November 20, 2006

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

NRC STAFF PRE-FILED TESTIMONY CONCERNING HEARING ISSUE I
RADIOLOGICAL REVIEWS AND CONFIRMATORY ANALYSES

Q.1. Please state your name, occupation, by whom you are employed and your professional qualifications.

A.1. (JL) Jay Y. Lee. I am employed as a Senior Health Physicist in the Division of Risk Assessment, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission ("NRC").

A.1. (SK) Stephen Klementowicz. I am employed as a Senior Health Physicist in the Division of License Renewal, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission ("NRC")

A.1. (EH) Eva Eckert Hickey. I am employed as a Staff Scientist with the Radiological Science and Engineering Group, Pacific Northwest National Laboratory operated by Battelle. I am providing testimony under a technical assistance contract with the staff of the U.S. Nuclear Regulatory Commission ("NRC"). A statement of my professional qualifications is attached.

A.1. (JR) James V. Ramsdell, Jr. I am employed as a Staff Scientist with the Atmospheric Chemistry & Meteorology Technical Group at the U. S. Department of Energy's Pacific Northwest National Laboratory operated by Battelle. I am providing testimony under a technical assistance contract with the staff of the U.S. Nuclear Regulatory Commission ("NRC"). A statement of my professional qualifications is attached.

A.1. (GB) Goutam Bagchi. I am employed as a Senior Advisor in the Division of Engineering, Office of Nuclear Reactor Regulation, NRC. A statement of my professional qualifications is attached.

Q.2. Please describe your professional responsibilities with regard to the review of the application by System Energy Resources, Inc. ("SERI" or "Applicant") for an early site permit ("ESP") for a new nuclear power plant or plants to be located on the existing Grand Gulf Nuclear Station ("GGNS") site near Port Gibson, Mississippi.

A.2. (JL) As part of the NRC Staff's health and safety review of the SERI ESP application, documented in NUREG-1840, "Safety Evaluation Report for an Early Site Permit (ESP) at the Grand Gulf Site" ("SER"), I reviewed the aspects of the Applicant's Site Safety Analysis Report that concerned geography and demography, and the radiological consequences of design basis accidents ("DBAs").

A.2. (SK) As part of the NRC Staff's health and safety review of the SERI ESP application, documented in NUREG-1840, "Safety Evaluation Report for an Early Site Permit (ESP) at the Grand Gulf Site" ("SER"), I reviewed the aspects of the Applicant's Site Safety Analysis Report that concerned the radioactive waste treatment system and the radiological impacts from routine operation to plant workers, members of the public, and to the environment. I was also part of the NRC Staff's environmental review of the SERI ESP application, documented in NUREG-1817, "Environmental Impact Statement for an Early Site Permit (ESP) at the Grand Gulf ESP Site: Final Report," April 2006 ("FEIS"). I reviewed the aspects of the Applicant's Environmental Report that concerned the radioactive waste treatment system and the radiological impacts from routine operation to plant workers, members of the public, and to the environment.

A.2. (EH) As part of the NRC Staff's environmental review of the SERI ESP application, documented in NUREG-1817, "Environmental Impact Statement for an Early Site Permit (ESP) at the Grand Gulf ESP Site: Final Report," April 2006 ("FEIS"), I assisted the NRC staff in its analysis of the aspects of the Applicant's Environmental Report that concerned health effects from radiological and non-radiological impacts, uranium fuel cycle impacts and decommissioning.

A.2. (JR) As part of the NRC staff's environmental review of the SERI ESP application, documented in the Grand Gulf FEIS, I assisted the NRC staff in its analysis of the aspects of the Applicant's Environmental Report that concerned meteorology, air quality, and the impact of postulated accidents.

A.2. (GB) As part of the NRC staff's health and safety review of the SERI ESP application, documented in the Grand Gulf SER, I reviewed the aspects of the Applicant's Site Safety Analysis Report that concerned hydrology.

