Executive Summary

A Site Evaluation Study was performed by Dominion Energy, Inc. and Bechtel Power Corporation under U. S. Department of Energy (DOE) Cooperative Agreement Number DE-FC07-02ID14313 of two commercial and three federal sites to determine if they are suitable for potentially siting new nuclear power plants.

Commercial Sites Evaluated

The commercial sites evaluated were Dominion's North Anna and Surry sites. The 1803-acre North Anna site is located on Lake Anna in northeastern Virginia. Two 944 MWe Westinghouse pressurized water reactors (PWRs) are currently in operation at North Anna. The 840-acre Surry site is located on the south side of the James River in Surry County, Virginia. Two 855 MWe Westinghouse PWRs are currently in operation at Surry. These sites were selected because they are owned and controlled by Dominion, they have been demonstrated acceptable in prior licensing actions with the U. S. Nuclear Regulatory Commission (NRC), both sites were originally issued construction permits for two additional units, and there is a large amount of data available on the sites.

Federal Sites Evaluated

The federal sites evaluated were the DOE's Idaho National Engineering and Environmental Laboratory (INEEL), Portsmouth, and Savannah River sites.

INEEL is one of nine multiprogram laboratories in the U. S. Department of Energy (DOE) complex. The 890 square mile INEEL site is located in east central Idaho about 29 miles west of Idaho Falls. The INEEL site has an extensive nuclear history and was recently established as DOE's leading center for nuclear energy research and development.

The Portsmouth site is a 3700-acre parcel of DOE-owned land located in south central Ohio about 65 miles south of Columbus. A major portion of the site and existing facilities are leased to USEC, Inc. for the Portsmouth Gaseous Diffusion Plant. The Portsmouth site has substantial available electrical transmission facilities that were used to support operation of the diffusion plant prior to the decision to cease operations at this facility.

The 310 square mile Savannah River site is owned by DOE and is located in southwest South Carolina on the Savannah River. The Savannah River site has an extensive nuclear history with substantial site infrastructure available to support existing DOE and new missions.

These federal sites were selected for evaluation because (1) the sites represent valuable national assets with prior nuclear experience, (2) the sites have the potential to support reactor demonstrations and/or commercial reactor development, (3) a large amount of site data exists, and (4) new nuclear power facilities would represent potentially promising new missions for these sites.

Reactor Technologies

Five advanced reactor designs were evaluated for each site. The five designs selected included two evolutionary advanced light water reactor (ALWR) designs, the ABWR and AP1000, and three advanced modular gas and water cooled reactor designs, the GT-MHR, IRIS, and PBMR. A brief description of each reactor type follows:

- ABWR. General Electric's Advanced Boiling Water Reactor (ABWR) is a 1350 MWe standardized plant that has been certified under the NRC's requirements in 10 CFR Part 52. Two ABWRs are in operation in Japan. Additional ABWRs are under construction in Taiwan and are planned in Japan.
- AP1000. Westinghouse's Advanced Pressurized Water Reactor, AP1000, is a standardized, two-loop 1117 MWe pressurized water reactor (PWR) with passive safety features. The AP1000 is derived directly from the NRC-certified AP600, a two-loop 600 MWe PWR.
- GT-MHR. General Atomic's Gas Turbine – Modular Helium Reactor (GT-MHR) is a 286 MWe modular, integrated direct-cycle nuclear power facility. In the GT-MHR, the high temperature helium coolant directly drives a gas turbine coupled to an electric generator. The typical plant configuration is 4 GT-MHR modules for a total electrical output of 1144 MWe.

- IRIS. Westinghouse's International Reactor Innovative and Secure (IRIS) is a modular, pressurized light water reactor of medium power (335 MWe). The IRIS module uses standard commercial fuel assemblies and is designed to operate over a five-year long straight burn fuel cycle. The design consists of an integral reactor vessel that contains all the reactor coolant system components, including the pressurizer, steam generators, and reactor coolant pumps, as well as radiation shields. Two plant configurations are envisioned for the IRIS, three single units (total output of 1005 MWe) or two twin units (total output of 1340 MWe).
- PBMR. PBMR Pty. Ltd's Pebble Bed Modular Reactor (PBMR) is a small-sized nuclear power plant, approximately 160 MWe, which uses coated uranium particles encased in graphite to form a fuel sphere. The PBMR is envisioned as an 8-module plant, resulting in a total electrical output of about 1280 MWe.

Bounding plant design information from each of the reactor vendors was used to determine whether the site and environmental conditions at the five sites would be compatible with each reactor type. The information included plant size, power level, general arrangement, required excavation, foundation bearing pressures, cooling and water use requirements, design basis for natural phenomena, required labor force, etc. The quantity and quality of the information received varied depending on how much of the engineering and licensing effort had been completed for each reactor design. The bounding design information is summarized for each reactor type in Part 1.

Site Evaluation Process

The siting study was performed in accordance with Bechtel's "Site Evaluation Process for New Nuclear Generation." This detailed process, which was recently updated to reflect the latest regulatory requirements and industry approaches, has been a Bechtel standard for over 25 years. Each site was evaluated against 45 siting criteria grouped into four major categories: Economic, Engineering, Environmental, and Sociological. Examples of the highest ranked criteria are provided below.

Economic Issues	Electric Market Projections, Transmission System Costs, Stakeholder Support, Site Development Costs
Engineering Issues	Cooling Water Source, Site Size, Emergency Planning, Site-Specific Earthquake, Capable Faults, Environmentally Sensitive Areas
Environmental Issues	Population, Groundwater, Aquatic Habitat/Organisms
Sociological Issues	Socioeconomic Benefits, Present/Planned Land Use, Environmental Justice

A key lesson learned during the study was the need to modify the Bechtel process to separate the economic and engineering issues into separate groups in order to better reflect the importance of market factors in site selection in a deregulated electric market.

