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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

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Before Administrative Judges:

Lawrence G. McDade, Chairman
Nicholas G. Trikouros
Dr. Richard E. Wardwell

In the Matter of

SYSTEM ENERGY RESOURCES, INC.

(Early Site Permit for Grand Gulf ESP Site)

Docket No. 52-009-ESP

ASLBP No. 04-823-03-ESP

January 26, 2007

INITIAL DECISION

(Authorizing the Issuance of the Grand Gulf Early Site Permit)

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I. INTRODUCTION

On October 16, 2003, System Energy Resources, Inc. (SERI) filed an application for a 10 C.F.R. Part 52, Subpart A Early Site Permit (ESP).¹ The ESP Application seeks approval of the site at the existing Grand Gulf Nuclear Station (GGNS) in Claiborne County, Mississippi, for the possible future construction of new nuclear power generation facilities.² Thereafter, in response to the Notice of Opportunity for a Hearing published in the Federal Register,³ the National Association for the Advancement of Colored People (Claiborne County, Mississippi

¹ An ESP proceeding allows an applicant to secure early review and approval of specific siting and environmental issues as a preliminary to the submission of an application for a construction permit or combined operating license (COL). See 10 C.F.R. § 52.39. Those issues resolved in an ESP proceeding may be banked (*i.e.*, relied on at the COL stage) for up to twenty years after an ESP is issued. However, any issues not expressly resolved during an ESP proceeding must be addressed by the applicant and resolved by the Nuclear Regulatory Commission at the COL stage.

² The site is on the east side of the Mississippi River, approximately twenty-five miles south of Vicksburg, Mississippi and six miles northwest of Port Gibson, Mississippi, and consists of approximately 2,100 acres. The proposed ESP site is adjacent to a single nuclear generating plant, which is capable of producing approximately 1,350 MWe.

³ 69 Fed. Reg. 2636 (Jan. 16, 2004).

Branch), Nuclear Information and Resource Service, Public Citizen, and the Mississippi Chapter of the Sierra Club (Petitioners) filed a request for hearing and petition to intervene. Based on the pleadings submitted, and after hearing argument regarding the standing of the Petitioners and the admissibility of their seven proffered contentions, a prior Atomic Safety and Licensing Board determined that, although the Petitioners established the requisite standing to intervene in this proceeding, they failed to submit any admissible contentions.⁴ The Petitioners collectively appealed the Board's Order and, on January 18, 2005, the Nuclear Regulatory Commission (NRC or Commission) affirmed the Board's rulings.⁵ Therefore, the only matter remaining before this Board is satisfaction of the Mandatory Hearing requirement with regard to SERI's ESP Application.⁶

This Initial Decision embodies this Licensing Board's findings regarding uncontested matters in the above-captioned proceeding. It is based on the Board's review of the record of this proceeding including, but not limited to, the evidentiary hearing that was held from November 29 to December 1, 2006. This Initial Decision, absent further direction or action from the Commission, is the final action by the Board in this proceeding, and authorizes the Director, Office of Nuclear Reactor Regulation, to issue to SERI an ESP for the Grand Gulf site consistent with the provisions of the Atomic Energy Act of 1954 (AEA) as amended, NRC Regulations, and this Initial Decision.

As described below, the Board has found that the NRC Staff's review of SERI's ESP Application has been adequate and, having performed an evaluation of the "baseline" issues under the National Environmental Policy Act of 1969 (NEPA), we have made an independent

⁴ See LBP-04-19, 60 NRC 277 (2004).

⁵ See CLI-05-04, 61 NRC 10 (2005).

⁶ See 42 U.S.C. § 2235 (2000); 10 C.F.R. §§ 52.18, 52.21, 52.24.

determination that, subject to the commitments and assumptions specified in (1) the Permit Conditions, COL Action Items, Site Characteristics, and Bounding Parameters specified in Appendix A of the Final Safety Evaluation Report (FSER) (NRC Staff Exhibit 44, ADAMS Accession No. ML0635603312), (2) Appendix J of the Final Environmental Impact Statement (FEIS) (NRC Staff Exhibit 45, ADAMS Accession No. ML063560332), (3) the table of Resolved Safety and Environmental Issues (NRC Staff Exhibit 3, ADAMS Accession No. ML063560116), and (4) the Summary of Issues for Which Cumulative Effects were Analyzed (NRC Staff Exhibit 9, ADAMS Accession No. ML063560097), that the Grand Gulf ESP should be issued.

II. LEGAL STANDARDS GOVERNING THIS PROCEEDING

The AEA, as amended, requires that “[t]he Commission shall hold a hearing . . . on each application under Section 103 or 104b for a construction permit for a facility.”⁷ NRC regulations define ESPs as “partial construction permits” and, as such, they are subject to the hearing requirements that are mandated under Section 189a of the AEA and “to all procedural requirements in 10 C.F.R. Part 2 which are applicable to construction permits.” 10 C.F.R. § 52.21.

When a proceeding involving an application for a construction permit is uncontested – as is the case here – the procedures to be followed by the Licensing Board to ensure compliance with Section 52.21, are described at 10 C.F.R. § 2.104(b)(2)(3) and the Commission’s 2005 answers to a series of certified questions submitted by the Chief Administrative Judge of the Atomic Safety and Licensing Board Panel (CLI-05-17, 62 NRC 5 (2005)). In uncontested

⁷ Atomic Energy Act of 1954 § 189a, 42 U.S.C. § 2239(a)(1)(A) (2000). The Commission delegated its responsibility to hold a hearing in this matter to the Atomic Safety and Licensing Board Panel. See Establishment of Atomic Safety and Licensing Board (Mar. 22, 2004) (unpublished). Thereafter, the Chief Administrative Judge of the Atomic Safety and Licensing Board Panel reconstituted the Atomic Safety and Licensing Board presiding over this matter, appointing Administrative Judges Lawrence G. McDade, Chair, Nicholas G. Trikourous, and Richard E. Wardwell, in place of Administrative Judges G. Paul Bollwerk, Chair, Paul B. Abramson, and Anthony J. Baratta. See Notice of Reconstitution (Dec. 15, 2005) (unpublished).

proceedings, Boards are directed not to conduct a “de novo review,” rather they “should conduct a simple ‘sufficiency’ review of [the] uncontested issues.”⁸ More specifically, the Commission has directed Boards to decide “whether the safety and environmental record is ‘sufficient’ to support license issuance. In other words, [B]oards should inquire whether the NRC Staff performed an adequate review and made findings with reasonable support in logic and fact.”⁹ Recently, the Commission reiterated the depth of the Licensing Board’s review, in its decision granting, in part, an appeal filed by the NRC Staff in this proceeding.¹⁰ In that decision the Commission explained that Boards “must narrow [their] inquiry to those topics or sections in Staff documents that it deems most important and should concentrate on portions of the documents that do not on their face adequately explain the logic, underlying facts and applicable regulations and guidance.”¹¹

In conducting its “sufficiency” review, Licensing Boards are directed to make specific findings.¹² First, with respect to matters involving safety – i.e. issues pursuant to the AEA – Boards must determine whether the application and the record of the proceedings contain sufficient information and the review of the application by the NRC Staff has been adequate to assure that:

- (1) the issuance of an ESP will not be inimical to the common defense and security or to the health and safety of the public (Safety Issue 1); and
- (2) taking into consideration the site criteria contained in 10 C.F.R. Part 100, a reactor, or reactors, having characteristics that fall within the parameters for the site, can be

⁸ CLI-05-17, 62 NRC at 39.

⁹ Id.

¹⁰ See CLI-06-20, 64 NRC 15 (2006).

¹¹ Id. at 21-22.

¹² See 69 Fed. Reg. at 2636; see also 10 C.F.R. §§ 2.104(b)(2), § 51.105, and 52.21.

constructed and operated without undue risk to the health and safety of the public (Safety Issue 2).¹³

Second, with respect to matters involving the environment – i.e. issues arising from NEPA –

Boards must:

- (1) Determine whether the requirements of Section 102(2)(A), (C), and (E) of NEPA and Subpart A of 10 C.F.R. Part 51 have been complied with in the proceeding.
- (2) Independently consider the final balance among conflicting factors contained in the record of the proceeding with a view to determining the appropriate action to be taken.
- (3) Determine, after considering reasonable alternatives, whether the ESP should be issued, denied, or appropriately conditioned to protect environmental values.
- (4) Determine whether the record of these proceedings contains sufficient information to conclude that the NEPA review conducted by the NRC Staff has been adequate.¹⁴

With regard to the first three (baseline) NEPA issues, the Board must do more than pass on the adequacy of the NRC Staff's NEPA review. In addition to finding that the Staff has conducted an adequate NEPA review, the Board must determine whether the applicable requirements of NEPA have been complied with and, after considering the final balance among conflicting factors, independently determine whether the ESP should be issued, denied, or appropriately conditioned to protect environmental values.¹⁵

¹³ See 69 Fed. Reg. at 2636.

¹⁴ See id.; see also 10 C.F.R. § 2.104(b)(3)(i)-(iii) and 10 C.F.R. § 51.105(a)(4). With regard to reasonable alternatives, at the ESP stage a discussion of the benefits, including need for power, is not necessary. See 10 C.F.R. § 52.17(a)(2). Further, the Commission has made clear that at the ESP stage “the board’s ‘reasonable alternatives’ responsibilities are limited” and focus on the consideration and comparison of alternative sites. CLI-05-17, 62 NRC at 48.

¹⁵ See CLI-05-17, 62 NRC at 45.

III. PROCEDURAL BACKGROUND OF THIS PROCEEDING

After this Board received the NRC Staff's FSER¹⁶ and FEIS,¹⁷ we issued an Order requesting additional documents and briefings from the NRC Staff.¹⁸ Specifically, we directed the Staff to provide the following: (1) Site Safety Analysis Report (SSAR); (2) emergency planning information; (3) Environmental Report (ER); (4) NRC Staff Requests for Additional Information (RAI) and SERI's replies thereto, including any written analyses of those replies that were prepared by the NRC Staff; and (5) minutes and/or transcripts of any Advisory Committee on Reactor Safeguards (ACRS) meetings relevant to SERI's ESP Application, and any reports, letters or memoranda prepared by or on behalf of the ACRS which relate to SERI's ESP Application.¹⁹

In addition, the Board directed the NRC Staff to provide "a narrative summary identifying all regulatory guidance documents that were used, or are being used, in its review of SERI's ESP Application," and where applicable, to explain "those areas where relevant portions of the published guidance documents were not used" and "why the chosen course of review was

¹⁶ NUREG-1840, Safety Evaluation Report for an Early Site Permit (ESP) at the Grand Gulf Site (Apr. 2006) (NRC Staff Exh. 44) [hereinafter FSER].

¹⁷ NUREG-1817, Environmental Impact Statement for an Early Site Permit (ESP) at the Grand Gulf ESP Site (Apr. 2006) (NRC Staff Exh. 45) [hereinafter FEIS].

¹⁸ See Licensing Board Order (Request for Documents and Briefings) (Apr. 19, 2006) (unpublished) [hereinafter April 19 Order].

¹⁹ See id. at 2. The NRC Staff sought interlocutory review of, inter alia, our request for any written Staff analyses of SERI's replies to RAIs, and our request for any documents prepared by or on behalf of the ACRS which relate to SERI's ESP Application. See NRC Staff Petition for Interlocutory Review of the Licensing Board's May 31, 2006 Order (June 15, 2006). The Commission granted the Staff's request for relief, in part, holding that the Staff need not submit to the Board any predecisional documents relating to SERI's responses to RAIs or any documents produced by the ACRS that the Staff had not reviewed in its consideration of SERI's Application. See CLI-06-20, 64 NRC at 24-26. This Board subsequently issued a Scheduling Order establishing a tentative schedule for the remainder of the proceeding. See Licensing Board Order (Establishing Tentative Case Schedule) (Aug. 1, 2006) (unpublished) [hereinafter August Scheduling Order].

followed.”²⁰ Finally, the Board directed the Staff to file proposed findings of fact and conclusions of law – to which SERI would be allowed an opportunity to comment – “relevant to the findings which the Board must make in the Mandatory Hearing.”²¹

Following its review of the documents submitted by the NRC Staff and SERI,²² the Board issued two sets of questions to the Staff regarding its analyses in the FSER and the FEIS. The focus of these questions were perceived inadequacies or inconsistencies with the Staff’s analyses, and/or inconsistencies between statements made by SERI in its own application and statements made by the Staff in the FSER or FEIS.²³ SERI was provided an opportunity to

²⁰ April 19 Order at 2-3. In response to an NRC Staff Motion for Reconsideration and Clarification, we deferred our request for this narrative summary based on representations by the Staff that the FSER and FEIS already contained the summary information requested by the Board. See NRC Staff Motion for Reconsideration and Clarification of Board Order (Request for Documents and Briefing) Dated April 19, 2006 (May 1, 2006) [hereinafter NRC Staff Motion]; Licensing Board Memorandum and Order (Ruling on Motions for Reconsideration and Clarification) at 7-8 (May 31, 2006) (unpublished). Ultimately, we determined that, while such a narrative summary would have been helpful, and would have facilitated and expedited the Board’s review of the record, it was not essential and we did not require that it be produced.

²¹ April 19 Order at 4. See NRC Staff’s Proposed Findings of Fact and Conclusions of Law in the Mandatory Hearing (Aug. 11, 2006); System Energy Resources, Inc. Comments on NRC Staff’s Proposed Findings of Fact and Conclusions of Law in the Mandatory Hearing (Aug. 25, 2006).

²² The SSAR, emergency planning information, the ER, and SERI’s replies to the NRC Staff’s RAIs, were all provided by SERI, instead of the Staff. See NRC Staff Motion at 4.

²³ See Licensing Board Order (Issuing Questions Relating to the Grand Gulf Early Site Permit Safety Evaluation Report) (Sept. 13, 2006) (unpublished) [hereinafter Order on FSER]; Licensing Board Order (Issuing Questions Relating to the Grand Gulf ESP Environmental Impact Statement, Requesting Briefing on Environmental Issues, and Addressing Scheduling Issues) (Oct. 3, 2006) (unpublished) [hereinafter Order on FEIS]. The NRC Staff timely submitted its answers to the Board’s questions pertaining to the FSER. See NRC Staff Response to Licensing Board’s Order of September 13, 2006 (Sept. 29, 2006); System Energy Resources, Inc. Comments on NRC Staff Response to Licensing Board’s Order of September 13, 2006 (Oct. 10, 2006).

On October 10, 2006, the NRC Staff filed a Motion for an Extension of Time in which to submit its answers to the Board’s questions relating to the FEIS. The Board granted the Staff’s motion, but given the delay sought, we deemed it necessary to revise the tentative schedule set
(continued...)

comment on the Staff's responses to these questions.

With respect to the FEIS, in addition to the specific questions, we directed that the NRC Staff and SERI brief the Board on what they each believed to be our responsibilities under NEPA. Specifically, the Board asked both parties to address

how the record of this proceeding demonstrates that the requirements of Section 102(2)(A), (C), and (E) of NEPA and Subpart A of 10 C.F.R. Part 51 have been satisfied. In addition these briefs shall identify and describe the conflicting environmental factors contained in the record of this proceeding, and analyze the balance among those conflicting environmental factors, with a view toward assisting the Board to determine the appropriate action to be taken regarding whether the ESP should be issued, denied, or appropriately conditioned to protect environmental values.²⁴

In addition, the Board requested the parties to discuss

whether, given the number of Staff assumptions and unresolved matters that are documented in the EIS, the Board has been presented with sufficient information to properly balance the harms and benefits of the proposed action

so that it may carefully consider the potential significant environmental effects, or to give this project the required "hard look" envisioned by NEPA.²⁵

Finally, the Board directed the parties "to describe whether, and if so how, the Board (on the record before us) can conduct the independent assessment and weighing of environmental factors, and the consideration of reasonable alternatives."²⁶

²³(...continued)

forth in our August Scheduling Order. See Licensing Board Order (Granting the NRC Staff's Motion for an Extension of Time and Revising Case Schedule) at 2 (Oct. 11, 2006) (unpublished) [hereinafter October Scheduling Order]; Licensing Board Notice (Change in Schedule) (Oct. 17, 2006) (unpublished). The Staff then timely submitted its answers pursuant to our October Scheduling Order. See NRC Staff Response to Licensing Board's Order of October 3, 2006 (Oct. 23, 2006); System Energy Resources, Inc. Comments on NRC Staff Response to Licensing Board's Order of October 3, 2006 (Oct. 30, 2006).

²⁴ Order on FEIS at 2-3.

²⁵ Id. at 3.

²⁶ Id.

After reviewing the NRC Staff's answers to our specific questions, SERI's additional comments, and the requested briefings, the Board set forth nine "hearing issues" that it believed should be addressed by the Staff in its pre-filed direct testimony for the evidentiary hearing,²⁷ and thereafter, during the hearing through live testimony.²⁸ These nine issues were as follows: (A) site characterization; (B) monitorability of inadvertent radiological releases; (C) seismic impacts; (D) slope and foundation stability; (E) alternative analyses; (F) evaluation of cumulative site impacts; (G) evaluation of plant parameter envelope; (H) continuity between the ESP stage and COL stage; and (I) radiological reviews and confirmatory analyses.

On November 20, 2006, the NRC Staff filed its pre-filed testimony on each of the nine hearing issues set forth in our November 6, 2006 Order. This written testimony was accompanied by twelve unmarked exhibits. On November 22, 2006, SERI submitted written testimony and exhibits to supplement the Staff's submissions.²⁹ Thereafter, between November 29 and December 1, 2006, the Board conducted an evidentiary hearing in Rockville, Maryland in accordance with the provisions of Section 189a of the AEA. As noted above, this Initial Decision sets forth the Board's findings of fact and conclusions of law with regard to the

²⁷ Although the Board allowed SERI the opportunity to file its own pre-filed testimony – after the Board received the NRC Staff's pre-filed testimony – SERI was strongly "urge[d] . . . to work together [with the Staff] in compiling [the Staff's] testimony," and that any additional testimony SERI submitted should be supplemental in nature. Tr. at 7-8 (Oct. 31, 2006 pre-hearing conference).

²⁸ See Licensing Board Order (Requesting Specific Summary Exhibits and Supplemental Briefs; Identifying Hearing Issues and Requesting Evidentiary Presentations on Specific Issues) (Nov. 6, 2006) (unpublished) [hereinafter Hearing Issues Order].

²⁹ We note that the guidance given by the Board during the pre-hearing conference regarding the form in which the pre-filed testimony and exhibits were to be submitted was not followed by the parties. See Tr. at 12-14 (Oct. 31, 2006 pre-hearing conference). If, in future proceedings, pre-filed testimony and exhibits are submitted in disregard to the Board's directions, the parties should anticipate that the hearing may be postponed and, thereafter rescheduled, only after the testimony and exhibits are submitted in accordance with the Board's direction.

uncontested safety and environmental matters relevant to this proceeding, is the final ruling by this Board in this proceeding, and authorizes the Director of Nuclear Reactor Regulation to issue to SERI the ESP for the Grand Gulf site, subject to the conditions set forth herein.³⁰

IV. FINDINGS OF FACT

A. Hearing Issue: Site Characterization

The NRC Staff documented its review of SERI's Application with respect to site characteristics in Chapter 2 of the FSER. The characteristics addressed included: geography and demography; nearby industrial, transportation, and military facilities; meteorology; hydrology; and geology, seismology, and geotechnical engineering. After reviewing SERI's information on site characterization in accordance with the applicable Nuclear Regulatory Commission Issuances (NUREG) and Regulatory Guides (RG), the Staff concluded that SERI's Application included sufficient site characterization details to meet the relevant requirements of 10 C.F.R. § 52.17 and 10 C.F.R. Part 100.³¹

SERI based its descriptions of the regional and site geology, hydrogeology and geotechnical engineering characteristics, on information contained in the GGNS Updated Final Safety Analysis Report (UFSAR), and on three additional borings, four cone penetrometer soundings, two downhole geophysical surveys, and geological field observations made for its ESP Application.³² Based on its review, the NRC Staff determined that SERI's description of regional geology, hydrogeology, and geotechnical engineering factors was adequate, and the Application sufficiently described onsite and offsite ground water use. Accordingly, the Staff

³⁰ See supra p. 3; infra p. 103.

³¹ See FSER at 2-3, 2-6, 2-11 to 2-12, 2-14, 2-24, 2-41, 2-48, 2-58, 2-63, 2-80, 2-118, 2-126, 2-165, 2-189, 2-193, 2-241, 2-246.

³² See id. at 2-126; see also Pre-Filed Testimony of Lori M. Evans, William R. Lettis, and Jeffrey L. Bachhuber on Behalf of [SERI] Concerning Hearing Issue A (Site Characterization) (Nov. 22, 2006) (fol. Tr. at 86) at 7 [hereinafter SERI PFT/HI-A].

concluded that the Application satisfied the requirements set forth in 10 C.F.R. §§ 52.17(a) and 100.20(c)(3).³³

The Board sought to verify that the applicable guidance documents had been followed and that the requirements of 10 C.F.R. § 52.17 and 10 C.F.R. Part 100 had been met. In evaluating whether the NRC Staff's review was adequate to support its conclusions regarding SERI's site characterization, the Board determined that further clarification of some items was necessary.³⁴

1. Regulations and Guidelines Relating to Site Characterization

By reference to other regulations, 10 C.F.R. § 52.17 requires an ESP applicant to submit, *inter alia*, the information required by 10 C.F.R. § 50.34(a)(12) and (b)(10) and to demonstrate that the characteristics of the proposed site comply with 10 C.F.R. Part 100. The NRC Staff's review of the topics addressed in Hearing Issue A is summarized in FSER Section 2.4.12 (Ground Water), Section 2.4.14 (Site Characteristics Related to Hydrology), Section 2.5.1 (Regional and Site Geology), and Section 2.5.4 (Stability of Subsurface Materials and Foundations).³⁵

2. Witnesses

To address the Board's questions relating to site characterization, the NRC Staff and SERI proffered expert witnesses who provided both written and oral testimony.

³³ See FSER at 2-132.

³⁴ These matters included: (1) geologic stratification; (2) site suitability; (3) hydrogeologic characterization of the site aquifers; (4) slope and foundation stability; and (5) delineation of the aquifer properties.

³⁵ The NRC Staff utilized a number of guidance documents in its review that are referenced where applicable.