Q.3. In its November 6, 2006, Order, the Board identified certain issues to be addressed in connection with the mandatory hearing. With regard to the Staff's radiological reviews and confirmatory analyses, the Board requested an overview of the radiological analyses performed by SERI and the NRC Staff's review of these analyses, including details regarding the nature of confirmatory analyses performed (or not performed) by the NRC Staff or its contractors. For normal releases, please provide an overview of the radiological analyses and results, and discuss the Staff review that was performed including the method and results of the confirmatory analyses.

A.3. (EH, SK) With respect to the radiological environment, the Staff reviewed annual radioactive effluent release reports for calendar years 2001, 2002, and 2003, (see ADAMS Accession Nos. ML021200537, ML031120162, and ML041260549, respectively) and found that doses to the maximally exposed individuals around GGNS Unit 1 were a small fraction of the limits specified in Federal environmental radiation standards, 10 C.F.R. Part 20; 10 C.F.R. Part 50, Appendix I; and 40 C.F.R. Part 190. FEIS at 2-19.

The Staff reviewed the documentation for SERI's proposed radiological environmental monitoring program ("REMP"). The Staff found the proposed REMP to be adequate, noting that SERI will provide an annual Radiological Environmental Operating Report for the entire site (including both GGNS Unit 1 and the new nuclear unit(s)) to compare data with those for previous years; that the REMP would utilize the sampling locations used by the GGNS Unit 1; and that SERI will implement a quality assurance program for the REMP. Both surface and groundwater are monitored under the Radiological Environmental Monitoring Program (REMP). The REMP includes 3 samples of surface water (1 upstream, 1 downstream, and 1 downstream during a liquid radwaste discharge) and 2 samples of groundwater taken at two different wells on an annual basis. All five of these samples are submitted for gamma isotopic and tritium analyses. This monitoring is an operational program, and the results are reported annually in the Grand Gulf Nuclear Station Annual Radiological Environmental Monitoring Program Summary. For the purposes of the ESP analysis, the Staff determined that the REMP for the operation of Unit 1 was also adequate for determining the baseline for comparison with the expected impacts to the environment related to construction and operation of any proposed new unit(s). FEIS at 5-61 to 5-62.

With respect to radiological health impacts, after reviewing SERI's estimate of dose to site preparation workers during construction activities (from direct radiation as well as from gaseous and liquid effluents), the Staff found the doses to be well within NRC exposure limits designed to protect the public health. The Applicant's evaluation included an annual dose estimate for the site preparation workers of approximately 0.36 mSv (36 mrem), which is less than the 1 mSv (100 mrem) annual dose limit to an individual member of the public found in

10 C.F.R. § 20.1301. Therefore, assuming the location of the proposed new nuclear unit does not change, the Staff concluded that the impacts of radiological exposures to site preparation workers would be SMALL. FEIS at 4-56.

The Staff evaluated the health impacts from routine gaseous and liquid radiological effluent releases from a new nuclear unit at the Grand Gulf ESP site. After independently evaluating SERI's assessment of likely exposure pathways and its use of the LADTAP II and GASPAR II modeling programs to calculate the dose to a maximally exposed individual and a collective whole body dose for the population within 80 km (50 mi) of the Grand Gulf ESP site, and comparing the calculated doses to regulatory design objectives, the Staff concluded that there would be no observable health impacts to the public from normal operation of a new nuclear unit, and therefore the health impacts would be SMALL. FEIS at 5-51 to 5-58. Furthermore, the Staff concluded that the health impacts from occupational radiation exposure would be SMALL. This conclusion is based on the determination that: the occupational exposures for the new nuclear unit would likely be bounded by occupational exposures from currently operating LWRs and the licensee of a new plant will need to apply the ALARA process to maintain individual doses to workers as low as reasonably achievable below the 0.05 Sv (5 rem) annual limit, as specified in 10 C.F.R. § 20.1201. FEIS at 5-58.

