

**Engineering Study to Determine  
the  
Feasibility of Interconnecting  
88 MW of Non-Utility Generation  
Near Uniontown, PA  
&  
Near Gans, PA**

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## **Introduction**

The Interconnection Customer (IC) has contacted Allegheny Power's System Planning and Operations Group on the feasibility of interconnecting gas turbine generators in Allegheny Power's (AP) service territory near Uniontown, Pennsylvania and near Gans, Pennsylvania.

Specifically, they propose to interconnect two 57 MVA, LM-6000 gas turbine generators (GT's) on Allegheny Power's transmission system close to AP's North Uniontown Substation near Uniontown, Pennsylvania and to interconnect two 57 MVA LM-6000 gas turbine generators (GT's) on Allegheny Power's transmission system near AP's Lake Lynn Substation near Gans, Pennsylvania. The IC's requested in-service date for both projects is July 1, 2000.

This document is a report prepared for the IC to address their request for interconnecting gas turbine generation in Allegheny Power's service territory near Uniontown and Gans, Pennsylvania.

## **Project Description**

The drawing on the following page shows the studied and proposed method to interconnect the two pairs of GT's. Figure 1 shows one set of GT's which are proposed to be located about 0.75 miles south of AP's North Uniontown Substation near Uniontown, Pennsylvania, and a second set, proposed to be located about 2.1 miles north of AP's Lake Lynn Substation near Gans, Pennsylvania. Each GT is rated to produce a maximum of 48 MW in the winter and 44 MW in the summer. Data provided by the developer, that can be found in Appendix B shows that each GT would operate at 0.85 power factor and would run roughly 2000 to 3000 hours per year. The units have been designated by the developer as peaking units and will probably operate during peak usage hours. Service to each proposed GT site consists of a single 138 kV line, 138 kV terminal equipment, a 138 kV circuit breaker, and 138 kV metering equipment. The output from the generators has not been designated and, therefore, many assumptions were required. They are listed in the Assumption Section of the report.

## Figure 1

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## **Results**

The Feasibility Study results indicate that, with appropriate system reinforcements, AP can accommodate the the IC request to connect both of the proposed pairs of 57 MVA GT's at the locations designated on Figure 1.

Short circuit studies indicate that neither proposed connection has a detrimental effect on the fault duty capability of the existing breakers on the AP transmission system.

The 138 kV lines that require reinforcement are the Bethelboro-Connellsville No. 142 138 kV line, the Stoner Junction-King Farm-Sony No. 450 138 kV line, and the King Farm-Sony No. 585 138 kV line. The circuits will need to be reconducted and, if necessary, redesigned and the cost will be the sole responsibility of the IC. This cost is over and above the substation work required to interconnect the proposed generators.

Below are the itemized costs determined thus far to interconnect the proposed generators.

- Reconductor/Rebuild 4.5 miles of the Bethelboro-Connellsville No. 142 138 kV line<sup>1</sup> \$ 766,000
- Reconductor/Rebuild 3.4 miles of the Stoner Junction-King Farm No. 450 and 0.4 miles of the King Farm-Sony No. 585 138 kV lines<sup>2</sup> \$ 646,000
- Construct a new 138 kV station with one 138 kV breaker and 138 kV meter at the Gans site \$ 1,405,000
- Construct a new 138 kV station with one 138 kV breaker and 138 kV meter at the Uniontown site \$ 1,438,000
- Install 138 kV bus tie breaker at South Union Substation \$ 312,000<sup>3</sup>

A summary of the power flow results is included as a Table in Appendix A. The percentages are based on the summer (90<sup>0</sup> F) rating of the conductor. The third column is the single contingency line flow prior to the the IC's Units being added. The next six columns are the single contingency line flows with the proposed AE Units in service.

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<sup>1</sup> This reinforcement would be necessary if either or both the Gans and Uniontown generation sites are interconnected.

<sup>2</sup> This reinforcement would be necessary if both the Gans and Uniontown generation sites are interconnected.

<sup>3</sup> An interest in the bus tie breaker was indicated by the customer as a sectionalizing device to limit exposure to the two proposed generation sites. The Lake Lynn-Bethelboro 138 kV line is 22.0 miles long and a fault anywhere on the line would outage both generation sites. A bus-tie breaker at South Union would split the line into two sections of 12.2 miles and 9.8 miles. There have been no unplanned outages of the Lake Lynn-Bethelboro 138 kV line since 1992. Note that this statement does not imply outages in the 1991-1992 period, only that the records available begin in 1992. There have been three planned outages since mid-1997: two outages in October of 1998 for 8 hours to replace insulators and one outage in January of 1999 of 8 hours to do relay maintenance. Again, the mid-1997 date chosen for the analysis indicates the date of available records.

