3.0 SITE SAFETY ASSESSMENT

3.1 Nonseismic Siting Criteria

3.1.1 Exclusion Area and Low-Population Zone

Section 2.1 of this safety evaluation report (SER) discusses the U.S. Nuclear Regulatory Commission (NRC) staff's evaluation of the information provided by the applicant, System Energy Resources, Inc. (SERI), regarding the site exclusion area and low-population zone (LPZ).

3.1.2 Population Center Distance

Section 2.1 of this SER discusses the staff's evaluation of the applicant's information regarding population center distance.

3.1.3 Site Atmospheric Dispersion Characteristics and Dispersion Parameters

Section 2.3 of this SER discusses the staff's evaluation of the applicant's information regarding site atmospheric dispersion characteristics and dispersion parameters. Section 3.3 summarizes the staff's evaluation of the potential consequences of postulated accidents used in the evaluation of the Grand Gulf early site permit (ESP) site. Finally, Section 3.2 provides the staff's evaluation of the potential consequences of normal radiological effluent releases used in the evaluation of the Grand Gulf ESP site.

3.1.4 Physical Site Characteristics—Meteorology, Geology, Seismology, and Hydrology

Section 2.3 of this SER presents the staff's evaluation of the applicant's information regarding the site's meteorological characteristics. Section 2.5 discusses its evaluation of the site's geologic and seismic characteristics. Finally, Section 2.4 provides the staff's evaluation of the site's hydrological characteristics.

3.1.5 Potential Offsite Hazards

Section 2.2 of this SER provides the staff's evaluation of the applicant's information regarding potential offsite hazards.

3.1.6 Site Characteristics—Security Plans

The NRC staff reviewed the physical security aspects of the ESP application to determine if site characteristics are such that adequate security plans and measures can be developed.

3.1.6.1 Technical Information in the Application

In Section 3.1.6 of the Grand Gulf Nuclear Station (GGNS) Site Safety Analysis Report (SSAR), the applicant stated that it has sufficient land area to accommodate any new unit(s) constructed on the ESP site. SERI indicated that the site characteristics are such that the applicable NRC regulations, guidance documents, and orders can be met. The applicant based this conclusion

on the size of the owner-controlled area (OCA), which is sufficiently large to provide adequate distances between vital areas and the probable location of a security boundary.

In Request for Additional Information (RAI) 3.1.6-1, the staff asked the applicant to provide scale drawings depicting various site features (e.g., roads, shoreline, culverts). In response to RAI 3.1.6-1, SERI provided a drawing and referred to other drawings in the application that depict the requested features.

Section 3.1.6 of the SSAR states that a security program is in place for the existing GGNS unit on the site and notes that the program complies with the NRC Order for Interim Compensatory Measures, dated February 25, 2002. Section 3.1.6 also states that the initial design requirements will incorporate security considerations as inputs and integrate them into the overall design as an important element. Further, the applicant asserts that the SSAR concludes that NRC security requirements could be met for such a facility. The nearby transportation of hazardous materials or nearby hazardous material facilities pose no security hazards that would preclude the development of an adequate security plan for a new unit(s).

3.1.6.2 Regulatory Evaluation

In SSAR Sections 1.8 and 3.1.6, SERI identified Title 10, Section 100.21(f), of the *Code of Federal Regulations* (10 CFR 100.21(f)) and 10 CFR 73.55, "Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors Against Radiological Sabotage," as the applicable regulations. The applicant also noted that Regulatory Guide (RG) 4.7, Revision 2, "General Site Suitability for Nuclear Power Reactors," issued April 1998, provides relevant guidance.

The NRC regulations require that ESP applicants address characteristics of the proposed site that could affect security. Specifically, 10 CFR 52.17, "Contents of Applications," requires that site characteristics comply with 10 CFR Part 100, "Reactor Site Criteria," and 10 CFR 100.21(f) indicates that site characteristics must be such that applicants can develop adequate security plans and measures. In RG 4.7, Revision 2, the NRC provides amplifying guidance and notes that 10 CFR 73.55 describes physical protection requirements for nuclear power plants.

Review Standard (RS)-002, "Processing Applications for Early Site Permits," states that the NRC staff provided guidance to the first three prospective ESP applicants by three substantially identical letters (ADAMS Accession No. ML030980029 for the SERI application). These letters serve as review guidance for the ESP applications to which they apply. However, RS-002 also indicates that the NRC's security orders referenced in the letters are, by their nature, subject to modification depending on changes in the terrorist threat level. The security orders do not form part of the licensing basis of the ESP and should not be imposed as conditions of prospective permits. Therefore, the NRC staff based the security review of ESP applications on the requirements of 10 CFR Parts 100 and 73, "Physical Protection of Plants and Materials," and other applicable existing regulations.

3.1.6.3 Technical Evaluation

The staff reviewed the application and RAI responses. It also examined the physical layout of the proposed site during an onsite visit. The proposed ESP site is located adjacent to the Mississippi River in Claiborne County, Mississippi, near one licensed nuclear power reactor

(GGNS Unit 1) owned by SERI and operated by Entergy Operations, Inc. The GGNS site is defined by a trapezoidal-shaped 2100-acre plot of land located directly adjacent to the Mississippi River. The ESP plant parameter envelope (PPE), or site footprint, that bounds the prospective location for any new nuclear power unit(s) that might be constructed on the proposed ESP site is located west of the existing GGNS protected area and no closer than 900 yards to the site boundary.