The NRC Staff presented five witnesses:³⁶ (1) Mr. Goutam Bagchi, Senior Level Advisor, Civil Engineering and Geoscience, Division of Engineering (DE), Office of Nuclear Reactor Regulation (NRR); (2) Dr. Thomas M. Cheng, Senior Structural/Geotechnical Engineer, Geosciences and Civil Engineering Branch A, DE, NRR; (3) Dr. Carl J. Costantino, Consulting Engineer, Professor Emeritus, Department of Civil Engineering, The City College of the City University of New York; (4) Mr. Stephen P. Klementowicz, Senior Health Physicist, Division of License Renewal, NRR; and (5) Mr. Lance W. Vail, Senior Research Engineer II, Environmental Technology Division, Pacific Northwest National Laboratory (PNNL). SERI presented six witnesses:³⁷ (1) Mr. Jeffery L. Bachhuber, Vice President and Senior Principal Engineering Geologist, William Lettis & Associates, Inc.; (2) Ms. Lori M. Evans, Senior Project Manager, ENERCON Services, Inc.; (3) Dr. William R. Lettis, President and Principal Geologist, William Lettis & Associates, Inc.; (4) Mr. Marvin Morris, Consulting Engineer and Analyst, ENERCON Services, Inc.; (5) Mr. Alcuin J. Schneider, Manager of Projects for the New Plant Services Division, ENERCON Services, Inc.; and (6) Mr. George A. Zinke, Project Manager, Business Development, Entergy Nuclear, Inc.

Based on the respective qualifications and experience of the proffered witnesses, the Board found that each of these individuals was qualified to testify as an expert witness regarding site characterization relative to SERI's ESP Application.

³⁶ The professional qualifications of Mr. Bagchi, Dr. Cheng, Mr. Klementowicz, and Mr. Vail are set out in NRC Staff Exhibit 13. Dr. Costantino's professional qualifications are set out in NRC Staff Exhibit 14. Dr. Costantino and Mr. Klementowicz did not submit pre-filed testimony for Hearing Issue A. See NRC Staff Pre-Filed Testimony Concerning Hearing Issue A: Site Characterization (Nov. 20, 2006) (fol. Tr. at 78) [hereinafter NRC Staff PFT/HI-A].

³⁷ The professional qualifications of each of SERI's six witnesses for Hearing Issue A are set out in SERI Exhibit 1. Mr. Morris, Mr. Schneider, and Mr. Zinke did not submit pre-filed testimony for Hearing Issue A. See SERI PFT/HI-A.

3. Evidence Presented

With respect to a general description of site geology, SERI described the “geologic information of both the site area (within an 8 kilometer radius) and the site location (within a 1 kilometer radius) in terms of the (1) site physiography and geomorphology, (2) site geologic history, (3) site geologic conditions, (4) site structure, and (5) geotechnical properties of subsurface materials.”³⁸

The NRC Staff reviewed SERI’s description of the geologic strata beneath the ESP site and extending west to the Mississippi River in FSER Sections 2.5.1.1.2 (Site Geology)³⁹ and 2.5.4.1.1 (Detailed Site Investigation Programs).⁴⁰ It concluded that SERI provided a thorough and accurate description of the surface features and characteristics for the ESP site. The Staff also concluded that SERI provided an accurate and thorough description of the site area stratigraphy, with emphasis on the younger layers of rock and soils. The Staff, therefore, found that SERI’s description of the geological structures was adequate.⁴¹ Nonetheless, the Staff stated that, based on RG 1.132, Site Investigations for Foundations of Nuclear Power Plants, any excavation made during construction will provide an opportunity to obtain additional geologic and geotechnical data. Accordingly, the Staff determined that SERI must perform “geologic mapping of any future excavations for safety-related structures, evaluate any unforeseen geologic features that are encountered, and notify the NRC no less than 30 days

³⁸ NRC Staff Pre-Filed Testimony Concerning Hearing Issue C: Seismic Impacts (Nov. 20, 2006) (fol. Tr. at 78) at 4 [hereinafter NRC Staff PFT/Hi-C] (citing FSER at 2-159 to 2-162).

³⁹ FSER at 2-159 to 2-162.

⁴⁰ Id. at 2-194 to 2-226.

⁴¹ See NRC Staff PFT/Hi-C at 4 (citing FSER at 2-164 to 2-165).

before any excavations for safety-related structures are opened.”⁴² The Staff proposed to document this requirement as Permit Condition 3.⁴³

The NRC Staff summarized its review of SERI’s hydrogeologic description of regional and local ground water aquifers in FSER Sections 2.4.12 (Ground Water)⁴⁴ and 2.5.4.1.2 (Site Ground Water Occurrence),⁴⁵ including the sources and sinks, and the present and projected local and regional ground water use. SERI’s descriptions were based in large part on the GGNS database developed for the UFSAR, and included information from three additional borings, four cone penetrometer soundings, two downhole geophysical surveys, and geological field observations made for its ESP Application.⁴⁶

a. Clarification of Geologic Stratification

It appeared to the Board that there were some discrepancies between the nomenclature used in the UFSAR and that used in the more recent ESP investigations, and between the geologic conditions used to describe the seismic and geotechnical engineering parameters, and the hydrogeologic conditions used to describe the site aquifers.⁴⁷ These differences were clarified by the testimony of Drs. Costantino and Lettis⁴⁸ and summarized in SERI Exhibit 4.⁴⁹

⁴² Id. at 5 (citing FSER at 2-165).

⁴³ See FSER at 2-164 to 2-165.

⁴⁴ Id. at 2-126 to 2-132.

⁴⁵ Id. at 2-226 to 2-227.

⁴⁶ See id. at 2-126; SERI PFT/Hi-A at 7.

⁴⁷ See Tr. at 103-09.

⁴⁸ Drs. Costantino and Lettis explained that the differences were due, in part, to the subtle change in classifications used by the different investigators. Tr. at 104-07.

⁴⁹ SERI Exh. 4 (Geologic Correlation Table).

As shown in NRC Staff Exhibits 40⁵⁰ and 41,⁵¹ the ESP site is underlain by approximately 60 to 70 feet of loess (windblown deposited sands, silts, and clay). During construction of GGNS Unit 1, uncontrolled earthen fill was placed in the areas where the northern and southern drainage basin swales incised the loess in places where these water courses crossed the site.⁵² The loess is underlain by the Upland Complex Alluvium (water deposited gravel, sand, and finer grained soil), which, in turn is divided up into two zones – the young alluvium overlying the old alluvium. The old alluvium is denser, stronger material than the young alluvium. The Catahoula Formation, a very stiff, very dense siltstone/claystone sedimentary deposit, is encountered below the Upland Complex at depths of 200 to 225 feet below plant grade. This depth is equivalent to an elevation of approximately 70 ft. mean sea level (msl).⁵³

SERI, through the testimony of Dr. Lettis, clarified that the terrace deposit, shown on the cross-sections in NRC Staff Exhibit 24⁵⁴ is actually the young alluvium of the Upland Complex and the old alluvium extends part way into what was then termed as the Catahoula Formation in NRC Staff Exhibit 24.⁵⁵ The dense alluvium gravels that exist on top of the siltstone and claystone of the Catahoula Formation were originally classified as the top of this formation. The

⁵⁰ NRC Staff Exh. 40 (SSAR Fig. 2.5-75).

⁵¹ NRC Staff Exh. 41 (SSAR Fig. 2.5-76).

⁵² See NRC Staff Exh. 40, supra note 50; NRC Staff Exh. 41, supra note 51.

⁵³ See Tr. at 102 (statement of Dr. Lettis).

⁵⁴ NRC Staff Exh. 24 (SSAR Fig. 2.4-37).

⁵⁵ See Tr. at 134-35.

more recent logging conventions group these gravels with the old alluvium to better reflect the actual depositional environment.⁵⁶

For the hydrogeologic conditions, Ms. Evans testified on behalf of SERI that the terms Mississippi River Alluvium, Holocene Alluvium, and Flood Plain Alluvium all describe the same formations. This Holocene Alluvium is composed of a clay/silt alluvium of varying thickness overlying the sand/gravel alluvium.⁵⁷ According to the Staff, SERI estimated that the depth of the ground water level ranges from 70 to 100 feet below the ground surface. Regional ground water flow near the ESP site is southwest towards the Mississippi River floodplain at a hydraulic gradient of 0.008 to 0.01.⁵⁸

The NRC Staff accepted SERI's deferral of some parameter measurements to the COL stage and identified COL Action Items 2.5-1 to 2.5-9, which in whole or in part, will help assure that additional geologic, hydrogeologic, and geotechnical engineering data will be taken at the COL stage to support design analyses.⁵⁹

b. Potential for Differential Settlements

The Board questioned whether adverse differential settlements could develop at the ESP site because of: (1) transitioning between native soils and uncontrolled fill placed at the site during GGNS Unit 1 construction; (2) undetected zones of foundation soil that do not achieve the required density and strength to support the power plant; (3) the collapse of undetected karst formations; or (4) blast-induced liquefaction from a river barge accident or

⁵⁶ See id. The Board interprets this testimony to mean the same reclassification applies to the upper portion of the Catahoula Formation identified in NRC Staff Exhibits 40 and 41.

⁵⁷ See id. at 125-26.

⁵⁸ See FSER at 2-137.

⁵⁹ See id. at 2-232 to 2-233, 2-237 to 2-238, 2-240 to 2-241; id., App. A.2, at A-7 to A-8.

premeditated action.⁶⁰ As mentioned supra page 15, uncontrolled earthen fill was placed during construction of GGNS Unit 1 in the northern and southern drainage basin swales that cross the Grand Gulf site. As uncontrolled construction, there is no information on the composition, strength and stiffness properties, or expected behavior of the material under design load conditions.⁶¹ SERI testified, through Mr. Bachhuber, that all of the fill material will be removed from below the footprint areas of safety-related facilities. He also testified that the use of the fill to support non-safety-related facilities, like parking areas and warehouses, will be evaluated at the COL stage to determine its suitability for its proposed purpose.⁶²

Dr. Cheng testified, on behalf of the NRC Staff, that SERI committed to satisfying the requirement – listed in the design certification document for several light water reactors – of using a minimum shear wave velocity (v_s)⁶³ of 1,000 feet per second (fps) as the required strength parameter for an adequate foundation support.⁶⁴ Based on the data SERI presented in its ESP Application, Dr. Cheng testified that the old alluvium (at the maximum Plant Parameter Envelope (PPE) bounding embedment foundation depth of about 130 to 140 feet below existing plant grade (elev. -5 ft. msl)) has a $v_s > 1,000$ fps.⁶⁵ Dr. Cheng further testified that the v_s of 1,000 fps is a site characteristic in the FSER, and noted that SSAR Section 2.5.4.6 states that

⁶⁰ See Tr. at 137-38.

⁶¹ See NRC Staff PFT/Hi-A at 7.

⁶² See Tr. at 129.

⁶³ The shear wave velocity is a geophysical field test parameter that can be used to evaluate the ability of geologic strata to support structures.

⁶⁴ See Tr. at 110.

⁶⁵ See id. at 111-12 (citing NRC Staff Ex. 40, supra note 50; NRC Staff Ex. 41, supra note 51; NRC Staff Ex. 42 (SSAR Fig. 2.5-77)).

SERI has committed to improving soil beneath the elevation of a selected plant foundation that is found to have a v_s below the design requirement of 1,000 fps.⁶⁶

SERI's witness, Dr. Lettis, clarified that the Upland Complex Alluvium at or below the bottom of the loess deposits – elev. 97 ft. msl – can be used to support the proposed power block area (PPBA) on material where the v_s exceeds 1,000 fps.⁶⁷ In addition, if the shear velocity criteria is not met at the desired foundation depth, the soils would need to be overexcavated to material exhibiting the 1,000 fps criteria or, alternatively, in-situ improvement would have to be applied to the unsuitable layer to provide the equivalent density and strength indicated by the desired shear wave velocity.⁶⁸ Dr. Lettis also testified that, in accordance with COL Action Item 2.5-3, RG 1.132, and RG 1.138, Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants, additional investigations will be required at the COL stage to, among other things, measure the variation of v_s with depth beneath the PPBA to better quantify the depth at which that the Upland Complex Alluvium achieves the minimum v_s of 1,000 fps required for foundation support of the PPBA.⁶⁹ The NRC Staff accepted SERI's deferral of some analyses at the ESP stage and identified COL Action Item 2.5-9, which in whole or in part, is intended to assure that specific design criteria will be established at the COL stage to incorporate the updated site v_s values.⁷⁰

⁶⁶ See id. at 116-19.

⁶⁷ See SERI PFT/HI-A at 7 (citing SERI Exh. 3 (SSAR Site Exploration Locations)).

⁶⁸ See id. at 8; see also Pre-Filed Testimony of William R. Lettis and Jeffrey L. Bachhuber on Behalf of [SERI] Concerning Hearing Issue D (Slope and Foundation Stability) at 7-8 (Nov. 22, 2006) (fol. Tr. at 86) [hereinafter SERI PFT/HI-D].

⁶⁹ See Tr. at 122-23.

⁷⁰ See FSER at 2-241; id., App. A-2, at A-8.

The NRC Staff testified that data in SERI's Engineering Report-02 (ER-02)⁷¹ indicated that some calcareous materials below the plant foundation could be susceptible to the effects of dissolution.⁷² The Staff stated that the potential for a karst formation should be determined by (1) searching and investigating the available database of known site materials, and (2) seeking the opinions of recognized experts versed in the area.⁷³ Likewise, additional borings and laboratory testing should be conducted by SERI at the COL stage to further determine the potential for karst formation beneath the footprint of the power plant foundation.⁷⁴ SERI agreed with this approach, but pointed out that calcareous deposits beneath the site are at a minimum depth of 200 feet below the deepest foundation grade considered in the ESP Application.⁷⁵ Dr. Lettis and Mr. Bachhuber stated that SERI has already performed a three-part investigation including evaluating: (1) the presence or absence of karst features in the site area; (2) the presence or absence of karst features in outcrop areas of the Vicksburg Group in the site area and site region, including discussions with geologic experts; and (3) the zone of influence of any new proposed foundation on the Vicksburg Group, assuming that dissolution might occur.⁷⁶ Each of these evaluations showed that karst development is not present in the site area, that the Glendon Limestone within the Vicksburg Group is not susceptible to dissolution, and,

⁷¹ SERI Exh. 8 (Engineering Report: ENTO002-ER-02, Geologic, Geotechnical, and Geophysical Field Exploration and Laboratory Testing, Grand Gulf Nuclear Station, Early Site Permit (Oct. 6, 2003) [hereinafter ER-02]).

⁷² See NRC Staff PFT/Hi-A at 8.

⁷³ See id. at 8-9.

⁷⁴ See id. at 9 (citing FSER at 2-233).

⁷⁵ See SERI PFT/Hi-A at 4-5.

⁷⁶ See id. at 5.

even if it were, it would not affect the power plant at the depths encountered.⁷⁷

The NRC Staff's witness, Dr. Costantino, testified that while nothing presented to date indicates that dissolution of carbonate material is a problem at the ESP site, this potential should be investigated further at the COL stage because, even at the anticipated depth of the limestone, a karst formation could still affect the PPBA due to the size of the plant foundation.⁷⁸ Accordingly, SERI must perform a deep boring program in accordance with COL Action Item 2.5-8 to search for purity of the carbonate, and any evidence of dissolution in the Glendon limestone. Specifically, this boring will sample materials below the plant foundation grade to look for any calcareous units, which will then be sampled and chemically analyzed to determine their potential for dissolution. SERI will also look at carbonate rich zones like the Glendon limestone, for evidence of historic dissolution.⁷⁹ The Staff agrees with the approach that SERI will take in performing the deeper boring program required of COL Action Item 2.5-8.⁸⁰

In regards to blast-induced liquefaction, Dr. Costantino testified that: (1) the soils below the foundation depth are overconsolidated; (2) the foundation depth is deeper than what is normally considered as the cut-off for seismic-induced liquefaction; (3) blast loadings are single cycle loadings which are much lower than the generally accepted threshold of fifteen cycles required for liquefaction; and (4) there is a very restricted zone due to the long distance between the ESP site and the river where the blast is postulated to occur.⁸¹ While these conditions minimize the likelihood of the facility being affected by soil liquefaction due to seismic vibrations and blasting, Dr. Costantino agreed that this does not rule out buoyant effects on the

⁷⁷ See id.

⁷⁸ See Tr. at 139-43.

⁷⁹ See id. at 147-48.

⁸⁰ See id. at 153-56.

⁸¹ See id. at 169-71.

power plant due to excess pore pressures developed during blast loadings. Dr. Costantino testified, however, that these pressures would only develop in a limited area very close to the blast, but would not be a factor at this site due to the low magnitude of potential blast and the distance between the plant and the river.⁸²

Mr. Bachhuber testified that the over-consolidation ratios were based on: (1) laboratory consolidation tests on the Catahoula Formation; (2) cone penetrometer tests through the loess and Upland Complex Alluvium; (3) dynamic testing, including resonant column and torsional shear tests; and (4) the geologic siting of the plant where the materials show higher loadings in the past from alluvium that has subsequently eroded from the surface due to historic river incision.⁸³ While little testing was performed on the loess, Mr. Bachhuber testified that this layer demonstrates cementation due to its fine particle size, and that this true cohesion is supported by his site observations of the stability exhibited in the existing bluff and drainage way slopes. In addition to the factors presented above, Mr. Bachhuber stated that foundation uplift, in the unlikely event that excess pore water pressures did develop, would be counteracted by the frictional resistance against the side walls of the plant foundation.⁸⁴

c. Hydrogeologic Characterization of Site Aquifers

The Board questioned the adequacy of the hydrogeologic characterization at the Grand Gulf site to ascertain if sufficient site information is available to determine (1) the need for and effectiveness of operational dewatering, and (2) the impacts on existing structural support for GGNS Unit 1 with construction and operational dewatering.⁸⁵

⁸² See id. at 178.

⁸³ See id. at 173-79.

⁸⁴ See id. at 177, 179.

⁸⁵ See id. at 180-81.

The NRC Staff indicated that SERI anticipates that some dewatering will be required during construction at the ESP site.⁸⁶ The Staff stated that the effects of dewatering during construction on the existing structures, will be reviewed during the COL stage under the requirements of 10 C.F.R. Parts 50 and 52, and that there are many engineered solutions to resolve specific dewatering conditions that might arise during construction. Based on the fact that the duration of construction dewatering will be short term and that the safety-related systems, structures, and components (SSCs) of the existing plant are distant from the ESP site boundary, the Staff expects that the potential effect on the structural integrity of GGNS Unit 1 from ground subsidence during dewatering at the ESP site would be temporary and minimal. In addition, the Staff indicated that a dewatering system can be adapted to assure that its impacts on surrounding structures are minimized.⁸⁷

At the hearing, Dr. Costantino testified for the NRC Staff that the inferred ground water table is at an approximate elevation of 60 ft. msl.⁸⁸ SERI, through the testimony of Dr. Lettis and Mr. Bachhuber, stated that the ESP explorations and logging indicates that the water table is in the Upland Complex Alluvium and that any water in the loess would tend to be perched. Mr. Bachhuber testified further that this information matches with the fact that he did not detect any sign of ground water seepage along the loess slopes of the bluff and perimeter drainage swales.⁸⁹

The NRC Staff confirmed, through the testimony of Mr. Bagchi, that construction dewatering would be likely, but that the need for a permanent dewatering system for operations

⁸⁶ See NRC Staff PFT/HI-A at 6.

⁸⁷ See id. at 6-7.

⁸⁸ See Tr. at 194.

⁸⁹ See id. at 193-97.

is going to be reviewed at the COL stage.⁹⁰ Ms. Evans, on behalf of SERI, explained that, without knowing the reactor type and footprint of the structure, it would be difficult to say at this point whether or not a permanent drain will be necessary.⁹¹ Ms. Evans and Mr. Bachhuber went on to testify that the ground water inflows for GGNS Unit 1 were controlled with sumps, and that the existing plant has a permanent dewatering system that is only operated on an intermittent basis. As a result, in their opinion, inflow rates for any new facility (shown through precedent excavations for the existing plant), can be handled with conventional techniques.⁹² In addition, they testified that the surface elevation of the Catahoula Formation, which controls the level of the unconfined aquifer in the alluvium, is lower under the ESP PPBA, which would cause slightly lower ground water levels and smaller inflows for a possible plant or plants.⁹³

According to the NRC Staff, the design of the proposed ESP plant or plants will be based on the ground water elevation at plant grade as a conservative approach. Therefore, there is a large safety factor, even with no dewatering, and larger still if any dewatering is implemented.⁹⁴

The NRC Staff accepted SERI's deferral of some parameter measurements to the COL stage and identified COL Action Items 2.4-2 and 2.4-9 to help assure that, if dewatering will be necessary for the operation of the proposed ESP facility, appropriate steps will take place at the COL stage and beyond.⁹⁵

⁹⁰ See id. at 186-87.

⁹¹ See id. at 187.

⁹² See id. at 188-89.

⁹³ See id. at 189-90.

⁹⁴ See id. at 190-91 (statement of Dr. Costantino).

⁹⁵ See FSER at 2-78, 2-132; id., App. A, at A-5, A-6.

d. Mississippi River Sediment Characterization

The Board questioned whether the sediments in the Mississippi River may need to be dredged during construction of the intake and/or outfall structures, and, if so, whether the sediment characteristics need to be specified at the ESP stage to assure there are no economic barriers to handling and disposing of these materials.⁹⁶

The NRC Staff stated that the river intake and outfall are related to the normal operations of the existing plant and are not safety related. Accordingly, the Staff represented that it is not necessary to characterize the sediment deposition rate or associated data.⁹⁷ Mr. Bagchi testified that the intake and outfall structures could be constructed without any dredging.⁹⁸ Mr. Vail stated that, while there would be some dredging in the embayment area, the construction of a surface diffuser would not necessarily require dredging activities.⁹⁹ Mr. Klementowicz testified that sediments in the discharge channel have been sampled as part of the Radiological Environmental Monitoring Program (REMP) and have been tested for plant-produced radionuclides. Several years worth of data were reviewed as part of his testimony.¹⁰⁰ In addition, Staff and SERI witnesses – Mr. Bagchi, Mr. Klementowicz, and Mr. Zinke – testified that if the Mississippi River could not be used for direct intake and outfall due to unfavorable sediment characterization, there are alternative designs that could avoid the use of the river if necessary.¹⁰¹

⁹⁶ See Hearing Issues Order at 4.

⁹⁷ See NRC Staff PFT/Hi-A at 10.

⁹⁸ See Tr. at 203-04.

⁹⁹ See id. at 204-05.

¹⁰⁰ See id. at 210.

