Allegheny Power

Allegheny Power Interconnection Feasibility Study

Savage Mountain - Connect (27) 1.5 MW Wind Turbine Generators

Allegany County, Maryland

Queue #68

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Appendices

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 interconnect (27) 1.5 MW wind turbine generators for a maximum total generating capability of 40 MW at their Savage Mountain site. The IC plans to have the generators in service and producing power by September 2004.

It should be noted that this analysis examined the AP transmission system assuming a 40 MW injection into the AP Transmission 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 Allegany County, Maryland near the city of Lonaconing. The generating plant will consist of twenty-seven wind-turbine generators and will generate at 0.6 kV.

AP will construct a 138 kV switching station, a 138 kV meter, and other necessary facilities to provide an interconnection point.

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.

See Figure 1 for a schematic depiction of the proposed interconnection facilities.

3. Summary of Costs

The total estimated cost to install all of the facilities described individually below is **$1,610,000 in 2004 dollars**.

Scope of work and estimated cost by project segment are listed under the following bullets:

- The estimated cost to acquire a site, approximately 2.2 miles south of Carlos Junction Substation, near the Cumberland-Carlos Junction 138kV line and construct a three-breaker, three-line, 138kV breaker and a half switching station is **$1,430,000 in 2004 dollars**. This new facility will be constructed to provide an interconnection point for the proposed Savage Mountain generators. Major equipment at the new switching station would include, three dead-end structures, six 138kV air-break switches, three 138kV circuit breakers and facilities for 138kV interconnection metering. This station would include a control building to house all relaying, metering and communications equipment required to accommodate the electrical facilities.

- The estimated cost to acquire necessary right of way and construct new facilities required to loop the Cumberland-Carlos Junction 138kV line into the proposed new switching station is **$135,000 in 2004 dollars**.

- While AP cannot mandate that our personnel install protective relaying and communications equipment at the generator site, AP is responsible for designing the protection scheme and providing specifications for all relays to be employed on the interconnection breaker terminal at the generation site to assure that the protective relaying equipment will be compatible with that installed on the interconnection breaker terminal at the new switching station. The relaying package will include both primary and backup protection with primary relays utilizing a fiber optic channel. AP also has the responsibility to test and calibrate all relays and perform all tests deemed necessary to make sure that protective relaying and the communication channel at the generator site are properly installed and functional. The estimated total cost of engineering and testing is approximately **$40,000 in 2004 dollars**.

  Note: Purchase and installation of protective relaying and associated equipment at the generation site is not included in this scope of work. This phase of work is the responsibility of the customer.

- Adding the proposed new generation will require that protective relaying coordination in the entire area be reviewed and changes will likely be required at one or more area substations. The estimated total cost for Controls Engineering staff to complete the coordination review, develop new settings and implement the necessary changes is approximately **$5,000 in 2004 dollars**.

These figures **do not** include construction of the 138kV line required to interconnect the customer's proposed new generating facilities with the AP system grid at the proposed new switching station. Route selection, line design, right of way acquisition and construction of this line will be entirely the responsibility of the customer.

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 system. This analysis is no exception.

The 2007 summer base case was selected to model the Savage Mountain generation project.

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 Savage Mountain site was assumed to stay within the AP system.

The IC did not provide information for the generators or transformers. Typical data was used for this type of installation. The GSU impedance was assumed to be 6% on a 2 MVA base. The intermediate voltage at the site was assumed to be 34.5 kV. The assumed impedance for the 34.5 kV – 138 kV transformer was 10% on a 30 MVA base. The subtransient reactance of the generator was assumed to be 0.15 per unit on a 1670 kVA base.

5. Results - Summary

Two base cases were run for this study. They include a case with the Savage Mountain generators on and a case with the Savage Mountain generators off. Credible single and double contingency cases were simulated to evaluate the impact of the Savage Mountain generating facility on the AP system.

Results of the power flow studies indicate that the installation of 40.5 MW of generation at the Savage Mountain site can be accommodated without system reinforcements. The Power factor at the interface will be limited to 98% lagging and 98% leading for this station.

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 generator installation is projected to be September 2004. Based on this date, a 2007 summer base model was selected with loads in the study area adjusted to represent 2007 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 2007 summer model to evaluate the effect the power output from the Savage Mountain 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, without the inclusion of any new generating plants. The second was run to evaluate the system with the inclusion of the Savage Mountain generating plant.

7. Short Circuit Study Results

Results of the short circuit evaluations for the Savage Mountain generator site are tabulated below.

The study focused on determining the maximum short circuit currents at Albright, Garrett, Carlos Junction, Ridgeley, Cumberland, and Savage Mountain 138 kV stations.

Shown below are the maximum three-phase and single line-to-ground fault currents at those stations most affected by the inclusion of the Savage Mountain generators.

Bus Faults

Fault Location	Savage Mountain In-Service				Savage Mountain Not In-Service			
	Three Phase		Line to Ground		Three Phase		Line to Ground	
	Symmetrical Fault		*Fault*		*Symmetrical Fault*		*Fault*	
	Amps	Angle	Amps	Angle	Amps	Angle	Amps	Angle
Albright 138 kV	27482	-83	24688	-83	27307	-83	24594	-83
Garrett 138 kV	8944	-80	6966	-78	8742	-79	6884	-78
Carlos Jct 138 kV	8709	-81	10913	-81	7841	-80	9990	-80
Ridgeley 138 kV	12767	-83	11328	-80	12212	-83	11031	-80
Cumberland 138 kV	12501	-83	10590	-80	11990	-82	10341	-80
Savage 138 kV	8595	-81	11561	-82	7690	-80	10459	-81

Existing circuit breakers at the stations listed above were not significantly impacted by the addition of the Savage Mountain generation. Further evaluation will be performed in the System Impact Study. The short circuit positive and zero sequence source equivalent impedance representing the AP system at the new Savage Mountain switching station 138 kV bus prior to the generators being added is as follows:

Positive Sequence **R+jX**	Zero Sequence **R+jX**
(0.00919+j0.05363)	(0.00026+j0.01130)

The above values are in per unit on a 100 MVA base.

8. Issues Beyond the Scope of this Study

The IC has not indicated how the power output from the generators will be sold. Since the IC could not commit to a direction or market for the power output from the Savage Mountain 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 customer'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 Savage Mountain at times might be restricted. In that case, PJM, as the operator of the AP transmission system, could invoke their congestion management system, or 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 these procedures can be downloaded via the Internet from the PJM website at http://www.pjm.com/. Additionally, the IC may choose to implement the NERC Market Re-dispatch or the Lake Erie Emergency Re-dispatch (LEER) procedures. Involvement in either procedure is voluntary. 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.