Using the criteria set forth in 10 CFR 100.21(f), the staff identified and considered various site characteristics that could affect the establishment of adequate security plans and measures. The staff considered pedestrian land, vehicular land, railroad, and water approaches, including potential high-ground adversary advantage areas, nearby road transportation routes, and culverts that could provide a pathway into the protected area.

With respect to pedestrian approaches, the staff found that various figures in the application (e.g., Figure 2.1-2) identify the applicant's PPE (within which all safety-related structures would be located if one or more reactors were to be constructed on the site). In RAI 3.1.6-1, the staff requested SERI to provide scale drawings that depict various site features (i.e., roads, shoreline, culverts). In its response, the applicant provided a drawing and referred to other drawings in the application that depict the requested features. The staff concluded that the distance from the planned locations of vital equipment and structures (which might be located anywhere within the PPE because a design is not specified at the ESP stage) to the planned protected area boundary can be made sufficiently large that holders of a combined license (COL) or construction permit (CP) could appropriately locate delay barriers, isolation zones, detection equipment, and vehicle barriers to protect vital equipment and structures.

With respect to water approaches, the need for restrictions on river access for any new units would depend on the design of the units and their location on the ESP footprint (PPE). The site's configuration, however, would not present any significant impediments to the development of such restrictions if needed.

With respect to vehicular land and railroad approaches, the staff identified existing roads, rail spurs, and site terrain features. The staff concluded that the location of existing roads and site terrain features does not preclude the establishment of adequate vehicle control measures to (1) prevent the use of a land vehicle to gain unauthorized proximity to vital areas and (2) protect against a vehicle bomb. The staff based its conclusion on the fact that the location of the existing vehicle checkpoint, which could be used for vehicular control to the ESP site, has adequate standoff distance from the PPE site boundary to mitigate vehicle-bomb effects. Further, the staff confirmed during a site visit that the terrain features on all borders of the site are amenable to the implementation of a vehicle barrier system if necessary.

With respect to threats posed by deliberate vehicle explosions on nearby transportation routes, the staff noted that the nearest public road is 3000 feet from the proposed powerblock area. A gasoline tanker explosion involving 8500 gallons of gasoline detonated at a distance of 3000 feet would not result in an overpressure greater than 1 psi at the proposed powerblock area (see RG 1.91, Revision 1, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants," issued February 1978). The pressure threshold for human eardrum rupture is 5 psi, which is the first point of human incapacitation (see U.S. Army Technical Manual 5-1300, "Structures to Resist the Effects of Accidental Explosions," issued November 1990). A peak positive overpressure of 1 psi is a conservative

threshold below which no significant damage would be expected for structures, systems, and components (SSCs) of concern (see RG 1.91, Revision 1).

The staff examined the overall site terrain with respect to features (including existing manmade features, such as culverts, as well as natural features) that potential adversaries could use to their advantage. No such features would preclude the establishment of adequate security plans and measures.

The COL applicant must provide specific designs for protected area barriers because such design information is not available at the ESP stage. This is **COL Action Item 3.1.6-1**.

3.1.6.4 Conclusions

As set forth above, the staff examined the site characteristics with respect to their potential to affect the establishment of adequate security plans and measures. The staff examined pedestrian, vehicle, and water approaches, including existing culverts, nearby railroad lines, and other transportation routes, as well as terrain features. Based on the above evaluation, the staff concludes that the ESP site characteristics would allow an applicant for a COL or CP to develop adequate security plans and measures for a reactor(s) that it might construct and operate on the ESP site.

3.1.7 Site Characteristics—Emergency Plans

Section 13.3 of this SER presents the staff's evaluation of the applicant's emergency response planning information.

3.1.8 Population Density

Section 2.1 of this SER discusses the staff's evaluation of the applicant's information regarding population density.

3.2 Gaseous Effluent Release Dose Consequences from Normal Operations

The NRC staff reviewed the information on radiological effluents and solid radioactive waste provided in the SERI ESP application in SSAR Section 3.2 and Environmental Report (ER) Sections 3.5 and 5.4 to determine whether site characteristics are such that the radiation dose to members of the public would meet regulatory requirements.

3.2.1 Technical Information in the Application

SERI provided information on the radioactive gaseous and liquid effluents and solid radioactive waste material that would be generated as a normal byproduct of nuclear power operations. These radioactive materials will be collected, processed, stored, and discharged in a controlled manner to the local environment or transported off site for long-term storage or disposal. The proposed facility will have the ability to handle these radiological effluents and solid waste materials in a manner that minimizes radioactive releases to the environment and maintains exposure to the public and plant personnel during normal plant operation and maintenance at levels that are as low as reasonably achievable (ALARA).