The Staff examined the Applicant's estimated doses to surrogate biota species for both liquid and gaseous effluent pathways. FEIS at 5-59. The Staff's independent evaluation of biota doses produced results similar to those generated by the Applicant. FEIS at 5-60. As stated in Appendix H, the Staff used the LADTAP II code, GASPAR II code, and input parameters supplied by SERI in its ER to calculate doses to the biota. As part of its independent review, the Staff requested SERI's input values for these codes, and reviewed them for reasonableness. It then ran the codes using SERI's input and default values from Regulatory Guide 1.109 (when input values were not provided) to verify the results of SERI's dose assessment. The Staff concluded that there was sufficient protection because the cumulative effects of the GGNS unit 1 and the new nuclear unit(s) would result in dose rates significantly less than those noted in studies by the National Council on Radiation Protection and Measurements ("NCRP") and International Atomic Energy Agency ("IAEA"), both of which found adequate protection for biota. Therefore, the Staff concluded that the radiological impact on biota) other than members of the public from routine operation would be SMALL. FEIS at 5-59 to 5-61.

Q.4. In its November 6, 2006, Order, the Atomic Safety and Licensing Board ("Board") identified certain issues to be addressed in connection with the mandatory hearing. With regard to the Staff's radiological reviews and confirmatory analyses, the Board requested an overview of the radiological analyses performed by SERI and the NRC Staff's review of these analyses, including details regarding the nature of confirmatory analyses performed (or not performed) by the NRC Staff or its contractors. Please discuss the selection of the design basis accidents and explain the difficulties associated with event names that appear in the SSAR, FSER, and FEIS.

A.4. (JL) The Staff used the design basis accidents ("DBAs") that are listed and analyzed in: (1) RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors"; (2) NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Report for Nuclear Power Plants," Section 15.0.1, "Radiological Consequence Analyses Using Alternative Source Terms"; and (3) NUREG-1555, "Standard Review Plan for Environmental Reviews for Nuclear Power Plants." The DBA event names, which appear in the SSAR, FSER, and FEIS, are reconciled and summarized in Exhibit [I.A.3].

Q.5. In its November 6, 2006, Order, the Board identified certain issues to be addressed in connection with the mandatory hearing. With regard to the Staff's radiological reviews and confirmatory analyses, the Board requested an overview of the radiological analyses performed by SERI and the NRC Staff's review of these analyses, including details regarding the nature of confirmatory analyses performed (or not performed) by the NRC Staff or its contractors. For accidental releases, please provide an overview of the radiological analyses and results for the design basis events (including the key input, assumptions, and methodology) and discuss the Staff review that was performed, including the method and results of any confirmatory analyses.

A.5. (JL) The Applicant did not select a particular reactor design, but instead used surrogate reactor designs (ABWR and AP1000) to demonstrate the site suitability of the proposed ESP site. Therefore, as stated in the FSER, Section 15.3.4 (page 15-8), the Staff did not perform independent confirmatory radiological consequence analysis reviews of the Grand Gulf ESP application, because the Applicant based its radiological analyses and design basis events on the AP1000 and ABWR designs.

The Staff did, however, perform an independent confirmatory review at the time of the design certifications of the AP1000 and ABWR. The Applicant did not perform a new radiological consequence analysis, but instead directly extracted the radiological consequence analysis results from design certification documentation previously submitted to and reviewed by the NRC in connection with the design certification applications.

The Applicant used either: (1) the ratio of the site-specific atmospheric dispersion factors (χ/Q values) to the postulated design χ/Q values along with the calculated doses in the certification document to assess the suitability of the proposed ESP site for the AP1000 DBAs and ABWR Loss of Coolant Accident (LOCA) (see Exhibit [I.A.4] for the methodology used by the Applicant - Case 1); or (2) calculated a site-specific dose using the source term releases in the certified ABWR Design Control Document (DCD) for ABWR DBAs other than LOCA (see Exhibit [I.A.4] for the methodology used by the Applicant - Case 2).

