

Allegheny Power Interconnection Feasibility Study

South Bend – Increase of 104 MW to 704 MW, 4-CT Generators

Armstrong County, Pennsylvania

Queue #53

December, 2001

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1. Introduction and Background

The Interconnection Customer (IC) has requested Allegheny Power (AP) to perform a Feasibility Study to determine the interconnection facilities and local system reinforcements required to increase the capacity of four combustion turbine (CT) generators by a total of 104 MW for a maximum total generating capability of 704 MW (Summer) at their South Bend site. The IC plans to have the generators, with or without the increase in capacity, in service and producing power by June 1, 2002.

It should be noted that, although this analysis examined the AP EHV and transmission system and the required reinforcements assuming an additional 104MW injection into the AP EHV system, this study does not guarantee that Transmission Transfer Capability to all possible destinations will exist when the IC's generation is placed in service.

2. Description of Project

The location for the IC 's proposed generating plant is in Armstrong County, Pennsylvania in South Bend Township about 2 miles from GPU's Keystone Substation at AP's South Bend Substation. The increase in generation will consist of four CT generators, previously rated at 150 MW at a 0.85 power factor, incremented by 26MW each to 176 MW at a 0.85 power factor. The increase will occur through the use of a closed loop cooling water system. The units will generate at 18kV using natural gas for fuel and will be used for peaking.

There were no additional reinforcements to the system or to the direct interconnection facilities identified during this incremental study that will be necessary prior to connection to the AP EHV system.

It should be noted that stability or transient analysis studies are not a part of the Feasibility Study process, and no studies of this type have been performed. No corrective actions to problems that may be identified in such studies, or resulting financial obligations, have been identified at this time.

3. Summary of Costs

There are no additional costs associated with the increase in generation for this project.

4. Assumptions

All studies that look into the future require assumptions concerning the load, facility additions and transmission sales within and external to the AP control area. This analysis is no exception.

The 2005 summer base case was selected to model the South Bend generation project. The AP control area load in the model was 8353 MW.

As in all studies, some type of generation dispatch needs to be used. For the purposes of the base study, a single economic-type dispatch was used. Study results which appeared to be somewhat generation dispatch sensitive, had alternative dispatches considered.

AP facility additions were assumed to be those as planned in the present series of cases that followed the present AP Planning Guide. The Bulk Power facility additions modeled for other utilities used in this study are those that have been included in the MMG (Multi-regional Modeling Group) base case by the other utilities. Transmission sales modeled for the study year are those sales that are known at the time the base case was created and include only confirmed, firm transmission service reservations.

The generation output from the proposed generators at the South Bend site was assumed to stay within the AP control area.

The IC provided generator data for the proposed installation. The information provided is aggregated in the appendices of this document.

5. Results - Summary

Results of the power flow studies indicate that incremental increase of the generation at the South Bend site by 104 MW can be accommodated without system reinforcements.

Two base cases were run for this study. They include a case with all four South Bend units generating 150 MW each and a case with all four South Bend units generating 176 MW each. Credible single and double contingency cases were simulated to evaluate the impact of the South Bend generating facility on the AP system.

Further discussion can be found in the *Study Methodology and Analysis* section of this report.

6. Study Methodology and Analysis

Methodology

The in-service date for the proposed generators with inlet cooling (fogging) equipment is projected to be June 1, 2002. Based on this date, a 2005 summer base model was selected with loads in the study area adjusted to represent 2005 summer conditions. A summer base case was chosen because line capacity in the summer months is more critical than that in winter. The assumptions previously stated in the section titled *Assumptions* regarding forecasted control area loads, maintenance schedules, confirmed Firm Point-to-Point Transmission reservations and generation dispatch were all used in the Feasibility Study.

Power flow cases were created and contingency tests were evaluated based upon the AP planning criteria reported in FERC Form 715, Part 4 which is available to the general public for a nominal fee. These criteria were applied to studies using the 2005 summer model to evaluate the effect the power output from the South Bend project might have on AP transmission facilities.

Analysis

Two base cases were run for this study. The first was run to evaluate the system as it currently is planned and is expected to perform including the South Bend generators running at 150 MW each (600 MW total). The second was run to evaluate the system with the inclusion of the South Bend generators incremental increase of 26 MW each (104 MW total) for a total generator output of 176 MW each (704 MW total).

7. Short Circuit Study Results

Results of the short circuit evaluations for the South Bend generator site are tabulated below.

The study focused on determining the maximum short circuit currents at the South Bend, Yukon and Cabot Substations. The study utilized the most recent generator data supplied by the IC and refined GSU data.

Shown below are the maximum three phase and single line-to-ground fault currents at those stations most affected by the inclusion of the South Bend generators with the incremental generation.

Bus Faults

Fault Location	South Bend Not in Service				South Bend @ 176 MW Each			
	Three Phase		Line to Ground		Three Phase		Line to Ground	
	<i>Symmetrical Fault</i>		<i>Fault</i>		<i>Symmetrical Fault</i>		<i>Fault</i>	
	<i>Amps</i>	<i>Angle</i>	<i>Amps</i>	<i>Angle</i>	<i>Amps</i>	<i>Angle</i>	<i>Amps</i>	<i>Angle</i>
South Bend 500 kV	27744	-88	27422	-86	30262	-88	29012	-86
Yukon 500 kV	20746	-87	18556	-85	21117	-87	18752	-85
Cabot 500 kV	18394	-87	13265	-81	18825	-84	13412	-81
South Bend 18 kV	---	---	---	---	69362	-90	0	0

The existing circuit breakers at Yukon and Cabot Substations were evaluated since they are impacted by the inclusion of the South Bend generating plant. All of the breakers evaluated did not exceed their maximum interrupting capacity and therefore no breaker replacements will be required.

