Solution: A project to install a Wake #3 500/230 kV bank has previously been identified to resolve loading on these facilities and is scheduled for 06/01/2013.
Schedule: The existing in-service date for this project addresses loading issues.

• Rockingham-West End 230 kV West Line

Solution: An operating procedure can be utilized to address loading issues on this facility. A project to install a 230 kV series reactor at the West End 230 kV Substation has previously been identified to resolve loading on this facility and is scheduled for 06/01/2016.
Schedule: The operating procedure and 06/01/2016 project address loading issues.

• Clinton-Vander 115 kV Line and Fayetteville-Vander 115 kV North Line

Solution: An operating procedure can be utilized to address loading issues on these facilities.
Schedule: The operating procedure is effective in this period.

• Laurinburg 230/115 kV Transformer Banks #1 and #2

Solution: A project to replace the existing 2-200 MVA 230/115 kV transformers at Laurinburg with 2-300 MVA transformers has previously been identified to resolve loading on these facilities and is scheduled for 06/01/2013.
Schedule: The existing in-service date for this project addresses loading issues.

• Cape Fear-West End 230 kV Line

Solution: An operating procedure can be utilized to address loading issues on this facility. A project to install a 230 kV series reactor at the West End 230 kV Substation has previously been identified to resolve loading on this facility and is scheduled for 06/01/2016.
Schedule: The operating procedure and 2016 project address loading issues.
- **Cape Fear-Erwin 115 kV Line**
  Solution: An operating procedure can be utilized to address loading issues on this facility.
  Schedule: The operating procedure is effective in this period.

- **Jacksonville-Jacksonville City 115 kV East Line and Marion-Whiteville 115 kV Line**
  Solution: These are existing local load serving issues being addressed and not related to the Customer’s request.
  Schedule: N/A

- **Asheboro-Asheboro East 15 kV North Line**
  Solution: A project to reconductor this line has previously been identified to resolve loading on this facility and is scheduled for 06/01/2015.
  Schedule: The existing in-service date for this project addresses loading issues.

- **Cape Fear-Biscoe 115 kV Line**
  Solution: An operating procedure can be utilized to address loading issues on this facility.
  Schedule: The operating procedure is effective in this period.

- **Durham-Research Triangle Park 230 kV Line**
  Solution: A project to reconductor this line has previously been identified to resolve loading on this facility and is scheduled for 06/01/2014.
  Schedule: The existing in-service date for this project addresses loading issues.

- **Method 230/115 kV Transformer Banks #1 and #2**
  Solution: The identified loading is based on the 55 degree rise transformer rating. It has been determined that both transformers can be operated up to 109% of this rating which resolves loading issues for these facilities.
  Schedule: Rating is available immediately.
Area voltage/reactive support

- **Depressed post contingency voltage and prolonged voltage recovery in PEC's Eastern Area.**

Solution: Install a 230 kV, 300 MVAR, Static Var Compensator at Jacksonville 230 kV Substation

Schedule: In-service date of 7/1/2012

Results from the System Impact Study indicated voltage sensitivity to this request requiring further investigation in the Facility Study. A stability study was performed at the 2012 summer peak load level with current and requested import obligations for PEC's eastern transmission system. The cases assumed the outage of a large generator and simulated a normally cleared fault on various transmission facilities. The modeling of system loads were varied between two types, 1) a static model and 2) a composite of static and dynamic motor components.

A static load model treats loads as an algebraic function of bus voltage and frequency at that point in time. The response of most loads to voltage and frequency changes is fast and the steady state is reached quickly, especially for modest changes in voltage or frequency. A static model is very generic and easily used, and has typically been the choice for stability studies unless other factors show it not to be adequate for study purposes.

Accounting for the dynamic characteristics of loads often becomes important as the transmission system becomes more stressed from higher facility loadings and use of power imports in lieu of local generation to supply system loads. Large changes in voltage or frequency often cause the stressed grid to respond very differently than predicted by simulations using only static load models. Since motors consume a very significant amount of the total energy in power systems, the dynamics associated with motors is usually considered important for simulation purposes. A composite load model comprised of static elements and motors often allows the best correlation of simulations and recorded events.