The Commission approved the key input, assumptions, and methodology used by the Applicant, and the Staff in its review, for each DBA, including the results of the Staff's confirmatory radiological consequence analyses for the referenced standard reactor design certifications (ABWR and AP1000). This information is documented in NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design,"and NUREG-1793, "Final Safety Evaluation Report Related to the Certification of the AP1000 Standard Design."

A.5. (JR) In the SSAR, ER, FSER, and FEIS, the Applicant and the Staff considered a range of design basis accidents for the ABWR and AP1000 reactor designs and a loss-of-coolant accident for the ACR-700 reactor design. The Staff has evaluated design basis accidents for the ABWR and AP1000 reactors at length as part of the design certification process for those reactors. As a result of this process, appropriate design basis accidents and source terms for each accident have been established. In addition, a design dispersion factor has been established for each design. This dispersion factor is a metric, which characterizes how good the atmospheric dispersion has to be at a site to ensure that doses resulting from design basis accidents will fall below regulatory evaluation criteria. This dispersion factor is a design characteristic, not a site characteristic.

The Staff assumes that information related to the ABWR and AP1000 designs from the design certification process is an appropriate starting point for review of design basis accidents related to the SERI application for the Grand Gulf site. The Staff compared the selection of accidents for these designs with accidents evaluated in the design certification process and with accidents listed in various guidance documents such as standard review plans (e.g. RS-002, NUREG-0800, and NUREG-1555) and in Regulatory Guides (e.g., Regulatory Guides 1.3 and 1.183) and determined that the set of design basis accidents considered in the SSAR and ER is appropriate. The Staff also determined that the design basis accident source terms and evaluation methods used by the Applicant were generally appropriate.

The Staff also evaluated the Applicant's site-specific information (i.e., meteorological data and distances to the exclusion area boundary and outer boundary of the low population zone) to ensure that the information was appropriate for estimating the potential consequences of design basis accidents. This information was found to be acceptable with the exception of the atmospheric dispersion factors used to evaluate the consequences of design basis accidents in the Environmental Report (ER).

Having reviewed the selection of DBAs, the calculational methods, and the input to the DBA calculation, Staff concludes that the Applicant's DBA analysis presented in the SSAR are acceptable for the safety review of the ESP application.

The atmospheric dispersion factors used in the ER are the same as those used in the SSAR. This is inconsistent with NRC guidance and with the intent of NEPA. The atmospheric dispersion factors used in safety analyses are for adverse meteorological conditions, while those used in environmental reviews are for typical meteorological conditions. Adverse meteorological conditions are those conditions that result in doses that are exceeded no more than about 5% of the time; typical meteorological conditions are those conditions that are exceeded 50% of the time. NEPA reviews are focused on realistic estimates of impacts, not worst-case estimates.

The Staff extracted realistic site-specific atmospheric dispersion factors from data provided by the Applicant and used those factors in its DBA review in the FEIS. With this exception, the DBA analyses performed for the FEIS were identical to those performed for the FSER. The results of the Staff's DBA analyses are presented in the FEIS. On the basis of the Staff's results, the Staff concludes that the environmental impacts of postulated DBAs would be of small significance at the Grand Gulf ESP site.

The Staff also reviewed the potential consequences of an ACR-700 loss-of-coolant accident. The ACR-700 design has not been submitted for design certification. However, the Staff notes that given the information provided by the Applicant, the consequences of a postulated loss-of-coolant accident for the ACR-700 reactor design are smaller than those of an AP1000 design.