3.2.2 Regulatory Evaluation

According to NRC regulations, applicants for an ESP must address characteristics of the proposed site that could affect the radiation dose to a member of the public from radiological effluents. SERI provided a comprehensive listing of NRC regulations applicable to its ESP SSAR and ER in SSAR Section 3.2 and ER Sections 3.5 and 5.4. These sections contain information which adequately addresses anticipated radiological effluents according to 10 CFR 52.17(a)(1)(iv). Specifically, 10 CFR 52.17(a)(1)(iv) states that an ESP application should describe the anticipated maximum levels of radiological effluents that each facility will produce.

3.2.3 Technical Evaluation

3.2.3.1 Gaseous Effluents

The gaseous waste management system will control, collect, process, store, and dispose of radioactive gases during plant operation, including startup, normal operation, shutdown, refueling, and anticipated operational occurrences. Routine radioactive gaseous effluents are released to the environment through the waste gas processing systems, which will minimize these releases to the environment. Radioactive gases that may be present in the plant buildings as a result of leakage from systems will also be monitored and released through the building ventilation systems. The applicant will control and monitor the release of these effluents from the facility so that they comply with the regulatory limits in 10 CFR Part 20, "Standards for Protection Against Radiation." It will maintain these effluents at ALARA levels in accordance with Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

In Table 1.3-2 of SSAR Section 1.4, "Plant Parameters Envelope," SERI estimated the bounding quantity of radioactive gaseous effluents that may be released from the gaseous waste management and the building ventilation systems. The applicant determined the gaseous radioactive effluent concentrations based on a composite of the highest activity content of the individual isotopes it anticipated would be released from the alternative reactor designs under consideration.

SERI also provided bounding gaseous effluent release data to support its compliance with the gaseous effluent release concentration limits in Table 2 of Appendix B, "Annual Limits on Intakes (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," to 10 CFR Part 20.

The applicant calculated the estimated dose to a hypothetical maximally exposed member of the public from the gaseous effluents using radiological exposure models based on RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," and the GASPAR II program (NUREG/CR-4653, "GASPAR II—Technical Reference and User Guide," issued March 1987). SERI evaluated several exposure pathways, including direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground, inhalation of gases and particulates,

ingestion of milk contaminated through the grass-cow-milk pathway, and ingestion of foods contaminated by gases and particulates. The calculated gaseous pathway total body dose to a maximally exposed individual at the nearest site boundary is 0.0084 mSv/yr (0.844 mrem/yr).

3.2.3.2 Liquid Effluents

The liquid waste management system will control, collect, process, store, and dispose of, as required, potentially radioactive liquids during plant operation, including startup, normal operation, shutdown, refueling, and anticipated operational occurrences. The applicant will typically operate the system in a manner that minimizes the release of radioactivity into the environment. Normal liquid effluents will discharge through the existing discharge mechanism of GGNS Unit 1.

Currently, the GGNS facility routinely discharges radioactive liquid wastes into the Mississippi River. SERI expects to continue this practice with its ESP facility. The applicant has given a bounding assessment to demonstrate its capability to comply with the regulatory requirements in 10 CFR Part 20 and Appendix I to 10 CFR Part 50.

SERI provided the bounding annual average quantity of radioactive liquid effluents that may be released from the ESP facility in ER Table 3.0-8. This quantity represents the highest activity content of the individual isotopes from the alternative reactor designs under consideration. These data show that the bounding liquid effluent release concentrations will fall within the liquid effluent release concentration limits in Table 2 of Appendix B to 10 CFR Part 20.

The applicant calculated the estimated dose to a hypothetical maximally exposed member of the public from the liquid effluents using radiological exposure models based on RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," and the LADTAP II program (NUREG/CR-4013, "LADTAP II—Technical Reference and User Guide," issued April 1986). SERI evaluated several exposure pathways, including eating fish or invertebrates caught near the point of discharge, using the shoreline for activities (e.g., sunbathing or fishing), and swimming and boating on the Mississippi River near the point of discharge. The calculated liquid pathway total body dose to a maximally exposed individual at the nearest site boundary is 0.0217 mSv/yr (2.17 mrem/yr).

3.2.3.3 Solid Waste

The solid waste management system of the ESP facility will control, collect, handle, process, package, and temporarily store the wet and dry solid radioactive waste materials generated during normal plant operations before shipping them off site. The solid waste materials may consist of filters; demineralizer resins; waste evaporator bottoms; paper; rags; contaminated clothing, tools, and equipment; and laboratory solid wastes. The applicant will periodically ship solid radioactive waste material from the ESP site to the permanent waste disposal facility.

In ER Table 3.0-3, SERI estimated that it will generate an average of 18,646 ft^3 of radioactive waste each year. The applicant estimated the maximum curie content of the waste at 5400 curies. SERI will package and ship the waste in accordance with the applicable regulations in 10 CFR Part 71, "Packaging and Transportation of Radioactive Material," and 49 CFR Part 173, "Shippers—General Requirements for Shipments and Packagings."

Consistent with the requirements of 10 CFR Part 100, Subpart B, and 10 CFR Part 52, Subpart A, SERI did not provide details regarding the solid waste management system. The NRC will evaluate solid waste management at the CP or COL stage.