¹⁰¹ See id. at 212-16.

e. Delineation of Aquifer Parameters to Ascertain Impacts to the Catahoula Aquifer

The Board questioned whether the characterization of the Catahoula Aquifer should be performed at the ESP stage to assure that impacts to ground water quality that could be caused by ground water extraction would not be a site-limiting factor for the Grand Gulf ESP.¹⁰² To address the Board's concerns, Mr. Vail testified on behalf of the NRC Staff that (1) the Catahoula is a sole source aquifer that has a special designation within Environmental Protection Agency (EPA) regulations, and that these regulations have specific restrictions on the activities of federal agencies, and (2) the limited characterization data available for this aquifer is insufficient to provide an adequate basis to determine the potential impact.¹⁰³ Mr. Vail stated that, in its Application, SERI provided information on the impacts of the existing wells that were understood to be completed into the Catahoula, but there was insufficient information for the Staff to determine whether the drawdowns associated with the incremental water use might induce water of lower quality to enter, either from above or below the Catahoula Aquifer. If, however, the extraction rate was shown to affect the Catahoula, then an alternative source of water would need to be identified to replace the incidental water needs at the plant.¹⁰⁴

SERI, through the testimony of Ms. Evans, stated that there are several alternative options to provide the plant water, including radial wells in the Mississippi River Alluvium aquifer or extracting water directly from the Mississippi River. In addition, Ms. Evans noted that the State of Mississippi requires a withdrawal permit for pumping out of the Catahoula Aquifer. This permit supplements the EPA's requirements as an additional safeguard to protect the aquifer.¹⁰⁵

¹⁰² See id. at 216-17.

¹⁰³ See id. at 217-18.

¹⁰⁴ See id.

¹⁰⁵ See id. at 220-22.

Mr. Schneider, also on behalf of SERI, testified that the miscellaneous water requirements are approximately 3,570 gallons per minute (gpm), and that one radial well could produce approximately 8,000 gpm.¹⁰⁶

The NRC Staff accepted SERI's deferral of the characterization data needed to evaluate the drawdown rates to the COL stage, and identified COL Action Items 2.4-8 and 2.4-9 to assure that this issue is addressed at the COL stage.¹⁰⁷

4. Board Findings Relating to Site Characterization

The Board has reviewed the NRC Staff's analysis of SERI's site characterization data, and finds that the Staff has done an adequate review utilizing guidance contained in Review Standard RS-002 (RS-002), Processing Applications for Early Site Permits, for geography and demography; nearby industrial, transportation, and military facilities; and meteorology. The Board finds that the Staff's review in these areas, as documented in the FSER, meets the requirements of 10 C.F.R. Parts 52 and 100.

The Board notes that SERI has adequately clarified the geologic strata at the site to include loess, Upland Complex Alluvium (consisting of young and old alluvium), and the Catahoula Formation. The dense gravel layer on top of the Catahoula siltstone/claystone was reclassified to be part of the old alluvium to better match its depositional process. The Board also notes that SERI clarified that (1) the strata beneath the Mississippi River Alluvium consists of a clay/silt alluvium overlying the sand/gravel alluvium, (2) the ground water elevation ranges from 70 feet to 100 feet deep below the ground surface, and (3) the ground water flow near the ESP site is towards the Mississippi River floodplain southwest of the ESP site at a hydraulic gradient of about 0.01.

¹⁰⁶ See id. at 222-24.

¹⁰⁷ See FSER at 2-131 to 2-132; id., App. A.2, at A-6.

The Board finds that the NRC Staff adequately reviewed SERI's site characterization in accordance with the regulatory guidelines, and agrees that their assessment of the geologic and hydrogeologic descriptions provided by SERI are adequate.

In addition, the Board finds that NRC Staff was justified in requiring additional geologic mapping of construction excavations for safety-related structures documented in Permit Condition 3. The Board further finds that the plant foundation can be placed on the Upland Complex below a grade of 97 ft. msl (i.e., a depth of about 37 feet below plant grade) where ever the strata meets the design requirement of a v_s exceeding 1,000 fps. We also note that: (1) uncontrolled fill will be removed from all safety-related facilities and evaluated for use at the COL stage for other non-safety-related purposes; (2) a program is in place to assure that the design requirements for foundation support will be verified in the field at the COL stage; (3) the potential for karst formation is minimal based on the existing site investigations, and that this potential will be further confirmed with addition site explorations and testing at the COL stage; and (4) blast-induced liquefaction from a river barge explosion would not likely occur in the site soils. Based on this information, the Board finds that whatever questions remain concerning the potential for differential settlements affecting the integrity of the plant structures may appropriately be investigated at the COL stage and that plant designs can be implemented to minimize any adverse structural impact.

With respect to ground water, the Board notes that SERI has clarified how the site borings and logging indicate that the ground water table under the PPBA is in the Upland Complex Alluvium and that any water encountered in the loess will be isolated and perched. The Board finds that the NRC Staff's review of SERI's Application establishes that ground water control for the proposed ESP plant or plants would be no more, and possibly less, than what was implemented for GGNS Unit 1 (e.g., routine sump pumping for construction control and intermittent underdrain control during operations). The testimony presented was persuasive in

demonstrating that any effects of drawdown from the proposed ESP plant or plants should have minimal impact on GGNS Unit 1 due to the limited drawdown and distance between the facilities. If needed, the effects of drawdown can be mitigated with design.

In regards to sediment characterization, the Board finds that there are other design options for providing makeup water and disposing of liquid effluents in the unlikely event that the use of the Mississippi River is precluded due to unfavorable conditions. Therefore, the NRC Staff's conclusion to allow sediment characterization to be deferred to the COL stage is not unreasonable. Thus, the Board finds that the Staff's review was adequate and in accordance with regulatory guidelines.

The Board finds that the Catahoula Aquifer is a sole source aquifer that has institutional controls, federal and state oversight, and specific requirements on allowable activities to protect the aquifer. We find that this designation will effectively preclude any activities that might impact this sensitive aquifer. The Board also finds that the NRC Staff's conclusion that there are other options to provide the 3,570 gpm of miscellaneous water requirements that could impact the aquifer is well rooted in fact and logic. These options include the Mississippi River and pumping from radial wells in the Mississippi River Alluvium aquifer. The Board finds that the Staff's review was adequate and acceptable in regards to addressing the incidental water needs for the plant, and SERI has adequately described the aquifer characteristics.

In regards to SERI's deferral of some site characterization data and analyses to the COL stage, the Board finds that the NRC Staff appropriately identified COL Action Items 2.4-2, 2.4-8, 2.4-9, and 2.5-1 to 2.5-9, which, in whole or in part, help assure that additional data will be obtained at the COL stage and that specific design criteria will be established to incorporate the updated site characterization values.

In summary, the Board finds that the NRC Staff has adequately reviewed the site characterization data in SERI's ESP Application. The NRC Staff verified that SERI addressed

the criteria of RS-002, which are used to assure that the Application meets the requirements of 10 C.F.R. Parts 52 and 100. The Staff accepted SERI's deferral of some parameter measurements to the COL stage and developed appropriate COL Action Items relating to geology, hydrogeology, and geotechnical engineering that will help assure the site characterization outlined in RS-002 will take place at the COL stage. The Board finds that the hearing record described above is sufficient for the Staff to make the conclusions documented in FSER Sections 2.4.12 (Ground Water), 2.4.14 (Site Characteristics Related to Hydrology), 2.5.1 (Regional and Site Geology), and 2.5.4 (Stability of Subsurface Materials and Foundations).

Further, the Board finds that the Staff's review provides reasonable logic to support their conclusions in the following issues: (1) clarification of geologic stratification; (2) site suitability relating to (a) differential settlements in the transition zone between fill material at the site and native geologic strata, (b) undetected zones of foundation material that do not achieve the required density and strength, (c) collapse of undetected karst formation, and (d) blast-induced liquefaction; (3) hydrogeologic characterization of the site aquifers for evaluating construction and operational foundation dewatering needs and impacts; (4) need for and adequacy of Mississippi River sediment characterization; and (5) delineation of the Catahoula Aquifer properties to evaluate water quality impacts caused by proposed ground water extraction of 3,570 gpm for incidental plant water needs.¹⁰⁸

Where information in SERI's Application was not sufficient to meet the standards in RS-002, the NRC Staff has verified that it is reasonable and, often times, advantageous to defer

¹⁰⁸ Other topics related to and initially presented in Hearing Issue A were discussed in separate hearing issues including: (1) evaluating the hydrogeologic radionuclide transport through the subsurface liquid pathways at the site (see infra Part IV.B); (2) review of site characteristics meeting the seismic criteria presented in 10 C.F.R. § 100.23 (see infra Part IV.C); and (3) slope and foundation stability of the perimeter bluff (see infra Part IV.D).

collection of the data to the COL stage, and has developed COL Action Items to assure that it will be accomplished prior to an applicant receiving a construction and operating license for this proposed site. Accordingly, the Board finds that the Staff's review of these issues is adequate to conclude that these aspects of the site characterization as presented by SERI are acceptable and meets the requirements of 10 C.F.R. §§ 52.17(a)(1), 100.23(c), and 100.23(d)(4).

B. Hearing Issue: Monitorability of Inadvertent Radiological Releases

The NRC Staff concluded that, while significant uncertainty exists in SERI's characterization of radionuclide migration – due, in part, to incomplete knowledge of subsurface hydrological properties – this issue can be adequately addressed by eliminating releases of radionuclides to the ground water through the use of proposed Permit Condition 2 (PC-2). PC-2 will require that SERI's design of any new unit(s)' radwaste systems include “features to preclude any and all accidental releases of radionuclides into any potential liquid pathway.”¹⁰⁹

In evaluating whether the NRC Staff's review was adequate to support its conclusions with respect to SERI's site characterization relating to the hydrogeologic parameters that could affect the transport of radionuclides from accidental releases,¹¹⁰ the Board questioned whether the suitability of the Grand Gulf site for construction of additional plant or plants hinged on SERI's ability to (1) detect inadvertent releases of radionuclides from plant equipment into the ground and surface water (which, in turn, might also end up impacting site soils and sediments), and (2) determine whether any future detections of radionuclides in these media are the result of historic impacts from the existing facility or are a result of new releases from the proposed

¹⁰⁹ FSER, App. A.1, at A-2.

¹¹⁰ To satisfy 10 C.F.R. § 100.20(c)(3), RS-002 indicates that the following hydrological parameters should be identified and described: (1) ground water coefficients of dispersion and adsorption, ground water velocities, travel times, gradients, permeabilities, porosities, and water table elevations or piezometric levels; (2) surface water transport parameters; and (3) potential pathways of containment to ground water and surface water users. RS-002, Att. 2, at 2.4.13.-2.

plant or plants.¹¹¹ If so, it seemed logical to the Board that the existing conditions and transport parameters may need to be better defined at the ESP stage to assure that there will be a viable mechanism to determine whether the existing plant or any future ESP plant or plants are responsible for potential future impacts.

1. Regulations and Guidelines Relating to Inadvertent Radionuclide Releases

In accordance with 10 C.F.R. Part 52 and 10 C.F.R. § 100.20(c), in determining the acceptability of an ESP site, the NRC Staff must consider hydrogeologic characteristics. More specifically, 10 C.F.R. § 100.20(c)(3) requires the Staff to address factors important to hydrologic radionuclide transport in the ground water using on-site measurements of the relevant characteristics, including, but not limited to, adsorption and retention coefficients of the geologic strata, ground water velocities, and travel distances to discharge zones. Compliance with 10 C.F.R. Parts 52 and 100 requires that local geologic and hydrological characteristics must be defined, because these parameters may bear on the potential consequences of radioactive materials escaping from a plant.¹¹²

Section 2.4.13 of Attachment 2 to RS-002 provides guidance to the NRC Staff relating to the issue of hydrogeologic site characterization.¹¹³ This Section addresses the ability of the geologic media to delay, disperse, dilute or concentrate radiological releases (presumably from any source within the plant) with an emphasis on relating the effects of such releases to existing and known future uses of ground water and surface water resources.¹¹⁴ The Staff's review

¹¹¹ See Hearing Issues Order at 4-5.

¹¹² See RS-002, Att. 2, at 2.4.13-1.

¹¹³ See id.

¹¹⁴ Section 2.4.13 does not limit this release from the radwaste system, rather it encompasses any accidental release of radioactive liquid effluent from the plant including, among others, the spent fuel storage pool.

procedures include independent calculations of transport capabilities and potential pathways for ground water and surface water contamination, and independent calculations of concentrations of radionuclides in the receiving water body.¹¹⁵

2. Witnesses

To address the Board's questions relating to monitorability of inadvertent radiological releases, the NRC Staff and SERI proffered expert witnesses who provided both written and oral testimony.

The NRC Staff presented two witnesses:¹¹⁶ (1) Mr. Goutam Bagchi; and (2) Mr. Stephen P. Klementowicz. SERI presented three witnesses:¹¹⁷ (1) Ms. Lori M. Evans; (2) Dr. William R. Lettis; and (3) Mr. Marvin Morris.

Based on the respective qualifications and experience of the proffered witnesses, the Board found that each of these individuals was qualified to testify as an expert witness regarding the impacts of accidental releases of liquid effluents to ground and surface water relative to SERI's ESP Application.

3. Evidence Presented

The NRC Staff reported in FSER Section 2.4.13 that SERI used the GGNS UFSAR analysis for accidental releases of liquid effluents, even though the proposed ESP site is almost

¹¹⁵ See RS-002, Att. 2, at 2.4.13-2 to -3. RS-002 also states that the Staff should summarize an applicant and the Staff's estimates of transport functions, compare the resulting values for consistency, and include a statement of the Staff's bases, if necessary.

¹¹⁶ The professional qualifications of both of the NRC Staff's witnesses for Hearing Issue B are set out in NRC Staff Exhibit 13. See also NRC Staff Pre-Filed Testimony Concerning Hearing Issue B: Monitorability of Inadvertent Radiological Releases (Nov. 20, 2006) (fol. Tr. at 78) [hereinafter NRC Staff PFT/Hi-B].

¹¹⁷ The professional qualifications of each of SERI's three witnesses for Hearing Issue B are set out in SERI Exhibit 1. See also Pre-Filed Testimony of Lori M. Evans, William R. Lettis, and Marvin Morris on Behalf of [SERI] Concerning Hearing Issue B (Monitorability of Inadvertent Radiological Releases) (Nov. 22, 2006) (fol. Tr. at 86) [hereinafter SERI PFT/Hi-B].

one-half mile west of GGNS Unit 1 towards the Mississippi River. SERI argued that the hydrogeologic characteristics of the site have not changed since the GGNS UFSAR and that the data therein were adequate to characterize the ESP site at this time.¹¹⁸ The Staff stated that SERI performed a new screening analysis to identify the radionuclides of interest that should be considered in a more detailed accidental release analysis at the COL stage. SERI estimated general transport pathways and travel times for the radionuclides of interest, using either aquifer values from the UFSAR (Sr-90 and Cs-134/137) or literature values for the other radionuclides of interest (Co-60, Fe-55, and Ni-63).¹¹⁹

Even with this information, however, the NRC Staff concluded that significant uncertainty exists in the characterization of radionuclide migration due to the “incomplete knowledge of subsurface hydrological and chemical properties and the likely composition of the radwaste effluent.”¹²⁰ The Staff added that a more reliable estimation of radionuclide migration to surface waters via subsurface pathways should be made at the COL stage when the reactor design is selected, and additional detail related to the design and locations of the relevant structures and components are known. The Staff stated that SERI should be required to perform updated screening of radionuclides at that time, and that the appropriate subsurface hydrological characterization be completed.¹²¹

The NRC Staff determined that these issues – identified in FSER Section 2.4.13 – could be resolved if there were no releases of radionuclides to the ground water. The Staff proposed to achieve this goal by including PC-2 in the ESP for the Grand Gulf site. This permit condition

¹¹⁸ See FSER at 2-132.

¹¹⁹ See id. at 2-135, 2-137 to 2-139.

¹²⁰ Id. at 2-139.

¹²¹ See id. at 2-139 to 2-140.

will require SERI to include in any facility to be built design features that will preclude any and all radionuclide releases into any liquid pathway. With this condition, the Staff concluded that SERI would meet the requirements set forth in 10 C.F.R. §§ 52.17(a) and 100.20(c)(3).¹²²

With respect to the feasibility of SERI satisfying the requirements of PC-2, the NRC Staff stated its belief that it would be technically feasible to design engineered barriers and other hydraulic conditions to preclude any and all accidental releases into any liquid pathway from the radwaste systems.¹²³ However, when questioned by the Board, Mr. Bagchi, for the NRC Staff, was not able to indicate how the absolute requirement in PC-2, i.e., that “any and all” releases be precluded, could be attained.

Mr. Bagchi stated that “in reality,” PC-2 “can be achieved through design,”¹²⁴ and that a robust design and facility location will provide “reasonable assurance” that the radwaste facility will not fail and that locating the facility on the PPBA “enhances containment” of spillage.¹²⁵ Mr. Bagchi, however, then seemingly contradicted this statement, when he later said that, if the design is based on RG 1.143, Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants, it would achieve ALARA (“as low a reasonably achievable”), a criteria that falls short of precluding “any and all” releases as stated in PC-2.¹²⁶ He also admitted that the requirement to preclude “any and all” radionuclide releases was “probably a little too strong.”¹²⁷

¹²² See id. at 2-140.

¹²³ See NRC Staff PFT/Hi-B at 3.

¹²⁴ Tr. at 237, 243.

¹²⁵ Id. at 230.

¹²⁶ Id. at 262-63.

¹²⁷ Id. at 237.

A number of potential engineered features to assist in containment were described by Mr. Bagchi, including intermediate sumps, curbs, retention dykes, elevated thresholds with flow drains routed to the liquid radwaste treatment system, and guard pipes.¹²⁸ He testified, that with over several thousand reactor years worth of operating experience to date, there has never been any accidental liquid radioactive release from radwaste facilities, and any such release would be so rare of an event that it could not be directly associated with the plant where the event occurred.¹²⁹ It was Mr. Bagchi's position that it is not appropriate at the ESP stage to establish a plan to monitor ground water, and that the need for a ground water monitoring system should be reviewed at the COL stage.¹³⁰

4. Board Findings Relating to Monitorability of Inadvertent Radiological Releases

The NRC Staff proposes to rely on PC-2 to overcome the uncertainty in the characterization of radionuclide migration that is caused, in part, by the lack of updated site specific measurements that pertain specifically to the ESP site. The Board finds that the NRC Staff's conclusion that, with respect to PC-2, a robust design will provide "reasonable assurance" that the radwaste facility will not fail, and that there is a high likelihood the radionuclides will not contaminate the ground or surface water, is well founded in logic and fact. Also, PC-2 is consistent with 10 C.F.R. Part 50, Appendix A – General Design Criteria for Nuclear Power Plants (GDC) – which requires a design to include measures to "control suitably"

¹²⁸ See id. at 232.

¹²⁹ See id. at 230-31. Nonetheless, it is not clear to the Board how to reconcile this testimony with the reported releases documented by the NRC Staff in the September 1, 2006 Liquid Radioactive Release Lessons Learned Task Force Final Report, of which the NRC Staff's witness, Mr. Klementowicz, was a member.

¹³⁰ See id. at 232, 240.

the release of radioactive materials,¹³¹ and RG 1.143, which recommends that design and construction of the radwaste and steam generator blowdown systems provide assurances that radiation exposures are as low as reasonably achievable and that the systems are designed to quality standards that enhance reliability, operability, and availability.¹³²

However, the anticipated performance expressed by the Staff in the hearing and the language of the regulations, are far less rigorous than the absolute nature of PC-2 – which precludes “any and all” radionuclide release.¹³³ Based on this, the Board concludes that the design requirements stated in PC-2 are meant to be a goal of the design feature rather than specific performance criteria. Accepted in that context, the Board supports this design goal as a step to protect the safety and health of on-site and off-site personnel. With this understanding of the meaning of PC-2, the Board finds that PC-2 does not fully resolve the uncertainty in the characterization required to address radionuclide transport, and as such, PC-2 does not inherently resolve the issues discussed in FSER Section 2.4.13.¹³⁴

The Board questioned the feasibility of deferring further testing of aquifer characterization and/or the precise wording of PC-2 to the COL stage when the reactor design will be selected. At that point, the likely composition of the radwaste effluent will be known and additional details related to the design and locations of the relevant structures and components

¹³¹ 10 C.F.R. Pt. 50, App. A, GDC 60.

¹³² See Tr. at 262-63.

¹³³ The Board could not find any statement or reference in RG 1.143 that sets a goal of precluding radionuclide release. In fact, the introduction to RG 1.143 references GDC 60, which as noted in text, requires the design to “include means to control suitably” the release of radioactive materials. The language in GDC 60 (see supra note 131 and accompanying text) more closely mirrors the “ALARA” standard, rather than the “preclude any and all” standard found in PC-2.

¹³⁴ Contra FSER at 2-139 to 2-140.

will be available to focus the characterization studies needed to resolve the transport issue.¹³⁵ The Staff believes that there may be instances when it is impossible to discriminate between existing impacts and future releases.¹³⁶ However, SERI's witness, Mr. Morris, testified that two offsite REMP monitoring wells – located approximately 2,100 feet west of GGNS Unit 1 and approximately 285 feet outside the western boundary of the proposed reactor building envelope¹³⁷ – had not measured any radiological concentrations above the laboratory detection levels.¹³⁸ It was the expert opinion of Mr. Klementowicz, based on this site experience, that potential ground water impacts from a new plant referencing an ESP license from this application could be separated from any impacts from the existing plant.¹³⁹

Based on the expert opinion that ground water impacts could be traced to the responsible plant, the Board finds that there is no immediate need at the ESP stage to quantify the aquifer parameters beyond the characterization that was done for the GGNS ESP (i.e., summary of the information from the initial plant design as documented in the UFSAR and the additional data obtained as a result of the ESP investigations). The Board also finds that it is not unreasonable and, in fact, possibly advantageous to defer further characterization of radionuclide transport to the COL stage when design details and facility locations are available to focus the additional investigations.

¹³⁵ As a starting point, the Board believes that the principle reason to require detailed characterization at the ESP stage is to be sure that the existing impacts and transport characteristics at the proposed site are not so unfavorable that they would preclude the use of the site for an ESP plant or plants, and to assure that potential future releases can be traced to the responsible plant (i.e., either the existing GGNS Unit 1 or an ESP plant) and to the specific source within the responsible plant.

¹³⁶ See Tr. at 258 (statement of Mr. Klementowicz).

¹³⁷ See SERI Exhibit 31 (SSAR Site Exploration Locations).

¹³⁸ See Tr. at 274-75.

¹³⁹ See id. at 276-78.

The Board notes that PC-2, as now written, only applies to radwaste systems.¹⁴⁰ It seems likely that the vast majority of potential radiological releases at a plant would be associated with the radwaste systems,¹⁴¹ and that the design of the radwaste components in accordance with the goals of PC-2 will help to assure that radiological exposures to the public would be as low as reasonably achievable.

The restriction of PC-2 to only the radwaste systems, however, raises a dichotomy between its stated goal of precluding “any and all” radionuclide releases, on the one hand, and its application to only those releases from the radwaste system, on the other. But more importantly, it is not clear from the evidence presented to the Board that the review requirements in RS-002 have been followed. RS-002 does not include a limitation on the source of radionuclides to be considered, and, as such, its review encompasses the release from any storage facility or conveyance system containing radioactive material that has the potential to release radionuclides to liquid pathways. Therefore, even with PC-2, the review criteria of RS-002 still applies to SERI’s proposed ESP, because there are other storage facilities and conveyance systems that contain radioactive materials that might, eventually, lead to a release of radionuclides to liquid pathways.

