Allegheny Power

Allegheny Power Interconnection Feasibility Study

NEDPOWER

Greenland Gap - Connect (200) 1.5 MW Wind Turbine Generators
Grant County, West Virginia
Queue #68
May 2002

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Appendices

1. Introduction and Background

NedPower has requested Allegheny Power (AP) to perform a Feasibility Study to determine the interconnection facilities and local system reinforcements required to interconnect (200) 1.5 MW wind turbine generators for a maximum total generating capability of 300 MW at their Greenland Gap site. NedPower plans to have the generators in service and producing power by September 2003.

It should be noted that this analysis examined the AP transmission system and the required reinforcements assuming a 300 MW injection into the AP EHV system, this study does not guarantee that Transmission Transfer Capability to all possible destinations will exist when NedPower's generation is placed in service.

2. Description of Project

The location for NedPower's proposed generating plant is in Grant County, West Virginia near the city of Mount Storm. The generating plant will consist of two hundred wind-turbine generators and will generate at 0.6 kV.

AP will construct a 500 kV switching station, a 500 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.

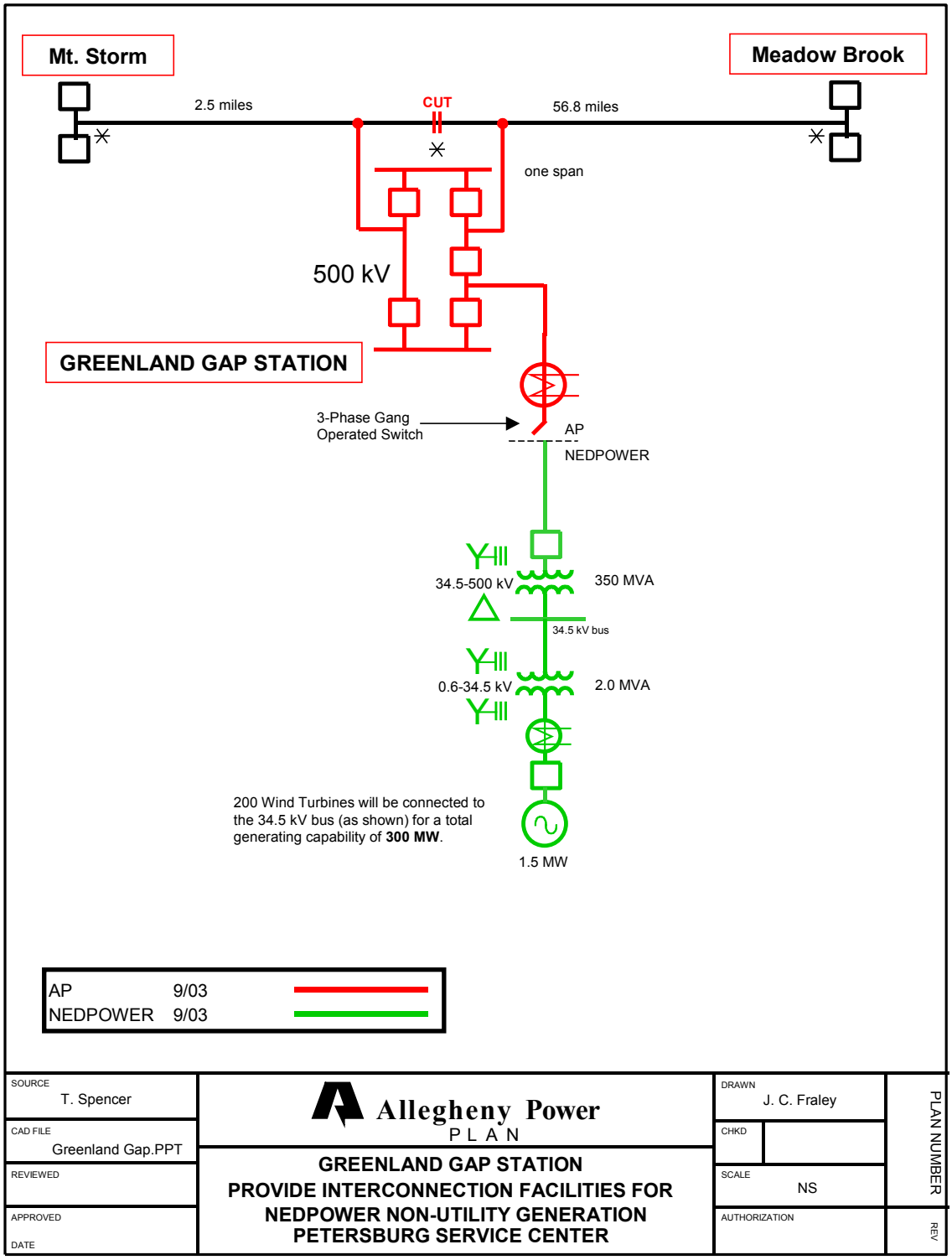
Mt. Storm
Meadow Brook
2.5 miles
CUT
56.8 miles
one span
500 kV
GREENLAND GAP STATION
3-Phase Gang
Operated Switch
AP
NEDPOWER
34.5-500 kV
350 MVA
34.5 kV bus
0.6-34.5 kV
2.0 MVA
200 Wind Turbines will be connected to the 34.5 kV bus (as shown) for a total generating capability of 300 MW.
1.5 MW
AP 9/03
NEDPOWER 9/03
SOURCE
T. Spencer
CAD FILE
Greenland Gap.PPT
REVIEWED
APPROVED
DATE
Allegheny Power
PLAN
GREENLAND GAP STATION
PROVIDE INTERCONNECTION FACILITIES FOR
NEDPOWER NON-UTILITY GENERATION
PETERSBURG SERVICE CENTER
DRAWN
J. C. Fraley
CHKD
SCALE
NS
AUTHORIZATION
PLAN NUMBER
REV