The short circuit positive and zero sequence source equivalent impedance representing the AP system at the South Bend 500 kV bus prior to the addition of the South Bend generating units is:

Positive Sequence <u>R+jX</u>	Zero Sequence <u>R+jX</u>
(0.00015+j0.00416)	(0.00052+j0.00429)

These values are in per unit on a 100 MVA base.

8. Issues Beyond the Scope of this Study

Before the IC produces power they must sign on as an AP Open Access Transmission Tariff (OATT) customer, or hire an agent who is an existing OATT customer of AP, to act as their agent to market and sell their generation.


The IC indicated that the power output from the generators might consist of long-term and short-term Point-to-Point transmission sales. Since the IC could not commit to a direction or market for the power output from the South Bend site, no tests were made modeling the power as though it were sold off system. The IC should also be aware that the tests performed with this analysis assumed that the new installations were control-area capacity resources. The IC, by not providing a direction or market, has assumed the risk that Transmission Transfer Capability may not be available when the project comes on line. Any firm transmission reservations made by other marketers or developers prior to an agreement would not only alter these study results, but could force limitations on the IC's generation output.


Additionally the IC needs to be aware that in the event that there is congestion on the Eastern Interconnection, generation dispatch out of South Bend 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 or their agent 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 could request the units at South Bend to participate. Involvement in either procedure is voluntary. AP has incorporated these procedures in its 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 the FERC-filed LEER procedure.

APPENDIX A

Generator and GSU Sequence Data
South Bend CT's

APPENDIX B

SIZE	DWG NO	SH	REV
A	373A4801	3	-
REACTANCES (Per Unit):			
		Direct Axis	Quadrature Axis
Saturated Synchronous	X_{dv}	2.12	X_{qv} 2.018
Unsaturated Synchronous	X_{di}	2.12	X_{qi} 2.018
Saturated Transient	X'_{dv}	0.23	
Unsaturated Transient	X'_{di}	0.26	X'_{qi} 0.464
Saturated Sub transient	X''_{dv}	0.023	X''_{qv} 0.152
Unsaturated Sub transient	X''_{di}	0.195	X''_{qi} 0.196
Saturated Negative Sequence	X_{2v}	0.15	
Unsaturated Negative Sequence	X_{2i}	0.196	
Saturated Zero Sequence	X_{0v}	0.125	
Unsaturated Zero Sequence	X_{0i}	0.125	
Saturated Leakage Reactance	X_{lv}	0.135	
Unsaturated Leakage Reactance	X_{li}	0.15	
FIELD TIME CONSTANTS (Seconds @ 125 °C)			
Open Circuit	T_{d0}	5.7	T'_{q0} 0.59
Three Phase Short Circuit Transient	T_{d3}	0.62	T'_q 0.13
Line To Line Short Circuit Transient	T_{d2}	0.96	
Line To Neutral Short Circuit Transient	T_{d1}	1.2	
Short Circuit Sub transient	T'_d	0.023	T''_q 0.023
Open Circuit Sub transient	T'_{d0}	0.034	T''_{q0} 0.069
ARMATURE DC COMPONENT TIME CONSTANTS (Seconds @ 100 °C)			
Three Phase Short Circuit	T_{a3}	0.33	
Line To Line Short Circuit	T_{a2}	0.33	
Line To Neutral Short Circuit	T_{a1}	0.31	
ARMATURE WINDING SEQUENCE RESISTANCES (Per Unit)			
Positive	R_1	0.0031	
Negative	R_2	0.0203	
Zero	R_0	0.0108	
Reactance, Resistance and Time Constant data may be interpreted per IEEE 115, section VII.			
The base reactance ("UNIT") is calculated by the armature kV squared / MVA.			
Base reactance = 1.3846		Ohms	
Rotor Short-Time Thermal Capacity, $(I_2)^2t$		10 s	
Turbine-Generator Combined Inertia Constant, H		4.76 kW-s/kVA	
Three Phase Armature Winding Capacitance		0.8062 μ F	
Armature Winding DC Resistance (Per Phase)		0.0017 OHMS (100 °C)	
Field Winding DC Resistance		0.196 OHMS (125 °C)	
Field Current At Rated Kva, Armature Voltage, & PF		1683 A	
Field Current At Rated Kva, Armature Voltage, 0 PF Lagging		2042 A	
(For Systems Study Only - Not Allowable Operating Point)			
GENERAL ELECTRIC COMPANY		SIZE	CAGE CODE
 GE POWER GENERATION SCENECTADY, NY		A	
DRAWN: Ian Smith		DWG NO	
ISSUED: Steve Warner		373A4801	
SCALE		SHEET 3	

SIZE A	DWG NO 373A4801	SH 4	REV -
<p><u>MACHINE SATURATION DATA</u></p> <p>S/1.0 = 0.07 Machine saturation may be calculated from the data of curves A and B of</p> <p>S/1.2 = 0.60 "ESTIMATED SATURATION AND SYNCHRONOUS IMPEDANCE CURVES".</p> <p>"S/1.0" is the field amp difference from B to A divided by the field amp of A at 1.0 pu voltage.</p> <p><u>X/R RATIO</u></p> <p>X/R = 124.6 X/R ratio equals "XPP/DV" * base reactance / armature DC resistance at 100 C</p>			
 GE POWER GENERATION		GENERAL ELECTRIC COMPANY SCHENECTADY, NY	SIZE A
DRAWN: Ian Smith		CAGE CODE	DWG NO 373A4801
ISSUED: Steve Warner		SCALE	SHEET 4