The NRC Staff’s testimony at the hearing demonstrates to the Board, however, that the uncertainty relating to the inadvertent releases of radionuclides discussed in FSER Section

¹⁴⁰ The Board assumes that the “radwaste systems” in PC-2 includes all the storage facilities and conveyance systems to which RG 1.143 applies; including the effluent discharge line and the steam generator blowdown system. As presented in RG 1.143, other systems that might contribute to the release of radionuclides to liquid pathways would include condensate storage tank for Boiling Water Reactors, spent fuel handling and storage systems, fuel pool water cleanup system, reactor water cleanup system, condensate cleanup system, CVCC system, reactor coolant and auxiliary building equipment drain tanks, sumps and floor drains for collecting liquid wastes, boron recovery system, building ventilation systems, main condenser circulating or component cooling water systems, whose components, if any, are outside primary containment.

¹⁴¹ See RG 1.143.

2.4.13 is still unresolved, even with the proposed PC-2. Based on a review of the record and the Staff's testimony, the Board deems it reasonable and preferable to defer to the COL stage the radiological transport characterization required by 10 C.F.R. § 100.20(c)(3), and the independent Staff calculations recommended in RS-002, Attachment 2, Section 2.4.13. To be consistent with 10 C.F.R. §§ 52.17(a) and 100.20(c)(3), and to help achieve the goals of PC-2, it seems logical to the Board that the design requirements of this permit condition should be expanded beyond just the radwaste systems to include all storage facilities and conveyance systems outside of containment that contain radionuclide material, and that an evaluation of the need for further site characterization with regard to possible ground water contamination by radwaste be added as a COL Action Item.¹⁴²

The NRC Staff represented that ground water monitoring will not be required at the ESP stage for any proposed new plant or plants.¹⁴³ The Staff stated that all radwaste tanks – both inside and outside the plant – will have provisions to monitor liquid levels, but there was no elaboration as to how this monitoring would preclude releases, rather than simply indicating when a release occurred. Nor was it explained how effective these monitoring devices would be in detecting a small leak or weep from tanks and ancillary pipelines. In fact, the Staff's witnesses admitted that the radwaste systems would not be leak-proof, and that even with

¹⁴² While the Board believes that it would be logical to expand the design requirements of PC-2 beyond the radwaste systems, we are only suggesting, not ordering that it be done, because we do not believe that such action is required by existing law and regulations.

¹⁴³ See Tr. at 231-33 (statement of Mr. Bagchi) (citing NRC Staff Exh. 19, at 51-52 (Hearing Issue I Hearing Presentation)). However, the Board believes that there is a reasonable likelihood that on-site ground water monitoring – downgradient of the radwaste system and other radiological storage facilities and conveyance systems – might be a necessary tool during operations to verify compliance with PC-2. The Board notes that nothing in the written or oral testimony refutes this possibility.

design-in-depth and other types of safeguards, accidents might happen.¹⁴⁴ Nonetheless, given that there are no indications of existing site impacts from radwaste effluents, the Board concludes that it is not necessary to perform further site characterization of radionuclide transport parameters at the ESP stage, because, based on the compelling testimony from the Staff, any impacts will be traceable back to the responsible plant.

In all other criteria related to FSER Section 2.4.13, the NRC Staff demonstrated that SERI has provided sufficient information to meet the requirements of 10 C.F.R. §§ 52.17(a) and 100.20(c)(3).

C. Hearing Issue: Seismic Impacts

The Board sought additional information regarding the NRC Staff's review and analysis of site seismicity. In the FSER, the Staff documented that SERI provided a detailed description of seismological properties in SSAR Section 2.5.¹⁴⁵ This description included documentation of ESP site characteristics relating to: (1) regional and site geology associated with seismic activity; (2) ground motions resulting from possible earthquakes inside and outside the site region; and (3) potential for tectonic fault rupture.¹⁴⁶ To better understand the depth and extent of the Staff's review of seismology, the Board directed the Staff to summarize and discuss their analysis in each of these three areas.¹⁴⁷

¹⁴⁴ See *id.* at 235-36. Although the Board is not suggesting that a ground water monitoring plan must be developed at the ESP stage, potentially such a plan may be needed in the future to verify SERI's compliance with PC-2. In this regard, while it seems apparent that it is not the goal of a ground water monitoring program to compensate for design deficiencies or to prevent radionuclide releases, its purpose is to verify compliance with PC-2 and help identify the specific sources of any resulting impacts for implementation of corrective actions.

¹⁴⁵ See FSER at 2-143.

¹⁴⁶ See *id.* (citing SSAR §§ 2.5.1 to 2.5.3).

¹⁴⁷ See Hearing Issues Order at 5.

1. Regulations and Guidelines Relating to Seismology

ESP applicants must provide a thorough characterization of the seismological characteristics of a proposed site and its environs to allow, inter alia, an estimate of the Safe Shutdown Earthquake (SSE) ground motion and “to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site.”¹⁴⁸ The seismic siting factors for design must also include the potential for surface tectonic deformations.¹⁴⁹

2. Witnesses

To provide summary and discussion relating to seismic impacts, the NRC Staff and SERI proffered expert witnesses who provided both written and oral testimony.

The NRC Staff presented one witness, Dr. Yong Li, Senior Geophysicist, DE, NRR.¹⁵⁰ SERI presented two witnesses:¹⁵¹ (1) Mr. Jeffery L. Bachhuber; and (2) Dr. William R. Lettis.

Based on the respective qualifications and experience of the proffered witnesses, the Board found that each of these individuals was qualified to testify as an expert witness regarding regional and site geology relative to SERI’s ESP Application.

3. Evidence Presented

Dr. Li testified that in its review, the NRC Staff sought to determine whether SERI had complied with applicable regulations and conducted its investigations with the level of

¹⁴⁸ 10 C.F.R. § 100.23(c).

¹⁴⁹ See 10 C.F.R. § 100.23(d).

¹⁵⁰ Dr. Li’s professional qualifications are set out in NRC Staff Exhibit 13. See also NRC Staff PFT/Hi-C.

¹⁵¹ The professional qualifications of both of SERI’s witnesses for Hearing Issue C are set out in SERI Exhibit 1. See also Pre-Filed Testimony of William R. Lettis and Jeffrey L. Bachhuber on Behalf of [SERI] Concerning Hearing Issue C (Seismic Impacts) (Nov. 22, 2006) (fol. Tr. at 86) [hereinafter SERI PFT/Hi-C].

thoroughness required by 10 C.F.R. § 100.23.¹⁵² The NRC Staff performed its review of the site seismology in accordance with the applicable sections of NUREG-0800, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, and RG 1.165, Identification and Characterization of Seismic Sources and Determination of [SSE] Ground Motion. As presented in the FSER, SERI provided detailed information on the regional and site geology, vibratory ground motion, and surface faulting.¹⁵³

a. Regional and Site Geology

According to RG 1.165, to develop the vibratory ground motion design for a new nuclear power plant, applicants should “update the[ir] geological, seismological, and geophysical database and evaluate any new data to determine whether revisions” to their selected seismic source models are necessary.¹⁵⁴ The NRC Staff, therefore, focused its review on data published since the late 1980s that could indicate a need for change to SERI’s selected seismic source model.¹⁵⁵ To thoroughly evaluate the geological and seismological information, Dr. Li testified that the Staff obtained the assistance of the U.S. Geological Survey (USGS).¹⁵⁶

Dr. Li explained that the NRC Staff reviewed SERI’s descriptions of “physiographic provinces within the site region, the Mississippi [River] embayment and Gulf Coast Basin, tectonic evolution for major geologic features, and the stratigraphy of the site region.”¹⁵⁷ SERI discussed eight seismic source zones and associated seismic activities and non-tectonic

¹⁵² See NRC Staff PFT/Hi-C at 3.

¹⁵³ See FSER at 2-144 to 2-162.

¹⁵⁴ NRC Staff PFT/Hi-C at 3 (citing FSER at 2-163).

¹⁵⁵ See id. (citing FSER at 2-163).

¹⁵⁶ See id.

¹⁵⁷ Id. at 4 (citing FSER at 2-163).

structural features surrounding the ESP site. As part of this, SERI considered the Saline River Seismic Zone (SRSZ) and the New Madrid Seismic Zone (NMSZ) in its investigation, even though the latter is outside the 200 mile radius recommend in RG 1.165. Dr. Li testified that the Staff reviewed SERI's characterization of the tectonic features in the Electric Power Research Institute (EPRI) seismic source model from the late 1980s focusing on these two seismic zones, and found them to be acceptable.¹⁵⁸

According to Dr. Li, the geologic and seismic information presented in support of the vibratory ground motion analysis in SSAR Section 2.5.1 and the SSE spectrum provided in SSAR Section 2.5.2, resulted from SERI's geologic investigations performed in progressively greater detail as they approached the site. As a result of their investigations, no geologic faults were identified within the 8-kilometer radius of the site area.¹⁵⁹

Dr. Li testified that based on the well-documented regional and local geological descriptions, the NRC Staff concluded that SERI had provided a relevant, accurate and thorough description of the regional site geology and seismology, and that the addition of two seismic sources – SRSZ and NMSZ – to the site seismic hazards estimate further enhanced the conservative assessment of ground motions for the ESP site. Based on this, the Staff concluded that SERI “accurately characterized the tectonic features and their correlations with the regional seismicity.”¹⁶⁰ Also, according to Dr. Li, the Staff considered a seismic catalog, which SERI revised in response to a Staff question, “and determined that SERI had provided an accurate and thorough description of the regional seismicity.”¹⁶¹

¹⁵⁸ See id. (citing FSER at 2-163 to 2-164).

¹⁵⁹ See id. (citing FSER at 2-159 to 2-162).

¹⁶⁰ Id. (citing FSER at 2-164).

¹⁶¹ Id. (citing FSER at 2-164).

b. Vibratory Ground Motion

Dr. Li testified that SERI outlined the major seismotectonic sources and materials in the site region, and described: “(1) its determination of the ground motions at the ESP site resulting from possible earthquakes inside or outside the site region; (2) the characteristics of seismic sources used in the ESP site seismic hazard calculation; (3) the procedure for the probabilistic seismic hazard analysis (PSHA) and its results; (4) site characteristics in seismic wave transmission; and (5) site responses at the ESP site.”¹⁶² Dr. Li stated further that SERI adequately “summarized the development of the SSE and operating-basis earthquake ground motion for the ESP site.”¹⁶³

In addition to describing the characteristics of all seismic sources in the ESP site region, Dr. Li testified that SERI: (1) “reviewed the original 1986 EPRI earthquake source model related to the ESP site and found that the model adequately captures the regional earthquake source characteristics and the uncertainty associated with the source model at the time the model was developed”; (2) “addressed the SRSZ and updated NMSZ and their associated parameters resulting from recent studies”; (3) “summarized the EPRI seismic source model and the seismic source information for the seismic sources in the site region, [including the] maximum magnitude, closest distance to the ESP site, probability of activity, and an indication as to whether new information regarding the seismic source has been identified since the original EPRI seismic hazard analysis”; and (4) “described the effect of updating the earthquake catalog on the EPRI-Seismicity Owners Group seismicity parameters.”¹⁶⁴

¹⁶² Id. at 6 (citing FSER at 2-166).

¹⁶³ Id. (citing FSER at 2-166).

¹⁶⁴ Id. at 6-7 (citing FSER at 2-166 to 2-170).

The SSE for a site “is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface.”¹⁶⁵ In its review, Dr. Li testified that the NRC Staff considered the regulatory requirements of 10 C.F.R. §§ 52.17(a)(1)(vi), 100.23(c), and 100.23(d), and used the applicable sections of NUREG-0800 and RG 1.165 to guide its review. According to Dr. Li, Section 2.5.2 of NUREG-0800 provides guidance concerning the evaluation of the proposed SSE, and RG 1.165 provides guidance regarding the use of PSHA to address the uncertainties inherent in estimating ground motion at the ESP site.¹⁶⁶

Based on the facts and reasoning set forth above with respect to vibratory ground motion, the NRC Staff concluded that: (1) SERI provided a thorough characterization of the seismic sources surrounding the site, as required by 10 C.F.R. § 100.23; (2) SERI adequately addressed the uncertainties inherent in the characterization of these seismic sources through a PSHA, which follows the guidance provided in RG 1.165; (3) the controlling earthquakes and associated ground motion derived from SERI’s PSHA are generally consistent with the seismogenic region surrounding the ESP site; and (4) SERI’s SSE was determined in accordance with RG 1.165 and Section 2.5.2 of NUREG-0800. Accordingly, the Staff concluded that the proposed ESP site is acceptable from a geological and seismological standpoint and meets the requirements of 10 C.F.R. § 100.23.¹⁶⁷

c. Surface Faulting

Dr. Li described the investigations that SERI performed to determine the potential for surface faulting at and within an 8 kilometer radius of the ESP site. Specifically, he noted that the information SERI used in its surface faulting studies came from three primary sources: (1)

¹⁶⁵ 10 C.F.R. § 100.23(d)(1).

¹⁶⁶ See NRC Staff PFT/Hi-C at 7.

¹⁶⁷ See id. at 8-9 (citing FSER at 2-189).

previous research for the existing GGNS; (2) published and unpublished geologic maps from USGS, the State of Mississippi, and the University of Memphis; and (3) seismicity data compiled from published journal articles.¹⁶⁸ Dr. Li also indicated that SERI performed field reconnaissance and interpreted aerial photography, which it then used to produce an updated map of surficial deposits and geomorphology for the site location. The new map was then used in combination with other preexisting maps to verify the absence of subsurface faulting or other forms of tectonic and non-tectonic deformation by showing the surface of buried stratigraphic layers.¹⁶⁹

Dr. Li stated that the NRC Staff and its USGS advisors “visited the ESP site and met with [SERI] to assist in confirming [SERI’s] interpretations, assumptions, and conclusions concerning potential surface deformation.”¹⁷⁰ Specific areas of the Staff’s review included the geological evidence or absence of evidence of surface deformation, correlation of an earthquake with capable tectonic sources, characterization of capable tectonic sources, zones of Quaternary deformation requiring detailed fault investigation, and the potential for surface tectonic deformation at the site.¹⁷¹ Dr. Li testified that the Staff reviewed SERI’s summary of previous site investigations – recorded in the UFSAR – along with SERI’s recent investigations. The Staff did not observe any evidence of Quaternary tectonic activity near the site and concluded that SERI had adequately investigated the potential for surface deformation in the site area.¹⁷² The Staff and USGS also “concurred with [SERI’s] conclusion that no evidence of

¹⁶⁸ See id. at 9 (citing FSER at 2-190).

¹⁶⁹ See id. at 9-10 (citing FSER at 2-190).

¹⁷⁰ Id. at 10 (citing FSER at 2-192).

¹⁷¹ See id. (citing FSER at 2-193).

¹⁷² See id. (citing FSER at 2-193).

Quaternary folding or faulting can be associated with these local faults.”¹⁷³

In its review of the geological and seismological aspects of the ESP site, the NRC Staff considered the pertinent information gathered by SERI during the regional and site-specific geological, seismological, and geophysical investigations. The Staff concluded that SERI performed its investigations in accordance with 10 C.F.R. § 100.23 and RG 1.165, and provided an adequate basis to establish that no capable tectonic sources exist in the site vicinity that would cause surface deformation in the site area. The Staff concluded that the ESP site is suitable from the perspective of tectonic surface deformation. In addition, the Staff found that SERI appropriately considered the most severe surface deformation historically reported for the site and surrounding area, with sufficient margin for uncertainties, and that the Application satisfies GDC 2 in that respect.¹⁷⁴

4. Board Findings Relating to Seismic Impacts

We find that the NRC Staff appropriately reviewed SERI’s description of regional and local geology specifically related to seismology, and had an adequate basis to conclude that SERI’s Application provided a relevant, accurate and thorough description of the site characteristics in this matter. Based on the facts and reasoning set forth above, we find that the Staff had sufficient basis to conclude that SERI identified and appropriately characterized all the significant seismic sources for determining the SSE for the ESP site – in accordance with RG 1.165 and NUREG-0800 Section 2.5.1 – and, therefore, satisfied the associated requirements of 10 C.F.R. § 100.23(c) and GDC 2 of 10 C.F.R. Part 50, Appendix A. The Staff reasonably concluded that the proposed ESP site meets the requirements of 10 C.F.R. § 100.23, and is acceptable from a geological and seismological standpoint.

¹⁷³ Id. (citing FSER at 2-193).

¹⁷⁴ See id. at 10-11 (citing FSER at 2-193); see also 10 C.F.R. Pt. 50, App. A, GDC 2.

We further find that with respect to vibratory ground motion, the NRC Staff reasonably concluded that: (1) SERI adequately followed the guidance provided in RG 1.165 in addressing the uncertainties in the seismic sources through a PSHA; (2) the derived earthquakes and associated ground motion are generally consistent with the seismogenic region surrounding the ESP site; and (3) SERI's SSE was determined in accordance with RG 1.165 and Section 2.5.2 of NUREG-0800.

Also, the Board finds that the NRC Staff had a sound basis to conclude that SERI performed site seismology investigations in accordance with 10 C.F.R. § 100.23 and RG 1.165 and provided an adequate basis to establish that no capable tectonic sources exist in the site vicinity that would cause surface deformation in the site area. We also find that it was appropriate for the Staff to conclude that the site is suitable from the perspective of tectonic surface deformation, that SERI appropriately considered the most severe surface deformation historically reported for the site and surrounding area, and that the Application satisfies the requirements of 10 C.F.R. § 100.23 and GDC 2 of 10 C.F.R. Part 50, Appendix A.

Based on the facts and reasoning set forth above, we find that FSER Section 2.5 adequately considered all factors relevant to seismology for the Grand Gulf ESP site. Further, we find that the NRC Staff's evaluation has reasonable basis in logic to support its findings. Accordingly, we find that the Staff's review of these matters was adequate.

D. Hearing Issue: Slope and Foundation Stability

The Board sought further information regarding the NRC Staff's review and analysis of the geotechnical stability of the bearing strata at the ESP PPBA and the exposed earthen slopes surrounding and crossing the ESP PPBA.¹⁷⁵ Relating to foundation support, the Staff reviewed SERI's Application in accordance with RS-002 guidelines, and concluded that SERI's

¹⁷⁵ See Hearing Issues Order at 5-6.

description of liquefaction potential, seismic stability, bearing capacity, potential for settlement, and lateral earth pressure for the ESP site meets the regulatory guidance and was, therefore, acceptable.¹⁷⁶ With regards to slope stability, the Staff considered the regulatory requirements in 10 C.F.R. § 100.23 and specific guidance in Section 2.5.5 of Attachment 2 to RS-002 to evaluate SERI's characterization. Based on this review, the Staff found that SERI provided a sufficient description of the slopes to support its Application, and concluded that the slope stability assessment presented in SSAR Section 2.5.5 was acceptable.¹⁷⁷

With respect to the NRC Staff's safety review of slope and foundation stability, the Board sought to verify that the guidance in RS-002 had been followed, and that the requirements of 10 C.F.R. §§ 52.17(a)(1), 100.23(c), and (d)(4) had been met. Specifically, the Board directed the Staff to summarize the geotechnical information that supported its conclusions regarding the slope and foundation stability of the ESP site. The Board also sought to verify that the Staff had reviewed the potential for retrogressive slope displacements of the 60-foot high bluff surrounding the PPBA, which could potentially impact the integrity of the proposed power plant, storage facilities, and pipelines and, in turn, could lead to inadvertent releases of radionuclides to liquid pathways. Accordingly, the Board also directed the Staff to provide the following: (1) a comprehensive summary of the geologic conditions at the site; (2) a summary of the geotechnical information on the shear strength, creep, and consolidation characteristics of the loess, alluvium and Catahoula Formation; (3) a discussion of the potential for slope deformations of the bluff due to creep and subsequent retrogressive movements towards the PPBA; (4) a description of the impacts of erosion from the flooded Mississippi River and the

¹⁷⁶ See FSER at 2-240 (citing SSAR §§ 2.5.4.4 to 2.5.4.5).

¹⁷⁷ See *id.* at 2-243 to 2-246.

potential for this action to accelerate slope displacement; and (5) a presentation of technical analyses supporting its conclusions in FSER Sections 2.5.4 and 2.5.5.¹⁷⁸

1. Regulations and Guidelines Relating to Slope and Foundation Stability

Pursuant to 10 C.F.R. § 100.23(c), the “engineering characteristics of a site and its environs must be investigated in sufficient scope and detail to permit an adequate evaluation of the proposed site.” In addition, 10 C.F.R. § 100.23(d)(4) requires evaluation of siting factors such as “soil and rock stability, liquefaction potential, [and] natural and artificial slope stability.” Section 2.5.4 of Attachment 2 to RS-002 provides specific guidance concerning the evaluation of information characterizing the stability of subsurface materials, including the need for geotechnical field and laboratory tests as well as the geophysical investigations.

2. Witnesses

To address the Board’s questions relating to slope and foundation stability, the NRC Staff and SERI proffered expert witnesses who provided both written and oral testimony.

The NRC Staff presented two witnesses:¹⁷⁹ (1) Dr. Thomas M. Cheng; and (2) Dr. Carl J. Costantino. SERI presented two witnesses:¹⁸⁰ (1) Mr. Jeffery L. Bachhuber; and (2) Dr. William R. Lettis.

Based on the respective qualifications and experience of the proffered witnesses, the Board found that each of these individuals was qualified to testify as an expert witness regarding slope and foundation stability relative to SERI’s ESP Application.

¹⁷⁸ See Hearing Issues Order at 5-6.

¹⁷⁹ Dr. Cheng’s professional qualifications are set out in NRC Staff Exhibit 13. Dr. Costantino’s professional qualifications are set out in NRC Staff Exhibit 14. Dr. Costantino did not submit pre-filed testimony for Hearing Issue D. See NRC Staff Pre-Filed Testimony Concerning Hearing Issue D: [Slope and Foundation Stability] (Nov. 20, 2006) (fol. Tr. at 78) [hereinafter NRC Staff PFT/HI-D].

¹⁸⁰ The professional qualifications of both of SERI’s witnesses for Hearing Issue D are set out in SERI Exhibit 1. See also SERI PFT/HI-D.