Figure 1

3. Summary of Costs

The total estimated cost to install all of the facilities described individually below is **$11,500,000 in 2003 dollars**. Scope of work and estimated cost by project segment are listed under the following bullets:

- The estimated cost to acquire a site, approximately 2.5 miles north of Mt. Storm, near the Meadowbrook-Mt. Storm 500kV line and construct a five-breaker, three-line, 500kV breaker and a half switching station is **$10,200,000** in **2003** dollars. This new facility will be constructed to provide an interconnection point for a proposed 350 MW, non-utility generation facility to be installed nearby. Major equipment at the new switching station would include, three dead-end structures, ten 500kV air-break switches, five 500kV circuit breakers and facilities for 500kV interconnection metering. This station would include a control building, which would house all protective 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 Meadowbrook-Mt. Storm 500kV line into the proposed new 500kV switching station is **$1,230,000** in **2003** dollars.

- While AP does not have the right to mandate that our personnel install protective relaying and communications equipment at the generator site, AP does have responsibility for designing the protection scheme and provide 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. We also have 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 this engineering and testing effort is approximately **$65,000 in 2003** 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. We estimate the total cost for our Controls Engineering staff to complete the coordination review, develop new settings, and implement the necessary changes to be approximately **$5,000 in 2003** dollars.

Note: The 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 NedPower. These figures **do not** include construction of the 500kV line required to interconnect NedPower'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 NedPower.

It should be noted that meeting the proposed in-service date of 9/2003 is a concern. Lead-time for delivery of 500kV breakers is now running around 60 weeks. The typical lead time for complete design and construction of an EHV station and short line (two spans or less) is 18 to 24 months from authorization if NedPower is providing a graded site; securing all necessary permits and approvals and taking responsibility for all environmental assessment activities and 30 to 36 months if AP is required to secure the property and permits. "Typical lead times" can vary based on workload and equipment lead times. Also, the System Impact Study must be performed before Engineering can begin on this project. The System Impact Study may take up to 6 months to complete. The System Impact Study will be performed by PJM.

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 NedPower's Greenland Gap 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 generator at NedPower's Greenland Gap site was assumed to stay within the AP system.

NedPower 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 10% 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 – 500 kV transformer was 10% on a 350 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 Greenland Gap generators on and a case with the Greenland Gap generators off. Credible single and double contingency cases were simulated to evaluate the impact of the Greenland Gap generating facility on the AP system.

Results of the power flow studies indicate that the installation of 300 MW of generation at NedPower's Greenland Gap site can be accommodated without system reinforcements. The Power factor at the interface will be limited to 99.9% 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 2003. 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 NedPower's Greenland Gap 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 NedPower's Greenland Gap generating plant.

7. Short Circuit Study Results

Results of the short circuit evaluations for the Greenland Gap generator site are tabulated below.

The study focused on determining the maximum short circuit currents at Pruntytown, Mount Storm, Doubs, Meadow Brook, and Greenland Gap.

Shown below are the maximum three-phase and single line-to-ground fault currents at those stations most affected by the inclusion of NedPower's Greenland Gap generators.

Bus Faults

Fault Location	Greenland Gap In-Service				Greenland Gap 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
Pruntytown 500 kV	35493	-88	27492	-82	35362	-88	27440	-82
Mt. Storm 500 kV	28509	-88	27301	-86	27387	-88	26606	-87
Doubs 500 kV	29744	-88	29885	-87	29682	-88	29843	-87
Meadow Brook 500 kV	13987	-87	9769	-80	13880	-87	9734	-80
Greenland Gap 500 kV	26095	-88	23225	-85	24922	-88	22595	-85

Existing circuit breakers at the stations listed above were not significantly impacted by the addition of the Greenland Gap 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 Greenland Gap switching station 500 kV bus not including NedPower's generating units is as follows:

Positive Sequence **R+jX**	Zero Sequence **R+jX**
(0.00015+j0.00463)	(0.00099+j0.00602)

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

8. Issues Beyond the Scope of this Study

NEDPOWER has not indicated how the power output from the generators will be sold. Since NEDPOWER could not commit to a direction or market for the power output from the NEDPOWER-Greenland Gap site, no tests were made modeling the power as though it were sold off system. NEDPOWER should also be aware that the tests performed with this analysis assumed that the new installations were control-area capacity resources. NEDPOWER, 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 NEDPOWER agreement would not only alter these study results, but could force limitations on the NEDPOWER generation output.

Additionally, NEDPOWER needs to be aware that in the event that there is congestion on the Eastern Interconnection, generation dispatch out of NEDPOWER-Greenland Gap 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, NEDPOWER 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.