

# **A Feasibility Study on Connecting Two 57 MVA, LM6000 Gas Turbine Generator Sets at Springdale Substation**

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## **Introduction and Background**

The Interconnection Customer (IC) has contacted System Planning and Operations on the feasibility of interconnecting two 57 MVA LM6000 Gas Turbine Generator sets (GT sets) to the Springdale Power Station 138 kV bus. The request was made to begin producing power and have the GT sets in-service by July 1, 1999. Since the original request was received, a delay in the delivery of materials that are required to complete the interconnection, and the need for air quality permits from Allegheny County, have delayed the in-service date to October 15, 1999.

## **Project Description**

The concept is shown on the sketch on the following page. As indicated, the two 57 MVA GT sets would be located about 1000 ft from the Springdale 138 kV bus. Each generator would consist of 48 MW winter or 44 MW summer, gas combustion turbines operating at 0.85 power factor. The units are designated as peaking units and will probably operate during peak usage hours, approximately 2,000 hours per year per unit. Service to the units will be provided by a single 138 kV line terminating on a single 138 kV circuit breaker, and will include a 138 kV metering package. The destination of output from the generators has not been designated and, therefore, many assumptions were required in order to complete the study. They are listed in the next section.

## Results

The Feasibility Study (FS) results indicate that AP can accommodate the request for interconnection of two 57 MVA LM6000 GT sets.

Both power flow and short circuit studies indicate that the installation has no detrimental effect on the AP transmission system. However, the IC needs to be aware that in the event that there is congestion on the Eastern Interconnection, generation dispatch out of Springdale at times might be restricted. In that case, AP will follow the North American Electric Reliability Council's (NERC) Transmission Line Loading Relief Procedure (TLR) and the guidelines set forth within that procedure. A copy of this procedure can be downloaded via the Internet from the NERC website at <http://www.nerc.com>. Additionally, the IC may choose to implement the NERC Market Re-dispatch or the AP Security Coordinator might implement the Lake Erie Emergency Re-dispatch (LEER) procedures that may require the units at Springdale to operate. Allegheny Energy (AE) has incorporated these procedures in its Open Access Transmission Tariff (OATT). More information on the NERC market re-dispatch procedure can be obtained from the NERC website at <http://www.nerc.com>. Information on the LEER can be obtained from your company's representative to the Lake Erie Security Process committee, or from the FERC-filed LEER proposal.

## **Assumptions**

All future studies require assumptions concerning the control area load, facility additions and transmission sales. This analysis is no exception. The most recent System models, the 1998 series, from the base case database for the 1999 summer, 2003 summer and 2008 summer seasons were selected as those to be tested. AP control area loads in those models ranged from 7,200 MW in the 1999 summer model to more than 8,000 MW in the 2008 summer model. Facility additions were assumed to be those as planned in the 1998 series of cases that followed the 1998-planning guide. Note that during the period studied there is no expectation that the existing Springdale Units 7 & 8 will be reenergized; so they were not modeled in this analysis. A quick review of data indicates that AP, PJM, FE and DQE plan no major facility additions. However, AEP and VP are planning to install major system additions in the Appalachian Power Company Area of AEP and the northern area of Virginia Power Company. Those planned facilities are modeled in the 2008 summer model but not in the 1999 summer or the 2003 model. Transmission sales modeled for those years are those included in the summer base case models and include only confirmed firm service reservations. The destination of the power output from the proposed GT sets at Springdale is unknown. Therefore, several transfer scenarios were assumed. Output from the GT sets was assumed to stay within the AP control area, or alternatively to be sold off-system to the west or to the east. Those additional tests modeling the output from the Springdale site to the east assumed the power was being sold to PJM, while those that took the power west modeled a transfer into DQE.

## **Study Methodology and Procedure**

The in-service date for the gas turbine project is tentatively set for October 1, 1999. As a result, power flow study models were selected and completed for the years 1999, 2003 and 2008. The assumptions listed above for forecasted control area loads, maintenance schedules, confirmed Firm Point-To-Point Transmission reservations and generation dispatch, were all used during the analysis.

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Power flow cases were created and contingency tests were evaluated based upon the AP planning criteria reported in FERC Form 715 Part 4 (See Appendix A). These criteria were applied to studies using the current years model, as well as those using the 2003 and 2008 models, in order to evaluate the long-term effect the power output from Springdale might have on the AP transmission system in and around the Springdale site. If required, additional study work was to be performed to determine what if any limiting facility would require system upgrades to accommodate the installation of the GT sets.