3. Evidence Presented

In accordance with RS-002, the NRC Staff reviewed the soil structure interaction (SSI) for the power plant foundations and underlying geologic strata, and concluded that SERI's description was acceptable since it was consistent with the approach generally taken by industry. However, to ensure that SERI's foundation design assumptions contain an adequate margin of safety, the Staff identified COL Action Item 2.5-5.¹⁸¹ This Action Item will require SERI "to correlate plot plans and profiles of each seismic Category I facility with the subsurface profiles and material properties to ascertain the sufficiency of selected borings to represent soil variations under each structure" prior to receiving a COL.¹⁸²

In his written testimony for the NRC Staff, Dr. Cheng stated that SERI provided adequate details of the ESP site's geotechnical characteristics, and based on that data, the Staff concluded: (1) for static stability, a bluff stand-off distance would minimize the potential effect of a slope failure on the plant, based on a stability calculation using the estimated shear strength parameter indicated by SERI for the loess material; and (2) while ground water flow estimates were not made for this Application, previous site data indicates no unusual ground water conditions that could not be handled with normal construction activities.¹⁸³ Dr. Cheng further stated that, presuming the plant is founded on Upland Complex Alluvium material or the Catahoula Formation, the loss of any lateral support for the west foundation wall by a slope failure through the loess material would not, in his professional judgment, affect the integrity of the plant.¹⁸⁴

¹⁸¹ See FSER at 2-237 to 2-238; id., App. A.2, at A-7.

¹⁸² Id., App. A.2, at A-7.

¹⁸³ See NRC Staff PFT/HI-D at 8.

¹⁸⁴ See id. at 9.

In response to the Board's questions, Dr. Costantino, on behalf of the NRC Staff, stated that SERI reported friction angles of the loess on the order of 33° to 34°, and that the underlying Upland Complex Alluvium and Catahoula Formation were much stronger than the loess based on his evaluation of Standard Penetration Test (SPT) blow counts. Accordingly, he concluded that if there were a slope failure, it would be restricted to the loess deposit.¹⁸⁵ SERI, through the testimony of Mr. Bachhuber, noted that the depth of the loess extends below the base of the slopes for both the river bluff and the tributary slope for Drainage Basin A – which is located north of the PPBA – and that loess is exposed along the north-south cut slope that runs across the PPBA. This fact, in the judgment of Mr. Bachhuber, supports the premise that the loess deposit is the critical material for slope stability considerations at the site.¹⁸⁶

Mr. Bachhuber also confirmed that the strength of the loess was based on a number of triaxial shear strength tests performed on samples from the borings made for the ESP Application, and also from four CPT soundings that were extended all the way through the loess. Each of these soundings indicated strong undrained strengths of 2,000 to 8,000 pounds per square foot (psf).¹⁸⁷ Dr. Costantino noted, however, that all but one of these explorations were made in the center of the PPBA.¹⁸⁸ He testified that the resulting strengths were likely influenced by higher confining stresses than would be anticipated at the edge of the slope.¹⁸⁹ While visual observations by SERI indicate that the loess exposed on the slopes is similar to that encountered in the CPT soundings, the Staff developed COL Action Items 2.5-3 and 2.5-4

¹⁸⁵ See Tr. at 294-95.

¹⁸⁶ See id. at 300-01.

¹⁸⁷ See id. at 299.

¹⁸⁸ See id. at 300.

¹⁸⁹ See id. at 306-07.

to require that the geotechnical characteristics be verified at the COL stage.¹⁹⁰

Dr. Costantino also testified that the NRC Staff performed a simplistic linear analysis of a triangular shaped failure surface to determine the relative stability of the bluff. This simplified model, using a very conservative friction angle of 30°, indicated that the failure plane would not encroach into the setback distance selected by SERI to protect the PPBA, and that the basemat of the PPBA will be located below the area of slough material.¹⁹¹ SERI elaborated on this issue through Mr. Bachhuber's testimony. He stated that a failure plane angle of 15° would be needed for the slough material to extend back to the setback zone, and an 8° angle would be needed to reach all the way back to the proposed reactor building envelope. He pointed out that comparing the friction angle of 33° to 34° to the inclination angle, results in a significant safety factor.¹⁹²

In regards to retrogressive failures due to creep that may also be exacerbated by erosion at the toe of the slope during flood stages of the Mississippi River, Dr. Costantino testified that the loess is the kind of fine grain material susceptible to long-term creep and subsequent erosion during flood stages of the Mississippi River and adjacent drainage basins. Likewise, the stable appearance that currently exists under relatively dry conditions could change drastically if the soil saturation increases during wet periods. Dr. Costantino also noted that the strength of the loess could be reduced during construction.¹⁹³

Dr. Costantino explained that, while strength loss or creep could occur (in addition to possible erosion leading to retrogressive slope failures back towards the PPBA), there are

¹⁹⁰ See NRC Staff PFT/Hi-C at 5; see also FSER, App. A.2, at A-7.

¹⁹¹ See Tr. at 294-97.

¹⁹² See id. at 303-04 (citing SERI Exh. 5 (Cross-Section Through Bluff)).

¹⁹³ See id. at 296-98.

straightforward mitigative measures that can be taken during design to assure that this behavior, if proven to be correct at the COL stage, is not an issue to the siting of a plant at the GGNS site.¹⁹⁴ SERI, through the testimony of Mr. Bachhuber, went on to note that the existing bluff slope has existed for a period of years and provides an indication of loess behavior during previous intense rainstorms and flood conditions. Mr. Bachhuber stated that site observations indicate there is no historic evidence of retrogressive-type failures that extend for any significant distance back from the top of the bluff.¹⁹⁵

As a result of its review, the NRC Staff concluded that SERI must perform additional analyses at the COL stage that will consider potential failure modes once the plant design is selected, to allow for the selection of the critical sections for stability.¹⁹⁶ In accordance with COL Action Items 2.5-9 and 2.5-10, SERI must develop specific foundation stability design criteria (e.g., potential wall rotations, facility sliding, and overturning) to incorporate the local topography or changes in topography in future SSI analyses, and must evaluate the effects of flooding on erosion of the bluff, including SSI impacts to the plant or plants.¹⁹⁷

4. Board Findings Relating to Slope and Foundation Stability

At the proposed embedment depths and the foundation requirement of $v_s > 1,000$ fps, the Board finds that the NRC Staff has performed an adequate review to verify that the underlying soils will have sufficient foundation stability to support the proposed plant or plants. Likewise, the Staff has demonstrated that SERI has shown that the seismic demand for the site is small (as discussed further in Hearing Issue C, supra Part IV.C), and that the liquefaction

¹⁹⁴ See id. at 296-97, 306-07.

¹⁹⁵ See id. at 300-02.

¹⁹⁶ See id. at 309 (statement of Dr. Costantino).

¹⁹⁷ See id. at 309-10; see also FSER, App. A.2, at A-8.

potential for the subgrade material is low at the high densities indicated by the velocity criteria (as discussed further in Hearing Issue A, supra Part IV.A). The Board also finds that the Staff has thoroughly reviewed SERI's geotechnical characteristics of the site strata as presented in ER-02, and finds that any potential slope failure along the perimeter bluff, drainage basin incisions, or cut slopes in the PPBA would be restricted to the loess material. We further find that COL Action Items 2.5-3 to 2.5-6 and 2.5-8 appropriately require additional site information to be gathered and that the ESP conclusions will be re-evaluated to verify both slope and foundation stability.

Based on this, the Board finds that the NRC Staff has performed an adequate review in accordance with RS-002 and had a significant basis on which to conclude that the site stability assessment presented by SERI was acceptable and met the requirements of 10 C.F.R. §§ 52.17(a)(1), 100.23(c), and (d)(4).

E. Hearing Issue: Alternative Analyses

The Board sought further information regarding the NRC Staff's review of possible alternatives for reducing or avoiding adverse environmental impacts from the proposed ESP. The Board sought to verify that the alternative analyses included in the FEIS adequately evaluated potential site impacts that might be caused by the construction or operation of the proposed plant or plants. Also, the Board questioned whether, and to what degree, future construction might affect the environmental factors that might conflict with the issuance of this ESP.¹⁹⁸

¹⁹⁸ These environmental factors include: (1) impact of proposed action on the environment; (2) unavoidable adverse environmental impacts; (3) alternatives to the proposed action; (4) conflicts between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and (5) irreversible and irretrievable commitments of resources. 10 C.F.R. § 51.45(b)(1)-(5). Within this discussion, the Board directed the NRC Staff to include a summary of the following alternative analyses: (1) power generation alternatives; (2) plant design alternatives; (3) alternate site options, including site screening
(continued...)

1. Regulations and Guidelines Relating to Alternative Analyses

In accordance with 10 C.F.R. § 52.21, ESP applications are partial construction permits and, as such, the NRC Staff must prepare an EIS pursuant to 10 C.F.R. § 52.18. This EIS must include an evaluation of alternative sites to determine whether there is any obviously superior alternative to the site proposed.¹⁹⁹

In accordance with 10 C.F.R. § 51.45, an applicant's ER for an ESP must include, inter alia, a discussion of the alternatives to the proposed action which, to the extent practicable, should be presented in a comparative form.²⁰⁰ If the proposed siting of a plant for an ESP involves unresolved conflicts concerning alternative uses of available resources, then this discussion must be sufficiently complete to allow the NRC Staff to develop and explore appropriate alternatives to the ESP.²⁰¹ Based on the information in the ER, the Staff is required to prepare a draft EIS in accordance with 10 C.F.R. § 51.71, which, inter alia, considers and weighs the environmental impacts of alternatives to the proposed action and alternatives

¹⁹⁸(...continued)
procedures, impact assessment for unresolved issues in the ESP, and alternative site comparison. See Hearing Issues Order at 6-7.

¹⁹⁹ The requirements in 10 C.F.R. Part 52 are consistent with NEPA, which requires every Federal agency for every major Federal action significantly affecting the quality of the human environment to prepare a detailed statement on alternatives to the proposed action. See 42 U.S.C. § 4332(2)(C)(iii) (2000). While the Grand Gulf ESP does not authorize SERI to conduct any construction activity, the NRC Staff is still required to consider related actions that could lead to a significant impact on the environment. See 40 C.F.R. § 1508.27(b)(7). "The fact that the licensing action concerning the Grand Gulf ESP is separate from any potential licensing action concerning the construction and operation of proposed plant or plants does not excuse the NRC from evaluating the potential site impacts from the construction and operation" at the ESP stage. NRC Staff Pre-Filed Testimony Concerning Hearing Issue E: The Alternative Analyses for the Grand Gulf ESP Proceeding at 3 (Nov. 20, 2006) (fol. Tr. at 78) [hereinafter NRC Staff PFT/Hi-E]. Likewise, when the Staff performs its alternative analyses it must evaluate how the cumulative impacts of future construction and operation of the plants might affect the environmental factors that could conflict with the issuance of an ESP. See id.

²⁰⁰ See 10 C.F.R. § 51.45(b)(3).

²⁰¹ See id.

available for reducing or avoiding adverse environmental effects.²⁰²

The NRC Staff conducts its review of an applicant's ER in accordance with the guidance contained in Attachment 2 to RS-002. For environmental issues, RS-002 applies NUREG-1555, Standard Review Plans for Environmental Reviews for Nuclear Power Plants. For additional guidance, 10 C.F.R. Part 51, Subpart A, Appendix A – Format for Presentation of Material in EISs – references the information and analyses provided in NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants. Other review guidance referenced by the NRC Staff in the FEIS includes RG 4.2, Preparation of Environmental Reports for Nuclear Power Stations – used to define the region of interest – and RG 4.7, General Site Suitability Criteria for Nuclear Power Stations – used in the screening process for alternative sites within the applicant's defined region of interest.²⁰³

2. Witnesses

To address the Board's questions relating to the environmental alternative assessment, the NRC Staff and SERI proffered expert witnesses who provided both written and oral testimony.

The NRC Staff presented four witnesses:²⁰⁴ (1) Mr. Paul L. Hendrickson, Staff Scientist, Engineered Systems Group, PNNL; (2) Dr. Michael J. Scott, Staff Scientist, Energy Science and Technology Division, PNNL; (3) Mr. Lance W. Vail; and (4) Mr. James H. Wilson, Senior Project Manager, New Reactor Environmental Projects Branch, Division of New Reactor Licensing,

²⁰² See 10 C.F.R. § 51.71(d).

²⁰³ See FEIS at 8-1.

²⁰⁴ The professional qualifications of Mr. Hendrickson, Mr. Vail, and Mr. Wilson are set out in NRC Staff Exhibit 13. Dr. Scott's professional qualifications are set out in NRC Staff Exhibit 51. Dr. Scott did not submit pre-filed testimony for Hearing Issue E. See NRC Staff PFT/Hi-E.

NRR. SERI presented four witnesses:²⁰⁵ (1) Mr. Michael D. Bourgeois, Manager of Project Management, Entergy Nuclear, Inc.; (2) Mr. John G. Cesare, Lead Licensing Project Engineer, ENERCON Services, Inc.; (3) Dr. Kyle H. Turner, Chief Executive Officer, McCallum-Turner, Inc.; and (4) Mr. George A. Zinke.

Based on the respective qualifications and experience of the proffered witnesses, the Board found that each of these individuals was qualified to testify as an expert witness regarding alternative analyses relative to SERI's ESP Application.

3. Evidence Presented

a. Power Generation Alternatives

The NRC Staff reviewed alternative power generation sources other than nuclear power including options that would require new generating capacity at the Grand Gulf site, as well as options that would not require new generating capacity.

For the analysis of options requiring new generating capacity, the NRC Staff used a target value of 2,000 MWe for the electrical output of the generating facility; which was the same value used by SERI in its Application and to which the other power options were compared.²⁰⁶ The issue of the target electrical output was discussed in depth at the hearing.²⁰⁷ In doing its comparison, SERI and the Staff relied on recommendations from the alternative power vendors as to the combinations of modules or units that would generate 1,000 MWe

²⁰⁵ The professional qualifications of each of SERI's four witnesses for Hearing Issue E are set out in SERI Exhibit 1. See also Pre-Filed Testimony of John G. Cesare, George A. Zinke, Kyle H. Turner, and Michael D. Bourgeois on Behalf of [SERI] Concerning Hearing Issue E (Alternative Analyses) (Nov. 22, 2006) (fol. Tr. at 86) [hereinafter SERI PFT/Hi-E].

²⁰⁶ See NRC Staff PFT/Hi-E at 4 (citing FSER at 8-3). Other portions of the FEIS used different target values for electrical output: 3,000 MWe for construction land use impacts, operation impacts of plant operation, and fuel cycle impacts (FEIS §§ 4.1, 5, 6.1); 2,200 MWe for cooling tower discharge effects (FEIS § 5; ER § 5.3); and up to a power level of 1,311 MWe for power transmission (FEIS §§ 3, 4, 5).

²⁰⁷ See Tr. at 342-70.

(e.g., two 500 MWe plants for coal fire). Where appropriate on a parameter basis, the impacts were then doubled to reach the equivalent impact from a 2,000 MWe output.²⁰⁸

SERI testified, through Mr. Cesare and Mr. Zinke, that, if at the COL stage the power level selected was either lower or higher than 2000 MWe, the different value would be considered new information. They went on to state that, in their opinion, in accordance with NEPA, and consistent with draft NRC regulation 10 C.F.R. § 51.50(c),²⁰⁹ this level must be reviewed to determine if it is significant information. If determined to be significant, the effects of the changed value on the conclusions of the alternative energy analysis in the FEIS would be reevaluated.²¹⁰

The NRC Staff also considered four alternatives not involving construction of new generating capacity – purchase of needed electric power, reactivation of retired plants, extension of operating life of existing plants, and implementation of power conservation – and two power generation alternatives – the construction of coal-fired or natural gas-fired plants. These were the only generating options the Staff considered to be technically reasonable and commercially viable for base load production.²¹¹

In regards to options not involving power generation, the NRC Staff concluded that power conservation was not a reasonable alternative to ESP base load generation.²¹² With respect to purchasing needed electric power, reactivating retired power plants, and extending the operating life of existing nuclear power plants, the Staff qualitatively evaluated the impacts

²⁰⁸ See id. at 345-46 (statement of Mr. Cesare); id. 354-60 (statement of Mr. Zinke).

²⁰⁹ See 71 Fed. Reg. 12,782 (Mar. 13, 2006).

²¹⁰ See Tr. at 349-52. Counsel for the NRC Staff and SERI explained that NEPA case law requires this new and significant analysis, which will be codified at 10 C.F.R. § 51.50(c)(1). Id. at 352, 360.

²¹¹ See NRC Staff PFT/Hi-E at 4-5 (citing FEIS at 8-4 to 8-5).

²¹² See id. at 4 (citing FEIS at 8-3).

of these alternatives, and concluded that these three options were not reasonable alternatives for providing base load power.²¹³

For power generating alternatives, the NRC Staff considered the impacts associated with four 509 MWe coal-fired or four 508 MWe natural gas-fired plants.²¹⁴ After comparing the environmental impacts with those assessed for the proposed ESP plant or plants, the Staff concluded that neither of these viable energy alternatives were clearly preferable to construction of a new base load nuclear reactor.²¹⁵

SERI's Application also identified other energy sources including oil, wind, solar, hydroelectric, geothermal, wood waste, municipal solid waste (MSW), biomass-derived fuels, and fuel cells. Based on its review, the NRC Staff determined that SERI's conclusion that these alternatives are not reasonable, was acceptable.²¹⁶ The Staff went on to consider a combination of alternatives and evaluated the environmental impacts of three 508 MWe natural-gas units combined with 30 MWe of wind energy, 30 MWe of hydropower, 90 MWe from biomass sources including MSW, and 326 MWe from conservation. After comparing the environmental impacts with those assessed for the proposed ESP plant or plants, the Staff concluded that none of these viable energy alternatives were clearly preferable to construction of a new base load nuclear reactor.²¹⁷

b. Plant Design Alternatives

The NRC Staff reviewed alternative plant designs, in part, to help assure that appropriate alternatives to construction and operation of the proposed ESP plant or plants were

²¹³ See id. at 4-5 (citing FEIS at 8-4 to 8-5).

²¹⁴ See id. at 5-9 (citing FEIS at 8-7 to 8-17).

²¹⁵ See FEIS at 8-24.

²¹⁶ See NRC Staff PFT/Hi-E at 9-10 (citing FEIS at 8-19).

²¹⁷ See id. at 11-12 (citing FEIS at 8-24 to 8-26).

developed and explored. The Staff testified that SERI evaluated several design alternatives relating to heat-dissipation and make-up water options.²¹⁸ Specifically, SERI considered seven heat-dissipation alternatives, including once-through cooling, wet mechanical draft cooling towers, wet natural draft cooling towers, wet-dry cooling towers, dry cooling towers, cooling pond, and spray canals.²¹⁹ SERI included wet natural draft and wet mechanical draft cooling towers in its PPE after ruling out the other options. In its review, the Staff agreed with SERI that the Mississippi River is not suited for once-through cooling, that land limitations make the site unsuitable for cooling pond and spray canals, and that dry cooling technology reduces the efficiency of steam turbines, which, in turn, has some detrimental effects on electricity production.²²⁰ Other system design alternatives would be discussed at the COL stage, because a specific cooling system design has not been selected for any proposed plant or plants at the Grand Gulf site.²²¹

For the intake system, SERI proposed to withdraw water directly from the Mississippi River through a shoreline embayment and intake constructed on the bank of the River. SERI considered two alternative types of makeup water intake for the heat-dissipation and circulating water systems: (1) constructing a direct-intake riverbed structure and pipeline connection to the bank; and (2) constructing a channel to direct water to an shoreline intake structure. The NRC Staff found no basis to suggest that these alternatives would be environmentally preferable to SERI's proposed embayment structure.²²²

²¹⁸ See id. at 12.

²¹⁹ See id. (citing FEIS at 8-26, 8-27).

²²⁰ See id.

²²¹ See id. at 12-13 (citing FEIS at 8-28 to 8-29).

²²² See id. at 13 (citing FEIS at 8-29).

For the discharge system, SERI proposed to release liquid effluent into the Mississippi River through a new outfall structure that would be located downstream of the existing outfall. The NRC Staff “evaluated a shoreline diffuser outfall and a submerged single-point discharge, but found no basis to suggest that the two discharge alternatives were environmentally preferable to SERI’s proposed [design].”²²³

Of the optional water supplies identified by the NRC Staff, none were preferable to the Mississippi River and wells in the alluvial aquifer. The Staff noted that, while water treatment requirements and water system effluents are not known, all discharges would be regulated by the Mississippi Department of Environmental Quality through the National Pollutant Discharge Elimination System process.²²⁴

c. Site Alternatives

The Board requested a summary of the site alternatives, including a discussion of the site screening procedures, impact assessment for unresolved issues, and alternative site comparison.²²⁵ Entergy Nuclear, a division of Entergy Corporation (Entergy), conducted the alternative site selection process for the Grand Gulf ESP Application.²²⁶

(i) Site Screening Process. The NRC Staff reviewed Entergy’s Region of Interest (ROI), which was used to examine potential ESP sites. It concluded that the criteria Entergy used to identify its ROI – that the NRC Staff has approved the site for nuclear power plant construction and operation, that site characterization data are available, that the operational impact of existing nuclear plants at the site has been determined, and that the sites

²²³ Id. (citing FEIS at 8-30).

²²⁴ See id. (citing FEIS at 8-30).

²²⁵ See Hearing Issues Order at 7.

²²⁶ See FEIS at 8-31.

are controlled by Entergy – are consistent with RG 4.2, and were reasonable.²²⁷ Entergy selected seven existing Entergy-operated sites with operating nuclear plants licensed by the NRC. Of these seven sites, Indian Point Energy Center was eliminated because its population density was in excess of 500 persons per square mile.²²⁸

Entergy's initial screening of the remaining six sites ranked each site with respect to eleven weighted screening criteria assigned by Entergy, including pricing, seismic evaluation, water availability, exclusion area, and spent fuel storage.²²⁹ While the NRC Staff recognized that the criteria weights could affect the results, Mr. Hendrickson testified that RG 4.2 does not mandate any specific method to conduct the screening process, and that it would be hard for Entergy to predict the outcome of the screening beforehand due to the number of screening criteria and the relative narrow range over which the weighting factors change.²³⁰

As a result of this initial screening, Waterford-3 and Arkansas Nuclear One were eliminated due to their close proximity to GGNS – because of Entergy's interest in ensuring regional diversity – while Pilgrim Nuclear Station, River Bend Station, and James A. Fitzpatrick Nuclear Power Plant were retained to improve regional and siting diversity when compared to GGNS. The Staff concluded that this initial screening was a reasonable basis for narrowing the sites for further examination.²³¹

The NRC Staff then reviewed Entergy's narrowing of the site selection to the final, preferred site. Entergy ranked the remaining four sites using a set of thirty-four separately

²²⁷ See NRC Staff PFT/Hi-E at 14 (citing FEIS at 8-32).

²²⁸ See FEIS at 8-33.

²²⁹ See NRC Staff PFT/Hi-E at 14 (citing FEIS at 8-33 to 8-34).

²³⁰ See Tr. at 392.