3.2.4 Conclusions

The applicant has provided adequate information to give reasonable assurance that it will control, monitor, and maintain radioactive gaseous and liquid effluents from the ESP facility within the regulatory limits in 10 CFR Parts 20, 71, and 49 CFR Part 173, as well as maintain them at ALARA levels in accordance with the effluent design objectives contained in Appendix I to 10 CFR Part 50. A COL applicant that references an ESP for the site should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquids effluents for any facility to be built on the ESP site are bounded by the radiological doses included in the SSAR for the ESP application and reviewed by the NRC staff as described above. In addition, the NRC may require detailed information on the solid waste management system used to process the radioactive gaseous and liquids effluents. This is **COL Action Item 3.2-1**.

3.3 Postulated Accidents and Accident Dose Consequences

3.3.1 Technical Information in the Application

In SSAR Section 3.3, "Postulated Accidents and Accident Dose Consequences," the applicant analyzed and provided the radiological consequences of design-basis accidents (DBAs) to demonstrate that a new nuclear unit(s) could be located at the proposed ESP site without undue risk to the health and safety of the public, in compliance with the requirements of 10 CFR 52.17 and 10 CFR Part 100. SERI did not identify a particular reactor design to be considered for the proposed ESP site. Instead, the applicant developed a set of reactor DBA source term parameters using surrogate reactor characteristics. SERI used these parameters in conjunction with specific site characteristics to conduct an accident analysis and assess the suitability of the proposed ESP site. These plant parameters are found in the PPE.

The applicant considered seven reactor designs, five water-cooled reactors and two gas-cooled reactors, though it used source terms for only three of these designs as inputs to the DBA analyses. The water-cooled reactors considered include (1) a version of the Westinghouse Advanced Plant 1000 (AP1000), (2) the certified General Electric Advanced Boiling-Water Reactor (ABWR), (3) the Atomic Energy of Canada Advanced CANDU Reactor (ACR-700), (4) the General Electric Economic and Simple Boiling-Water Reactor (ESBWR), and (5) the Westinghouse-led International Reactor Innovative and Secure (IRIS). The ACR-700 is light-water cooled but heavy-water moderated. The two gas-cooled reactors include (1) the General Atomics Gas Turbine Modular Helium Reactor (GT-MHR) and (2) the Pebble Bed Modular Reactor (PBMR). The reactor designs used in developing the PPE include (1) a version of the AP1000, (2) the ABWR, and (3) the ACR-700. SERI stated that the PPE values are not intended to be limited to these reactor designs, but rather to provide a broad overall outline of a design concept and to include other potential reactor designs if they fall within the parameter values provided in the PPE.

In selecting DBAs for dose consequence analyses, SERI focused primarily on two light-water reactors (LWRs)—the certified ABWR and a version of the AP1000[1] to serve as surrogates. Using source terms developed from these two designs, the applicant performed and provided radiological consequence analyses for the following DBAs:

- pressurized-water reactor (PWR) main steamline break
- PWR feedwater system pipe break
- locked rotor accident
- reactor coolant pump shaft break
- PWR rod ejection accident
- boiling-water reactor (BWR) control rod drop accident
- failure of small lines carrying primary coolant outside containment
- PWR steam generator tube failure
- BWR main steamline break
- PWR and BWR loss-of-coolant accidents (LOCAs)
- fuel-handling accident

For all AP1000 DBAs and ABWR LOCAs, SERI calculated site-specific DBA doses by first obtaining DBA dose information from the certified ABWR design control document (DCD) and the proposed AP1000 DCD. (The reactor designers used assumed atmospheric dispersion factors (χ/Q values) to obtain such values.) The applicant then calculated site-specific χ/Q values using onsite meteorological information. (SERI provided the site-specific χ/Q values used in its radiological consequence analyses in SSAR Section 2.3.4, "Short Term Diffusion Estimates.") Finally, the applicant multiplied the doses from the two designs by the ratio of the site-specific χ/Q values to the assumed χ/Q values from the DCDs. For the remaining ABWR DBAs (other than a LOCA), SERI used the isotopic release rates provided in the ABWR DCD and the site-specific χ/Q values to determine the radiological consequence doses for the proposed ESP site.

SERI presented the dose consequence assessment results in tables in SSAR Section 3.3, which provide the postulated radiological consequences of the DBAs identified above at the proposed exclusion area boundary (EAB) and the LPZ. The applicant also provided the accident-specific source term (i.e., release rates of radioactive materials from the ESP footprint to the environment) and resulting site-specific dose consequences for each DBA selected.

In RAI 3.3-1, the staff asked SERI to clarify whether the 0 to 2-hour EAB doses presented in the SSAR are for the 2-hour period with the greatest EAB doses. In its response, the applicant stated that the 0 to 2-hour EAB doses presented in the SSAR apply to any 2-hour period with the greatest EAB doses. For the ABWR design, the EAB doses are calculated for the first 2 hours of the accident. SERI clarified this information in Revision 1 of its ESP application.

In RAI 3.3-2, the staff asked SERI to provide references and explain the methodology it used to determine time-dependent activity releases for each DBA and provide the time-dependent activity releases for each DBA in curies. In its response, the applicant stated that the respective

[1]As discussed later in this section, the applicant referenced a version of the AP1000 design available at the time it submitted its ESP application. Westinghouse subsequently revised the AP1000 design before the NRC staff issued a final SER for the AP1000 design certification.

design certification documents for the ABWR and AP1000 present the methodologies it used for calculating their time-dependent releases. SERI also provided new tables in Section 3.3 of Revision 1 of its ESP application to show the time-dependent activity releases for each DBA in curies.