Prior to 1999, Springdale had two generators that were included in the AP Integrated Resource Plan. Total capacity of Springdale Units 7 and 8 was 207 MW. The proposed GT sets together totaled 114 MVA at an 85 % power factor, or about 96 MW. The studies looked for adverse loading due to the proposed installation and unit output, and its effect on system transfer capability.

In all, fourteen transfer test scenarios were completed and analyzed. Results of the single contingency tests concluded that with the Springdale (AP)-Cheswick (DQE) 138 kV tie open, which is a normal operating situation, the installation had little effect on the 138 kV lines in the study area. If the tie were closed, the 138 kV tie-line was the thermal limit to regional and inter-regional transfers as well as intra-regional transfers, regardless of whether the proposed GT sets were in-service or not. Therefore, it is recommended that the operating practice of allowing the Springdale (AP)-Cheswick (DQE) 138 kV tie line to be operated normally open should remain in effect for the foreseeable future.

Although the proposed generation addition is small and the effect it has on system transfer capability is minimal with the operating procedure in place, the effect on system losses was also considered. Power flow evaluations indicate that with the two GT sets at Springdale dispatched at maximum output the AP system losses are reduced by two MW.

## Short Circuit Studies

Results of the short circuit evaluation are tabulated below. The fault current values determined in the study indicate that the substation equipment at Springdale and neighboring substations is adequate, and that the addition of two 71.2 MVA\*\* GT sets at Springdale will not cause any of the equipment to exceed short circuit ratings.

<b>JUNE 1999 SYSTEM CONDITIONS</b> <b>CHESWICK–SPRINGDALE 138 kV LINE IN SERVICE</b> <b>2@36/48/60 MVA, 138/13.8 kV Transformer(Z1=10%,Z0=8.5% @36 MVA)</b>		
	<b>BASE CONDITIONS</b> <b>(Without the new CTs)</b> <b>(3-phase symmetrical faults)</b>	<b>(With the new CTs)</b> <b>Z1=12.4% @71.2 MVA</b> <b>Z2=16.6% @71.2 MVA</b> <b>Z0=9.0% @ 71.2MVA</b> <b>(3-phase symmetrical faults)</b>
<b><u>Springdale 138 kV</u></b>		
Three Phase Fault	35724 Amps ∠ -83.25°	37569 Amps ∠ -83.50°
Phase to Ground Fault	27128 Amps ∠ -81.40°	27782 Amps ∠ -81.48°
<b><u>Springdale (G1)</u></b> <b><u>13.8 kV</u></b>		
Three Phase Fault	14453 Amps ∠ -87.17°	38474 Amps ∠ -88.94°
Phase to Ground Fault	0 Amps ∠ 0°	80.0 Amps ∠ -0.15° *
<b><u>Springdale (G2)</u></b> <b><u>13.8 kV</u></b>		
Three Phase Fault	14453 Amps ∠ -87.17°	38474 Amps ∠ -88.94°
Phase to Ground Fault	0 Amps ∠ 0°	80.0 Amps ∠ -0.15° *
* Note: It was assumed that a grounding resistor of 100 ohms is installed on generator neutral.		
**Note: The value used for the short circuit study (71.2 MVA) differs from the value used for the steady state power flow analysis (57 MVA). This is necessary because of differently sized equipment in the generation facilities.		

## **Stability Considerations**

The transmission system is designed so that generating units remain in synchronism and that cascading outages do not occur for credible contingencies such as electrical faults or sudden network changes caused by fault clearing and line reclosings.

Transient stability simulations are made to assess expected performance of generating units when the transmission network is subjected to severe disturbances. Test results are used to determine critical fault clearing times and the ability of the system to prevent cascading outages. They are also used to study the effectiveness of alternative transmission plans to optimize the system's transient performance. Since it is impossible to anticipate and test for all combinations of contingencies that could occur on an interconnected network, those cases judged to be less severe, using APS transient stability criteria as a guide, are not routinely tested.

There are also many areas of the system, which are considered strong enough to support the proposed amounts of generation without the need for stability analysis. It may, therefore, be deemed unnecessary to perform any stability simulations and will be evaluated on a case by case assessment.

Transient stability testing was not done as part of this study because the Project generators are relatively small and, therefore, should not cause stability concerns for any APS units.

When the proposed generating station is designed and dynamics data for turbine generators are available, the Developer should perform a transient stability study to determine critical fault clearing times and effects of line reclosings on the transient stability of the Project units. In addition, any updated dynamic machine data should be forwarded to Allegheny Power.