## **Results (continued)**

The IC will also be required to designate whether the new installation will become a control area capacity resource or to indicate to AP how the plant will be operated. Note that any firm transmission reservations made by other marketers or proposed installation by other developers prior to an AP/AE Agreement will invalidate the results of this study, require a new analysis, and may increase reinforcement costs for the Gans and Uniontown projects.

The IC also needs to be aware that in the event that there is congestion on the Eastern Interconnection, generation dispatch out of Gans and Uniontown 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 web site 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 and may request the units at Gans and Uniontown to operate. Both of these programs are voluntary. Allegheny Energy, Inc. (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 web site at <http://www.nerc.com>. Information on the LEER can be obtained from the FERC-filed LEER procedure.

If the IC chooses to move forward with this project, AP will require more detailed studies to refine the costs, expand the analysis to evaluate both winter and summer scenarios, explore the voltage schedule for the proposed units, investigate generator dispatch patterns, and quantify stability considerations.

## **Assumptions**

All future studies require assumptions concerning the control area load, facility additions and transmission sales. This analysis is no exception. The present 1999 summer and 2008 summer series base cases were selected as those to be tested for this analysis because they are the most current in the series from the base case database. Allegheny Power control area loads in these models ranged from 7200 MW in the present summer model up to 8200 MW in the 2008 summer model. Facility additions were assumed to be those as planned in the present series of cases that followed the present planning guide. A quick review of data indicates that Allegheny Power, Pennsylvania New Jersey Maryland, First Energy or Duquesne Light Company plans no major facility additions. However, American Electric Power and Virginia Power are planning to install major system additions in the Appalachian Power Company Area of American Electric Power and Northern area of Virginia Power. Those planned facilities are modeled in the 2008 summer model but not in the present 1999 summer base case model. Transmission sales modeled for those years are those included in the summer base case models and are only confirmed Firm Point to Point Transmission reservations. The destination of the power from the proposed GT's near Uniontown, Pennsylvania and Gans, Pennsylvania is unknown. Therefore several transfer scenarios were assumed. Output from the GT's was assumed to stay with in the Allegheny Power control area as well as being sold off system to the west and to the east. Tests modeling the output from the proposed GT's to the east assumed all the power was being sold to either PJM or Virginia Power. While the power that went west assumed the power was all being sold to either Duquesne Light Company or First Energy or American Electric Power.

The IC provided generation and step-up transformer data for the purpose of this analysis which has been aggregated in Appendix B.

## **Study Methodology and Procedure**

The in-service date for the proposed GT's installation is projected to be the July 1, 2000. Based upon an in-service date of July 2000, power flow base models were selected and studies completed for the summer of the years 1999 and 2008. The assumptions, summarized above, regarding forecasted control area loads, maintenance schedules, confirmed Firm Point-To-Point Transmission reservations and generation dispatch, were all used in the feasibility analysis.

As indicated in the assumptions, the destination of the power output from the proposed GT's near Uniontown, Pennsylvania and Gans, Pennsylvania is unknown. The IC has indicated that the power output from the generators could be made up of long-term and short-term Point-to-Point energy sales and spot market hourly sales. It should also be noted that the IC has not made transmission arrangements with AP.

Power flow cases were created and contingency tests were evaluated based upon the 1998 Allegheny Power planning criteria reported in FERC Form 715, Part 4 which is available to the general public for a nominal fee. This criteria was applied on the present years model as well as the 2008 model in order to evaluate the long-term effect the power output from the proposed GT's near Uniontown, Pennsylvania and Gans Pennsylvania may have on the Allegheny Power transmission system. If required, additional study work was to be performed to determine what if any limiting facility would require system upgrades to accommodate the proposed installation of 176 MW of GT generation.

The preliminary study work revolved around the IC request to install four 44 MW GT's. This initial analysis was first performed on the proposed four 44 MW GT's that totaled 176 MW summer output capability with a generator nameplate total of 228 MVA at an 85 % power factor. The single contingency studies were reviewed and adverse loading due to the proposed installation and unit output, and its effect on system facilities were determined. Appendix A holds an abbreviated table of the facilities that were adversely effected by the proposed installation.

Many transfer test scenarios were completed and analyzed. Results of the single contingency tests concluded that system reinforcement would be required in order to accommodate the the IC request of 176 MW. Cost estimates for the upgrades and reinforcements, which would be the total responsibility of the IC, are in the neighborhood of \$ 1.4 to 1.7 million. These costs are in addition to the construction cost of the proposed Uniontown & Gans sites. Cost estimates to construct the Uniontown & Gans sites, which would include substation 138 kV breakers, one 138 kV breaker, and associated control equipment at each substation site is about \$1.4 million. Upon completion of the proper system upgrades and reinforcements, the AP transmission system could accommodate the the IC request to install 176 MW of generation at the Uniontown & Gans sites.