In RAI 3.3-3, the staff asked SERI to justify its use of the alternative source term methodology in accordance with RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," issued July 2000, for evaluating ABWR radiological consequences, since the ABWR design is certified with the source term from Technical Information Document (TID)-14844, "Calculation of Distance Factors for Power and Test Reactors," issued March 1962, and with the dose criteria in thyroid and whole body doses. The applicant revised Section 3.3.3 in Revision 1 of its ESP application to clarify that it based the ABWR radiological consequence analyses on a TID-14844 source term. SERI also revised Table 3.3-1, "Comparison of Reactor Types for Limiting Off-Site Dose Consequences," in Revision 1 of its ESP application to provide the offsite doses in thyroid and whole body doses.

In RAI 3.3-4, the staff noted that Westinghouse revised its χ/Q values in the AP1000 DCD since the applicant submitted its ESP application and asked whether it planned to use the updated values when revising its application. SERI responded that it elected not to update its ESP application to incorporate the latest χ/Q values in the AP1000 design certification because the AP1000 design certification is still undergoing NRC review and may receive additional changes in the future.

In RAI 3.3-7, the staff asked SERI to provide, for each DBA, the doses it used for the EAB and the LPZ for the AP1000 and the ABWR, as well as the ratios of site-specific χ/Q values to the design certification χ/Qs used. In its response, the applicant stated that it would revise the dose tables in SSAR Section 3.3 to show the χ/Q values and doses from the AP1000 and ABWR DCDs, in addition to the ratios of site-specific χ/Q values to the design certification χ/Q values. SERI provided this information in the SSAR Section 3.3 tables in Revision 1 of its ESP application.

In RAI 3.3-8, the staff noted that SSAR Section 3.3 provides total effective dose equivalent (TEDE) values for the ABWR design, while the ABWR design is certified with the thyroid and whole body doses specified in 10 CFR Part 100. The staff asked SERI to compare the doses. In its response, the applicant revised the SSAR in Revision 1 of its ESP application to include the thyroid and whole body doses from the ABWR DCD, in addition to the estimated TEDE values.

3.3.2 Regulatory Evaluation

In SSAR Table 1.4-1, "Conformance with NRC Regulatory Guides and Guidance," and in response to RAI 1.4-1, SERI identified the applicable NRC regulations and guidance regarding the site location and description as defined in 10 CFR 52.17, 10 CFR Part 100, and 10 CFR 50.34(a)(1). The staff finds that the applicant correctly identified the relevant regulations and guidance.

The staff considered the following regulatory requirements and guidance in reviewing the accident analyses:

- 10 CFR 52.17
- 10 CFR Part 100
- 10 CFR 50.34, “Contents of Applications; Technical Information”
- RG 1.3, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Boiling Water Reactors,” issued June 1974
- RG 1.25, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors,” issued March 1972
- RG 1.145, “Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants,” issued November 1982
- RG 1.183
- NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants” (known as the SRP), issued July 1981
- TID-14844

In its evaluation, the staff used the dose consequence evaluation factors found in 10 CFR 50.34(a)(1) to determine the acceptability of the site in accordance with 10 CFR 52.17(a)(1).

The regulations at 10 CFR 52.17(a)(1) require that ESP applications contain an analysis and evaluation of the major SSCs of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1). In addition, the ESP site characteristics must comply with the requirements of 10 CFR Part 100. The regulations at 10 CFR 50.34(a)(1)(ii)(D) require the following for a postulated fission product release based on a major accident:

- An individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of the postulated fission product release would not receive a radiation dose in excess of 25 rem TEDE.
- An individual located at any point on the boundary of the LPZ, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a radiation dose in excess of 25 rem TEDE.

Because it did not select a reactor design to be constructed on the proposed ESP site as described earlier, SERI used a PPE approach to demonstrate that it meets these requirements. A PPE is a set of plant design parameters that are expected to bound the characteristics of a reactor(s) that may be constructed at a site, and it serves as a surrogate for actual reactor design information. As discussed in RS-002 and Chapter 1 of this SER, the staff considers the PPE approach to be an acceptable method for assessing site suitability. For the radiological consequence analysis, SERI proposed a fission product release from the ESP footprint to the environment, and the staff reviewed the applicant’s dose evaluation based on this release.

3.3.3 Technical Evaluation

The applicant evaluated the suitability pursuant to 10 CFR 50.34(a)(1), using bounding reactor accident source terms and dose consequences as a set of PPE values based primarily on two surrogate designs, as well as site-specific χ/Q values based on the ESP footprint.