²³¹ See id. at 391 (statement of Mr. Hendrickson); see also NRC Staff PFT/Hi-E at 14-15 (citing FEIS at 8-33 to 8-34).

weighted screening criteria.²³² SERI testified that the screening process was performed in accordance with the EPRI siting guide, and that weighted criteria were developed by an intricate procedure known as the Delphi technique.²³³ The Staff testified that SERI's overall site selection for alternative sites was reasonable and that the ordered ranking of Grand Gulf, FitzPatrick, River Bend, and Pilgrim was consistent with SERI's approach.²³⁴

(ii) Impact Assessment for Unresolved Issues. The NRC Staff conducted its own evaluation of the potential environmental impacts of constructing and operating new nuclear units at each of the three alternative sites. The Staff compared the proposed action – the GGNS ESP – with the alternatives for each major impact area.²³⁵ Based on site visits and data review, the Staff concluded that SERI “reasonably identified alternative sites, adequately evaluated the environmental impacts of construction and operation, and used a logical means of comparing sites.”²³⁶

Where the NRC Staff was unable to reach a single determination level for the Grand Gulf ESP site due to insufficient information, the Staff indicated a likely impact level for unresolved issues, so that a comparison could be made to the alternative sites. The likely impact level was based on professional judgment, experience, and consideration of controls likely to be imposed under required Federal, State, or local permits.²³⁷ It was the Staff's opinion that impacts assigned for unresolved issues are sufficiently defined for the purpose of comparison between the proposed and alternative sites. The Staff testified that the “final impact

²³² See NRC Staff PFT/HI-E at 15 (citing FEIS at 8-35 to 8-37).

²³³ See Tr. at 405 (statement of Mr. Turner).

²³⁴ See NRC Staff PFT/HI-E at 15 (citing FEIS at 8-37).

²³⁵ See FEIS at 9-3 to 9-4 (Tables 9-1 and 9-2).

²³⁶ NRC Staff PFT/HI-E at 15 (citing FEIS at 9-2).

²³⁷ See id. at 15-16 (citing FEIS at 9-2).

assessment of construction and operation of new nuclear units at the Grand Gulf ESP site would be performed at the [COL] stage for issues that were not resolved during its review of the ESP application.”²³⁸ Unresolved construction impacts include: (1) Land Use (site and vicinity, and power transmission line rights-of-way and offsite areas); (2) Water-related (water use and water quality); and (3) Ecological (terrestrial ecosystems).²³⁹ Unresolved operational impacts include Water-related impacts related to water use and water quality.²⁴⁰

(iii) Alternative Site Comparison. The NRC Staff analyzed whether any of the alternative sites were environmentally preferable to the Grand Gulf site for both construction and operational issues. The Staff concluded that the impacts were generally small for all four sites.²⁴¹ Although the Grand Gulf site had higher adverse impacts for some issues, each alternative site had similar or higher impacts for the same issues and/or higher impacts in other respects.²⁴² Accordingly, the Staff concluded that “none of the differences were sufficient to determine that any of the alternative sites is environmentally preferable to the Grand Gulf ESP site,” and, therefore, “by extension that none of the alternative sites is obviously superior to the Grand Gulf ESP site.”²⁴³ The Staff also compared the proposed action with the no-action alternative. It noted that denial of the ESP Application would prevent early resolution of safety and environmental issues for the site, and that any of the potential paths SERI might take to

²³⁸ Id. at 16.

²³⁹ See FEIS at 9-3 (Table 9-1).

²⁴⁰ See FEIS at 9-4 (Table 9-2).

²⁴¹ See NRC Staff PFT/Hi-E at 16-17 (citing FEIS at 9-5).

²⁴² See id. at 17 (citing FEIS at 9-6).

²⁴³ Id. at 18 (FEIS at 9-6 to 9-7).

satisfy its electrical power needs would have associated environmental impacts.²⁴⁴

4. Board Findings Relating to Alternative Analyses

The Board has reviewed the NRC Staff's analysis of SERI's ER with respect to its analysis of alternatives, and reviewed the Staff's FEIS for compliance with 10 C.F.R. § 52.18 (and, by reference 10 C.F.R. Part 51). The Board finds that, for purposes of the FEIS, the potential construction and operation of the ESP plant or plants is the proposed action and was the focus of this Board's review under NEPA (42 U.S.C. § 4332(2)(C)). The Board also finds that the Staff, in its alternative analyses, evaluated how future construction and operation of the proposed nuclear power generating facility might affect the environmental factors that could conflict with the issuance of an ESP, and it evaluated all reasonable alternatives, specifically, addressing power generation options, plant design options, and alternative siting options.

The Board finds that the NRC Staff reviewed alternative power generation sources, including options requiring new generating capacity at the Grand Gulf site and options not requiring new generating capacity. For comparison of impacts from the varied plants, the Staff used a site target value of 2,000 MWe as the common basis for the electrical output of the potential generating facilities. The Board finds that any selected power level other than the 2,000 MWe target value would be new information. As a result, the differing power level must be reviewed to determine if it is significant information. If so, any effects of the changed value on the conclusions reached in the alternative energy analysis in the FEIS must be re-evaluated at the COL stage.²⁴⁵

The Board finds that the NRC Staff's consideration of four alternatives not involving new generating capacity and two power generation alternatives was adequate and reasonable. The Staff's comparison of the environmental impacts from these options with those assessed for a

²⁴⁴ See *id.* (citing FEIS at 9-7 to 9-8).

²⁴⁵ Cf. Tr. at 354-64.

new base load nuclear plant at the ESP site and their conclusion that none of the viable energy alternatives were clearly preferable to construction of a new nuclear plant was logical, supported by the facts, and in accordance with the regulations and guidance documents. The Board also finds that the other energy alternatives identified by SERI, and the combination of alternatives evaluated by the Staff, were reasonable and that the Staff's conclusion that none of these options were clearly preferable to construction of a new base load nuclear reactor was logical and well supported.

In regards to design alternatives, the Board finds that the NRC Staff's conclusion that all of the proposed alternatives – except the wet natural draft and wet mechanical draft cooling towers – are not suitable for the Grand Gulf site, and its conclusion that dry cooling technology has some detrimental effects on electricity production was reasonable. Because a specific cooling system design has not been selected for the Grand Gulf site, the Board notes that the system design alternatives must be discussed at the COL stage. The Board also finds that it was reasonable for the Staff to conclude that: (1) there is no basis to suggest that the two makeup water intake alternatives considered by SERI would be environmentally preferable to SERI's proposed embayment structure; (2) there is no basis to suggest that the two discharge alternatives (i.e., a shoreline diffuser outfall and a submerged single-point discharge) were environmentally preferable to SERI's proposed design; and (3) none of the optional water supplies identified by the Staff were preferable to the Mississippi River and wells in the alluvial aquifer.

The Board finds that the initial screening to seven sites was reasonable, and that the removal of one site due to population density was consistent with review guidance.²⁴⁶ The Board also finds that (1) the selection of the weighted screening criteria is based on industry guidance, and (2) the final screening to four sites (ESP and three alternative sites), the

²⁴⁶ See RG 4.2.

subsequent ranking of the sites, and the selection of Grand Gulf site as the preferred site is consistent with applicable regulatory guidance.

The Board finds that the impact levels assigned by the Staff for unresolved issues are sufficiently defined for the purposes of comparison between the proposed and alternative sites. The Board also finds that (1) the alternative sites do not have unresolved impacts because impacts at alternative sites were evaluated using reconnaissance-level information, and (2) the final impact assessment of construction and operation of new nuclear unit(s) at Grand Gulf would be performed at the COL stage for issues that were not resolved during the review of the ESP Application. Accordingly, the Board finds that the assessment for unresolved issues is reasonable and appropriate for comparison of the Grand Gulf ESP site with alternative sites.

The Board finds that there is nothing in the record to dispute the approach and conclusions reached by the NRC Staff in their comparison of the alternative sites. Accordingly, the Board finds that the Staff had adequate basis to conclude that none of the differences in impacts were sufficient to determine that any of the alternative sites is environmentally preferable to the proposed site, and, by extension, conclude that none of the alternative sites is obviously superior to the Grand Gulf ESP site.

In summary, the Board finds that the NRC Staff's review of SERI's ESP Application and its alternative analysis is adequate and acceptable.

F. Hearing Issue: Evaluation of Cumulative Site Impacts

At the Grand Gulf site, various factors may have an impact on the environment that will be cumulative in nature; i.e., the relevant impacts will emanate from a combination of the existing nuclear reactor at Grand Gulf as well as from new generating facilities that are the subject of this ESP Application. While these environmental impacts, standing alone, may be

negligible, when aggregated they could have significant detrimental consequences on the environment.²⁴⁷

Accordingly, the Board directed the NRC Staff to identify and discuss the environmental impacts that could have a cumulative environmental effect relating to construction, operation, fuel cycle, transportation, and/or decommissioning of the proposed Grand Gulf facilities.²⁴⁸

1. Witnesses

To address the Board's questions relating to the evaluation of cumulative impacts, the NRC Staff and SERI each proffered expert witnesses who provided both written and oral testimony.

The NRC Staff presented four witnesses:²⁴⁹ (1) Mr. Joseph D. Anderson, Security Interface Team Leader, Division of Preparedness and Response, Office of Nuclear Safety and Incident Response; (2) Dr. Charles A. Brandt, Resource and Ecosystems Management Product Line Manager, PNNL; (3) Mr. Stephen P. Klementowicz; and (4) Dr. Michael J. Scott. SERI presented three witnesses:²⁵⁰ (1) Mr. David J. Bean, Senior Environmental Scientist, ENERCON Services, Inc.; (2) Mr. John G. Cesare; and (3) Mr. Marvin Morris.

Based on the respective qualifications and experience of the proffered witnesses, the Board found that each of these individuals was qualified to testify as an expert witness

²⁴⁷ See 40 C.F.R. § 1508.7.

²⁴⁸ See Hearing Issues Order at 7.

²⁴⁹ The professional qualifications of Dr. Brandt and Mr. Klementowicz are set out in NRC Staff Exhibit 13. Mr. Anderson's professional qualifications are set out in NRC Staff Exhibit 52, and Dr. Scott's professional qualifications are set out in NRC Staff Exhibit 51. Mr. Anderson and Dr. Scott did not submit pre-filed testimony for Hearing Issue F. See NRC Staff Pre-Filed Testimony Concerning Hearing Issue F: Cumulative Site Impacts for the Grand Gulf ESP Proceeding (Nov. 20, 2006) (fol. Tr. at 78) [hereinafter NRC Staff PFT/HI-F].

²⁵⁰ The professional qualification of each of SERI's three witnesses for Hearing Issue F are set out in SERI Exhibit 1. See also Pre-Filed Testimony of John G. Cesare, David J. Bean, and Marvin Morris on Behalf of [SERI] Concerning Hearing Issue F (Evaluation of Cumulative Site Impacts) (Nov. 22, 2006) (fol. Tr. at 86) [hereinafter SERI PFT/HI-F].

regarding cumulative site impacts relative to SERI's ESP Application.

2. Evidence Presented

The NRC Staff identified and summarized their review of the issues and associated parameters that it believed relevant to its cumulative impacts analysis. Specifically the Staff analyzed the following issues for their potential cumulative impacts: (1) land use; (2) air quality; (3) water use and quality; (4) terrestrial ecosystems; (5) aquatic ecosystems; (6) socioeconomic; (7) historic and cultural resources; (8) environmental justice; (9) non-radiological health; (10) radiological impacts from normal operations; (11) fuel cycle; (12) nuclear fuel and waste transport; and (13) de-commissioning.²⁵¹

A summary of the NRC Staff's analysis was presented and admitted into evidence at the hearing as NRC Staff Exhibit 9.²⁵² The Staff did not, however, discuss or analyze the cumulative effects of design basis accidents (DBAs).

3. Board Findings Relating to Cumulative Site Impacts

The NRC Staff considered and documented all material, cumulative impacts that have the potential to affect the environment for the duration of the proposed action (the construction period plus the forty year operating life of the proposed facility). The Board finds that NRC Staff Exhibit 9 summarizes the Staff's analysis of these cumulative impacts, and identifies those potential impacts which can not be accurately determined at this stage and, therefore, as unresolved issues, they will need to be addressed at the COL stage of this proceeding. In addition, the Board finds that the NRC Staff adequately explained why, given how unlikely, in its view, it would be for a DBA to occur at multiple plants at the same time, it would not be feasible

²⁵¹ See NRC Staff PFT/HI-F at 3-4.

²⁵² NRC Staff Exh. 9 (Summary of Issues for Which Cumulative Effects Were Analyzed), clearly identifies those cumulative site impact issues that have not been resolved, and that will need to be addressed at the COL stage.

to analyze the cumulative effect of such occurrences. The Board finds that the NRC Staff's review was adequate and acceptable.

G. Hearing Issue: Evaluation of Plant Parameter Envelope

NRC regulations do not require that an ESP applicant specify a particular plant design or reactor vendor in their application. As an option, an ESP applicant may provide a set of bounding parameters for the potential plant designs under consideration. This information is captured in what is referred to as the Plant Parameter Envelope (PPE), which consists of postulated design parameters that bound the characteristics of any reactor or reactors that might be built at the Grand Gulf site. The PPE serves as a surrogate plant facility for a selected design during the NRC Staff's safety and environmental reviews that are conducted for the ESP. The surrogate plant design parameters, in conjunction with the actual site specific information, are used to support the analyses required to demonstrate site suitability that are provided in the applicant's SSAR and ER, and which are reviewed by the Staff in preparation of the FSER and FEIS.

A PPE can be developed for a single facility of a given type or for several different facilities. SERI's Application chose the latter approach, and selected the most limiting parameter values among several possible plant designs. The broader the envelope of candidate design characteristics represented in a composite PPE, the greater the conservatism, because a broad PPE will influence the selection and suitability of specific sites.

Because the ESP site will need to support the reactor facilities characterized in SERI's ESP Application, the Board sought to clarify that the NRC Staff evaluated whether SERI's PPE is consistent with the facility design limits proposed in its ESP Application. Specifically, the Board wanted to clarify the relationship between the parameters included in SERI's PPE and

those identified in the Nuclear Energy Institute (NEI) guidance document, NEI 01-02, Industry Guideline for Preparing an Early Site Permit Application.²⁵³

In addition, the Board sought to gain a clearer understanding of how the NRC Staff reviewed SERI's PPE to demonstrate its consistency with the 8,600 MWt site power level proposed by SERI in its Application. In this regard, the Board requested an overview of how the Staff reviewed SERI's PPE, to provide assurance that its procedures were in line with the maximum site thermal power level requested in the Application. The Board also sought to clarify any differences or inconsistencies in the Staff's treatment of SERI's PPE in its safety and environmental reviews, (e.g., the relationship between an environmental analysis that uses an assumed MWe value and the PPE which does not specify a MWe value). The Board was also interested in understanding further the nature of the Staff's review of the composite accident release source term provided as part of SERI's PPE.²⁵⁴

1. Regulations and Guidelines Relating to Plant Parameter Envelopes

An ESP application must include the plant design specifications detailed in 10 C.F.R. § 52.17. Section 52.17 requires applicants to provide information regarding: (1) the interface between the proposed site and facility and the functional or operational needs of the facility from the site's natural and environmental resources; (2) the facility's capability to withstand natural and man-made environmental hazards of the site; and (3) the direct impact of the facility on the site's natural and environmental resources. The use of a "PPE" as a means of providing this information is a term of art established in NEI 01-02. There is no specific regulatory imprimatur

²⁵³ NEI 01-02 was developed after extensive interaction between the NRC Staff and industry representatives. The NRC Staff noted that it has not formally endorsed NEI 01-02, and that although NEI 01-02 identifies other possible PPE parameters, the Staff does not require an applicant to address all of the NEI 01-02 parameters. See NRC Staff Pre-Filed Testimony Concerning Hearing Issue G: Evaluation of Plant Parameter Envelope at 10 (Nov. 20, 2006) (fol. Tr. at 78) [hereinafter NRC Staff PFT/HI-G].

²⁵⁴ See Hearing Issues Order at 7-8.

for the use of a “PPE” in an ESP application. Section 4.4 of RS-002, however, states that references to “the plant” will be deemed to refer to “a nuclear power plant or plants of specified type that might be constructed on the proposed site (or falling within a [PPE]).”²⁵⁵ This terminology is used throughout RS-002 and supports the option for an applicant to use either plant specific information or a surrogate plant or plants via a PPE to satisfy the requirements of 10 C.F.R. § 52.17.

2. Witnesses

To address the Board’s questions relating to SERI’s PPE and the NRC Staff’s review of the selected parameters, the NRC Staff and SERI each proffered expert witnesses who provided both written and oral testimony.

The NRC Staff presented seven witnesses:²⁵⁶ (1) Mr. Goutam Bagchi; (2) Mr. R. Brad Harvey, Physical Scientist, Division of Risk Assessment (DRA), NRR; (3) Ms. Eva Eckert Hickey, Staff Scientist, Radiological Science and Engineering Group, PNNL; (4) Mr. Stephen Klementowicz; (5) Mr. James V. Ramsdell, Jr., Staff Scientist, Atmospheric Chemistry and Meteorology Technical Group, PNNL; (6) Mr. James H. Wilson; and (7) Mr. George F. Wunder, Project Manager, Economic Simplified Boiling Water Reactor (ESBWR)/Advanced Boiling Water Reactor (ABWR) Projects Branch 1, Division of Licensing Project Management, Office of New Reactors. SERI presented three witnesses:²⁵⁷ (1) Mr. John G. Cesare; (2) Mr. Alcuin J. Schneider; and (3) Mr. George A. Zinke.

²⁵⁵ RS-002 at 12.

²⁵⁶ The professional qualifications of each of the NRC Staff’s seven witnesses for Hearing Issue G are set out in NRC Staff Exhibit 13. Ms. Hickey did not submit pre-filed testimony for Hearing Issue G. See NRC Staff PFT/HI-G.

²⁵⁷ The professional qualifications of each of SERI’s three witnesses for Hearing Issue G are set out in SERI Exhibit 1. See also Pre-Filed Testimony of John Cesare, Al Schneider, and George Zinke on Behalf of [SERI] Concerning Hearing Issue G (Evaluation of [PPE]) (Nov. 22, 2006) (fol. Tr. at 86) [hereinafter SERI PFT/HI-G].

Based on the respective qualifications and experience of the proffered witnesses, the Board found that each of these individuals was qualified to testify as an expert witness regarding the PPE relative to SERI's ESP Application.

3. Evidence Presented

To clarify the definition and use of the PPE, Mr. Zinke and Mr. Cesare, on behalf of SERI, provided a discussion of the major components of an ESP application and compared those to what would be required of SERI in a COL application.²⁵⁸ As part of this presentation, they explained: (1) the difference between site parameters and site characteristics; (2) the relationship between the major features of emergency planning presented at the ESP stage and NRC requirements at the COL stage; (3) the development of PPE parameters for the SSAR and the ER and why the values may differ between these two documents; and (4) the procedures for handling the Permit Conditions, COL Action Items, site characteristics, and bounding parameters (Appendix A of the FSER) during the preparation of the COL application.

Mr. Zinke and Mr. Cesare also provided insight into the continuity between the ESP and COL stage discussed in the next hearing issue. Specifically, they testified that the ESP SSAR is incorporated verbatim into the COL application. In a similar fashion, the ESP ER is supplemented at the COL stage to compare parameters, address new and significant information, deal with unresolved items, supplement deferred issues, and determine completeness for issues not requiring any action at the ESP stage.²⁵⁹

Mr. Ramsdell, on behalf of the NRC Staff, discussed the Staff's review of SERI's PPE and its determination that none of the parameter values were unreasonable given the requested maximum reactor power of 8,600 MWt. In his hearing presentation, Mr. Ramsdell discussed the

²⁵⁸ See Tr. at 479-517.

²⁵⁹ See id.

various environmental PPE parameters associated with radiological, hydrological and aquatic ecology, and terrestrial ecology and land use socioeconomic impacts. According to Mr. Ramsdell, the parameters directly related to site power level include normal heat sink blowdown flow rate, evaporation rate, and makeup water flow rate. He further indicated that land use and terrestrial ecology impacts related to site power level are not likely to be particularly sensitive to the ultimate site power level, except to the extent that they will be impacted if the ESP site power level exceeds the capacity of the existing transmission system.²⁶⁰

Mr. Wunder and Mr. Wilson, also on behalf of the NRC Staff, stated in pre-filed testimony that SERI's Application included a table that compared the SERI PPE to the parameters in NEI 01-02,²⁶¹ which demonstrated that SERI's PPE included a subset of the NEI 01-02 parameters. They stated that the Staff agreed with SERI's choice of the parameters that it selected for its PPE.²⁶² Counsel for the NRC Staff stated that the site characteristics included in FSER Appendix A incorporates many of the NEI 01-02 parameters, and will be included in the ESP permit.²⁶³

With respect to the Board's request that the NRC Staff clarify any inconsistencies in its treatment of SERI's PPE in the FSER and in the FEIS, the Staff explained that there were no inconsistencies; rather, the review differed because of the different functions they were designed to serve. In the FSER, the Staff evaluated the effects of the site environment on the facility. In the FEIS they evaluated the impact of the facility on the environment. "Whereas the safety review is focused primarily on protecting the health and safety of the public, the

²⁶⁰ See id. at 545-66; see also NRC Staff PFT/Hi-G at 5-7.

²⁶¹ See NRC Staff Exh. 12.

²⁶² See NRC Staff PFT/Hi-G at 7.

²⁶³ See Tr. at 782-87 (statement of Mr. Weisman); see also NRC Staff Exh. 50 (Draft Early Site Permit).

environmental review considers a much broader range of impacts to the environment as a whole. This broader range of impacts is reflected in the longer set of PPE values relevant to the environmental review.”²⁶⁴ According to the Staff, as a result of these differences, its analyses in the FSER often address extreme levels of impact while the FEIS, consistent with NEPA, evaluates reasonably foreseeable impacts.²⁶⁵ Accordingly, the Staff did not view these differences as inconsistencies.

4. Board Findings Relating to Evaluation of the Plant Parameter Envelope

The Board finds that SERI’s PPE is sufficiently detailed to meet the applicable requirements of 10 C.F.R. § 52.17. The Board also finds that the Staff’s review of SERI’s PPE was adequate and supports the maximum site power level, bounding parameters and environmental parameters which will be documented in the Grand Gulf ESP.

H. Hearing Issue: Continuity Between the ESP Stage and COL Stage

Appendix A of the FSER provides a list of Permit Conditions, COL Action Items, Site Characteristics, and Bounding Parameters. Appendix J of the FEIS provides a list of “SERI Commitments and NRC Staff Assumptions Relevant to the Analysis of Impact.” In addition, the FSER and FEIS identify numerous unresolved items and deferred issues. The Board questioned whether these permit conditions, action items, site characteristics, plant parameters, unresolved items, commitments, assumptions, and deferred issues should be captured in one location and tracked between the ESP and the COL stage, and questioned how these issues

²⁶⁴ NRC Staff PFT/Hi-G at 7. Any differences in the treatment of the PPE in the FSER and FEIS were because the safety review is performed under the Atomic Energy Act in accordance with 10 C.F.R. Part 52. The environmental review is performed under NEPA as implemented in 10 C.F.R. Part 51.