A ranking or score was assigned (from 0 to 5, with 5 being the best score) for each criterion and reactor type in accordance with the quantitative ranking metrics in the site evaluation process. The relative importance of each criterion to the overall evaluation was established by assigning weights that reflect the consensus opinion of the Dominion and Bechtel experts involved in the study and are appropriate for large-scale merchant energy plants. The sum of the weighted scores for all criteria is the total "Site Merit" score. In addition, a "Bounding Plant" was evaluated in order to establish a ranking score that would envelope all five reactor designs. A brief summary of the Site Evaluation Process is provided in Appendix A.

Available information on each site was obtained from site personnel and reviewed to assess site conditions and identify pertinent issues that could impact site suitability. No new analyses were performed for the study. Documents reviewed included Safety Analysis Reports, Environmental Reports, Environmental Impact Statements, license renewal applications, selected reports and studies, drawings, calculations, etc. In addition, environmental, seismological, geotechnical, hydrological, transmission, licensing, and construction personnel conducted walkdowns at each site.

Table 1. Walkdown Dates	
Site	Walkdown Date
INEEL	April 28-29, 2002
North Anna	September 6, 2001 *(see Note)*
Portsmouth	June 5, 2002
Savannah River	May 14-15, 2002
Surry	September 25, 2001 *(see Note)*

Note: The Surry and North Anna site walkdowns were performed as part of a previous Dominion/Bechtel study completed in December 2001. The results of that study are included in this report in Part 3.

Study Results

The final Site Merit scores for each of the five sites are provided in Table 2. A discussion of the major findings for each site follows.

North Anna

- Highest site merit score
- Compatible with all reactor technologies
- Selected as preferred Dominion site for an Early Site Permit (ESP) demonstration project
- Total ESP project costs estimated at $11.8 million
- ESP Application to be submitted in September 2003
- ESP anticipated to be issued in May 2005

Savannah River

- Second highest site merit score
- Unique level of local, state, and federal support
- Selected as preferred federal site to estimate ESP project cost and schedule
- Total ESP project costs estimated at $12.7 million
- ESP schedule duration estimated at 36 months

Portsmouth

- Third highest site merit score
- Robust transmission access
- Electric market potential currently limited by strong baseload generation in region
- Site potential may increase in the future through improved access to outside markets and growth in demand

Surry

- Strong potential for future development
- Strength in transportation infrastructure to support modular plant construction
- Potential engineering and environmental issues would have to be resolved for AP1000 containment building height

Table 2. Site Merit Scores[1]					
Site	Economic	Engineering	Environmental	Sociological	Total
North Anna	392	326	359	418	377
Savannah River	323	382	344	489	372
Portsmouth	321	348	345	453	358
Surry	348	304	339	416	351
INEEL	188	350	419	477	324

[1] Based on the Bounding Plant. 500 is the maximum Site Merit score that can be achieved for the Total Site Merit or any criteria subgroup.

- **INEEL**

— Current potential for commercial scale development limited by economic factors—small power market, high cost for transmission access, and relatively low projected price for baseload generation in western United States
— Excellent potential location for modular reactor demonstration based on INEEL's extensive experience with demonstration reactors and new nuclear energy mission
— Long term potential for commercial scale development--requires upgrades to Western power grid, growth in baseload demand, and dependent on future coal development

A breakdown of the estimated costs for the North Anna and Savannah River ESPs is provided in Table 3.

Table 3. Order of Magnitude ESP Cost Estimate

ESP Section	North Anna ESP	Savannah River ESP
Part 1 Introduction	$7,122	$7,410
Part 2 Site Safety Analysis Report	$1,729,111	$2,320,500
Part 3 Environmental Report	$1,695,636	$1,856,600
Part 4 Major Features Emergency Response Plan	$59,350	$61,800
Part 5 Programs and Plans	$120,124	$125,000
NRC Review and Other Activities		
Applicant	$5,279,369	$5,506,500
NRC	$2,855,000	$2,817,000
TOTAL	$11,745,712	$12,694,810

The results of the study will be provided to the Electric Power Research Institute (EPRI) to support an update to their guidance document on siting evaluations and site selection.

Conclusions and Recommendations

The overall conclusion of the study is that all five sites are suitable locations for deployment of new nuclear power plants. The North Anna site ranks higher than Surry and thus is the preferred Dominion site for an Early Site Permit demonstration. The Savannah River site ranks higher than the Portsmouth and INEEL sites and thus is the preferred federal site for which an ESP cost and schedule estimate has been developed.

It is recommended that:

- The North Anna ESP project should be pursued in order to demonstrate this critical part of the NRC's new reactor licensing process.
- For the Savannah River site, issues associated with reliance on existing infrastructure, demonstrating control of the site by a prospective ESP Applicant, and compatibility with current and future site missions should be evaluated as part of any consideration of pursuing an ESP for this site.
- Further evaluation of the NRC's Combined License (COL) process should be performed, including development of an estimated cost and schedule. A preliminary table of contents for a COL Application is provided in Part 5. This table of contents should be expanded into a detailed outline of a COL Application and used as a basis for estimating the resources required to prepare a COL Application, including the amount of first-time engineering required. Further work is also needed to clearly establish the interfaces between the COL, ESP, and Design Certification processes and documents outlined in 10 CFR 52.