3.3.3.1 Selection of DBAs

SERI selected the DBAs listed in Section 3.3.1 of this SER based primarily on the proposed AP1000 reactor design and the certified ABWR reactor design. The applicant selected DBAs which are consistent with those analyzed in the SRP and RG 1.183. Therefore, the staff finds that SERI provided an acceptable DBA selection for evaluating the compliance of the proposed ESP site with the dose consequence evaluation factors specified in 10 CFR 50.34(a)(1). The applicant stated, that because of their greater potential for inherent safety, the DBAs analyzed in the proposed AP1000 and certified ABWR DCDs are expected to bound the DBAs of the other reactors under consideration for the proposed ESP site. While it has not reviewed these designs in detail, other than the AP1000 and ABWR, the staff believes that any conclusions drawn regarding the site's acceptability based on the AP1000 and ABWR designs are likely to be valid for the other reactor designs that the applicant is considering. The staff would determine whether these DBA analyses will in fact bound such designs during its consideration of any COL or CP application that might be filed with respect to the construction and operation of a reactor at the ESP site.

3.3.3.2 Design-Specific (Assumed) χ/Q Values

To support its accident analyses based on the ABWR as a surrogate design, SERI used the assumed χ/Q values in the certified ABWR DCD. In evaluating the AP1000, the applicant used those χ/Q values in the proposed AP1000 DCD under review by the staff at the time the Grand Gulf ESP application was submitted. Westinghouse subsequently revised the χ/Q values in the AP1000 DCD. Consequently, the assumed χ/Q values and the calculated design-specific doses used in the Grand Gulf ESP application may differ from those associated with a certified AP1000 DCD. However, the staff determined that the PPE values for the assumed χ/Q values associated with the AP1000 design used by SERI in its accident analyses are reasonable and adequate to demonstrate that a reactor with design characteristics similar to an AP1000 could be sited at the proposed ESP site. In response to RAI 3.3-7, the applicant provided the AP1000 and ABWR χ/Q values it used for the version of the AP1000 and the certified ABWR that it considered. Table 3.3-1 shows the χ/Q values that SERI used.

Table 3.3-1 Design-Specific (Assumed) χ/Q Values in s/m^3

Location and Time Interval	AP1000	ABWR
0–2-hour EAB	$6.0x10^{-4}$	$1.37x10^{-3}$
0–8-hour LPZ	$1.35x10^{-4}$	$1.56x10^{-4}$
8–24-hour LPZ	$1.0x10^{-4}$	$9.61x10^{-5}$
1–4-day LPZ	$5.4x10^{-5}$	$3.36x10^{-5}$
4–30-day LPZ	$2.2x10^{-5}$	$7.42x10^{-6}$

3.3.3.3 Site-Specific χ/Qs

The staff reviewed the applicant's site-specific χ/Q values and performed an independent evaluation of atmospheric dispersion in accordance with the guidance provided in Section 2.3.4 of RS-002. The staff finds the applicant's site-specific χ/Q values to be acceptable, as described in Section 2.3.4 of this SER. Table 3.3-2 of this SER lists the site-specific χ/Q values used by SERI and reviewed by the staff. These site-specific χ/Qs will be part of any ESP that the NRC may issue for the Grand Gulf ESP site.

3.3.4 Source Terms and Radiological Consequence Evaluations

To evaluate the suitability of the site using the radiological consequence evaluation factors specified in 10 CFR 50.34(a)(1), SERI provided the bounding reactor accident source terms as a set of PPE values using (1) the surrogate AP1000 and ABWR designs and (2) the site-specific χ/Qs based on the ESP footprint. The source terms are expressed as the timing and release rate of fission products to the environment from the proposed ESP site. The dose consequences are then derived from the source terms and the site-specific χ/Qs based on the ESP footprint.

The guidance provided in RG 1.183 forms the basis for the AP1000 source terms. The methodologies and assumptions used by Westinghouse, the AP1000 vendor, in its radiological consequence analyses are consistent with the guidance provided in RG 1.183. The resulting doses calculated for the AP1000 design using assumed site parameters meet the dose consequence evaluation factors specified in 10 CFR 50.34(a)(1) (i.e., 25 rem TEDE). The guidance in TID-14844 forms the basis for the ABWR source terms. The methodologies and assumptions used by General Electric, the ABWR vendor, in its radiological consequence analyses for the ABWR design are consistent with the guidance provided in RGs 1.3 and 1.25. The resulting doses for the ABWR reactor design using assumed site parameters meet the dose consequence evaluation factors specified in 10 CFR 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance" (300 rem to the thyroid and 25 rem to the whole body). While the requirements of 10 CFR 100.11 do not apply to SERI's application, the Commission determined in Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor," to 10 CFR Part 52, "Domestic Licensing of Production and Utilization Facilities," states the following:

> The Commission has determined that with regard to the revised design-basis accident radiation dose acceptance criteria in 10 CFR 50.34, the ABWR design meets the new dose criteria, based on the NRC staff's radiological consequence analyses, provided that the site parameters are not revised.

62 FR 25,819-20 Therefore, the staff concludes that the certified ABWR design, in conjunction with the assumed site parameters, meets the dose consequence evaluation factors specified in 10 CFR 100.21 and 10 CFR 50.34(a)(1).