²⁶⁵ See *id.* at 8-9.

would subsequently be managed (i.e., discovered, implemented, reviewed, and approved), so as to assure that they are satisfactorily completed at the COL stage.²⁶⁶

The Board raised concerns as to whether the NRC Staff will utilize a consistent approach for characterizing the conclusions and limitations contained in SERI's ESP Application for unambiguous transition to the COL stage. In this regard, the Board sought to better understand the following: (1) the Staff's progression from the ESP stage to the COL stage in terms of its use of lists (e.g., SERI commitments, Staff assumptions, COL Action Items), and how the lists are sufficiently comprehensive; (2) how the Staff conducted its reviews and what steps were taken to assure consistency among the Staff reviewers and contractors; and (3) the logic behind the Staff's selection of which transition items would be formally documented and which would not.²⁶⁷

1. Regulations and Guidelines Relating to Continuity Between the ESP Stage and COL Stage

An ESP application is reviewed in accordance with the requirements of 10 C.F.R. § 52.18 and RS-002. A review conducted in accordance with these documents should provide for an adequate transition between an ESP application and an application for a COL that references the ESP.

2. Witnesses

To address the Board's questions relating to continuity between the ESP stage and the COL stage, the NRC Staff and SERI proffered expert witnesses who provided both written and oral testimony.

²⁶⁶ See Hearing Issues Order at 8-9.

²⁶⁷ See id. at 8.

The NRC Staff presented five witnesses:²⁶⁸ (1) Mr. Goutam Bagchi; (2) Dr. Thomas M. Cheng; (3) Mr. Andrew J. Kugler, Senior Environmental Project Manager, Division of Siting and Environmental Review, Office of New Reactors; (4) Mr. James H. Wilson; and (5) Mr. George F. Wunder. SERI presented five witnesses:²⁶⁹ (1) Mr. Jeffrey L. Bachhuber; (2) Mr. John G. Cesare; (3) Dr. William R. Lettis; (4) Mr. Marvin Morris; and (5) Mr. George A. Zinke.

Based on the respective qualifications and experience of the proffered witnesses, the Board found that each of these individuals was qualified to testify as an expert witness regarding the continuity between the ESP stage and COL stage relative to SERI's ESP Application.

3. Evidence Presented

As part of their presentation for the previous hearing issue, Mr. Zinke and Mr. Cesare, on behalf of SERI, provided insight into the continuity between the ESP stage and COL stage. They testified that the ESP SSAR is incorporated verbatim into the COL application. In a similar fashion, the ESP ER is supplemented by the COL applicant to show that the design characteristics are compared to the design parameters, any resulting new and significant information relating to this comparison and other items such as bounding values and site characteristics are addressed, unresolved items are dealt with, and issues deferred to the COL

²⁶⁸ The professional qualifications for Mr. Bagchi, Dr. Cheng, Mr. Wilson, and Mr. Wunder are set out in NRC Staff Exhibit 13. Mr. Kluger's professional qualifications are set out in NRC Staff Exhibit 53. Mr. Kluger did not submit pre-filed testimony for Hearing Issue H. See NRC Staff Pre-Filed Testimony Concerning Hearing Issue H: Continuity Between the ESP Stage and COL Stage (Nov. 20, 2006) (fol. Tr. at 78) [hereinafter NRC Staff PFT/Hi-H].

²⁶⁹ The professional qualifications of each of SERI's five witnesses for Hearing Issue H are set out in SERI Exhibit 1. See also Pre-Filed Testimony of George A. Zinke, Marvin Morris, John G. Cesare, William R. Lettis, and Jeffrey L. Bachhuber on Behalf of [SERI] Concerning Hearing Issue H (Continuity Between the ESP Stage and COL Stage) (Nov. 22, 2006) (fol. Tr. at 86) [hereinafter SERI PFT/Hi-H].

stage or otherwise not required at the ESP stage are evaluated for completeness of the COL application.²⁷⁰

Mr. Wunder explained the internal NRC Staff review process for an ESP application. He indicated that RS-002 was developed to provide a consistent review of the ESP by all branches of the Staff, including its contractors. He also indicated that the Project Manager is tasked by RS-002 with reviewing all sections of the draft SER for internal consistency and consistency with the application, and making modifications where appropriate. After the draft SER is compiled, it is evaluated by the Division of New Reactor Licensing Management. Changes to the draft SER are reviewed by the NRC technical branches to insure that there was no loss of technical accuracy. The ACRS review is then conducted.²⁷¹

Mr. Wunder testified about the NRC Staff's safety review process with respect to the development of COL Action Items and Permit Conditions and their use in the COL review. Mr. Wunder stated that the Staff had concluded that the list of Permit Conditions in the FSER is comprehensive, because these were the only conditions necessary to insure that 10 C.F.R. Part 100 will be satisfied.²⁷² Mr. Wunder further stated that all significant assumptions made for findings regarding safety were documented in the FSER and are listed as a Permit Condition.²⁷³ In pre-filed testimony, Mr. Wunder indicated that there are no other lists of commitments or assumptions on which the Staff based its analysis. If a particular assumption or commitment did not rise to the level of a Permit Condition or COL Action Item, no further formal documentation was included beyond the discussion or reference in the FSER. Mr. Wunder

²⁷⁰ See Tr. at 479-517.

²⁷¹ See id. at 571-75.

²⁷² See id. at 576.

²⁷³ See id. at 588-89.

stated that, in his view, all key assumptions were made into Permit Conditions or COL Action Items.²⁷⁴ In response to a Board question, it was explained that each COL Action Item must be addressed in the COL application, but that a COL Action Item need not be specifically met if an acceptable alternative is justified by the applicant.²⁷⁵

Mr. Wilson, on behalf of the NRC Staff, provided an overview of the environmental review that will be performed at the COL stage and how it will relate back to an ESP FEIS. He described the process of assuring the validity of earlier assumptions, particularly with respect to any new and significant information that is required to be considered in the COL FEIS. He indicated that the NRC Staff will verify the continued applicability of any ESP FEIS assumptions at the COL stage to determine whether there is new and significant information from that discussed in the FEIS.²⁷⁶

Pre-filed testimony indicated that the Staff deferred certain issues if SERI's ESP Application did not address the issue, if the issue could not be resolved because the Application did not provide sufficient information, or if the information was not then reasonably available to allow the Staff to reach a conclusion on impacts.²⁷⁷ The oral testimony further indicated, however, that the Staff was able to resolve or address all environmental issues necessary for reaching its conclusion with respect to SERI's ESP Application.²⁷⁸

When asked which environmental issues were being referred to in the pre-filed testimony, Mr. Wilson indicated that at this stage, without a site redress plan, in his judgment

²⁷⁴ See NRC Staff PFT/HI-H at 8-9.

²⁷⁵ See Tr. at 589-97 (statements of Mr. Wunder and Mr. Cesare).

²⁷⁶ See id. at 576-81.

²⁷⁷ See NRC Staff PFT/HI-H at 9.

²⁷⁸ See Tr. at 589-97.

the only matter that the NRC Staff needed to resolve was whether there are any obviously superior alternative sites. He stated that all remaining issues can be addressed later at the COL stage.²⁷⁹

4. Board Findings Relating to Continuity Between the ESP Stage and COL Stage

With respect to the transition between the ESP stage and a future COL application, the Board finds that SERI has provided sufficient information for the NRC Staff to adequately support its preparation of the FSER and the FEIS.

The Board also finds that the NRC Staff's review as documented in the FSER and FEIS, is adequate and supports the continuity between the ESP stage and a future COL application that references this ESP.

I. Hearing Issue: Radiological Reviews and Confirmatory Analyses

In support of its ESP Application, SERI performed radiological dose analyses for both normal and accidental radiological releases. Because the results of these analyses are critical to the acceptability of the site, the Board requested a presentation that would discuss the NRC Staff's review of the radiological analyses performed by SERI, including details regarding the nature of whether confirmatory analyses were performed by the Staff. The Board's specific areas of concern included: (1) the selection of the DBAs and discrepancies in the event names that appear in the SSAR, FSER, and FEIS; (2) the Staff's review for both normal release analyses, accident analyses and severe accident analyses, including the method and results of the Staff's confirmatory analyses; (3) why the contribution of external events was not specifically factored into the core damage frequencies used in the presentation of the severe accident risk; (4) whether PC-2 removes the need to perform an analysis of the liquid radwaste tank failure event at the COL stage, or if it does not, to what extent PC-2 impacts the assumptions

²⁷⁹ See id. at 583-84.

associated with the analysis of such an event; and (5) for the non-MACCS2 severe accident effects, such as ground water release, the basis for the Staff's conclusion that the risks for these pathways are acceptably small.²⁸⁰

1. Regulations and Guidelines Relating to ESP Radiological Analyses

The regulations relating to radiological releases are discussed subsection by subsection below. The NRC Staff's review is guided by RS-002, NUREG-0800, NUREG-1555, and RG 1.183, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors.

a. Normal Release Dose Consequences

In accordance with 10 C.F.R. § 100.21(c)(1), “[r]adiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site can be met for any individual located offsite.” RG 1.109, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 C.F.R. Part 50 Appendix I, and RG 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors, provide guidelines for the description of the exposure pathways and the calculation methods to estimate doses to the maximally exposed individual and to the population surrounding a site.

b. Postulated Accident Dose Consequences

The radiological consequences of DBAs must be analyzed to demonstrate that any new nuclear unit or units could be sited at the proposed ESP site without undue risk to the health and safety of the public.²⁸¹ 10 C.F.R. § 52.17(a)(1) requires a site safety assessment that demonstrates “the acceptability of the site under the radiological consequence evaluation

²⁸⁰ See Hearing Issues Order at 9.

²⁸¹ See 10 C.F.R. § 52.17; 10 C.F.R. Pt. 100.

factors identified in [10 C.F.R.] § 50.34(a)(1)” and that site characteristics comply with the requirements of 10 C.F.R. Part 100. 10 C.F.R. § 50.34(a)(1) requires that doses from DBAs be calculated for hypothetical individuals located at the closest point on the exclusion area boundary for a two-hour period and at the outer radius of the low population zone for the course of the accident.²⁸² The suitability of the site can be demonstrated by the selection of the DBAs to be evaluated, the use of conservative source terms, and the use of site-specific meteorology for calculating the doses to the public.²⁸³

2. Witnesses

To address the Board’s questions relating to radiological reviews and confirmatory analyses, the NRC Staff and SERI proffered expert witnesses who provided both written and oral testimony.

The NRC Staff presented six witnesses:²⁸⁴ (1) Mr. Goutam Bagchi; (2) Ms. Eva Eckert Hickey; (3) Mr. Stephen P. Klementowicz; (4) Mr. Jay Y. Lee, Senior Health Physicist, DRA, NRR; (5) Mr. James V. Ramsdell, Jr.; and (6) Mr. James H. Wilson. SERI presented two witnesses:²⁸⁵ (1) Mr. John G. Cesare; and (2) Mr. Marvin Morris.

Based on the respective qualifications and experience of the proffered witnesses, the Board found that each of these individuals was qualified to testify as an expert witness

²⁸² See 10 C.F.R. § 50.34(a)(1)(ii)(D)(1).

²⁸³ See NRC Staff Pre-Filed Testimony Concerning Hearing Issue I: Radiological Reviews and Confirmatory Analyses at 9-13 (Nov. 20, 2006) (fol. Tr. at 78) [hereinafter NRC Staff PFT/HI-I].

²⁸⁴ The professional qualifications of each of the NRC Staff’s six witnesses for Hearing Issue I are set out in NRC Staff Exhibit 13. Mr. Wilson did not submit pre-filed testimony for Hearing Issue I. See NRC Staff PFT/HI-I.

²⁸⁵ The professional qualifications of both of SERI’s witnesses for Hearing Issue I are set out in SERI Exhibit 1. See also Pre-filed Testimony of Marvin Morris and John Cesare on Behalf of [SERI] Concerning Hearing Issue I (Radiological Reviews and Confirmatory Analyses) (Nov. 22, 2006) (fol. Tr. at 86) [hereinafter SERI PFT/HI-I].

regarding radiological reviews and confirmatory analyses relative to SERI's ESP Application.

3. Evidence Presented

a. General Approach to Radiological Reviews

With respect to the effects of normal radiological releases, SERI performed the radiological effluent analyses listed in Section 3.2 of its SSAR and Sections 3.5 and 5.4 of its ER, to determine whether the site characteristics are such that the radiation dose to members of the public from normal reactor operations would be within regulatory requirements. The NRC Staff documented its review of these analyses in Section 11 of the FSER and Sections 5.9 and 7.8 of the FEIS. The source terms used in estimating these doses are based on the values provided in Tables 3.0-7 and 3.0-8 of the ER,²⁸⁶ which are composite source terms based on the highest individual radionuclides released for each of the plant types that were considered. In Section 3.3 of its SSAR, SERI analyzed the radiological consequences of DBAs and the Staff documented its review of these analyses in Section 15 of the FSER and Section 5.10 of the FEIS.

Instead of identifying a single reactor design, SERI used combined reactor source term parameters from the AP1000 and the ABWR certified designs. For Loss-Of-Coolant Accident (LOCA) analyses, they also used the Advanced CANDU Reactor (ACR)-700 source term. These accident source terms were used in conjunction with Grand Gulf site characteristics and the plant parameters included in the PPE to assess the suitability of the proposed ESP site.²⁸⁷

b. Design Basis Accident Selection and Nomenclature

Mr. Lee, on behalf of the NRC Staff, provided a table that compared the nomenclature of the design basis events in SERI's SSAR with those used in the FSER and

²⁸⁶ See FEIS, App. I, at I-11 to I-12.

²⁸⁷ See NRC Staff PFT/HI-I at 10.

FEIS.²⁸⁸ The table showed that while there were some differences in the nomenclature used, there was consistency in the events SERI referenced.²⁸⁹ One exception was that the reactor coolant pump (RCP) locked rotor event evaluated in the SSAR utilized a different initiating event than the RCP shaft break and RCP rotor seizure events evaluated in the FSER and FEIS, respectively. Mr. Lee explained, however, that although the initiating event was different, the accident sequence and radiological consequences were the same; therefore, he viewed them as consistent for the purpose of his analysis.²⁹⁰ NRC Staff Exhibit 19 stated that “the SSAR and FSER both listed the [Boiling Water Reactor (BWR)] Control Rod Drop Accident for completeness, but neither [SERI] nor the Staff analyzed the radiological consequence for this event since the certified ABWR includes several unique features that preclude [its] occurrence.”²⁹¹ The Staff compared SERI’s selection of accidents with the accidents listed in guidance documents, including standard review plans (e.g., RS-002, NUREG-0800, and NUREG-1555) and RGs (e.g., RG 1.183), and determined that the set of DBAs considered in SERI’s SSAR and ER were appropriate.²⁹²

c. NRC Staff Review of Radiological Analyses

The NRC Staff’s review of normal radiological releases, as it was explained by Ms. Hickey, followed the requirements in 10 C.F.R. Part 51, RS-002 (where applicable), and NUREG-1555 (Environmental Standard Review Plan (ESRP)). The ESRP sections utilized by the Staff include: Section 3.5 (radioactive waste management system); Section 5.4 (radiological

²⁸⁸ See NRC Staff Exh. 19, supra note 143, at 26.

²⁸⁹ See Tr. at 642-49.

²⁹⁰ See id. at 649.

²⁹¹ NRC Staff Exhibit 19, supra note 143, at 28 note 2.

²⁹² See NRC Staff PFT/HI-I at 8-9.

impacts for normal operation); and Section 6.2 (radiological monitoring).²⁹³ The Staff reviewed the input and assumptions and performed confirmatory LADTAP II and GASPARE II analyses; however, it did not perform an independent review of the source terms provided by SERI.²⁹⁴ The Staff judged the source terms not to be unreasonable and the composite approach used by SERI was acceptable to the Staff.²⁹⁵

With respect to accidental radiological releases, Mr. Lee stated, on behalf of the NRC Staff, that SERI did not perform new radiological consequence analyses for the stated events. Rather, SERI used the analyses that were performed for the AP1000 and the ABWR LOCA in their respective Design Certification Documents (DCD), which had already been reviewed by the Staff. The results of these analyses were adjusted by SERI for the specific characteristics of the Grand Gulf site. For the ABWR non-LOCA events, SERI calculated the doses using the DCD source terms. For the ACR-700 LOCA, SERI calculated the site specific doses using the source term provided by the vendor for this purpose.²⁹⁶ The AP-1000 LOCA results were found to be bounding. The Staff determined that the DBA source terms and evaluation methods used by SERI were generally appropriate, and concluded that SERI demonstrated the suitability of the proposed ESP site by meeting the dose consequence evaluation factors set forth in 10 C.F.R. §§ 50.34 (a)(1) and 100.21, and complied with the requirements of 10 C.F.R. § 52.17.²⁹⁷

The environmental risk from severe accidents was evaluated in SERI's ER. The risk was calculated as the product of severe accident event frequencies and the event

²⁹³ See Tr. at 622.

²⁹⁴ See NRC Staff PFT/HI-I at 5-6.

²⁹⁵ See Tr. at 626-28.

²⁹⁶ See id. at 650.

²⁹⁷ See id. at 651 (citing FSER at 15-6 to 15-8).

consequences. In this analysis, event frequencies from existing Probabilistic Risk Analyses (PRA) were used in conjunction with site specific consequence analyses. SERI determined severe accident risk by using the AP-1000 and ABWR DCD internal event sequence frequencies for the various release categories evaluated in the PRA for the respective plant. The consequences for each release were determined by SERI using the source terms for each release category in the MACCS2 code to develop the ESP site specific consequences using population data projected to the year 2070.²⁹⁸ The results are presented in FEIS Tables 5-13 to 5-16.²⁹⁹ The source term input to the MACCS2 code runs were provided by the vendors via letters to SERI and was not independently reviewed by the NRC Staff.³⁰⁰

d. Contribution from External Events

The Board expressed concern about the absence, in the NRC Staff's presentation on severe accident risk, of external events in the core damage frequencies. In response, Mr Ramsdell stated that the ABWR and AP1000 design certification process considered externally-initiated events, but that the Staff did not adopt any numerical core damage frequencies associated with externally-initiated events. Instead, the Staff chose to characterize them as extremely small, which makes it difficult to calculate risk.³⁰¹ He explained further that the Staff looked at externally initiated events with respect to current generation reactors in NUREG-1742, Perspectives Gained from the Individual Plant Examination of External Events Program, which showed that the core damage frequencies for externally-initiated events are typically at the same magnitude or smaller than those from internally-initiated events. Therefore, Mr. Ramsdell

²⁹⁸ See id. at 689-701 (statement of Mr. Ramsdell).

²⁹⁹ FEIS at 5-71 to 5-75.

³⁰⁰ See Tr. at 697-98 (statement of Mr. Ramsdell).

³⁰¹ See id. at 703-04.

explained that the standard practice has been to use a multiplier on internally-initiated events to account for externally-initiated events. The risk for advanced reactors is small enough to accommodate multipliers that are much larger than a factor of two and still meet or exceed the Staff's safety goals.³⁰² The Staff did not independently review the source terms utilized in the MACCS2 code for these analyses, but it did review the code input, output, and assumptions, and performed confirmatory analyses with their own version of the code.³⁰³

e. Impact of Permit Condition 2

Permit Condition 2 does not specifically address the analysis of radwaste tank failure events.³⁰⁴ According to the NRC Staff, no DBA radwaste tank failure analysis is needed for a reactor design that incorporates suitable barriers to contain any accidental spillage of radioactive liquid effluents due to tank failure.³⁰⁵ Mr. Lee stated that the failure of a liquid (and gaseous) radwaste tank has been removed as a design basis event for the ABWR, but not for the AP1000. He explained that this will be evaluated during the review of the COL application.³⁰⁶

f. Risk from Ground Water Release

Mr. Ramsdell explained that the NRC Staff did not consider liquid pathway releases for severe accidents because the probability of such events occurring was judged to be significantly less than the probability for a gaseous release given that a basemat melt-through would be

³⁰² See id.; see also NRC Staff PFT/HI-I at 12-13.

³⁰³ See NRC Staff PFT/HI-I at 10-11.

³⁰⁴ See FSER, App. A.1, at A-2.

³⁰⁵ See NRC Staff PFT/HI-I at 14.

³⁰⁶ See Tr. at 678-79.

needed for a release into the water pathway.³⁰⁷ While NUREG-1437 considered a 10^{-4} per reactor year probability for basemat failure, the Staff judged this to be about three orders of magnitude too high for any of the advanced reactors being considered for the proposed ESP site.³⁰⁸ Regardless, the Staff concluded that the liquid release pathway would be considerably slower than the atmospheric pathways so there would be time for mitigating action following the accident and a much smaller risk to the public.³⁰⁹

4. Board Findings Relating to Radiological Reviews and Confirmatory Analyses

With respect to the effects of normal radiological releases, the Board finds that the NRC Staff adequately reviewed SERI's radiological effluent analyses listed in Section 11 of the FSER and Sections 5.9 and 7.8 of the FEIS, and that the Staff had an adequate basis for their determination that the site characteristics are such that the radiation dose to members of the public from normal reactor operations would be within regulatory requirements. The Staff adequately documented its review of SERI's analysis of the radiological consequences of DBAs.

The Board also finds it was appropriate that: (1) instead of identifying a single reactor design, SERI used a combined reactor source term parameter from the AP1000 and the ABWR certified designs; (2) for LOCA analyses, SERI used the ACR-700 source term; and (3) these accident source terms were used in conjunction with Grand Gulf site characteristics and the plant parameters included in the PPE to assess the suitability of the proposed ESP site.

The NRC Staff clarified the nomenclature of the DBAs, and noted that there was consistency in the events. The Board finds that it was logical for the Staff to conclude that: (1)

³⁰⁷ See id. at 701-05.

³⁰⁸ See id. at 702-03.

³⁰⁹ See id.

SERI's set of DBAs was appropriate; (2) the source terms and composite approaches used by SERI were not unreasonable; (3) SERI met the dose consequence factors required by the regulations and has complied with 10 C.F.R. § 52.17; (4) consideration of radwaste tank failure could be deferred to the COL stage; and (5) externally initiated events can be characterized as being extremely small.

In conclusion, the Board finds that the NRC Staff has documented that SERI has provided sufficient information regarding its radiological analysis to meet the requirements of 10 C.F.R. § 52.17, and has adequately supported the preparation of the FSER and FEIS for the issuance of the ESP. The Board also finds that the Staff's review of SERI's radiological analyses as documented in the FSER and FEIS are sufficient and support the conclusion that the regulatory requirements associated with radiological limits have been met by SERI.

V. REVIEW OF SAFETY-RELATED MATTERS

The NRC Staff was required to make determinations on two safety issues as follows:

(1) Whether the issuance of an ESP will be inimical to the common defense and security or to the health and safety of the public (Safety Issue 1); and

(2) [W]hether, taking into consideration the site criteria contained in 10 C.F.R. Part 100, a reactor, or reactors, having characteristics that fall within the parameters for the site, can be constructed and operated without undue risk to the health and safety of the public (Safety Issue 2).³¹⁰

The NRC Staff answered the first question in the negative and the second question in the affirmative.