Q.6. In its November 6, 2006, Order, the Board identified certain issues to be addressed in connection with the mandatory hearing. With regard to the Staff's radiological reviews and confirmatory analyses, the Board requested an overview of the radiological analyses performed by SERI and the NRC Staff's review of these analyses, including details regarding the nature of confirmatory analyses performed (or not performed) by the NRC Staff or its contractors. For the severe accidents discussed in the FEIS, please provide an overview of the MACCS2 analyses, results, and the nature of the NRC Staff's review, including the results of any confirmatory analyses for the air and water ingestion pathways. In addition, for the non-MACCS2 severe accident effects, such as groundwater release, please elaborate further on the basis for the conclusion that the risks for these pathways are acceptably small.

A.6. (JR) The potential impacts of severe accidents are evaluated as part of the environmental review of an ESP application. In its application, SERI evaluated the potential impacts of severe accidents using general correlations between severe accidents and impacts presented in NUREG-1437,"Generic Environmental Impact Statement for License Renewal of Nuclear Plants." The Staff believes that a site-specific evaluation of these potential impacts is more appropriate. Consequently, the Staff requested that SERI provide such evaluations; SERI complied with this request and provided the Staff with input to and output from the MACCS2 computer code for postulated severe accidents for both ABWR and AP1000 reactor designs at the Grand Gulf ESP site. The Staff reviewed SERI's input to the MACCS2 code and then used the input to rerun the code. When the results of the SERI and Staff code runs were compared, there were no differences in the output. In addition to providing the Staff with code input and output, SERI provided its summarized results, which the Staff reviewed. Ultimately, the Staff extracted pertinent results from the computer code output for the evaluation presented in the FEIS rather than using the information in the SERI summary.

The MACCS2 computer code is a second generation code used for assessing the environmental consequences of severe accidents. It was developed by Sandia National Laboratory for both the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy. It uses time-varying site-specific meteorology to evaluate transport, dispersion, and deposition of radionuclides, which might be released to the atmosphere during a severe accident. Other input to the code includes land use patterns and population distributions. Given this input, MACCS2 estimates probability distributions for health and economic impacts of these releases and accounts for short- and long-term mitigative actions.

MACCS2 deals with the atmospheric pathway and, to the extent that surface water is contaminated by the deposition of radionuclides, the surface water pathway. MACCS2 does not deal with the contamination of surface water due to liquid spills or due to the contamination of ground water as a result of core damage followed by basemat melt-through.

The FEIS presents a limited discussion of the groundwater pathway, based on the NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," evaluation of the groundwater pathway for severe accidents at current generation nuclear power plants. This NUREG discusses the probability of a severe accident followed by basemat melt through, which was assumed to be $1x10^{-4}$ Ryr^{-1}. Using this assumption, NUREG-1437 estimates, based on the Liquid Pathway Generic Study (NUREG-0440), that for large river sites (e.g. Grand Gulf) the population risk is approximately 12 person-rem per reactor year, but notes that interdiction can reduce the risk by an order of magnitude.

The basemat melt-through assumed in NUREG-1437 is unrealistically conservative for the ABWR and AP1000 reactor designs. The total core damage frequencies from internal events for the ABWR and AP1000 reactor designs are about 2 x 10^{-7} Ryr^{-1}. It is unrealistic to assume that the probability of basemat melt-through is greater than the core damage frequency. The Staff believes that for advanced light water reactors, a basemat melt-through probability of 1x10^{-6} Ryr^{-1} would be bounding and a probability of 1x10^{-7} Ryr^{-1} would be reasonable because 1) not all core damage events lead to basemat melt-through, and 2) advanced light-water reactors have design features intended to prevent melt-through (e.g., systems to flood the reactor cavity). Thus, the Staff believes that the risks associated with the groundwater pathway are acceptably small.

Q.7. In its November 6, 2006, Order, the Board identified certain issues to be addressed in connection with the mandatory hearing. With regard to the Staff's radiological reviews and confirmatory analyses, the Board requested an overview of the radiological analyses performed by SERI and the NRC Staff's review of these analyses, including details regarding the nature of confirmatory analyses performed (or not performed) by the NRC Staff or its contractors. Please explain why the contribution of external events was not specifically factored into the core damage frequencies used in the presentation of the analysis results.