The staff has verified the applicant's design-specific source terms and finds them to be consistent with those evaluated by the staff as part of the design certification reviews. Based on its review, the staff finds acceptable the references provided by SERI and the methodology it used to determine the timing and release rate of fission product source terms to the environment (and resulting dose consequences) from the proposed ESP site. Therefore, the staff finds the source terms from the ESP footprint (PPE values) to be reasonable and acceptable. The staff intends to include the source terms in any ESP that the NRC might issue for the Grand Gulf ESP site.

Based on its evaluation of the applicant's analysis methodology and inputs to that analysis, the staff agrees with SERI's conclusion that the dose consequences for the chosen surrogate designs comply with the dose consequence evaluation factors of 10 CFR 50.34(a)(1).

The staff has identified the site χ/Q values given in Table 3.3-2 as appropriate for inclusion in any ESP that the NRC might issue for the ESP site.

Table 3.3-2 Site-Specific χ/Q Values

Location and Time Interval	χ/Q Value
0–2-hour EAB	5.95×10^{-4} s/m^3
0–8-hour LPZ	8.83×10^{-5} s/m^3
8–24-hour LPZ	6.16×10^{-5} s/m^3
1–4-day LPZ	2.82×10^{-5} s/m^3
4–30-day LPZ	9.15×10^{-6} s/m^3

The guidance in RS-002 calls for the staff to perform a confirmatory radiological consequence calculation. However, the design-related inputs to the applicant's dose calculation were directly extracted from design documentation previously submitted to and reviewed by the NRC in connection with design certification applications. SERI either multiplied these inputs by the ratio of the site χ/Q values to the assumed design χ/Q values, or multiplied the source term release rates (PPE values) by the site χ/Q values (PPE values) and standard dose conversion factors, and as a result, the staff did not consider an independent calculation to be useful or necessary and did not perform one.

3.3.4 Conclusions

As set forth above, the applicant submitted its radiological consequence analyses using site-specific χ/Q values and PPE source term values and concluded that the proposed site meets the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1).

Based on the reasons set forth above, the staff finds that the applicant's PPE values for the source terms that it included as inputs to the radiological consequence analyses are reasonable. Furthermore, the staff finds that the applicant's site-specific χ/Q values and dose consequence evaluation methodology are acceptable.

Therefore, the staff concludes that the proposed distances to the EAB and the LPZ outer boundary of the proposed ESP site, in conjunction with the fission product release rates to the environment provided by SERI as PPE values, will provide reasonable assurance that the radiological consequences of the DBAs will be within the dose consequence evaluation factors specified in 10 CFR 50.34(a)(1) for the proposed ESP site.

The staff further concludes that (1) SERI has demonstrated that the proposed ESP site is suitable for power reactors with source term characteristics bounded by the PPE without undue risk to the health and safety of the public and (2) SERI has complied with the requirements of 10 CFR 52.17 and 10 CFR Part 100.

3.4 Geologic and Seismic Siting Criteria

Section 2.5 of this SER presents the staff's evaluation of the applicant's information regarding the site's geologic and seismic engineering characteristics.

3.5.1.6 Aircraft Hazards

For an ESP application, the NRC staff reviews an applicant's assessment of aircraft hazards to ensure that the risks associated with such hazards are sufficiently low to allow for a new nuclear power plant(s) to be constructed at the proposed ESP site.

3.5.1.6.1 Technical Information in the Application

In Section 2.2.1 of its SSAR, SERI presented information concerning the site relative to airports and airways that could affect the design of SSCs important to the safety of a nuclear power plant(s) falling within the applicant's PPE that might be constructed on the proposed ESP site.

SERI did not identify any private airports and airstrips within 10 kilometers (6 miles) of the proposed ESP site. Figure 2.2-3 of the SSAR shows that 12 public airports are located within approximately 30 miles of the proposed ESP site. Section 2.2.1 of the SSAR discusses six of the closest airports, as well as the Jackson International Airport approximately 60 miles northeast of the proposed site.

The proposed ESP site lies within a triangle formed by three low-altitude airways (V245, V417, and V71) passing near the site. These airways, which are used by aircraft flying below 18,000 feet, are 8 nautical miles (approximately 9.1 statute miles) in width. The centerline of the closest airway, V245, lies about 10 miles to the east of the site.

The SSAR does not contain an analysis of the hazards associated with aircraft operations near airports, air traffic on nearby airways, or aircraft activities with respect to military training routes and areas.

3.5.1.6.2 Regulatory Evaluation

In SSAR Table 1.4-1, SERI listed the applicable NRC regulation and guidance related to the identification and evaluation of hazards associated with aircraft as Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or after January 10, 1997," of 10 CFR Part 100 and RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)."

According to Section 3.5.1.6 of RS-002, the proposal will meet the requirement in 10 CFR 100.20, "Factors To Be Considered When Evaluating Sites," for a low probability of individual and societal risks resulting from potential plant accidents if the probability of aircraft accidents having the potential for radiological consequences greater than the exposure guidelines in 10 CFR 50.34(a)(1) is less than about $1x10^{-7}$ per year.

The probability is considered to be less than about $1x10^{-7}$ per year by inspection if the distances from the site meet all of the following three criteria:

(1) The site-to-airport distance D is between 5 and 10 statute miles and the projected annual number of operations is less than 500 D^2, or the site-to-airport distance D is greater than 10 statute miles and the projected annual number of operations is less than 1000 D^2.