The Board was directed by the Commission to conduct a "sufficiency" review of the NRC Staff's analyses of these issues.³¹¹ In conducting our "sufficiency" review on safety issues, we were directed to take an independent "hard look" at the Staff's findings, but not to replicate the

³¹⁰ 69 Fed. Reg. at 2636.

³¹¹ CLI-05-17, 62 NRC at 39.

Staff's work. Rather than conducting a de novo determination on the two safety issues that are of consequence in this proceeding, we were directed to probe the facts and logic behind the Staff's findings, determine whether the Staff's review was adequate, and whether the record supported the issuance of the ESP. We also were directed to "carefully probe [the Staff's] findings by asking appropriate questions, and by requiring supplemental information when necessary."³¹²

Rather than put every NRC Staff decision associated with its review of SERI's ESP Application on trial during the evidentiary hearing, we focused on the nine hearing issues discussed above. These were, in our judgment, the issues that retained the greatest significance after this Board's review of the source documents, and the exchange of written questions between the Board, the Staff, and SERI.³¹³

After a review of the record – including SERI's Application, the FSER, the FEIS, the answers to the safety and environmental questions asked by the Board,³¹⁴ and the evidentiary hearing – with special emphasis on those hearing issues that we viewed as most significant, the Board concludes that the NRC Staff's review of the safety issues was adequate and that its conclusions regarding these two safety questions subject to the Permit Conditions, COL Action Items, site characteristics and bounding parameters in Appendix A to the FSER, are supported by logic and the facts in the record.

³¹² Id. at 40; see also 10 C.F.R. § 2.104(b)(2).

³¹³ See CLI-06-20, 64 NRC at 21-22.

³¹⁴ See Order on FSER; Order on FEIS.

VI. REVIEW OF NEPA-RELATED MATTERS

A. **Regulations and Guidelines Relating to NEPA**

The Commission requires that the NRC Staff prepare an EIS during its review of an ESP application.³¹⁵ This EIS must be prepared in accordance with 10 C.F.R. Part 51, and must focus on the environmental effects of construction and operation of reactors that have the characteristics of the postulated site parameters, and must include an evaluation of alternatives to determine whether there are any obviously superior options to the proposed action. The Staff's EIS analysis for the ESP need not, however, include an assessment of the benefits (e.g., need for power).³¹⁶

While the Grand Gulf ESP does not authorize any construction activity, the NRC Staff is still required by Council on Environmental Quality (CEQ) regulations to consider actions that are related to other actions that could lead to a significant impact on the environment.³¹⁷ As a result, the Staff appropriately focused on the environmental effects of the construction and operation of reactors, with characteristics that fall within the PPE developed by SERI, as the ultimate federal action that could realistically result from a chain of events initiated by the issuance of an ESP.

In preparing the FEIS, the NRC Staff used SERI's ER, which was prepared in accordance with 10 C.F.R. § 52.17(a)(2) (and by reference therein, 10 C.F.R. §§ 51.45 and 51.50), and used the same provisions that apply to the Staff in its preparation of the FEIS. In accordance with 10 C.F.R. § 51.45, SERI's ER for this ESP considered, inter alia: (1) the impacts of the proposed action on the environment, discussed in proportion to their significance;

³¹⁵ See 10 C.F.R. § 52.18.

³¹⁶ See 10 C.F.R. §§ 52.17, 52.18.

³¹⁷ See 40 C.F.R. § 1508.27(b)(7); see also 10 C.F.R. § 51.10.

(2) unavoidable adverse environmental effects; (3) alternatives to the proposed action, presented in a comparative form to the extent practicable; (4) relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and (5) any, irreversible and irretrievable commitments of resources.³¹⁸

Based on the information in SERI's ER, the NRC Staff prepared an EIS in accordance with 10 C.F.R. § 51.71, that included, *inter alia*, an analysis that considers and weighs the environmental impacts of alternatives to the proposed action, and alternatives available for reducing or avoiding adverse environmental effects.³¹⁹ The Staff conducted its review of SERI's ER in accordance with guidance set forth in RS-002, which, for environmental issues, references NUREG-1555. Appendix A to 10 C.F.R. Part 51, Subpart A, references the information and analyses provided in NUREG-1437, as additional guidance in this review.

With respect to the NRC Staff's analysis of alternatives, it must include: (1) a discussion of alternatives to the recommended course of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources;³²⁰ (2) the no-action alternative in accordance with 10 C.F.R. §§ 52.18 and 52.21, exclusive of the portion dealing with the need for power since SERI does not propose to consider this issue at this time; and (3) a comparison of alternative sites, using the March 7, 2003 NRC Staff letter³²¹ for additional guidance concerning reviews of alternative sites. In addition, SERI proposed to include in the ESP

³¹⁸ See 10 C.F.R. § 51.45(b)(1)-(5).

³¹⁹ See 10 C.F.R. § 51.71(d).

³²⁰ See NEPA Section 102(2)(E), 42 U.S.C. § 4332(2); 10 C.F.R. § 51.45(b)(3).

³²¹ Letter from James E. Lyons, NRR, to Ronald L. Simard, NEI (Mar. 7, 2003), ADAMS Accession No. ML030520434.

several alternatives made optional at this stage by the June 2, 2003 NRC Staff letter.³²² These include energy alternatives and alternative energy sources.

Following the practice the NRC Staff used in NUREG-1437, environmental issues were evaluated using the three-level standard of significance – SMALL, MODERATE, LARGE – developed by NRC using guidelines from the CEQ.³²³ Additional review guidance referenced by the NRC Staff in its review includes RG 4.2, used to define the ROI, and RG 4.7, used in the screening process for alternative sites within SERI's defined ROI.

The Commission provided guidance to the Board regarding the depth of review necessary to address the “baseline” NEPA issues summarized supra page 5.³²⁴ They directed that the Board must reach an independent determination on these uncontested NEPA “baseline” issues. In reaching these determinations, however, the Commission stated that a Board should not second-guess the underlying technical or factual findings of the NRC Staff, except when the reviewing Board finds that the Staff's review is incomplete or that the Staff findings lack sufficient explanation.³²⁵ The Board's findings on these NEPA issues follows in the next three sections.

³²² Letter from James E. Lyons, NRR, to George A. Zinke, Entergy (June 2, 2003), ADAMS Accession No. ML031480443.

³²³ Table B-1 of 10 C.F.R. Part 51, Subpart A, Appendix B, provides the following definitions of the three significance levels: SMALL – “environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource”; MODERATE – “environmental effects are sufficient to alter noticeably, but not to destabilize important attributes of the resource”; LARGE – “environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.”

³²⁴ CLI-05-17, 62 NRC at 45.

³²⁵ See id.

B. Compliance with NEPA Sections 102(2)(A), (C), and (E)

As part of the NEPA-related matters in this Grand Gulf ESP proceeding, this Board was required to determine whether the requirements of NEPA Sections 102(2)(A), (C), and (E) had been met.

1. Section 102(2)(A) Compliance

Section 102(2)(A) of NEPA requires the agency to use a “systematic, interdisciplinary, approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact of man’s environment.”³²⁶ Environmental impacts of the construction and operation of the proposed ESP plant or plants were presented in Sections 4 and 5, respectively of the FEIS. In addition, with respect to the more natural scientific impacts, the NRC Staff also considered socioeconomic, historic, cultural resource, and environmental justice impacts. Socioeconomic impacts include physical impacts, social and economic issues, demography, infrastructure, and community services.

The Board finds that the NRC Staff’s description of these impacts, based on SERI’s ER, was prepared in accordance with the review guidance provided in RS-002, which, in turn, was based primarily on the detailed steps in NUREG-1555. Finally, the Staff demonstrated that it used a systematic, interdisciplinary approach as the basis for its decisions in the FEIS. Based on these facts, the Board finds that Section 102(2)(A) of NEPA has been complied with in this proceeding.

2. Section 102(2)(C) Compliance

Section 102(2)(C) of NEPA requires the agency to include a detailed statement on: (1) “the environmental impact of the proposed action”; (2) “any [unavoidable] adverse

³²⁶ 42 U.S.C. § 4332(2)(A).

environmental effects”; (3) “alternatives to the proposed action”; (4) “the relationship between local short-term uses of man’s environment and the maintenance and enhancement of long-term productivity”; and (5) “irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.”³²⁷ The FEIS for the Grand Gulf ESP comprises over 200 pages of text presenting a detailed description of the environmental impacts of the proposed construction and operation of a potential ESP plant or plants at the Grand Gulf site. Adverse environmental effects of construction and operation contained in these sections include fuel cycle, fuel and waste transportation, decommissioning, and cumulative impacts. In Sections 8 and 9 of the FEIS, alternatives to the proposed action were developed by the Staff, analyzed, and compared to the impacts from the proposed ESP plant or plants.

In regards to the other issues, the NRC Staff found that there would be no short-term damage to the environment associated with the ESP and that there would be no commitment of resources, because the ESP does not authorize SERI to perform any construction activities. The Board finds that this reasoning is inconsistent with CEQ regulations, which require any agency to consider actions that are related to other actions that could lead to a significant impact on the environment.³²⁸ Specifically, the Commission must consider the use of the environment and commitment of resources from the construction and operation of the proposed ESP plant or plants since these actions are directly related to granting the ESP license and could lead to a significant impact on the environment. Regardless, this finding did not ultimately affect the Board’s decision in this proceeding because these issues are unresolved and deferred to the COL stage when the plant design is selected.

³²⁷ 42 U.S.C. § 4332(2)(C)(i)-(v).

³²⁸ See 40 C.F.R. § 1508.27(b)(7).

In regards to the short-term use and long-term productivity, the NRC Staff concluded that the long-term productivity assessment can only be performed by discussing the benefits of operating the unit, which does not need to be assessed at the ESP stage.³²⁹ Therefore, this issue is not resolved and must be performed at the COL stage when the benefits of the selected unit would be known.³³⁰ The Staff stated that the irretrievable commitment of resources during construction of the new unit(s) would be similar to any major construction project (i.e., concrete, steel, and other building materials), but that the actual commitment can only be defined once the reactor design is selected. Therefore, the Staff deferred the issue of irreversible and irretrievable commitment of resources to the COL stage and considers it unresolved at the ESP stage.³³¹

Section 102(2)(C) also requires the agency to consult with and obtain comments from other Federal, State, and local agencies and from the public prior to making the detailed statements discussed above. A list of the agencies and persons consulted, public comments, and key consultation correspondence are documented in Appendices B, D, E, and F of the FEIS.

Based on the facts discussed above, the Board finds that Section 102(2)(C) of NEPA has been complied with in this proceeding.

3. Section 102(2)(E) Compliance

Section 102(2)(E) of NEPA requires the agency to “study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves

³²⁹ See 10 C.F.R. § 52.18.

³³⁰ See FEIS at 10-8.

³³¹ See id. at 10-6.

unresolved conflicts concerning alternative uses of available resources.”³³² As discussed in Hearing Issue E (supra Part IV.E), the NRC Staff presented the environmental impacts of alternatives to the proposed action including energy, plant design, and site alternatives. In the FEIS, the Staff described its study and development of these alternatives to the proposed action, which involves unresolved conflicts concerning alternative uses of available resources. The Board finds that the impacts from the proposed site were compared to the alternatives and that none of the alternatives were obviously superior options. Based on these facts, the Board finds that Section 102(2)(E) of NEPA has been complied with in this proceeding.

C. Independent Consideration of the Final Balance Among Conflicting Factors

As part of its consideration of the NEPA-related matters in this uncontested proceeding for the Grand Gulf ESP, the Board was required to independently consider the final balance among the conflicting factors contained in the record of this proceeding. In the Board’s view, the conflicting factors include: (1) the relative magnitude of the environmental impacts of the proposed action (i.e., construction and operation of one or more ESP base load nuclear plants at the Grand Gulf site) as compared to other energy, plant design, and site alternatives; (2) unavoidable adverse environmental impacts during construction and operation of the plant or plants and the mitigative actions proposed to minimize their effects; (3) potential cumulative impacts in the context of past, present, and future actions at Grand Gulf site; (4) the magnitude of the irreversible and irretrievable commitment of resources; and (5) the relationship between short-term uses and long-term productivity of the human environment.

1. Alternative Comparison

The Board has independently reviewed the NRC Staff’s comparisons of energy, plant design, and site alternatives with the relative magnitude of the environmental impacts from a

³³² 42 U.S.C. § 4332(2)(E).

base load nuclear power plant at the Grand Gulf ESP site. In its balancing, the Board considered four energy alternatives not involving new generating capacity and two power generating alternatives considered by the Staff. The Board finds that the energy alternatives not involving new generating capacity were not clearly preferable to construction of a new nuclear plant. In regards to the power generating alternatives, the Board notes that construction and operation of a nuclear plant will have up to a moderate impact on the ecology. However, coal has higher impacts than a nuclear plant on the ecology, air quality, waste management, land use, and aesthetics. Natural gas has the same impacts as nuclear power on the ecology, higher impacts on air quality, and less beneficial socioeconomic and environmental justice impacts.³³³ For these reasons, the Board independently finds that none of the viable alternative energy sources are clearly preferable to construction of a nuclear plant at the Grand Gulf ESP site.

The Board has reviewed plant design alternatives including heat-dissipation alternatives and circulating water system alternatives. The Board finds that (1) all the heat-dissipation options, except the wet natural draft and wet mechanical draft cooling towers, are not suitable for the site and the premise that dry cooling technology has some detrimental effects on electricity production is reasonable, and (2) it is reasonable to defer further discussion of the system design alternatives to the COL stage when a specific cooling system design is selected for the Grand Gulf site.

In addition, the Board finds that: (1) for the intake system, there is no basis to suggest that the two makeup water intake alternatives considered by SERI would be environmentally preferable to SERI's proposed embayment structure; (2) for the discharge system, there is no basis to suggest that the two discharge alternatives (i.e., a shoreline diffuser outfall and a

³³³ See FEIS at 8-26 (Table 8-4).

submerged single-point discharge) were environmentally preferable to SERI's proposed design; and (3) none of the optional water supplies identified by the NRC Staff were preferable to the Mississippi River and wells in the alluvial aquifer.

The Board compared the impacts from construction and operation of a new nuclear plant at the Grand Gulf ESP site to three other potential sites at River Bend, Pilgrim, and FitzPatrick. In regards to construction impacts, the Board notes that the unresolved impacts to land use and water-related issues were assigned a small level and terrestrial ecosystem impact was assigned a moderate level for purposes of comparison to the other sites. For operational impacts, the Board notes that the unresolved water related issues were assigned a small impact. Based on a review of the record, the Board finds nothing illogical about the NRC Staff's assignment of these levels for this comparison, but that these issues will need to be re-addressed at the COL stage.

In addition to these assignments, the Board finds that the NRC Staff concluded that the plant construction and operation at the Grand Gulf site has a potentially large level of impact on demography and a moderate level of impact for infrastructure and community services. However, each of the alternative sites has the same or other elevated impact levels for the other categories for both construction and operation. Based on its independent review of the construction and operational impacts, the Board concurs with the Staff that none of the alternative sites is obviously superior to the Grand Gulf site.

2. Cumulative Impacts

In Section 7 of the FEIS, the NRC Staff evaluated the potential cumulative impacts resulting from the construction, operation, and decommissioning of one or more units in the context of past, present, and future actions at the Grand Gulf site. The Board notes that the Staff concluded that the potential cumulative impacts are generally small and that additional mitigative measures are not warranted. Ecological impacts from construction and

socioeconomic impacts and environmental justice all have the potential for a moderate impact.³³⁴

Information was not available at the ESP stage to resolve other categories of impacts including land use, water use and quality, terrestrial ecosystems, nonradiological health, radiological impacts of operation of non-light-water reactor designs, and decommissioning. These issues would need to be addressed at the COL stage. In its independent review, the Board finds that there is nothing illogical with the Staff's assessment of cumulative impacts and that there is nothing to indicate that the facts in the record do not support the Staff's conclusions.³³⁵

3. Other Issues

The magnitude of the irreversible and irretrievable commitments of resources, and the relationship between short-term uses and long-term productivity of the human environment are unresolved since the Board finds that they can only be meaningfully evaluated when the plant design is selected. These were appropriately deferred by the NRC Staff to the COL stage.

D. Determination of Actions on the ESP to Protect Environmental Values

Based on our discussion here and in Hearing Issue E (supra Part IV.E), the Board finds that the NRC Staff's review pursuant to 10 C.F.R. Part 51 has been adequate. The Board also finds that (1) the requirements of NEPA Sections 102(2)(A), (C), and (E) have been complied with in the proceeding, (2) its independent consideration of the final balance among the conflicting factors contained in the record of this proceeding supports the issuance of the ESP license, and (3) after considering reasonable alternatives, protection of the environment

³³⁴ See FEIS at 7-12.

³³⁵ See id.

does not require denial of or further conditioning of the ESP license. The Board concludes that these factors support the granting of the ESP.

VII. CONCLUSION

The Board has reviewed the record in this proceeding, including the FSER, the FEIS, the answers to the questions propounded by the Board and responded to by the NRC Staff and SERI,³³⁶ the pre-filed direct testimony and documentary evidence submitted by the Staff and SERI with respect to the topics the Board requested additional information, and the well presented oral testimony of Staff and SERI witnesses given during the evidentiary hearing.

In our findings, we have relied upon, without independent verification, the accuracy and veracity of: (1) the content of the NRC Staff's documents, including the FEIS and the FSER, and those of SERI as placed into the record of this proceeding; and (2) the Staff's and SERI's responses to the Board's inquiries and their pre-filed and in-person testimony at the oral portion of this proceeding. We have also, pursuant to Commission direction, relied upon the Staff's NEPA-related examination of the matters related to SERI's Application, including its consideration of alternatives.

In several instances, the Board's findings amplify, modify, or change statements made by the NRC Staff in the FSER or FEIS. These include the following: (1) as a design goal, PC-2 does not fully resolve the issues relating to inadvertent radiological releases in FSER Section 2.4.13, but it is reasonable and preferable to defer the radiological transport characterization required by 10 C.F.R. § 100.20(c)(3) to the COL stage;³³⁷ (2) to be consistent with 10 C.F.R. § 52.17(a) and 100.20(c)(3), the design requirements of PC-2 should be expanded to include all storage facilities and conveyance systems outside of containment that could release

³³⁶ See supra note 23 and accompanying text.

³³⁷ See supra note 142 and accompanying text.

radionuclides to the liquid environment;³³⁸ (3) any power level selected at the COL stage other than the 2,000 MWe target value used in the alternative energy analysis would be new information; and (4) the short-term use of the environment and commitment of resources from construction and operation of the ESP plant or plants must be considered, but it is logical to defer this to the COL stage when the specific plant is defined.

Subject to the foregoing, and to the commitments and assumptions specified in (1) the Permit Conditions, COL Action Items, Site Characteristics, and Bounding Parameters specified in Appendix A of the FSER (NRC Staff Exhibit 44, ADAMS Accession No. ML0635603312), (2) Appendix J of the FEIS (NRC Staff Exhibit 45, ADAMS Accession No. ML063560332), (3) the table of Resolved Safety and Environmental Issues (NRC Staff Exhibit 3, ADAMS Accession No. ML063560116), and (4) the Summary of Issues for Which Cumulative Effects were Analyzed (NRC Staff Exhibit 9, ADAMS Accession No. ML063560097), we have reached the following determinations.

With respect to matters involving safety, i.e. issues pursuant to the AEA,³³⁹ the Board has determined that: (1) the Application and the record of this proceeding, as supplemented by the information provided to the Board during the course of its review, contain sufficient information to support the NRC Staff's conclusions; (2) the review of the Application by the NRC Staff has been adequate,³⁴⁰ (3) the issuance of the ESP will not be inimical to the common defense and security or to the health and safety of the public; and (4) taking into consideration the site criteria contained in 10 C.F.R. Part 100, a reactor, or reactors, having characteristics

³³⁸ See id.

³³⁹ See 69 Fed. Reg. at 2636.

³⁴⁰ See 10 C.F.R. § 2.104(b)(2)(i).

that fall within parameters for the site, can be constructed and operated without undue risk to the health and safety of the public.

With respect to matters involving the environment, i.e. issues arising from NEPA,³⁴¹ the Board has determined that the review conducted by the NRC Staff has been adequate.³⁴² In addition, the Board: (1) finds that the requirements of Sections 102(2)(A), (C), and (E) of NEPA and Subpart A of 10 C.F.R. Part 51 have been complied with in this proceeding; (2) having conducted its own independent balancing of the conflicting environmental and other factors, but excluding examination of the costs and benefits of the proposed facility, finds that the overall balance supports issuance of the ESP; and (3) after considering reasonable alternatives,³⁴³ finds that protection of the environment does not require denial or conditioning of the license except to the extent specified herein. Therefore, the Board concludes that these items support issuance of the requested ESP.

For the foregoing reasons, it is ORDERED that the Director, Office of Nuclear Reactor Regulation is authorized to issue to SERI an Early Site Permit for the Grand Gulf site for a duration of twenty (20) years, consistent with the Atomic Energy Act of 1954, Commission regulations, and this Initial Decision.

³⁴¹ See 69 Fed. Reg. at 2636.

³⁴² See 10 C.F.R. § 2.104(b)(2)(ii); 10 C.F.R. Pt. 51.

³⁴³ As previously discussed, the Board did not consider those alternatives that the Commission has directed be postponed until the COL stage, including design alternatives.

This Initial Decision will constitute the final decision of the Commission forty (40) days from the date of its issuance unless a petition for review is filed or the Commission directs otherwise.

It is so ORDERED.

THE ATOMIC SAFETY
AND LICENSING BOARD³⁴⁴

/RA/

Lawrence G. McDade, Chairman
ADMINISTRATIVE JUDGE

/RA/

Nicholas G. Trikouros
ADMINISTRATIVE JUDGE

/RA/

Dr. Richard E. Wardwell
ADMINISTRATIVE JUDGE

Rockville, Maryland
January 26, 2007

³⁴⁴ Copies of this Initial Decision were sent this date by Internet e-mail transmission to (1) Counsel for the NRC Staff and (2) Counsel for SERI.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of)
)
SYSTEM ENERGY RESOURCES, INC.) Docket No. 52-009-ESP
)
)
(Early Site Permit for Grand Gulf ESP Site))

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing LB INITIAL DECISION (AUTHORIZING THE ISSUANCE OF THE GRAND GULF EARLY SITE PERMIT) (LBP-07-01) have been served upon the following persons by U.S. mail, first class, or through NRC internal distribution.

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Docket No. 52-009-ESP
LB INITIAL DECISION (AUTHORIZING THE ISSUANCE OF
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Office of the Secretary of the Commission

Dated at Rockville, Maryland,
this 26th day of January 2007