A.7. (JR) The Staff has considered external initiating events for severe accidents. NUREG-1742, "Perspectives Gained From the Individual Plant Examination of External Events (IPEEE) Program," presents a detailed discussion of external initiating events at current power plants. It shows that core damage frequencies from external events are, in general, not significantly larger than those from internally initiated events, and in many cases are smaller.

In the design certification process, the Staff considered external initiating events for ABWR and AP1000 severe accidents. Specifically, Chapter 19 of the ABWR design control document and Chapter 19 of the AP1000 FSER consider seismic events, internal fires, and internal floods; the ABWR DCD also considers tornadoes. The AP1000 FSER has some numerical core damage frequency values supplied by the vendor. In contrast, the ABWR DCD does not include core damage frequency values; instead, it makes qualitative statements related to CDFs such as "extremely small."

The AP1000 FSER has some numerical core damage frequency values supplied by the vendor. However, the Staff did not adopt these values because it believes that such conclusions are not possible without a detailed PRA. Rather, the FSER makes qualitative statements related to CDFs, as in the case of internal fires where it states: "the AP1000 design is capable of withstanding severe accident challenges from internal fires in a manner superior to most, if not all, operating plant designs." Section 19.1.5.2.1 of the FSER, page 19-83.

Finally, the Staff compared the risks from internally initiated severe accidents with the Commission's safety goals and determined that those risks are significantly below the risks set forth in the goals.

For these reasons, the Staff concluded that an attempt at detailed consideration of external initiating events would not contribute significantly to the purposes of the FEIS or NEPA.

Q.8. In its November 6, 2006, Order, the Board identified certain issues to be addressed in connection with the mandatory hearing. With regard to the Staff's radiological reviews and confirmatory analyses, the Board requested an overview of the radiological analyses performed by SERI and the NRC Staff's review of these analyses, including details regarding the nature of confirmatory analyses performed (or not performed) by the NRC Staff or its contractors. Please address whether or not ESP Permit Condition 2 (FSER, App. A, Table A.1) precludes the need to perform an analysis of the liquid radwaste tank failure event at the COL stage, or to what extent it impacts the assumptions associated with the analysis of such an event.

A.8. (GB) The Staff's proposed Permit Condition 2 requires the preclusion of any and all accidental releases of radionuclides to any potential liquid pathway. Permit Condition 2 does not address the analysis of radwaste tank failure events or the design of the tank itself. No radwaste tank failure analysis is needed at the COL stage for reactor designs that incorporate the same design criteria as the entire seismic Category I structures, systems and components for the selected reactor design, and that incorporate features, such as suitable barriers, to contain any accidental spillage of radioactive liquid effluents due to random component failure. Therefore, Permit Condition 2 does not impact the need to perform an analysis of the tank failure event at the COL stage. The preclusion of accidental spillage of liquid radwaste effluents is achievable by design, it has already been incorporated into some certified designs. There is therefore no need to use a COL Action Item to require a review of a postulated radwaste tank failure.

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In the Matter of	)	
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SYSTEM ENERGY RESOURCES, INC.	)	Docket No. 52-009-ESP
	)	
(Early Site Permit for Grand Gulf ESP Site)	)	ASLBP No. 04-823-03-ESP

CERTIFICATE OF SERVICE

I hereby certify that copies of the NRC STAFF PRE-FILED TESTIMONY CONCERNING HEARING ISSUE [A through I], with associated exhibits, in the above-captioned proceeding have been served on the following by electronic mail and with copies by deposit in the Nuclear Regulatory Commission's internal mail system, or, as indicated by an asterisk (*), through electronic mail with copies by deposit in the U.S. Mail on this 20th day of November, 2006:

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