(2) The site is at least 5 statute miles from the edge of military training routes, including low-level training routes, except for those associated with a usage greater than 1000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation.

(3) The site is at least 2 statute miles beyond the nearest edge of a Federal airway, holding pattern, or approach pattern.

If the above proximity criteria are not met, or if sufficiently hazardous military activities are identified, a detailed review of aircraft hazards should be performed. Section 3.5.1.6 of RS-002 provides guidance on the performance of such reviews.

3.5.1.6.3 Technical Evaluation

SERI did not identify any private airfields near the proposed ESP site. The staff has not identified any private airfields within 16 kilometers (10 miles) of the site. However, it is the staff's experience that the typical number of flight operations per year from private airfields is significantly less than the first criterion in the list above. Moreover, because of existing protection requirements against tornado missiles, safety-related plant SSCs are sufficiently protected against the impact effects of aircraft of the size and type that generally use private fields. Hence, the staff concludes that, in this case, a detailed analysis of the risk to a nuclear power plant(s) at the proposed ESP site from operations at private fields is not necessary for the staff to make a site suitability finding.

SSAR Section 2.2.3 does not address potential accidents resulting from airport or airway hazards identified in SER Sections 2.2.1–2.2.2. In response to an RAI, SERI provided the distances of airways V245 and V417 from the ESP site and indicated that no airports exist within 10 miles of the ESP site.

The applicant identified 12 public airports within 50 miles of the proposed ESP site but did not evaluate the potential hazards associated with operations at any of these airports. The staff performed an independent assessment of the risks associated with the 12 airports identified by SERI, as well as an additional 4 airports between 50 and 61 miles from the proposed ESP site. Table 3.5.1.6-1 lists the airports considered by the staff, their distances from the proposed ESP site, and the number of operations per year at each airport. In addition, the table includes a comparison of the number of operations per year with the first criterion listed above. For all airports, the number of operations per year is a small fraction (less than one tenth) of the criterion limit. Therefore, the staff concludes that aircraft operations currently associated with airports do not pose a significant risk at the proposed ESP site.

The proposed ESP site is approximately 10 statute miles from the centerline of the closest low-altitude airway. The edge of the airway is approximately 4.6 miles from the centerline. Therefore, the proposed ESP site is more than 2 miles from the edge of the closest Federal airway. On this basis, the staff concludes that air traffic along the airway does not pose a significant risk to the proposed ESP site.

In SSAR Section 2.2.1, SERI stated that no military installations are located near the ESP site. England Air Force Base, which was the closest military installation to the site, closed in 1993. Figure 2.2-5 does not show any military training routes on the air route map. On this basis, the staff finds that military aircraft operations do not pose a significant risk to the proposed ESP site.

3.5.1.6.4 Conclusions

The staff reviewed the applicant's aircraft hazard analysis using the procedures set forth in RS-002, Section 3.5.1.6. As discussed above, the staff reviewed the applicant's assessment of aircraft hazards at the ESP site that result in a probability less than about 1×10^{-7} per year for an accident having the potential for radiological consequences greater than the exposure guidelines in 10 CFR 50.34(a)(1). The staff also conducted its own independent analyses. Based upon these analyses, the staff concludes that aircraft hazards at the proposed ESP site pose no undue risk to the health and safety of the public. Therefore, staff concludes that, from the perspective of aircraft hazards, the proposed ESP site is acceptable for siting a nuclear power plant(s) of the type specified by SERI. In addition, the ESP site meets the relevant requirements of 10 CFR Parts 52 and 100.

Table 3.5.1.6-1 Public Airports in the Vicinity of the Proposed ESP Site

Airport	Distance from ESP Site (mi)	Reported Operations per Year[(a)]	Fraction of RS-002 $1000D^2$ Criterion	Operations by Aircraft Type[(a)]
Tensas Parish	12	6987	5.1%	100% general
Newellton	13	6987	4.4%	100% general
Scott	29	20075	2.4%	100% general
Vicksburg Municipal	17	7300	2.4%	94% general, 6 % military
Hardy-Anders Field	31	16425	1.7%	92% general, 4% air taxi, 4% military
John Bell Williams	43	24455	1.3%	100% general, <1% military
Winnsboro Municipal	39	20075	1.3%	100% general
Vicksburg Tallulah Regional	24	6361	1.1%	94% general, 6% military
Copiah County	40	13505	0.8%	93% general, 7% air taxi
Brookhaven-Lincoln County	47	13140	0.6%	100% general
Concordia Parish	40	9125	0.6%	100% general
Delhi Municipal	38	8030	0.5%	100% general
Hawkins Field	53	62415	2.2%	88% general, 6% military, 6% air taxi
John H Hooks Jr Memorial	54	17885	0.6%	100% general
Byerley	57	6987	0.2%	100% general
Jackson International	61	90155	2.5%	54% general, 25% commercial, 15% air taxi, 6% military

[(a)] Aircraft operations information is based on data obtained at http://www.airnav.com/airports/us/ (November 17, 2004).

Section 2.2, Nearby Industrial, Transportation, and Military Facilities
Section 3.5.1.6, Aircraft Hazards