## **Study Methodology and Procedure (Continued)**

Details of this study include the review and evaluation of substations and line configuration interconnection. Each was considered and used for the power flow testing. The power flow tests were conducted on the Figure 1, which taps the 138 kV lines near Uniontown and Gans sites. Power flow test results show that with 176 MW of generation added to system model severe overloads occurred during the single contingency testing. An outage of Layton Jct. 138 kV lines resulted in a remaining line loading above 100 % of its continuous rating. Other single contingency tests resulted with similar facility overloads.

It should be noted that this feasible interconnection scenario does not provide a guarantee that the IC will have the ability to sell the full power output of the plant at all times. Interim transmission service agreements or generator additions by other developers preceding the IC's request for transmission service will take precedence.

Additionally, the proposed installation effect on system losses was considered. Power flow evaluations indicate that when the output of the plant is being retained within the AP control area, AP system losses increase due to the location of the plant with regard to the control area load. AP transmission system losses are also increased when the plant output is being sold off system. For these reasons, the IC will be required to either purchase system losses as an ancillary service from the AP Control Area or generate additional MW to cover the estimated losses caused by the proposed installation.

## 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 near Gans and near Uniontown sites and neighboring substations is adequate. The addition of two 71.2 MVA\*\* GT sets near Gans and Uniontown sites will not cause any equipment short circuit ratings to be exceeded.

<b>DECEMBER 1999 SYSTEM CONDITIONS</b> <b>2-36/48/60 MVA, 138/13.8 kV Transformers (Z1=10%,Z0=8.5% @36 MVA) @ Gans Site</b>		
	<b>BASE CONDITIONS (Without the new GT's) @Gans Site (3-phase symmetrical faults)</b>	<b>(With the new GT's) Z1=13.0 @71.2 MVA Z2=17.6% @71.2 MVA Z0=9.5% @ 71.2MVA (3-phase symmetrical faults)</b>
<b><u>Gans 138 kV</u></b> Three Phase Fault Phase to Ground Fault	15510 Amps $\angle$ -80.94° 13818 Amps $\angle$ -80.33°	17760 Amps $\angle$ -81.87° 14887 Amps $\angle$ -80.80°
<b><u>Gans (G1) 13.8 kV</u></b> Three Phase Fault Phase to Ground Fault	13735 Amps $\angle$ -86.77° 0 Amps $\angle$ 0°	36806 Amps $\angle$ -88.82° 80.0 Amps $\angle$ -0.14° *
<b><u>Gans (G2) 13.8 kV</u></b> Three Phase Fault Phase to Ground Fault	13735 Amps $\angle$ -86.77° 0 Amps $\angle$ 0°	36806 Amps $\angle$ -88.82° 80.0 Amps $\angle$ -0.14° *
* 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.		

<b>DECEMBER 1999 SYSTEM CONDITIONS</b> <b>2-36/48/60 MVA, 138/13.8 kV Transformers (Z1=10%,Z0=8.5% @36 MVA) @ Uniontown Site</b>		
	<b>BASE CONDITIONS (Without the new GT's) @ Uniontown Site (3-phase symmetrical faults)</b>	<b>(With the new GT's) Z1=13.0% @71.2 MVA Z2=17.6% @71.2 MVA Z0=9.5% @ 71.2MVA (3-phase symmetrical faults)</b>
<b><u>Uniontown GT 138 kV</u></b> Three Phase Fault Phase to Ground Fault	11253 Amps $\angle$ -81.24° 9815 Amps $\angle$ -80.56°	13313 Amps $\angle$ -82.34° 10734 Amps $\angle$ -81.04°
<b><u>Uniontown GT (G1) 13.8 kV</u></b> Three Phase Fault Phase to Ground Fault	13291 Amps $\angle$ -86.62° 0 Amps $\angle$ 0°	36411 Amps $\angle$ -88.80° 80.0 Amps $\angle$ -0.14° *
<b><u>Uniontown GT (G2) 13.8 kV</u></b> Three Phase Fault Phase to Ground Fault	13291 Amps $\angle$ -86.62° 0 Amps $\angle$ 0°	36411 Amps $\angle$ -88.80° 80.0 Amps $\angle$ -0.14° *
* 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 must be 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 is simulated to assess expected performance of generating units whenever 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 AP transient stability criteria as a guide, are not routinely tested.

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

Transient stability testing done in the past has indicated that transient stability problem do not exist in the area of the proposed projects.

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



## **APPENDIX B**

### **Information Provided by Developer**