The inertia of a motor/load combination largely determines how quickly the motor responds to a voltage or frequency change, while the load’s torque characteristic helps determine the motor's ability to re-accelerate to normal speed following a fault. A fault depresses the supply voltage to a motor and causes its speed to drop. A 10-20% drop in motor speed significantly reduces the motor's power factor and increases the current drawn by the motor. The increased current can be several times its full-load current and is largely reactive. The post-fault reactive current drawn through the largely inductive grid contributes to keeping system voltage down and delays recovery of system voltage as the motor tries to re-accelerate to its normal speed. Prolonged recovery of system voltage can result in significant loss of load through operation of internal thermal overload devices, dropout of motor contactors, or tripping of distribution feeders. It can also cause operation of generator excitation limiters with subsequent further decline in system voltage or reduction in grid stability. The addition of a dynamic reactive source, such as a Static Var Compensator (SVC), can significantly aid post-disturbance voltage recovery by quickly providing enough reactive support to allow the motors to re-accelerate to their normal speed.
PEC studied locations on the PEC transmission sensitive to voltage deviations. The eastern portion of the PEC system has experienced significant load growth without accompanying growth in area generation. Figure 1 shows the difference in simulated voltages at the Jacksonville 230 kV bus when using a static load model only versus when also including a motor component. Results show that the voltage recovery with the motor component takes much longer and recovery is to a much lower and unacceptable level. The figure shows that with existing reactive compensation, motors are unable to accelerate to normal speed and bus voltage lingers around 0.78 pu. (assumes no loss of motor load).

Figure 1
PEC then performed simulations (modeling the motor load component) with the addition of a SVC. Figure 2 shows the voltage recovery at the Jacksonville 230 kV bus following normal clearing of a three-phase fault on a major 500 kV facility in the Raleigh area. The figure compares summer 2012 results, with and without dynamic voltage compensation. The figure shows that adding a 300 MVAR SVC at the Jacksonville 230kV Substation provides enough dynamic reactive support to allow the motors to accelerate to normal speed and to allow voltage to quickly recover to a normal operating level. In addition, the SVC will reduce area loss of load and improve overall stability of the area’s transmission system. Figure 3 is a one-line diagram of the proposed SVC connection. PEC surveys of similar project lead-times indicate that the requested July 1, 2012 in-service date can be achieved.
Transmission Facilities Study Report:
DNR-OASIS #71196974

FIGURE 3

REV. 07/26/07

TARGET DATE: 07-01-12  OASIS # 71196974
JACKSONVILLE 230 KV SUB,
INSTALL 300 MVAR SVC

SLA 1 OF 1

Progress Energy Carolinas, Inc.
July 26, 2007

Transmission Operations & Planning Department
Summary
This Facility Study identifies the necessary transmission solutions to the system impacts associated with the Customer’s OASIS request #7119674 (600 MW DNR, 7/1/2012, Duke-to-PEC). All thermal issues identified in the System Impact Study were determined to be resolved by operating procedures or existing projects that are included in PEC’s planned transmission additions.

PEC identified voltage stability issues in the eastern portion of its system that will require the installation of dynamic voltage compensation. Specifically, PEC will plan for the installation of 300 MVAR, 230 kV SVC at its Jacksonville 230 kV Substation with an in-service date of July 1, 2012. PEC surveys of similar project lead-times indicate that the requested July 1, 2012 in-service date can be achieved. With the addition of the SVC, PEC can accommodate the Customer’s OASIS request #7119674.

PEC has identified no Direct Assignment Facilities costs for the Customer associated with this request. The Customer’s share of the required new Network Upgrades identified in this study will be addressed according to the Customer’s existing Network Integration Transmission Service Agreement with PEC.